A SUMMARY AND ANALYSIS OF CULTURAL RESOURCE INFORMATION ON THE CONTINENTAL SHELF FROM THE BAY OF FUNDY TO CAPE HATTERAS

FINAL REPORT

Volume II - Archaeology and Paleontology

This study was funded by the New York Outer Continental Shelf Office of the Bureau of Land Management, Department of the Interior, under contract number AA 551-CT8-18.

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PREFACE

This is the second in a series of four volumes entitled "Summary and Analysis of Cultural Resource Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras" which were prepared for the Bureau of Land Management (BLM) by the Institute for Conservation Archaeology (ICA) of the Peabody Museum at Harvard University. These four volumes, their accompanying chart sets, a computer-compatible tape documenting the accumulated inventories, and a set of large scale (1:125,000) maps showing the inventory and the results of our analysis constitute the final report for the project, performed under contract #AA551-CT8-18 for the BLM. The purpose of this project is to provide the BLM with information about the existence of known or expected prehistoric sites and historically important sunken ships, as well as appropriate methods for locating the same, and planning recommendations for both offshore and onshore land use.

Archaeologists and historians generally agree that given the length of time the Continental Shelf (CS) was above sea level (about 15,000 years) and the intensity of European and other shipping along the northeastern coast of the US in the period after the CS was inundated, there is probably no area on the Shelf that does not have the possibility for containing remains of either prehistoric peoples or sunken shipping. All other things being equal, this would mean that whenever federal funds were involved in land-modifying projects anywhere on the CS, federal antiquities legislation would apply to these activities (see 36 CFR 800 for a summary of the necessary procedures). On the other hand, the cost of looking for and recovering data from any possible properties which might be impacted could in many cases exceed the cost of exploring for the resources that are considered necessary for the economic well-being of the nation. It is at this point that decisions about early planning with respect to possible cultural resources on the CS will assist land users not only to meet their legal responsibilities in terms of historic preservation but to use cost-effectively different levels of survey intensity to locate those sites or wrecks which may be endangered by land use.

It is important to stipulate here that, using the data presently available, nobody in the historic preservation community could, in good conscience, ever entirely eliminate any area from consideration for further work. This study attempts to give guidance to potential land users and those having jurisdiction over the use of lands on or abutting the CS from the Bay of Fundy to Cape Hatteras.

Volume II, "Archaeology and Palaeontology," we feel represents an advance in the state of the art of predictive modeling for the nature and distribution of prehistoric sites. This modeling is a combination of inductive and deductive approaches. We have drawn not only upon the known inventory but also on the theory of optimal foraging strategy, environmental reconstruction, paleoclimatology, and many other sciences. Volume I of this study identified the locations of major Shelf features such as river valleys, deltas, etc. The results of this work allow us to predict the type and frequency of prehistoric sites across the Shelf with considerably more confidence than if only one approach had been used.

This volume is the result of research conducted by a number of individuals. Mitchell T. Mulholland collected site inventory from the southern New England area, prepared programs for the computer inventory and analysis, and oversaw much of the collection of data from other areas. Arthur Spiess collected site data for Maine, as did John Cavallo, John Rempelakis, and Anthony Kurland for the mid-Atlantic states. Dolores Root collected much of the information on paleoresources and devised the basic models developed out of optimal foraging theory. Dane Morrison collected ethnohistoric data for the entire project area.

A number of specialists read and commented upon the interim and final versions of this volume. These include Bruce Bourque, Dena Dincauze, Steven Perlman, Bert Salwen, and Ronald Thomas (archaeologists); Thomas Schoener (population biologist); and Raymond Bradley (climatologist). In addition, Philip Thomas read and commented on all reports for the Bureau of Land Management. Various portions of Section 4 were read and commented on by Randall Moir in terms of geology. Section 4.1 of this volume was researched and written entirely by John E. Rempelakis.

The following institutions opened their site files to us for this project: American Museum of Natural History, New York State Historic Preservation Office, Public Archaeology Laboratory (Department of Anthropology, Brown University), University of New Hampshire (Department of Anthropology), Central Connecticut State College (Department of Anthropology), University of Massachusetts (Department of Anthropology), University of Connecticut (Department of Anthropology), Museum of American Indian (Heye Foundation), Haffenreffer Museum (Brown University), Massachusetts Archaeological Society, Massachusetts Historical Commission, Maine State Museum, Narragansett Archaeological Society (Rhode Island), North Carolina Office of Historic Preservation, Nassau County Museum (New York), University of Vermont (Department of Anthropology), Queens College (New York), Rhode Island Office of Historic Preservation, Suffolk County Archaeological Association (New York), Staten Island Museum (New York), Robert S. Peabody Foundation (Massachusetts), Peabody Museum (Harvard University, Massachusetts), and various other agencies within the project area. In addition, the following individuals contributed site information or assisted in the use of institutional files: Charles Bolian, Bruce Bourque, John Cavallo, Lynn Ceci, Mary Lou Curran, Dena Dincauze, William Fowler, Douglas Jordan, Richard MacNeish, Ross Moffett, Geoffrey Moran, Robert

Paynter, Steven Perlman, David Phelps, Maurice Robbins, Valerie Talmage, Peter Thomas, Ronald Thomas, Peter Thorbahn, Thomas Ulrich, and Fred Warner.

Thanks are expressed to all individuals who assisted in the data collection and interpretation, both those mentioned above and those omitted through oversight or space limitations. Great thanks is also expressed to those researchers who completed preliminary studies for this project and produced many of its ideas and conclusions and to the readers who helped refine those ideas and conclusions. The final responsibility for accuracy of facts, logical consistency, and approach remain the author's.

Acknowledgements for production on this volume goe to a team of dedicated individuals from the ICA and the Peabody Museum, specifically Janet Johnson (Editorial Assistant), Georgess McHargue (Manuscript Editor), Mary Beth Zickefoose (Staff Assistant), Joyce Christos (typist), Lynne Perrotte (artist), and to Anne Wendell (ICA Business Manager). Acknowledgements for the production of the Chart Set which accompanies this volume goes to Whitney Powell (Peabody Museum Artist), and to Nancy Lambert-Brown and Elizabeth Wahle (freelance artists).

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1.0 INTRODUCTION

1.1 Purpose

The overall purpose of this project is to summarize and analyze the available information pertinent to the distribution of cultural resources on the Continental Shelf (CS) of the northeastern United States. Out of this analysis, specific recommendations will be made regarding the likelihood of occurrence of different types of resources and effective means of locating such resources. Because many of those resources will be prehistoric relics of periods when sea levels were lower and the Shelf was dry land, a thorough discussion of prehistoric archaeology is necessary.

This volume provides that discussion of prehistoric archaeology, beginning with discussions of the data base and current formulations of culture history, It goes on to discuss the inventory of known archaeological sites which has been compiled in the course of this study, to discuss known and predicted site distributions on the present land and on the CS, and to generate predictions of where sites will be found on the Shelf and what types of sites can be expected.

In addition, the relevant palaeontology of the CS is summarized and discussed. The fossil record provides our only source of data regarding the flora and fauna which both comprised the biological environment for any prehistoric human occupants, and provided resources for human sustenance. In addition, species distributions can yield information about other aspects of environments, such as climate.

This report is written primarily for the educated reader who is not a specialist in palaeontology or archaeology. On the other hand, a wealth of documentation must be provided so that the specialist has sufficient data to evaluate the conclusions derived. To ease any difficulties the non-specialist might encounter in reading the technical discussions, a glossary is included at the end of the volume.

1.2 Project Limits

The project area has been defined by the Bureau of Land Management as the Continental Shelf from the Bay of Fundy to Cape Hatteras (Fig. II-1). This area includes portions of the CS offshore from the following states: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina.

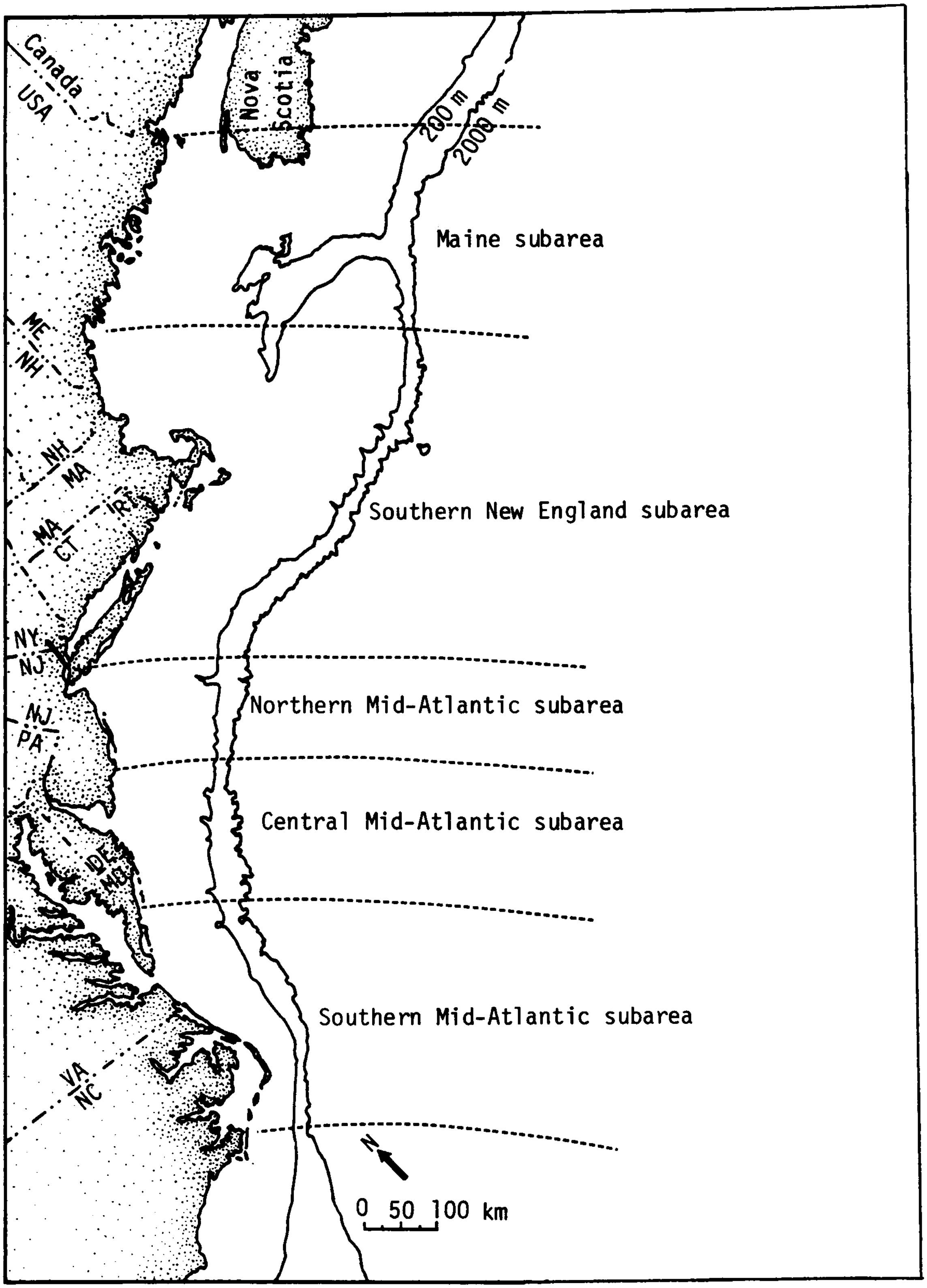


Fig. II-1: Divisions of the project area.

The primary interest of the project is the offshore CS and coastal zones, but it has been necessary to draw upon data from sites on what is now land. The dearth of information from the CS itself makes it imperative that settlement patterns from better-known terrestrial areas be examined for possible extension to the inundated shelf.

The temporal span studied by this project begins with the earliest human occupation of the area. The data used for the early limit is 15,000 B.P. (Before Present). While there is not complete agreement, archaeological opinion generally favors the interpretation that human beings appeared in North America by 20,000 B.P. (Gruhn 1977).

The earliest dated archaeological sites east of the Mississippi River, however, are about 5,000 years more recent and the earliest dated sites on the Atlantic Slope are between 2,500 and 4,000 years later than that. Accordingly, the 15,000 B.P. date is considered to approximate the early limit of human occupation in the study area.

In the past, however, there have been suggestions that archaeological sites in the study area have greater antiquity than 15,000 years.

In the latter portion of the nineteenth century, there was a spate of research arguing that the gravels around Trenton, New Jersey (Abbot 1870, 1872, 1873; Cresson 1892; Putnam 1898) and elsewhere (Gilbert 1887) contained artifacts indicating human occupation before the glacial period. These arguments fell before more sophisticated rebuttals (Hay 1919; Holmes 1892, 1893; Hrdlicka 1902; Mercer 1893, 1898; Spier 1916). Recently, there have been suggestions that pre-glacial artifacts have been found at the Timlin site in New York (Raemsch 1968; Timlin and Raemsch 1971) and in occurences of the "Lively Complex" in Virginia (Josselyn 1965, 1967). These suggestions, however, are based on evidence generally believed to be misinterpreted. In particular, imprecise stratigraphic control and the naive equation of implement crudeness with antiquity have biased the conclusions of these workers (Cole and others 1978).

The earliest dated archaeological site in eastern North America is the Meadowcroft Rockshelter in western Pennsylvania (Adovasio and others 1975, 1977, 1978). A series of six radiocarbon dates from Stratum IIa, the lowest cultural level, range from 12,800 $\pm$ 870 to 16,205 $\pm$ 975 B.P. Dates obtained from the lowest microstratum of Stratum IIa are 19,100 $\pm$ 810 and 19,600 $\pm$ 2400 B.P. The excavators accept the 16,205 B.P. and later dates and consider the earlier dates suggestive of an earlier occupation, but not compelling (1978).

There has been considerable concern among archaeologists about whether these early dates from the Meadowcroft Rockshelter are valid or the result of samples contaminated by older lignin, vitrinite, or coal. Adovasio and others (1978) have published a detailed assessment of the likelihood of such contamination and that likelihood seems slim.

On the eastern side of the Appalachian Mountains, nearer the study area, the earliest dates for sites are considerably later. The earliest date comes from a single radiocarbon determination at the Dutchess Quarry Cave in the lower Hudson Valley: 12,580 ± 370 B.P. (Funk, Walters, Ehlers, Guilday, and Connally 1969). There is some question, however, about the validity of this date, since it occurs with a Cumberland-like point, believed on stylistic grounds to date to a period considerably later. Fifteen secure radiocarbon dates from the Debert site in Nova Scotia (MacDonald 1968) and the Shawnee-Minisink site in eastern Pennsylvania (Kauffman and Dent 1978) range from 11,026 ± 225 to 9310 ± 1000 B.P., excepting a single anomalous date of nearly 20,000 B.P. at the latter site.

In summary, human occupation of western North America is probable by 20,000 B.P., but the earliest secure dates from eastern North America are around 16,000 B.P. east of the Appalachians, the earliest occupations date around 11,000 to 12,500 B.P. The failure to locate sites with earlier dates may indicate that human populations did not cross the Appalachian Range before that date or it may reflect the scarcity of radiocarbon-dated early sites. Inferred migration routes for the initial human populating of the Atlantic coastal province (Borns 1972-1973) suggest that population of the prehistoric coast earlier than the contemporary area inland (today's coast) is unlikely.

The late limit of this study, as discussed in this volume, is the mid-1600's A.D. It is generally accepted that relative sea-level rise is an ongoing process in the project area and that sites are being constantly — though usually very gradually — inundated (see Volume I). The Spruce Swamp site (Powell 1965) is just one example of such a late coastal site over which the sea is transgressing. Further, since relative sea level has risen throughout the last 15,000 years, inundation has obscured the archaeological record to a greater extent in earlier periods than in later periods. In order to discuss settlement patterns in early periods, it is helpful to examine the more complete record for later periods.

In this chapter, only aboriginal prehistory has been discussed. There is also a tradition of scholarship and pseudo-scholarship whose aim is the investigation of Old-World-to-New-World contacts before Columbus. At its best, such investigation has demonstrated the existence of and analyzed a Norse settlement at L'Anse aux Meadows, Newfoundland (Ingstad 1969); at its worst, it has perpetrated fantasies no more academically justifiable than the "Mound Builder" myths of the nineteenth century.

The Norse presence in North America has been demonstrated, but scholarly debate continues over whether or not L'Anse aux Meadows equates with the southernmost of Norse settlements. Upon the outcome of this debate hinges the likelihood whether one or more Norse settlements might lie in the study area. The finding of a Norse coin, dated between 1060 and 1085 A.D. by Dr. Kølbjørn Skaare, at the Goddard site, a prehistoric aboriginal site in Maine (Bruce Bourque, personal communication). This coin may indicate Norse presence or may be the result of trade with more northern regions. The question of Norse settlement is discussed in more detail in Volume III and will not be treated further here.

Stone chambers in northeastern North Atlantic are claimed to have been associated with Celts, Phoenicians, and various other Old World cultures of antiquity. It is notable, however, that despite a great deal of searching, not a single authentic artifact relating to any of these cultures has been found. There is strong documentary and archaeological evidence that these stone chambers are agrarian storage facilities of the seventeenth through nineteenth centuries (Neudorfer 1977).

Carvings claimed to be ancient script have been found to be glacial striae; supposed European bronze daggers have been found to be made of native copper and to be of aboriginal style; "rune stones" have been found to be in epigraphic styles developed only in the nineteenth century. In short, there is no conclusive evidence of pre-Columbian contacts between the Old World and the study area.

In summary, the project limits used in the discussion of prehistoric resources are:

1) area: Bay of Fundy to Cape Hatteras;

2) zones: Continental Shelf, coastal zone, nearby low elevation terrestrial areas;

3) time: 15,000 B.P. to 1650 A.D.; and

4) cultural tradition: aboriginal only.

2.0 METHODS AND MATERIALS

2.1 Models

Aside from partially drowned sites from the intertidal zone, there are no known prehistoric archaeological sites on the Continental Shelf in the study area. This absence does not imply that the area never was occupied by human beings, only that very little archaeological research has been directed there. In the absence of an inventory of known sites on the Shelf itself, an indirect approach to predicting the likelihood of prehistoric occupation must be taken.

The real world is immensely complicated. For example, decisions about where to locate a settlement may be based on scores of considerations, some solidly rational, some irrational or founded on false premises. The integration of these considerations is accomplished in complex ways of which even the decision makers are not fully aware. To try to understand all of the relevant factors in a modern situation is impossible; to try with the less complete data of archaeology is absurd. What one can do, however, is construct a model, a simplified picture of reality derived from those factors which the modeler argues to be important to the situation being modeled.

Building a model is like speaking prose: everyone does it whether consciously or not. But, like prose, the more conscious one is of the rules governing its construction and application, the more successful it will be. Four basic rules of model use are given here.

First, a model must be formulated for a specific purpose. A model of Paleo-Indian settlement patterns, for example, would tell little about Paleo-Indian religious concepts and while an all-encompassing model of Paleo-Indian culture could be constructed, it would probably be too complicated to be easily comprehensible.

Second, the components of the model (the factors used), their interrelationships, and their overall relevance to the situation being modeled must be justified. It is not acceptable to select random elements and weave them into a model without reasons for the selection and interrelation. A model which fits one situation well cannot be applied offhandedly to another without justifying the application.

Third, following Haggett and Chorley (1967), Skilling (1964) and Suppes (1962), a model may be inductive or deductive. An inductive model is merely a generalization that certain factors empirically occur in a certain pattern. For example, if sites of a certain class usually appear on glacial kames, that factor should be part of a settlement pattern model. There is no implication that the prehistoric group actively sought out (or even recognized) kames, but only that they placed their sites on them. The true inducement may have been a certain plant which might prefer the soils found on kames. A deductive model, on the other hand, assumes that the factors and nexus involved reflect the process of causation. A deductive model, for example, might argue that agricultural societies require soils of a certain fertility for their crops and that settlement might be restricted to those soils. In short, an inductive model argues from the data, making generalizations which are known empirically; it need not treat causation or explanation. On the other hand, a deductive model argues from known or assumed generalizations, applying or extending them to a more restricted category of phenomena.

Fourth, every model is an approximation of reality. Levins (1966) has argued that the complexity of real world phenomena necessitates that models simplify their picture reducing the number of factors and interrelationships considered. In the course of this simplification, models must sacrifice one or more of three qualities: realism, precision, or generality. Realism, the faithfulness with which truly causal factors are integrated into the model, may be sacrificed by omitting factors with small or rare affect. Precision, the detail predicted by a model, may be sacrificed by shifting from quantitative to qualitative predictions or by shifting scale. Finally, generality, applicability to a broad range of phenomena, can be sacrificed by restricting the range of phenomena studied.

When an empiric case does not fit a model, the model need not be considered faulty. Instead, such cases (termed "residuals") may point to other factors which can be used to refine the model further.

The main point of this discussion has been that models are not just academic artifices, excuses for esoteric conjectures. When used with thought and discretion, they constitute the basic form of generalization.

Both inductive and deductive models have limitations, discussed in more detail below. Accordingly, both were used in this project in an effort to achieve reliability greater than either alone could offer. The approaches are complementary, not contradictory.

2.2 Inductive Models

2.2.1 Methods

2.2.1.1 Approach - It is assumed that all time periods from which archaeological sites may be expected on the CS are represented by sites on present-day dry land. The gist of the inductive modeling process was to derive a model of the variables which define the settlement pattern on present land and to extend that pattern, when justified by environmental similarity, to the CS.

Environment, in the loose sense, consists of all physical, biological, and social conditions surrounding and affecting a social group. Different locations have differing environments and those environments are what caused a settlement to be located in one place rather than another. A swamp (physical environment) might be a poor place to live because of dampness, but a rise overlooking a swamp might be excellent because of proximity to edible roots and waterfowl (biological environment). Proximity to other human communities (social environment) might be desirable for trade, mate exchange, or other reasons.

The biological environment is conditioned largely by the physical environment and, because the physical environment can be reconstructed moderately successfully, these factors can be included in a settlement model. Even in dry land situations, the social environment, however, is very difficult to reconstruct. While the location of one community on the CS indubitably affected the settlement choices of other communities, the absence of data on the location of any such communities necessitates that this factor not be considered.

The other primary limitations of such a settlement model lie in the bias in the known archaeological record and in the incomparability between certain paleoenvironments in areas now under water and others on dry land. Bias is discussed more thoroughly in the section on sources, but briefly it stems primarily from the fact that different amounts of effort have been expended by researchers in locating sites in different geographical areas and zones.

Incomparability of paleoenvironments is a more complex issue. The factors affecting the composition of a paleoenvironment include landform, elevation, soil, climate, flora, fauna, and many others. In the wake of the climate changes of the last 15,000 years, relative sea level has risen drastically and early coastal zones are drowned. Because of a series of factors including climate, rate of relative sea level rise, and proximity to refugia for various species, modern coasts offer a very different suite of biological resources than did the earlier, submerged coasts. (See Section 4 for further discussion.)

On the other hand, there are considerable areas of the CS whose paleoenvironments had analogues in the contemporary paleoenvironments of areas that are now dry land. These have been discussed briefly in Volume I and will be discussed further in later sections of this volume.

2.2.1.2 Subareas - The concept of culture area was defined explicitly by Alfred Kroeber (1939) and since then has become a basic organizing principle in all modern syntheses of North American prehistory. Culture varies over space, and generalization becomes difficult if space is not divided into units with moderately similar cultural expressions. Because culture usually changes gradually from region to region, these units have been defined many different ways by different researchers and have a large component of arbitrariness in them. They do, however, facilitate research by dividing a large tract into more heterogeneous, more generalizable units.

The project was divided into three subareas: the subarea between the Bay of Fundy and the Saco River, Maine; the subarea between the Saco River and the New York/New Jersey border, and; the subarea between that border and Cape Hatteras (Fig. II-1). For convenience, although the correspondence is not exact, these subareas have been called Maine, southern New England, and the Mid-Atlantic states respectively.

The partition between Maine and southern New England is based on markedly different prehistoric archaeological remains and cultures (especially during the Late Archaic Period, the best-known period of Maine prehistory) and on the historic distribution of aboriginal agriculture, which is unreported north of the Saco River.

The division between southern New England and the Mid-Atlantic states is considerably more arbitrary, since cultural diffeerences between the two subareas accumulate gradually over space. While New York and New Jersey are quite similar, Massachusetts and North Carolina are very dissimilar.

The data from these subareas were gathered by different researchers, each familiar with the archaeology and sources of his or her subarea.

2.2.1.3 Data collection - All major sources of site locations were consulted in the compilation of the site inventory. These sources included literature, state and private archives, amateur archaeologists and artifact collectors, and other available sources. These sources will be detailed in Appendix II-1. It is believed that the final site inventory for this project, including 6600 sites, contains information on the majority of sites known in the project area. It should be noted, however, that many sites remain undiscovered or were destroyed by Euro-American development or natural processes without ever having been recorded.

Fig. II-2 shows the limits of the areas for which site data were collected systematically. These selected areas comprise the data base most likely to be extensible to the CS, in terms of both proximity and gross paleoenvironmental similarity in the past. There are no portions of the Continental Shelf, for instance, with environmental conditions similar to those of the contemporary Adirondack Mountains or western New York, so these regions were excluded.

Fig. II-3 reproduces the site data form used in data collection. Most of the categories are locationally, temporally, or generally descriptive. The nine data categories to be used for model construction were: surface relief, landform type, soil types/characteristics, soils drainage characteristics, slope, aspect (direction a slope faces), elevation, type of nearby surface water, and distance to nearest surface water.

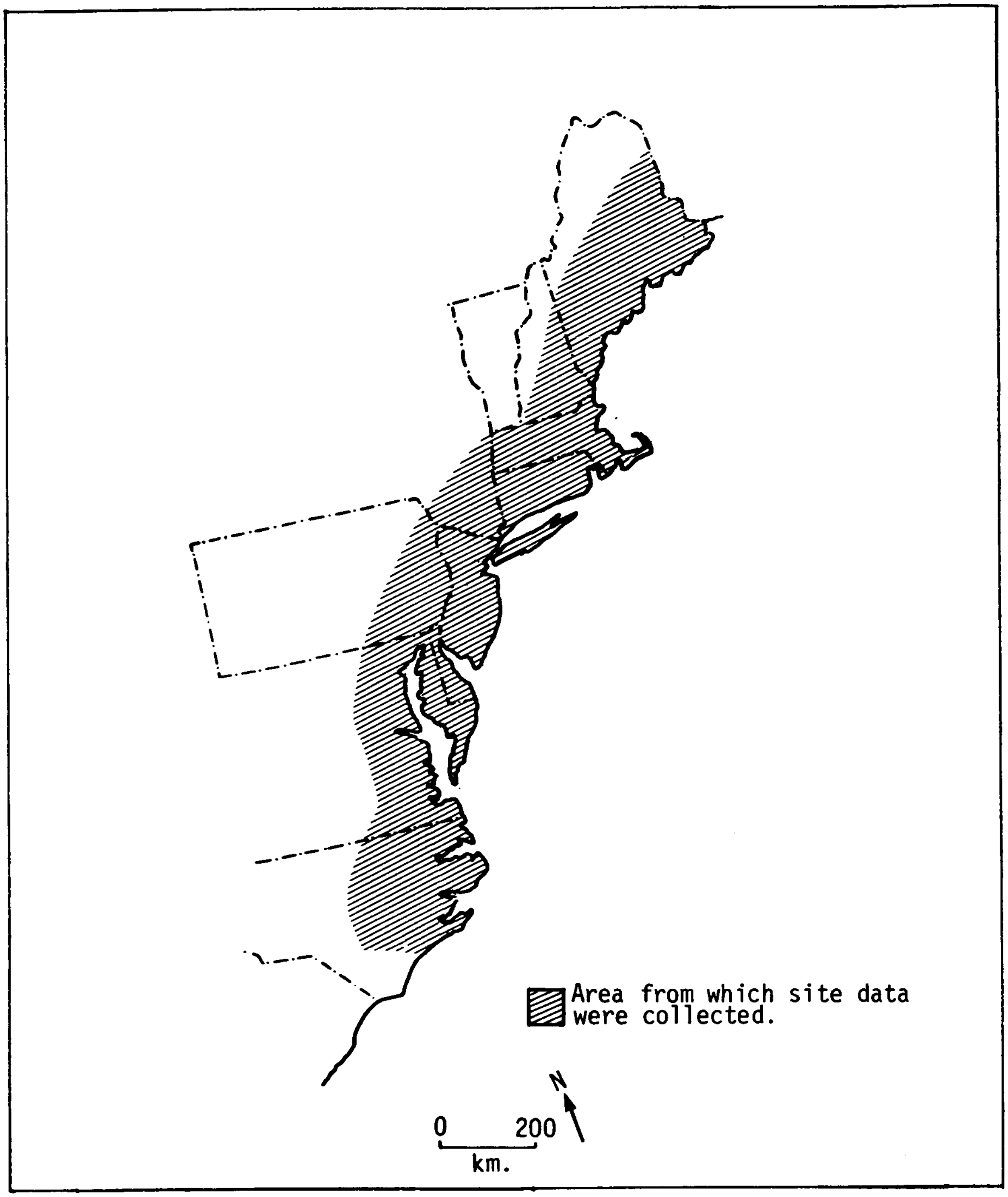


Fig. II-2: Approximate limits of area from where site data were collected.

SITE DATA FORM

SITE NAME ______________________ TOWN ________________

PERIODS OF OCCUPATION ____________ COUNTY ________________

______________________________ STATE ________________

SITE CONDITIONS AT TIME OF EXCAVATION ________________

STRATIFICATION ______________________________

EVIDENCE OF REPEATED REUSE ______________________

RC DATES ________________________ LAB ________________

U.S.G.S. QUAD ______________________________

LOCATION: UTM ZONE ________ E ______ N ____ LAT ___ LONG ____

SURFACE RELIEF AND RELATIVE LOCATIONAL DATA:

LANDFORM TYPE ______________________________

SOIL'S TYPE/CHARACTERISTICS ______________________

SOIL'S DRAINAGE CHARACTERISTICS ______________________

SLOPE % ________ ASPECT __________ ELEVATION ____________

NAME OF SURFACE WATER ______________________________

TYPE: [ ] SPRING [ ] BROOK [ ] RIVER [ ] OTHER ________

DISTANCE TO SURFACE WATER ______________________

NATURE OF ARTIFACTS AND FEATURES. KEY ITEMS OF MATERIAL CULTURE:

SITE AREA: ______________________________

NON-LOCAL RAW MATERIALS AND SOURCES ____________________

ORGANIC MATERIALS EXCAVATED ______________________

____

INVESTIGATOR(S) ________ LOC. OF SITE RECORDS ____________

BIBLIOGRAPHIC REFERENCES: REMARKS:

Fig. II-3. Site data form.

Each of these site characteristics has been found to have value in predicting site locations in the Northeast (Dincauze, Moore, and Root 1977; Casjens 1978) or Mid-Atlantic states (C.H. Lee 1976; Ray 1976; Schneider and Frantz 1977). There are no clearcut reasons for the association of most of these characteristics with human settlement. An association with a particular soil type, for example, might reflect interest in a well-drained campsite, high densities of plants which prefer that soil, high densities of animals feeding on those plants, any combination of these interests, or none of them. Any resulting model, then, will be "unidentified" (Harvey 1969); that is, there will be no consistent casual nexus between site characteristics and settlement and will remain only an empiric generalization.

In practice, several of the settlement characteristics listed proved to be recorded only rarely. In particular, surface relief, soil type/characteristics, and soil drainage characteristics seldom were included in site records. Both the lack of precision with which many sites were located and the prohibitive amounts of time that would have been required for obtaining these data elsewhere precluded their inclusion unless they appeared in the original record. The other settlement variables consistently were included.

A general caveat regarding these variables is that they refer to modern conditions. Over the course of several millenia, the environments at some of these sites have changed significantly. Relative sea level rise, increased salinity intrusion, pond-to-bog succession, and a host of other natural processes have in some cases changed the environment of a site since its period of occupation. In most cases, only detailed field and laboratory analyses can verify whether such changes have taken place.

Two other data entries were found to serve little purpose: site area and non-local raw material. Site area, if discussed at all, usually referred to the area excavated, not the total area of the site. In few cases was field testing directed in such a way as to permit reasonable estimation of area. In at least one state (Barber 1978), the area occupied by the site symbol on a map relates more to the number of artifacts found than to the distribution of those artifacts. Non-local raw material frequently was discussed in Paleo-Indian site reports, but in reports concerning later periods, however, such information was rarely available.

2.2.2 Materials

2.2.2.1 Sources - Sources consulted during the compilation of the site inventory included all major archives, the vast majority of the relevant literature, and as many informant interviews as practical and productive. Appendix II-1 lists the sources consulted.

The most complete source of information on the characteristics of individual sites are reports published by academic archaeologists. These generally supply a considerable amount of information as well as explicit locational data. Unfortunately, this type of source treats only a small fraction of the known sites. Some archaeologists also have published surveys of sites of specific periods for their areas of expertise. These are extremely useful, but are few and primarily restricted to the earlier periods of aboriginal occupation.

Major published surveys of archaeological sites of all periods also are useful sources of locational and environmental data. These surveys include those of Bullen (1941, 1949), Dorothy Cross (1941), Dincauze (1973b, 1974), Funk (1976), Haag (1958), Moorehead (1922, 1931), Rainey (1932), Ritchie (1944, 1957, 1965), Salwen (1960), Carlyle Smith (1950), and Willoughby (1935).

Regional and state archaeological society journals comprise an extensive source of information. These societies include members whose capabilities and sophistication range from that of professional archaeologists to that of curiosity collectors; not surprisingly, articles in these journals, especially in their early years, vary widely in quality. While much valuable information has been gleaned from these sources, many vaguely located and described sites had to be omitted. Illustrations are rare in most of these journals before the 1950's and, in most portions of the project area, widely used artifact taxonomies were not developed until the 1950's or 1960's. Consequently, an early site report may describe a site well, but not provide sufficient information to place it temporally. In general, however, detailed environmental data are lacking.

Site inventories in State Historic Preservation Offices and other state agencies can provide valuable and extensive data, but here, as elsewhere, there is much variation. Some state inventories have been enriched by generous contributions of the site records of amateur societies; others have not. Some have inaugurated programs to expand their site inventory; others have not even organized the data they already possess. Finally, some have placed primary emphasis on historic properties, while others have sought to attain a better balance between history and prehistory. Beyond the quantity of sites represented, the quality of information in a site record varies from mere location to detailed discussions of site contents and significance.

Private inventories at museums, universities, libraries, and other institutions, suffer from the same range of variation in completeness and organization as do state inventories.

Informant interviews accounted for a small but significant portion of the site inventory compiled. Many informants were amateur archaeologists or artifact collectors who have kept meticulous records of the materials in their collection. On the other hand, many collectors have been less scrupulous about the keeping of written records and their site locations, filed in memory only, were not sufficiently reliable to be included in the inventory.

2.2.2.2 Biases - To an archaeologist active in the project area, it will be no shock to hear that the inventory of known sites is probably biased. A number of factors conspire to produce a pattern of known sites which almost certainly is a distortion of the true pattern of site distribution.

For various reasons, areas have received differential archaeological attention. A classic case is the survey of Massachusetts conducted by the Massachusetts Archaeological Society. After two years, the survey had compiled records of 1,013 site locations. The spatial distribution of these sites corresponded directly and strongly with that of active society members (Bullen 1941). On the other hand, the absence of an amateur archaeological society in Rhode Island has resulted in an anomalously low site density in that state, almost certainly due to bias.

Centers of professional archaeological research can produce similar biased distributions. Virtually every university with a local archaeology program produces a ring of high known-site density around it. Large surveys or long term projects similarly can produce abnormally high apparent site densities. In 1970, the Pine Barrens of New Jersey had received little archaeological attention and had a low recorded site density, but recent work (Cresson and Bonfiglio 1978) has documented numerous sites.

Topics that have attracted archaeological interest, professional or amateur, are disproportionately reflected in the record of known sites. The Paleo-Indian Period, the earliest known period of aboriginal occupancy, is spectacular and has received more than its share of coverage in the literature. The description of a single diagnostic Paleo-Indian artifact--perhaps only a stray surface find--may occupy two pages of a journal. The find spot is usually recorded as a site, although it may be unknown whether other cultural materials actually are found there. Similar treatment is accorded no other period of prehistory.

From later periods, however, more conspicuous, plentiful, or visually appealing materials have a greater likelihood of being recorded. Moorehead (1931), writing of his Merrimack Valley survey, noted: "There are a number of shellheaps, rather small, scattered throughout the entire (lower estuarine) region. These were examined, but yielded little..." These sites apparently never were recorded. Relatively low artifact yields have prejudiced many other workers against shell midden research, just as the spectacular nature of burial sites has stimulated their study.

Another possible source of bias comes from duplication of site records in different places. Especially if site names or numbers are not the same, a single site could be counted as two or more. This bias is believed to be trivial, however, since locational information specific enough to be usable in this project usually would be recognizable as a duplication and culled.

Selective destruction of sites in certain areas, especially through urban development, has caused further bias in the site inventory. Locations favorable for Euro-American settlement often were or had been favorable for aboriginal settlement as well. In the project area, Euro-American settlement came early and few site records were made during the first two and one-half centuries of terrain alteration. Certain forms of destruction of unrecorded sites— looting, erosion, public and private development—continue today.

A lengthy discussion of biases in the data base is not intended to persuade the reader that the data are too flawed to be useful. Rather, it is intended to point out merely that patterns seen on maps plotting the distributions of known sites reflect a mixture of reality and a series of sampling biases. The basic correctness of individual site records is in no way impugned by this discussion, only the representativeness of the known archaeological record.

The only assessment of the reliability of the site records used in this study treats only northeastern Massachusetts (Barber 1978). There, 17.7% of the site records were found to mislocate sites or to refer to locations which apparently were not sites. The records used in that study stretched back to the mid-nineteenth century and had never been revised systematically. That figure, therefore, probably represents the greatest percentage of unreliable records a source is likely to display.

2.2.2.3 Assessment - A wide variety of data sources of varying degrees of completeness have been searched in the compilation of the site inventory. The coverage of available sources, while not total, appears to be quite thorough. A series of biases plague the data base, resulting in apparent site densities which probably do not reflect the true densities. The degree of this biasing cannot be assessed, since the true (population) densities are unknown and cannot be compared to the apparent (sample) densities. The reliability and accuracy of the site data are largely untested, but a single study suggests that their reliability is greater than 80% (Barber 1978).

2.3 Deductive Model

2.3.1 Methods

2.3.1.1 Approach - The deductive model used in this study is an optimal foraging model, derived from ecological theory. Optimal foraging models make predictions (or retrodictions) about the nature of foraging behavior, focusing on the adaptive strategies used by various animals to exploit an environment. In particular, they can predict the intensity with which an area of zone was utilized, the seasonal variations in use of an area or zone, the size of the group exploiting it and, under the best of conditions, the most likely location of settlements.

Three basic assumptions underlie optimal foraging models. First, goals are achieved by the strategy that consumes the least time. By and large, animals or people will feed themselves on foods which provide an adequate yield for the least amount of time spent in locating, capturing, and processing them (Debenedictus and others 1978; Pyke and others 1977; Schoener 1971).

Second, the goal of foraging is to obtain an adequate food supply. In other words, the goal is to satisfy a need, rather than to maximize yields. The latter can be important if food is preserved on a large scale, since food beyond one's immediate needs must be preserved or wasted. Preservation is not considered in this model.

Third, settlement patterns of hunting-gathering societies are based primarily on proximity to food resources. The availability and distribution of food resources condition subsistence, which in turn conditions settlement. Of the three assumptions, this last suffers most from approximation and simplification. Elements of the physical environment, such as lithic sources (Fanale 1974), and especially elements of the social environment affect the location of settlements. In particular, proximity to other settlements for trade (Olsson 1965), information exchange (Moore 1977; Moore and Root in press), and mate exchange (Wobst 1976) affect site location. Data necessary to incorporate these elements into a model, unfortunately, are unavailable.

By quantifying the time output required in exploiting various resources versus the energy input obtained by consuming them, caloric return rates can be calculated. These return rates, coupled with knowledge of the distribution of resources over space, then can be used to derive optimal subsistence patterns and the settlement patterns best suited for the following of those subsistence patterns. The resulting model is unabashedly a first approximation and is untested at present.

Previous applications of optimal foraging models in social anthropology and archaeology (Jochim 1976; Perlman 1976; Moore and Root in press; Bruce Smith 1974; Winterhalder 1977) have met with considerable success. Applications in animal ecology are far more numerous (MacArthur 1972; Schoener 1971; and many others) and comprise the output of a major school of research.

To some critics, the borrowing of theory formerly applied to animals seems inappropriate for human studies. In truth, of course, the source of an idea has no effect upon its applicability; in any case, the biological ecologists borrowed or reinvented the basis concepts from economics, a specifically human discipline. The economist or economic geographer would immediately recognize the assumptions discussed above as nearly identical to the principle of least effort, the satisfier principle, and the concept of Weberian industrial location (Dillon and Heady 1960; Hamilton 1967; Zipf 1949). These concepts trace their development in economics back to the nineteenth century.

2.3.1.2 Scale - In principle, optimal diet models can make predictions with unlimited specificity and detail; in practice, predictions can be no more specific than the data available. For the Continental Shelf, the quality of paleo-environmental data is such that only large scale (in space and time) patterns of environmental differentiation can be determined. Consequently, fine grained predictions will be impossible. The model, however, will be able to predict broad, qualitative differences between periods, zone and areas in terms of settlement and subsistence patterns.

2.3.1.3 Application - In application of the optimal foraging model to the CS, biological environment was reconstructed using a combination of the scant fossil evidence known from the Shelf and information about paleoclimates. Climate is a major determinant of both flora and, either directly or through its effect on plants, fauna. Paleoclimatic reconstructions come largely from the interpretation of pollen analysis and analogy to extant climates.

To facilitate the discussion of paleoclimate and environmental zones, the study area was divided into the subareas used for site distribution analysis, although the Mid-Atlantic states were further divided into northern (central and northern New Jersey), central (the Chesapeake and Delaware Bay regions), and southern (central Virginia to Cape Hatteras) portions (Fig. II-1). Reconstructions were made at 1,000-year intervals.

Not all food resources known or expected to have been available to residents of the CS could be considered, because the list is extensive. Ten items, selected because they were either large or abundant and had high caloric return rates, were chosen to represent the resources most likely to have been important in shaping settlement patterns. These are: mammoth, mastodon, caribou, moose, white-tailed deer, seal, walrus, fish (migratory and non-migratory), marine and estuarine mollusks, and nuts.

The decision to weigh animal rather than plant foods more heavily was based on several considerations. First, few wild plant taxa have high caloric return rates. Second, recent research by Ember (1978), discussed in Section 3 of this report, strongly suggests that the gathering of wild plants typically has far less imput to hunter-gatherer diets than previously has been believed. Finally, modeling density and distribution for plant species (other than trees) which might have provided human sustenance is considerably more difficult than comparable modeling for faunal species.

The construction of the model and the derivation of predictions are treated thoroughly in Section 6 and will not be treated further here. A discussion of sources and data gaps also appears in Section 6.

2.4 Combining the Models

The two models produced by this study are both academically justifiable approaches to the prediction of site distribution on the CS. There are, however, important differences which govern their applicability.

As a deductive model, the optimal foraging model has a built-in explanation for whatever predictive power it may have. Deviations from those predictions can be considered in a refined version of the model, incorporating other factors to explain residual variation. In sum, the model has tremendous explanatory potential. It is, however, untested for goodness of fit with an empiric data set.

The inductive model, based on known site distributions, is "tested" in the sense that its generalizations are known to fit with a data set; the problem lies in whether the data set of sites on modern dry land is patterned the same way as the data set of sites on the CS. Given the assumption that physical and biological environments have important effects on the distribution of settlements over a landscape, areas with similar environments should have similar settlement distributions. If one could determine that all paleoenvironments on the inundated Shelf had such contemporary analogues in areas which now are dry land, the inductive model could be extended to the CS justifiably and totally.

It is not clear, however, that such analogous environments existed in all cases. As shown in Section 4 of this volume, early coastal environments appear to have been quite dissimilar from more recent ones and, in virtually all of the study area, early coasts are completely inundated. In other cases, the environments on the CS and on presently dry land appear to have been more similar.

A difficulty arises in trying to assess the degree of similarity of environments. The appropriate criteria for determining whether environments are analogous are based on the factors which affect human settlement, but, as discussed earlier, these factors are not clearly defined for the inductive model. Accordingly, two heuristic criteria of of similarity have been applied.

First, environments are considered analogues if they appear to have had comparable resource mixes because one is merely a geographical extension of the other. For example, upland interior areas at a given date may have formed a broad zone of similar resources, part of which subsequently was inundated and part of which was not. These two areas would be considered analogous.

Second, when two areas share a determinate resource -- a resource whose highly restricted distribution "draws" settlement to it -- they are said to be analogous. For example, two areas each containing shellfish beds would be considered analogous, since settlement in each likely would be drawn by the shellfish resources. (Section 6 of this volume provides a more detailed discussion of determinate resources.)

Using these criteria, Shelf environments with contemporary analogues on presently dry land can be identified and the inductive model can be extended to them. The results of the deductive model, on the other hand, can be applied to the entirety of the project area at all periods, since that model is derived from data pertaining directly to the CS.

The results of the two models should not be viewed as alternative possibilities; rather, they are complementary. While the predictions from the inductive model are primarily at a very fine scale, treating local or detailed environmental characteristics, the predictions from the deductive model are at a much broader scale, dealing with relatively gross environmental characteristics. Neither scale is inherently more valuable or "correct" than the other and ideally they should combine to make richer predictions than possible with either alone. Because of the coarseness of the environmental reconstruction of the Shelf which the available data permit, however, many of the factors important in the inductive model cannot be used for site prediction.

For some environments, the scale of prediction is similar for both models, as in the case of estuaries. In those cases, it is conceivable that the predictions derived from the two models could be mutually exclusive, indicating erroneous assumptions in one or the other. The following summarizes the rules for combining the predictions of the two models in such cases:

1. If the predictions of the two models are not mutually exclusive, use both.

2. If the predictions of the two models are mutually exclusive and the paleoenvironment in question had contemporary analogues now on dry land, use the inductive model.

3. If the predictions of the two models are mutually exclusive and the paleoenvironment in question had no contemporary analogues now on dry land, use the deductive (optimal foraging) model. Section 7 will show that such conflicts are insignificant.

These models suffer from general shortcomings. Both are moderately primitive and are based on data which are biased or scanty. Both deal almost exclusively with the physical environment because other aspects of the environment are so poorly known. We believe, however, that the judicious combination of the two models is the most sophisticated and reliable approach available at present.

3.0 BACKGROUND

3.1 Previous Research

3.1.1 Maine

Serious interest in the archaeology of Maine began with H. P. Chadbourne's (1859) recognition that the shell middens at Damariscotta were of human origin. A few years later, Jeffries Wyman (1867) initiated study at a broader range of shell middens, ushering in a period of dominance of Maine archaeology by non-locally based scholars. F. W. Putnam (1882-1883, 1883, 1887) and C. C. Willoughby (1898, 1910, 1915, 1935) of Harvard University had long-term research interests in Maine during the latter third of the nineteenth and the beginning of the twentieth centuries. Other scholars such as Henry Mercer (1897) and Loomis and Young (1912) conducted shorter but still influential researches.

In Maine and elsewhere the period before about 1910 was characterized by intense interest in artifacts and less interest in their interpretation in cultural terms. In large part, archaeologists received funding because of their ability to fill museum cases; conjectural reconstructions of culture were not encouraged nor were they rewarded highly.

In the early 1900's, archaeology developed an interest in defining cultures, recurrent patterns of physical remains. To date, the only accepted cultural unit defined on the basis of data from Maine alone remains the "Red Paint People" (Bates and Winlock 1912). (Rowe (1940) defined the "Asticou complex" and Byers (1959a) defined the "Kelley phase," but neither has been generally accepted.)

Over time, the range of interests in Maine archaeology expanded. Early students had been interested exclusively in shell middens, especially searching for signs of antiquity comparable to those found in European shell middens. Soon, interest expanded to spectacular cemetery sites (Willoughby 1898) and finally to sites as mundane as a prehistoric stone quarry (Willoughby 1901). In general, however, interest remained focused on shell middens and cemeteries until the 1960's.

Through about 1910, quality of reporting and field control improved as the standards of the discipline rose. In the earliest researches, little attention was accorded stratigraphy and the locational information recorded in published accounts or notes rarely is adequate to locating the site. Following the scrupulous work of Willoughby, careful mapping became the norm and at least some workers observed stratigraphy.

In a sense, the period between 1910 and 1940 was a reversal of trends. Ironically, this period which saw the most ambitious of all Maine archaeological programs was characterized by overall poor field methods and recording. Between 1912 and 1920, W. K. Moorehead spent eight seasons surveying for sites in Maine and produced his report in 1922. This ambitious project investigated scores of sites and located many more, but Moorehead's failure to maintain adequate records caused most of them to fade back into obscurity: many of their locations simply were not described well enough to be plotted on a map or located in the field today. Despite its faults, Moorehead's work is to be commended for his interest in locating interior sites other than cemeteries, a project to which he devoted an entire season.

Following Moorehead's activities in Maine and before 1940, only a handful of publications appeared, mostly rehashes of others' earlier work (for example, W. B. Smith 1930).

Through the 1940's and 1950's in Maine, there was a resurgence of more systematic field archaeology, though there were no projects as ambitious as those which had come earlier. Hadlock (1939, 1941a, 1941b, 1943) contributed a series of site reports describing both shell middens and cemeteries. Rowe (1940) published a thorough site report and Byers (1959a, 1974) published a series of site reports, including one on the Ellsworth Falls site. At this site, he attempted to define a culture sequence based on a stratified, riverine habitation site. The work of Rowe (1940) during this period showed the first strong interest in deriving the culture history of Maine. (Willoughby [1935] presents a culture classification, but its intellectual roots lie in turn-of-the-century conjectural interpretation.)

In the 1960's, Maine moved back into the mainstream of archaeology. The Maine Archaeological Society was activated, forming a potent force in the location of sites. Dean Snow (1969b) and Robert McKay tried to ferret out information hidden in Moorehead's records and devoted several seasons to wide-ranging field survey. These records form the basis of the present state records, which have been augmented by recent surveys, especially by the Maine State Museum and the University of Maine at Orono.

In the late 1960's and 1970's, the interpretation of this expanded data base has begun to take shape. Bourque (1971, 1973, 1975, 1976) initiated the modern study of subsistence and settlement patterns and has been joined by Snow (1972) and Sanger (1975).

A series of current studies will greatly expand the understanding of Maine prehistory. Bourque's Fox Islands Project, including his Turner Farm site investigation, is nearing completion and will provide a multidisciplinary picture of 5,300 years of prehistory. Sanger's Hirundo Project, also nearing completion, will provide a similarly detailed picture of an interior site. More recent work includes Robson Bonnichsen's study of settlement on pre-glacial lake shores in northern Maine and David Yesner's survey of Casco Bay.

The varied fortunes of the archaeology of Maine have set the stage for the northern phase of this project and have set limits to its potential for success. The failure to establish a central file for site records before the 1960's, coupled with the low standard of record keeping by many of the early surveyors, has left Maine with a relatively small inventory of known sites. The strong bias against sites other than shell middens and cemeteries skews the record further. Finally, the shortness of the period devoted to the study of settlement and subsistence patterns has restricted the depth of conclusions drawn to date.

3.1.2 Southern New England

While southern New England cannot be described as well studied in the sense that can be applied to many other areas of North America, it has received far more archaeological attention than has Maine. Accordingly, the history of research in New England is rich enough to warrant division into periods. The periods used are: Descriptive (1865 to 1935), Culture Historical (1935 to 1970), and Explanatory (1970 to present). These labels are only loosely descriptive and many researches, events, or trends in a given period may relate more strongly to the dominant interests of another.

3.1.2.1 Descriptive Period, 1867 to 1935 - In New York, serious scholarly interest in archaeology began as early as the mid-1800's (Squier 1849), but this interest was confined basically to inland areas. Interest in the coastal portions of the state developed considerably later.

In the rest of the southern New England area, Wyman (1867) of Harvard University initiated serious archaeological study with his work on coastal shell middens. Through Putnam (1877 among others) and then Willoughby (1911, 1924, 1935), Harvard became the dominant force in regional archaeology for nearly 50 years, with efforts directed largely toward eastern Massachusetts and New Hampshire. The standards of field work, record keeping, and publication were generally high.

In the early twentieth century, Warren K. Moorehead accepted a position at the Robert S. Peabody Foundation, establishing a dynasty which would dominate southern New England archaeology through 1950. Moorehead's research interests were far-ranging geographically; his southern New England efforts included the study of a series of earthworks in northeastern Massachusetts (mistakenly presumed to be aboriginal-1912), minor surveys in Connecticut, and a major survey along the Merrimack River (1931). Unfortunately, Moorehead's energy far exceeded his care in record keeping and much of this work retains greatly reduced value.

In coastal New York, serious archaeological work began under the auspices of the American Museum of Natural History and the Museum of the American Indian, Heye Foundation in the early 1900's. These organizations were to be important in local archaeology through 1950. Early scholars were Skinner (1903, 1912, 1925 among others) and Harrington (1909a, 1909b, 1924), both conducting surveys and excavations.

Harrington, in particular, was an important influence. Probably because of earlier association with Arthur Parker, Harrington brought to his work an interest in tribal identification of archaeological materials, the forerunner of the direct historical method and subsequent culture classificatory schemes. Other scholars (Beauchamp 1900; Parker 1920) discussed the coastal area, but they personally had not been active there.

Throughout this period, in all portions of southern New England, amateur archaeologists were active. These practitioners ranged from looters to insightful students; some wrote accounts of their work (Luce n.d., for example) and others did not. In some areas, such as Rhode Island, there was virtually no other research done in this period.

The general characteristic of the Descriptive Period was the absence of a framework of culture classification. With only a minimal recognition of time depth (through much of the period, aboriginal occupation was thought to have extended for only 200 years or so), cultural materials typically were treated as a homogeneous set and nearly all variation was deemed functional. Research problems often were attacked, but patterns which might have contributed to their solution were obscured by a general failure to segregate space-time units.

This treatment led to the description or illustration primarily of "significant" artifacts: ones which were unusual or aesthetically pleasing. Since such artifacts often have little value in assessing the culture classification unit(s) at a site, the value of these reports is diminished for modern use. On the other hand, archaeological naivete (by modern standards) led to the investigation of a somewhat more diverse sample of sites, rather than the emphasizing of certain culture historic units which characterized later periods.

3.1.2.2 Culture Historical Period, 1935 to 1970 - The Culture Historical Period is characterized by efforts to segregate cultures or other classificatory units out of the mass of archaeological data. Early efforts (Parker 1920; Willoughby 1935) really are mere extensions of known ethnographic or linguistic groupings into the past. As might be expected, the forcing of several thousand years of prehistory into categories taken from the early Historic Period did considerable violence to the data and these early efforts were far from successful.

William Ritchie provided the first usable culture historic scheme for the Northeast in New York. His establishment of the Archaic Period (1932) broke with earlier ethnographically based classifications and later became a major organizing concept of the Midwest Taxonomic System (McKern 1939), the first usable culture historic classification for eastern North America. Ritchie (1944) became the first to apply that system to the Northeast. His revision of that system, based on Willey and Phillips (1958) and incorporating fuller chronological data based on absolute dating, remains the standard work (Ritchie 1965).

As a result of Ritchie's prolific and well reported research and of the research by others, the archaeology of New York is far better known than that of surrounding states. Coastal New York, however, has remained a relatively poorly known portion of the state. Surveys by Ralph Solecki, M. C. Schreiner, and Carlyle S. Smith during the 1930's and 1940's eventually led to C. Smith's (1950) synthesis of the archaeology of coastal New York, which provided the basic framework for the area. Ritchie (1965) provided a revision of that framework.

The construction of these culture historic classifications required (and stimulated) a great deal of field work and resulting publication. At this period, the amateur archaeological community became more organized and formed the New York State Archeological Association, publishing accounts of members' investigations.

In Connecticut, too, amateur archaeologists banded together in 1935 to form the Archaeological Society of Connecticut. This group worked closely with professional archaeologists at Yale University, forming a productive and long-lasting alliance that resulted in the publication of a journal (Bulletin of the Archaeological Society of Connecticut) with generally high quality reports and a great deal of documented field investigation.

Archaeological interest in Connecticut during this period focused largely on coastal sites, principally of the Woodland Period. Rouse (1945, 1947) and Pope (1953) provided classification systems for the pottery in the coastal zone, as did Byers and Rouse (1960) for the interior area. No full scale culture historical system was set up, nor has one been to date, and the coastal New York system usually is extrapolated to Connecticut.

In Massachusetts, Douglas Byers, Frederick Johnson, and Ripley Bullen of the Robert S. Peabody Foundation dominated the early portion of this period. Their various studies ranged widely in time period studied and approach, but were closely clustered spatially. With the exception of Byers's work at the Guida Farm site (cited above under Connecticut, because of its location and cultural similarity), all of these researches took place within 15 miles of the coast and all but one were in coastal or estuarine sites.

These studies established bits and pieces of a culture sequence, but neither artifact classifications nor thorough culture historic classifications.

In 1939, prompted by Bullen, the Massachusetts Archaeological Society was founded and with it were established its journal and a statewide site survey. The results of the survey-over 1,000 sites located in its first year - became the core of all major site inventories in the state. Various amateur archaeologists from the Society, such as Fowler (1968), Moffett (1957), and Ribbins (1960, 1968) have made significant contributions in terms of site reports, culture sequences, and artifact taxonomies. Most professional archaeologists, however, have found these taxonomies confusing and use others.

Massachusetts Archaeological Society activity has been centered near its active members. In the 1940's, these areas included much of eastern Massachusetts, but since then, activity has been increasingly focused in northeastern Massachusetts. Focus in terms of period investigated is harder to determine, but most local archaeologists have the impression that Late Archaic sites have received the greatest attention, especially at the expense of Woodland sites.

In the late 1950's, professional archaeologists began Massachusetts studies with renewed interest. Byers (1954, 1959b) described and dated the Bull Brook site, a Paleo-Indian site, and described the Wayland site (1960). Ritchie (1969) conducted and reported on a series of excavations on Martha's Vineyard. In the mid-1960's, Dena Dincauze (1968, 1972) began a series of studies into the Late Archaic Period in Massachusetts which have established artifact taxonomies and a culture historical classification and sequence for that period. Her synthesis of the prehistory of the greater Boston area (1974) represents the first usable framework, but, reflecting a general lack of study by the discipline, is weak in the Woodland Period.

Neither Rhode Island nor New Hampshire received very much archaeological study during the Culture Historical Period. Rhode Island received sporadic study by such workers as Bullen (1940) and Fowler (1952, 1956), but no local archaeologists were actively publishing reports or collecting archives. In coastal New Hampshire, apparently no professional researchers were active, but the New Hampshire Archaeological Society has collected and published data on several sites.

3.1.2.3 Explanatory Period, 1970 to present - In a sense, "Explanatory Period" is a misnomer or at least an editorial comment. Research in earlier periods also sought to explain the archaeological record, but by less rigorous means. The appearance of a new pottery style might be explained by a migration of people, but the cause of the migration might be ignored or perhaps discussed by conjecture. The Explanatory Period is marked by a concern with explaining the "why" of cultural process, using quantification, interdisciplinary studies, explicit hypotheses and testing, or whatever techniques prove necessary. As with any other discipline, modern archaeology is being molded by today's practitioners and "standard" procedures or approaches are not rigid. Nevertheless, the general concerns outlined above are important in modern archaeological research. (See Redman 1973 for a discussion of modern archaeology.)

A few cautions are in order, lest this period appear to be an abrupt break from the preceding ones. Viewed from within, the change to modern archaeology seemed like a revolution, but in broader perspective, it was largely an intensification of existing concepts and practices, coupled it is hoped, with a greater awareness of assumptions and reasoning. Culture historical studies continue to be conducted as they must, especially in areas such as New England where entire millenia of culture sequences are unstudied.

A significant change in emphasis marks the Explanatory Period, however: interest in ecological interpretation. It is patent that human beings must extract resources in order to live and that the distribution of those resources in space and time is an important factor in the patterning of settlement. Exclusive of inventory data, most of the studies whose results will bear upon the models derived in this volume were conducted during this period.

During the Explanatory Period, coastal New York has received considerable archaeological attention. Salwen (1962 among others) and Brennan (1974 among others) have conducted a series of studies of settlement and subsistence which, although they lie slightly outisde the span of the period as defined, lie squarely within its areas of interest. Eisenberg (1978) and Funk (1972) have contributed to the understanding of the ecology of early hunter-gatherers in the area. Funk (1976) has made an important culture historical synthesis of the Hudson Valley, including parts of the coastal zone.

In the rest of southern New England, various studies by Curran and Dincauze (1977), Dincauze (1971b, 1973b, 1976), and Dincauze and Mulholland (1977) have dealt with subsistence and settlement patterns, largely in reference to early hunter-gatherers. Dincauze's students at the University of Massachusetts at Amherst have contributed a series of related studies (Curran 1978; Moore 1977; Moore and Root n.d.; Perlman 1976; Peter Thomas 1979).

Specifically in Massachusetts, Ritchie (1969) presents a culture historical framework; its billing as cultural ecological is subject to strong criticism (Barber 1979b). Barbara Luedtke (1975) has been conducting a program studying coastal adaptations on the Boston Harbor Islands. Russell Barber (1979) has completed a study of settlement and subsistence patterns in the estuarine zone of the Merrimack River.

In the rest of southern New England, problem-oriented research has been scanty. Most research has been oriented toward either description (for example, Lemire 1976) or archive accumulation. In Connecticut, for example, the State Archaeologist (University of Connecticut, Stoors), the Connecticut Archaeological Survey (Central Connecticut State College), and the Office of the State Historic Commission all have inventories of prehistoric sites and survey programs of differing intensities. Other such archives and programs include those of the American Indian Archaeological Institute (mostly interior Connecticut), the Department of Anthropology, University of Massachusetts at Amherst (Massachusetts and New Hampshire), and the Department of Anthropology, University of New Hampshire (New Hampshire).

In addition to recent research studies, other studies and archives have been necessitated by recent environmental legislation. Under the rubric of "cultural resource management", it has become necessary for states to have Offices of Historic Preservation to assist with and provide quality control over archaeological studies of areas to be disturbed by planned or proposed land using activities. Other governmental agencies sometimes have seen fit to compile archives or sponsor studies relevant to archaeology.

These recently established governmental facilities, in some cases, have extensive and well organized archives and programs; in other cases, initial organization or data compilation is still under way. Depending on the state and its history of research, the magnitude of the task and the urgency of its completion can vary widely.

3.1.2.4 Retrospect - Those familiar with the history of American archaeology written by Willey and Sabloff (1974) no doubt have noticed that the data ascribed to different periods in this section all run about ten years later than the dates they give. This pattern reflects the slower acceptance of new approaches in southern New England and probably provides an index of intensity of archaeological endeavor. Perhaps significantly, New York, overall the best studied state in this subarea, consistently has adopted new approaches more quickly than states to the east.

In terms of both compilation of archives, and overall archaeological knowledge, the states of this subarea can be divided into "better" (New York, Connecticut, and Massachusetts) and "worse" (Rhode Island, New Hampshire). For overall knowledge, however, New York outstrips the rest considerably.

This basic inequality of research intensity creates a bias in the record. Further biases include:

--greater emphasis on Woodland sites in Connecticut;

--greater emphasis on Late Archaic sites in Massachusetts; and

--greater emphasis on sites in areas of low elevation (that is, (de-emphasis on mountainous and plateau regions).

These biases are specific to the southern New England subarea and operate in addition to more general biases discussed in Section 2.

3.1.3 Mid-Atlantic States

Serious interest in archaeology in the study area-indeed, in North America-began in Virginia in 1784. Thomas Jefferson excavated a burial mound on his estate sometime prior to 1782 with the explicit goal of determining whether it was of aboriginal origin. When he published his report (1784) on the research, he inaugurated prehistoric archaeological study on this continent.

Given this auspicious and precocious start, one might expect the archaeology of the mid-Atlantic subarea to be exceptionally well known, but such is not the case. Standard histories of archaeological research (Brose 1973; Schmitt 1952; Stoltman 1973; Willey and Sabloff 1974) cite only a few studies from this subarea. With those exceptions, research until the last few years has been directed predominantly toward data collection, with few attempts at wide-scale interpretation.

After the long lull following Jefferson's early work, large-scale interest revived only with the definition of and controversy over the Trenton Argillite culture around Trenton, New Jersey. Abbott (1870, 1872, 1873 among others) claimed pre-glacial antiquity for a series of remains which later research (Mercer 1893, 1898; Spier 1916; and others) demonstrated to have no claim to such antiquity. The debate over these remains, however, consume most archaeological interest in the mid-Atlantic subarea until the 1910's, although Holmes's (1903) encyclopedic study of eastern North American ceramics touched upon the area.

During the 1910's, at least in the northern portion of this subarea, archaeological surveys began to swell the number of recorded sites and expand the data base (see for example, Skinner and Schrabisch 1913; Volk 1911). Further south, Fowke (1894) had surveyed in the James and Potomac Valleys of Virginia, but it was only later that surveys became common (see for example Haag 1958; Holland 1948).

Throughout the Atlantic Slope of the mid-Atlantic states, site reports began to appear frequently by the 1930's. These reports were primarily descriptive, but many made comparisons to other areas and attempted to erect culture sequences by extension from these areas. Examples include Cross (1941), Slattery (1946), Stearns (1940), and many others. This phenomenon correlates with the widespread establishment of amateur archaeological societies and probably is in part a result of their activities.

The period preceding 1950 saw the collection of many important archaeological data, but the development of culture-historical interpretation has taken place primarily since then. Sears (1954) conceived of a basic cultural continuity through time along the Atlantic Slope and Coe (1964) provided documentation with which others (such as, Broyles 1971 and Dincauze 1971a) could compare their data, supporting Sears's concept. Evans (1955) conducted survey and excavation in Virginia with the purpose of establishing a ceramic classification around which Woodland culture could be developed. Ritchie and Dragoo (1960) proposed an Adena migration onto the Delmarva Peninsula, which, although it is now no longer accepted, stimulated research. These and other researches have produced a culture-historical framework for the mid-Atlantic states which was unavailable at the time of Schmitt's (1952) attempt at a regional synthesis.

Since around 1960, an increasing amount of archaeological research in the mid-Atlantic subarea has been directed toward problems of cultural process. Examples include Cresson and Bonfiglio (1978), Eisenberg (1978), Gardner (1978), Mounier (1978), Thomas and others (1975). In addition data collection has escalated as a result of archaeological management studies.

3.2 Culture History

3.2.1 General

In order to provide a framework for the study of archaeology in eastern North America, archaeologists use a series of classification schemes. The most commonly accepted of these, used here, divides time into three long periods (Paleo-Indian, Archaic, and Woodland), each with internal divisions (early, middle and late). Within one or more periods, a tradition represents continuity of material remains and (presumably) way of life. Traditions are subdivided into cultures and smaller units as necessary.

These basic concepts will be used to describe the basic patterns of prehistory in the project area as it is known presently. There clearly are limitations to the classification scheme, such as failure to incorporate variation because of differing site functions, but its utility lies in its simplicity.

Basically, the Paleo-Indian Period is defined as the glacial and immediately post-glacial period when now extinct Pleistocene megafauna such as mammoths and giant sloths were in existence. The extinction of these creatures occurred in stages, but was mostly complete by 10,000 B. P., although there are sporadic records as late as 6000 B. P. (Butzer 1971). The 10,000 B. P. date more or less corresponds to distinctive changes in tool types, so that approximate date forms the boundary. Following the extinctions of megafauna is the Archaic Period, lasting until around 3000 B. P. and the advent of ceramics. The Woodland Period extends until the virtual eradication of traditional Indian culture in the seventeenth century A. D.

Since the events which mark boundaries between periods took place at different times in different places, the system is inexact. Great exactitude, of course, is unnecessary, since culture change usually is gradual and the boundaries are partially arbitrary. Chart II-1 summarizes culture history in the project area.

3.2.2 Maine

3.2.2.1 Paleo-Indian Period - Among the many tool types documented for the Paleo-Indian Period in eastern North America (Funk 1976; Kraft 1973; MacDonald 1968; Ritchie 1957, 1965; and others), only one has been demonstrated to be unique to that period and an infallible diagnostic. That tool is the fluted point, a symmetrical, thin tool suitable for hafting on a spear shaft. Its distinctive feature is its flute, a flake or series of flakes taken from one or both faces of the tool. The purpose of this feature is unclear, but the product forms an index of Paleo-Indian occupation.

Until June, 1979, there were seven known fluted points from Maine. With a single exception which was excavated from the shores of Lake Munsungan (Robson Bonnichsen, personal communciation), all of these were found on the ground surface and in no cases is it known whether more remains exist within the soil. (The distinction is made between a find spot [an area where a single artifact has been found] and a site, where further work has confirmed the presence of further remains. Six of the Maine fluted points come from find spots.) A blade-like sidescraper at the Maine State Museum is tentatively assigned by Bruce Bourque (personal communication) to the Paleo-Indian Period, but definite proof for such an assignment is lacking.

While examining collections in the possession of amateur artifact collectors, R. Michael Gramly located a large collection from the Vail site, a lakeside Paleo-Indian site in northwestern Maine. The collection includes more than 40 fluted points, as well as scrapers, gravers, blades, and other distinctive Paleo-Indian tools. The collection is presently under study by Gramly and, although few conclusions can be drawn yet, the site appears to have been moderately large.

In the absence of further evidence, little can be written about the Paleo-Indian period in Maine. The most profitable approach probably is to assume that the patterns known for adjacent areas in the Maritime Provinces of Canada and in southern New England can be extrapolated to Maine. These patterns are dealt with in the discussion of the culture history of southern New England.

3.2.2.2 <u>Archaic Period</u> - The Early Archaic (10,000 to 8000 B. P.) and Middle Archaic (8000 to 6000 B. P.) periods are very poorly known in Maine, with all known data being encapsulated in Sanger and Bourque (1977).

Opinions vary as to why these periods should have had such sparse occupation in Maine. Fitting (1968) has suggested that zonal shifts of the boreal forest, an environment inimical to human occupation, resulted from changing climate, forcing southward shifts of human population. Dincauze and Mulholland (1977), on the other hand, have criticized Fitting's environmental reconstruction. In its place, they have described the Early and Middle Archaic forests as ephemeral and unique, the product of differential colonization rates of different species of trees which were spreading into environments which recently had become able to support them. Using 20% oak composition as an index of resource stability (and attractiveness to human settlement), they produced predictions of site densities which were found to match well with the distribution of known sites of these periods. Dincauze and Mulholland (1977) predicted few Middle Archaic sites north of the Penobscot basin and very few Early Archaic sites in Maine as a whole.

An alternative or additional reason for low site densities in these periods may be failure to recognize the distinctive tool types. Throughout the project area, there are many artifact forms whose age or cultural affiliation is unknown. In Maine, the history of archaeological thought has made this particularly true. Virtually all knowledge of Early and Middle Archaic tool types in eastern North America is built upon the studies of Coe (1964) and Broyles (1971) in North Carolina and West Virginia. Only in the 1970's was it recognized (Tuck 1970, 1975; Tuck and McGhee 1975) that contemporary cultures in the Maritime Provinces had very different material cultures. Maine lies on the cusp, a largely uninvestigated area bordered by one pattern to the north and another to the south. Thorough attempts to find analogues to the artifacts of the Maritime Archaic documented at this date further north have not been made. Accordingly the question of whether presently unrecognized Early and Middle Archaic sites would alter the impression of low population is unresolved.

Sanger and Bourque (1977) list only two possible Early Archaic points. One (illustrated in Sanger 1975: Fig. 2b) resembles the Kirk type, defined in North Carolina. The second is a bifurcate-based point resembling points found in southern New England and LeCroy points in West Virginia.

Sanger and Bourque (1977) list six localities with artifacts apparently referable to the Middle Archaic Period, but only a single example was found in stratigraphic context, making possible at least relative dating. The artifacts in all cases resemble Neville or Stark types, defined by Dincauze (1971, 1976) at the Neville site, Manchester, New Hampshire and dated around 7000 to 8000 B. P. there.

The single case of stratified context in Maine comes from the Hirundo site. There, a Neville-like point was found in possible association with an unfinished serrated biface, several large flakes, and quartz scrapers, none of which are temporally definitive. Sanger, the excavator and analyst, considers the Neville designation preliminary and is currently comparing his specimen with those in other collections.

With the Late Archaic Period, the quantity of archaeological data from Maine mushrooms. Intense interest in spectacular mortuary sites brought attention from archaeologists, professional and amateur, and from relic hunters and looters. With this period, data become numerous enough to allow generalization.

What probably constitutes the earliest Late Archaic remains in Maine are classified within the Laurentian tradition. (Throughout this volume, "Laurentian tradition" is used in the broad sense, indicating a complex of broad-bladed notched points, particular forms of endscrapers, and bifacial knives. See Tuck [1977] for a discussion of the broad and restricted senses of "Laurentian tradition".) This tradition is found at the Hirundo site (Sanger and MacKay 1973) and at the Ellsworth Falls site (Byers 1959a), characterized by Otter Creek points. Absolute dates are available from neither site, but in each case, the Laurentian material is found beneath all other Late Archaic components. Similar materials at the Sylvan Lake rock shelter have been radiocarbon dated to 6560 ± 100 B. P. (Funk 1976); other dates are as recent as 4000 B. P.

Laurentian tradition sites are known only from interior portions of Maine, and Ritchie (1969) has postulated an interior adaptation. In evaluating such a postulation, it should be recalled that a tradition is a pattern of artifacts and that the different peoples sharing those artifact styles may have carried on many different ways of life.

The other tradition which may be as early as or earlier than Laurentian is the Small Stemmed Point tradition. The latter tradition is known from the bottom level of the Turner Farm site, where it is radio-carbon dated 5290 ± 100 B. P. (Bourque 1975). Dincauze (1976) believes that this tradition grew out of local Middle Archaic antecedents; if such is the case, even earlier dates should be expected.

Following the Laurentian and Small Stemmed Point traditions was the Moorehead phase of the Maritime Archaic tradition. At Ellsworth Falls (Byers 1959a) and at Turner Farm (Bourque 1976), the above-mentioned traditions occur below the Maritime Archaic. Radiocarbon dates place this cultural unit between 4600 and 4300 B. P. at the Turner Farm site (Bourque 1975) and 5100 B. P. at the Hathaway site (Snow 1975), but the expression probably extends later than these dates indicate, on the basis of cross-dating with sites in the Maritime Provinces (Sanger 1973).

The Moorehead phase, the modern term for the "Red Paint People", undoubtedly is the best known cultural expression in Maine. Its cemeteries attracted much attention, yielding handsome ground slate tools and other attractive artifacts.

Unfortunately, understanding of the phase did not keep pace with the plundering of its cemeteries. Until relatively recently, all graves with "red paint" (red ochre) were classed as graves of the "Red Paint people", confounding the Moorehead phase with later traditions. Only in the last ten years has there been any consistent interest in reconstructing the way of life of these people or even the reasons for the opulence of their graves.

Based on information from the Turner Farm site (Bourque 1975, 1976), the Moorehead phase shows some signs of continuity with the preceding Small Stemmed Point tradition in terms of shared tool forms.

The Moorehead phase apparently had a strong maritime focus. At the Turner Farm site, the first unequivocal large-scale use of shellfish is documented. In addition, there and at other sites, seals, walrus, swordfish, and other maritime animals make up substantial portions of the faunal remains. This phase is the only one for which such a strong maritime focus can be documented in Maine.

At around 3600 B. P., the first evidence of the Susquehanna tradition appears in Maine, again at the Turner Farm site. Bourque (1975) sees this appearance as the result of a migration, as opposed to diffused ideas or styles, but supporting evidence for either view is scanty.

The evidence from Turner Farm shows a shift from maritime resources to a greater input of terrestrial resources. Shellfish use persists, but the deeper water species, such as swordfish, are dropped out and seal and beaver are present only in minor quantities.

At the Turner Farm, a cemetery of ten cremations plus interments has been excavated (about 50% of the cemetery has been excavated). Radiocarbon dates are 4020 ± 80, 3855 ± 75, and 3610 ± 90 B. P. (Bruce Bourque, pers. comm. Burials of the Susquehanna tradition also are known. One has recently been discovered at the Hirundo site and another was reported, though in slightly confused manner, by Moorehead (1922a and b). He attributes the cremation pits to the "Red Paint People" on the basis of red ochre inclusions and proximity to a ground slate tool producing site. His illustrations and descriptions of the cremation pits, however, label them unmistakably of the Susquehanna tradition; his poor description of the village site nearby leaves one in doubt of its cultural affiliation.

The poor state of knowledge of Maine prehistory in general and the legacy of a long-term inequality between copious field investigation and scanty interpretation have conspired to confuse the Late Archaic Period in Maine. In summary, available information appears to support the reconstruction of the Laurentian and Small Stemmed Point traditions as contemporary and locally derived from earlier cultures. By around 5000 B. P., one or both had modified sufficiently to become the Moorehead phase, strongly influenced by tool types and subsistence patterns common to the north. Around 3600 B. P., people (or ideas) of the Susquehanna tradition intruded from the south and subsistence shifted radically. During this last period, it is unclear how many (if any) of the other Late Archaic traditions were still in existence.

3.2.2.3 Woodland Period - Some archaeologists active in Maine archaeology (Bourque 1971, for example) have eschewed the term "Woodland Period" for fear that it might be misconstrued to imply agriculture, as in its original usage in the 1930's. It has become increasingly evident, however, that many Woodland cultures around North America were non-agricultural and "Woodland" no longer should bear the connotation of agriculture. In Maine, east of the Saco River in particular, there is no evidence supporting aboriginal agriculture before it was introduced by Europeans.

With a single class of exceptions, all reported Woodland sites excavated in Maine are coastal middens. The exceptions are so-called "accidental excavations," when a Woodland component overlies an Archaic component or is mistaken for one. The Woodland occupations at the Turner Farm and Hirundo sites are examples of the former, but have not been analyzed yet.

The Bradley, Sullivan Falls, and Winslow sites are examples of mistaking a Woodland site for Archaic and provide the earliest evidence of Woodland in Maine. These sites are noted briefly by W. B. Smith (1930) and ascribed to the "Red Paint People," presumably on the basis of red ochre in grave pits. The artifacts illustrated, however, are Early Woodland points, namely, one Fulton point and two Adena points. This evidence argues for the presence of the Eastern Mortuary Complex (Dragoo 1976) in Maine. This complex is known from New Brunswick (Turnbull 1976) and various localities as far south as Maryland and is expectable in Maine.

The evidence from the shell middens suggests a gradual evolution of artifact styles which approximates the pattern of development seen in southern New England. How similar patterns of organization or subsistence may have been cannot be assessed reliably with the incomplete data on hand, but preliminary studies by Bourque (1971, 1973) and Barber (1979b) suggest that the basic pattern may be quite similar.

3.2.2.4 Historic Period - While the basic continuity between Late Woodland cultures and ethnohistoric cultures in Maine is clear, it is equally clear that there was considerable culture change between the two. This change may have been simply part of ongoing internal change, unrecognized for earlier periods because of lack of study, or it may have been induced by the trauma of European invasion.

This historic Indian groups of Maine were called by several fanciful European names, such as Tarrentines, but there is no doubt that they were the ancestors of the Penobscot, Malecite, and other Algonquian-speaking groups documented later for the area. At the time of European contact, apparently, all groups north of the Saco River of southern Maine were hunter-gatherers, with no use of agriculture. Champlain (1605) was told that recent warfare had caused the abandonment of agriculture along the coast and Rasles (1723) reported that the Indians at Norridgewock along the Kennebec River grew maize, squash, and beans, but the former report is only hearsay and the latter is late enough to reflect European influence.

Biard (1616) reported a seasonal round including a period of spring capture of anadromous fish, followed by coastal exploitation of fish, shellfish, and other resources with little use of forest zones. This period lasted until mid-September, when the groups retired above the estauries for eel fishing, hunting, and ice fishing until the cycle began again in mid-March.

Biard reports this cycle in detail but it must be remembered that these early reports were collected at the coast during the summer. Consequently, knowledge of settlement or activities at other seasons and zones was based upon information provided by informants. The vagaries of translation, interpretation, and other factors may have caused inaccuracies or biases in these reports, especially as they relate to inland zones.

Historic aboriginal communities were relatively small, rarely exceeding 100 persons. These bands were led by a sagamore, a leader whose power lay in persuasion, not coercion (Biard 1616).

Bourque (1973) has documented a settlement pattern for 200 to 1150 A.D. in Maine, including coastal settlement in late winter and early spring, yet ethnohistoric sources beginning around 1550 A.D. indicate that populations were exploiting interior resources during that season and moved to the coast only during late spring and summer.

Moreover, Sanger (personal communication; Bonnichsen and Sanger [1977]) has found around Passamaquoddy Bay several Woodland shell middens with floors indicating semi-subterranean houses. These remains may represent houses of the type reported ethnohistorically as winter habitations (Bruce Bourque, personal communication).

Cynthia Wood (1977) has hypothesized that these and other changes between prehistoric and early historic aboriginal culture can be related directly to the European presence. She posits that sixteenth-century settlement shifted toward the coast in the summer in an attempt to cultivate trade with the Europeans sailing by. Later, around 1620, missions and trading posts attracted settlement for much the same reasons.

This brief overview of Maine prehistory and ethnohistory has focused on space-time relationships and establishing the basic framework of cultural development. More detailed studies of subsistence and settlement, valuable to deriving settlement models, will be discussed in more depth later.

This overview has tried to present a coherent picture of the Maine cultural continuum, despite the universal recognition among archaeologists active there that many gaps remain. In addition to the unresolved problems discussed above, there are further apparently anomalous data. R. Michael Gramly (personal communication) believes that there may be an unrecognized range of Woodland cultures which occupied interior Maine, appearing at the coast only rarely, as at the Goddard site. The archaeology of Maine is still more poorly known than that of any other portion of the study area.

3.2.3 Southern New England

3.2.3.1 Paleo-Indian Period - The Paleo-Indian Period in southern New England is known from several excavated sites and a far larger number of find spots. These data document the abundant use of fluted points, but fail to produce convincing evidence of Plano-like and other points associated with the latter part of the Paleo-Indian Period to the west (Quimby 1959) and to the south (Kraft 1973).

Until quite recently, prevailing reconstructions of paleoenvironments in southern New England and adjacent areas painted a harsh picture of early post-glacial conditions. As late as 1957 Ritchie believed that the environment before 11,000 B. P. totally precluded human occupation and that only around 7000 B. P. did the area become attractive enough to draw human occupation (Ritchie 1957). Then, in 1959, the first radiocarbon dates from a southern New England Paleo-Indian site appeared to confirm this impression. Dates from the Bull Brook site in eastern Massachusetts ranged from 9292 ± 400 to 6932 ± 800 B. P., the later result being rejected as anomalous and run on a small sample (Byers 1959b).

The Bull Brook dates served as the standard for eastern North America for about a decade, until a series of dates (Funk and other 1969a; Funk and others 1970; MacDonald 1968) at northeastern Paleo-Indian sites (Debert and Dutchess Quarry Cave sites) extended the range back to around 10,500 B. P. and possibly earlier. The Bull Brook dates now are generally believed to have been based on contaminated samples.

The only evidence for human occupation in the southern New England area before 10,500 B. P. comes from the Dutchess Quarry Cave, where a radiocarbon date of 12,500 ± 370 B. P. has been obtained (Funk and others 1969a). This date was based on bone associated with a fluted point of the Cumberland style. In other parts of eastern North America, the Cumberland style dates to the latter part of the Paleo-Indian Period, some 3,000 years later than the date found associated at this site. This anomaly and the association within strata of species normally not sharing any single environmental zone suggest that there may have been mixing of strata and cast some doubt on the validity of this early date for Paleo-Indian occupation of the Dutchess Quarry Cave.

3.2.3.2 Archaic Period - The Early Archaic Period in the southern New England subarea is characterized by bifurcate-based points and, to a much lesser extent, other point types known from farther south and west. A number of Early Archaic sites have been excavated (Funk 1977a and b; Ritchie and Funk 1971; Snow 1977; Charles Bolian, personal communication; and others) and have yielded radiocarbon dates ranging from about 9500 to 7500 B. P. Dincauze and Mulholland (1977) have provided a distributional study of Early Archaic sites for most of this subarea.

For the Middle Archaic Period, more sites are known and more have been excavated (Brennan 1974; Dincauze 1971a, 1976; Funk 1977a and b; and others). Dincauze and Mulholland (1977) have provided a distribution of this period, too.

The general pattern of culture sequence(s) discussed in the works cited above closely parallels that derived by Coe (1964) and Broyles (1971) for the Piedmont provincefrom North Carolina to West Virginia. Dincauze (1971a) has postulated a "cultural domain" with basically homogeneous material culture extending along the Atlantic Slope from at least North Carolina to New Hampshire during Early and Middle Archaic times.

Another source of Middle Archaic artifact styles is the Laurentian tradition, primarily a Late Archaic tradition, but beginning demonstrably earlier. At Sylvan Lake rock shelter in the Lower Hudson Valley, Otter Creek points, indicative of the Laurentian Archaic tradition, have been radiocarbon dated to 6560 $\pm$ 100 B.P. (Funk 1976). Further afield, Lee (1957) has argued on geological grounds for the dating of Otter Creek points at the Sheguindah site in Ontario at nearly 10,000 B.P., but that date is highly controversial. The impact of Laurentian styles on the Middle Archaic Period in coastal southern New England and New York is unassessed, but may be a source of distortion, since these remains usually are classified as belonging to the Late Archaic Period.

The number of sites recognized as Early or Middle Archaic is small when compared to the numbers of sites in succeeding periods. There are several competing hypotheses explaining this phenomenon; these have been discussed in the discussion of Maine and will be treated more thoroughly in Section 5.

With the Late Archaic Period in southern New England, there is a drastic increase in the number of sites and the variety of styles of material culture. Apparently population increased markedly as a result of in situ growth, in-migration, or a combination of the two.

Dincauze (1975b) has provided a synthesis of the Late Archaic Period in New England and much of the following discussion has been taken from hers. The Small Stemmed Point tradition (also termed the Narrow Point tradition) is the earliest dated tradition of the Late Archaic Period in this area. It is characterized chiefly by small stemmed points, classified into a plethora of slightly divergent types by different researchers, and small triangular points. In some of the older literature, these points are termed "Lamokoid" in reference to Lamoka points of western New York, whose possible relation to small stemmed points remains a matter of controversy. Dincauze believes the Small Stemmed Point tradition to be indigenous to the area, having developed from local Middle Archaic predecessors.

The second major Late Archaic tradition in the area is the Susquehanna tradition (also termed the Broadpoint tradition). This tradition is moderately well known and has been divided into phases by Dincauze (1968, 1972); Funk (1976) and Ritchie (1965). Diagnostic artifacts include broad-bladed points of several types, broad bifacial tools typically used as knives, and bowls carved of soapstone. Elaborate cremation and mortuary ceremonialism also is associated with this tradition.

The earliest dates for the Susquehanna tradition in southern New England lie around 3800 B.P. Absence of recognizable antecedents locally, coupled with apparently rapid establishment and marginally earlier dates to the south, have led Dincauze to interpret the evidence as indicating a northward population movement of more southerly peoples. T. G. Cook

(1976) has expressed doubt, favoring the explanation of a diffused complex of traits, rather than population movements.

In addition to these traditions, there are other traditions or at least cultural manifestations of the Late Archaic Period. The Laurentian tradition was present in the Lower Hudson Valley (Funk 1976) and Ritchie (1969) has argued for its presence in eastern Massachusetts. The argument for the eastern part of southern New England is weak, the remains appearing primarily as minority inclusions in sites of other traditions. There are, however, anomalous Late Archaic assemblages from such sites as at Assawompsett (Robbins 1960, 1968) which cannot be reconciled easily with the other traditions.

To date, attempts to explain the co-existence of several traditions in a single area have been unsuccessful. In ethnographic cases, societies in close contact with one another typically exploit different zones to minimize competition (Barth 1969) and typically have sufficient interaction to blur some of the differences between their artifactual styles. In the Late Archaic Period of southern New England, however, neither of these patterns has been detected.

Around 3200 B.P., however, Dincauze (1975b) postulates that a fusion of the Small Stemmed Point and Susquehanna traditions finally did occur, producing a projectile point sharing traits of its predecessors. This point is termed the Orient point and, along with steatite bowls and cremation ceremonialism, characterizes the Orient phase.

During the latter part of the Orient phase, ceramic pottery was introduced or invented. Consequently, some researchers (Funk 1976; Ritchie 1965; and others) have defined a Transitional period to include the Orient phase and related cultural manifestations. While this period is a logical mediator between the Archaic (without ceramics) and Woodland (with ceramics) Periods, its utility in describing or explaining cultural change is suspect and it has been omitted. Since cultural change is almost always gradual and different aspects of culture change at different rates and on different schedules, such inconsistencies are unavoidable.

3.2.3.3 <u>Woodland Period</u> - The Woodland Period is defined as beginning at 3000 B.P., although its defining feature - ceramic pottery - probably came into use some hundreds of years later in some parts of southern New England.

In one sense, ceramics form a poor criterion for a major division between periods, since their presence does not indicate any necessary changes in ways of life. On the other hand, the technology of ceramics allows greater freedom in the variation of styles. This greater freedom in decoration implies greater potential for information content on date, ethnic group, intercultural relationships, and other factors. It also demands far more complicated typologies or other means of analysis.

In areas where pottery has been studied extensively (New York and western Connecticut), chronologies for the Woodland Period are fine-grained, and precise dating is often possible on the basis of ceramic styles alone. In areas where pottery has received little study (eastern Connecticut, Rhode Island, Massachusetts, and New Hampshire), the complexities of unraveling the chronological implications of ceramics have led to as much confusion as understanding. The dating of sites in the latter areas has usually been based on point types, typically far less common than pottery, or has been classed merely as "Woodland" if diagnostic points were unavailable.

The Early Woodland Period spans about 3000 B.P. to 2000 B.P. (0 A.D.) and is characterized by distinctive interior-exterior cord-marked pottery (Vinette I ware), various point types, distinctive pipe forms, and a series of other artifact types.

Ritchie and Dragoo (1960) defined the Middlesex culture, an Early Woodland culture whose members supposedly fled political upheaval in Ohio and brought their culture to the Northeast. Their definition was based on burial sites alone and subsequent research has demonstrated that the manifestation was only a burial complex, a single aspect of culture, which was overlain on various local cultures in the Northeast (Dragoo 1976). The local habitation sites appear much like those that went before and those that followed, but the burial ceremonialism and trade patterns surrounding it were very different.

In southern New England, this Early Woodland burial complex, sometimes called the Eastern Mortuary Complex, is known only from western Massachusetts. There, it occurs near Quabbin Reservoir (Maurice Robbins, personal communication) and at a series of non-mound cemeteries reported by Willoughby (1935). Overall intensity of this burial complex in southern New England appears to have been low.

In coastal New York and western Connecticut, the Windsor tradition has been defined (C. S. Smith 1950) for the Middle Woodland Period, about 0 to 900 A.D. This tradition was defined almost entirely on the basis of ceramic styles, incorporating stamped, incised, cord marked, and other techniques into a series of combinations.

In the rest of southern New England, the extension of the ceramic styles defined for upstate New York (Ritchie and MacNeish 1949) has met with only limited success, but most scholars have not made concerted efforts to construct a more applicable taxonomy. Moffett (1957) and Dincauze (1975a) are exceptions.

The Late Woodland Period in coastal New York and western Connecticut (about 900 to 1650 A.D.) includes the Windsor tradition, continuing from Middle Woodland times, and the East River tradition, presumed to be an intrusion from further south at about 1000 A.D. (Ritchie 1965). Salwen (1968) has argued for an alternative model of _in-situ_ development.

The relationship between these two traditions - ethnic, political, or other - is unknown. Decorative techniques draw heavily upon cord marking and incising and include castellation. Shell temper gradually becomes more common than grit temper.

In the rest of southern New England, the Late Woodland Period is even less well studied. The inapplicability of upstate New York ceramic typologies is obvious, even upon superficial inspection, but alternatives have not been formulated.

At some time during the Late Woodland Period, probably around 1000 A.D., maize cultivation was adopted. This change had repercussions throughout the culture(s), affecting settlement, demography, and social organization. This topic will be discussed further at the end of this chapter.

While the culture history of the Woodland Period in southern New England is anything but well known, reports on sites of this period are surprising frequent. The greatest lack is not data, but synthesis. Because the point type characteristic of the Late Woodland Period apparently extends back to mid-Middle Woodland times, the use of point types for dating is not entirely satisfactory.

3.2.3.4 Historic Period - In the southern New England subarea, aboriginal peoples considered themselves to be members of several different ethnic groups, including the Abnaki, Pennacook, Massachusett, Nauset, Nipmuck, Wampanoag, and others. These divisions were not comparable units: some were tribes, some were confederations of tribes, and still others were loose groups of bands. The leaders of these groups were called sachems, but disagreement among authors regarding their powers (Champlain 1605; Gookin 1675; Roger Williams 1634) suggests that they ranged from advisory to mildly coercive. All of these groups spoke languages of the Algonquian family.

When Europeans first contacted southern New England, aboriginal subsistence patterns included strong inputs of maize, squash, and beans from agriculture. Near the coast, seasonal movements took the inhabitants to the coast in summer to plant crops; in autumn, groups moved inland for fishing and hunting; in the spring, spawning runs of anadromous fish were exploited (Mourt 1620-1621). In inland areas, a major village would be occupied during summer (for planting) and winter (when the people lived largely off stored food); spring fishing and fall hunts broke the pattern of year-around sedentism (Peter Thomas 1976b). This simplified picture, however, omits a series of specialized camps used sporadically or by special work groups, such as winter shellfish gathering sites (Wood 1634). The variety of such sites may have been great, complicating any simple or widely applicable generalization about site types and seasonal rounds.

During the winter (and summer, as well, inland), settlement was focused in fixed villages. The population of these villages was variable, generally ranging from 200 to 500 persons. At least in some cases, smaller populations remained in these villages while part of the group sojourned in other settlements, particularly in spring and fall.

Disease, trade, dependency, and finally defeat in the Indian Wars of 1675-1676 thoroughly disrupted Indian culture in this area, severing the aboriginal culture continuum.

3.2.4 Mid-Atlantic States

3.2.4.1 Paleo-Indian Period - As in southern New England, the Paleo-Indian Period in the mid-Atlantic states is known from a few excavated sites and a large number of find spots of distinctive artifacts. The number of known sites and find spots in the mid-Atlantic states, however, is considerably greater than in areas further north. This disproportion is too great to be explained by possible differing intensity of research in different areas and seems to indicate more intensive occupation further south. (The total of reported sites and find spots for the mid-Atlantic area is greater than shown in the inventory compiled by this project, since many have been recorded with too little information to permit them to be located. The following reports of fluted point surveys indicate the frequency of Paleo-Indian remains in the mid-Atlantic states: Bottoms 1969, 1970; Mason 1959; McCary 1976; and others.)

Four radiocarbon dates from the Paleo-Indian component at the Shawnee-Minisink site in eastern Pennsylvania range from 9310 to 11,050 B.P., averaging 10,425 B.P. (McNett and others 1977). These dates are comparable to those for the Paleo-Indian Period in southern New England and probably indicate approximate contemporaneity in the two subareas.

In the mid-Atlantic states, the earlier portions of the Paleo-Indian Period are evidenced by fluted points similar to those found further north. The later portions of the period, however, are represented by point types unlike those further north. At the Plenge site, Plano-like points are known (H. Kraft 1973) and Dalton-Hardaway points, a fluted form, are known throughout the southern portion of the mid-Atlantic subarea.

A particular artifact, claimed by some archaeologists to be of Paleo-Indian age, deserves special comment. In 1864, H. T. Cresson and W. L. deSuralt reported finding an engraved whelk shell in saltwater peat deposits near Holly Oak, Delaware. The engraving appears to be a naturalistic representation of a mastodon, suggesting contemporaneity of this creature with human occupation of the area. Kraft and Thomas (1976) studied the Holly Oak locality and found evidence indicating that deposition of the artifact might date either to around 3000 B.P. or earlier than 40,000 B.P., based on the age of sediments at the locality. Deposition between these dates appears impossible and those authors consider the artifact authentic and assign its date accordingly.

One may remain skeptical, however. The early date predates known human occupation in eastern north America by several tens of millennia; the late date postdates the latest known survival of mastodon by several millennia. In addition, the style of the art work emphasizes three-dimensionality and perspective, elements important to nineteenth-century Euro-American art, but rarely encountered in surviving aboriginal art from North America at later dates. (See Kraft and Thomas 1976 for a representation of the Holly Oak artifact.) Finally, the effects upon the shell of several millennia of burial in an acidic peat environment have been far less than would be expected. In summary, the evidence for the authenticity of the Holly Oak engraving is uncompelling and it seems most likely that the specimen is a fraud or prank.

3.2.4.2 Early Archaic Period

In more northerly portions of the study area, the technologies associated with Paleo-Indian and Early Archaic cultures are quite distinct, giving the impression of sharp change between those periods, especially in terms of points. In the mid-Atlantic area, especially its southern portion, technological change produces a less-well-demarcated shift in point types, which are thus better described as falling along a continuum. Settlement patterns also show considerable continuity between these periods (Coe 1964; Gardner 1977). Presumably the less drastic environmental changes involved in more southerly regions fostered less drastic cultural change.

In the piedmont of North Carolina, Coe (1964) has developed the Archaic chronology which has been extended to much of the Atlantic Slope by subsequent research. Coe's Hardaway, Palmer, and Kirk complexes represent the Early Archaic Period in the piedmont and their diagnostic point types are found throughout the study area in North Carolina and non-peninsular Virginia (Hranicky 1974). On the Delmarva Peninsula and in New Jersey, only the Bifurcate tradition (approximately equivalent to the LeCroy complex of West Virginia [Broyles 1971] and reminiscent of the Hardaway complex) has been recognized as representing the Early Archaic Period (R. A. Thomas 1976a). In these locales, Palmer, Kirk, and Stanly series points usually are rare. Along the coastal plain of New Jersey, however, points similar to Palmer and Kirk types have been recorded in "substantial numbers" (Cavallo 1978).

Along the coastal plain, very few Early Archaic sites have been excavated. An exception is the Dill Farm site in Delaware (Thomas 1976), where radiocarbon dates on an associated buried forest range from 10,000 to 9000 B.P.

3.2.4.3 Middle Archaic Period - In the North Carolina piedmont, Coe (1964) defined the Stanley and Morrow Mountain complexes representing the Middle Archaic Period. Points analogous to the diagnostic points of these complexes are recognized in North Carolina and Virginia (Hranicky 1974), the Delmarva Peninsula (Thomas 1976), and New Jersey (Cavallo 1978). Indeed, these points are stylistically similar to Neville and Stark points defined for the Middle Archaic Period in New England.

On the Delmarva Peninsula, R. A. Thomas (1976a) has defined the Crude Corner-notched tradition as dominating the Middle Archaic. It is characterized by crudely flaked corner-notched points, made from pebbles. These points have vague stylistic similarities with Early Archaic and Late Archaic points, but their derivation is obscure and the tradition has not been described elsewhere.

3.2.4.4 Late Archaic Period - As in areas further north, the Late Archaic Period in the mid-Atlantic subareas was characterized by multiple traditions, perhaps in part representing contemporary peoples. The Small Stemmed Point tradition is represented in New Jersey (Kinsey 1972), the Delmarva Peninsula (R. A. Thomas 1976a), and Virginia and North Carolina north of the Roanoke Basin (Coe 1964; Hranicky 1974). In northern portions of the mid-Atlantic states, it is usually known as the Piedmont tradition; in Virginia and North Carolina, as the Halifax complex. Diagnostic artifacts include small stemmed points with thick, nearly round bases. The Laurentian tradition is reported for New Jersey and the Delmarva Peninsula (R. A. Thomas 1976a), but is represented only by sporadic finds in the more southerly portion of the mid-Atlantic subarea. Brewerton and Vosburg points are the primary diagnostic artifacts of the Laurentian tradition in the mid-Atlantic states. The Small Stemmed Point and Laurentian traditions, while only poorly dated, appear to be partially contemporary, spanning dates around 5500 (?) to 4000 B.P.

At the end of the Late Archaic Period, around 4200 to 4000 B.P., points referable to the Susquehanna tradition began to appear throughout the mid-Atlantic subarea. This tradition, usually termed the Broadspear tradition in the northern portion of this subarea and the Savannah River complex in the southern portion, is characterized by broad points of Lehigh, Koens-Crispen, Perkiomen, Susquehanna, and Savannah River types. Another artifact category appearing for the first time in this tradition is the soapstone (steatite) pottery in the form of a shallow bowl carved from soft stone.

The Orient phase (sometimes called the Fishtail tradition in New Jersey) extends southward into New Jersey, but is unreported further south. The diagnostic Orient and Dry Brook points of this phase intergrade with one another and with points of the Susquehanna tradition (Kinsey 1972). The Orient phase, like the earlier Susquehanna tradition, was also characterized by soapstone pottery. Radiocarbon dates for the Orient phase range from 3450 to 2713 B.P. (Kinsey 1972; Ritchie 1965).

Ritchie (1965) and H. Kraft (1970), following John Witthoft, have argued that the addition of stone bowls to the assemblages during the Susquehanna tradition and Orient phase indicates a basic change to a more sedentary lifestyle. Accordingly, they have grouped these cultural units into a "Transitional Period," distinct from both the Archaic and Woodland Periods. While most archaeologists now are skeptical regarding the magnitude of increased sedentism, the label "Transitional Period" continues to appear in the literature.

3.2.4.5 Early Woodland Period - As elsewhere, the Woodland Period is defined by the presence of ceramic pottery. In New Jersey, interior-exterior cord-marked pottery (Vinette 1 ware) is the typical Early Woodland pottery. Further south, typical Early Woodland pottery is steatite-tempered ceramic ware (Hranicky 1974; Manson 1948; and R. A. Thomas 1976a). R. A. Thomas (1976) has termed the cultural unit containing steatite-tempered pottery on the Delmarva Peninsula the Clyde complex. Painter (1977) has described beaker-like pottery radiocarbon dated to 2610 ± 60 B.P., recovered from the Currituck site in the extreme southern portion of the study area. The distribution of this pottery is unknown.

Later in the Early Woodland Period, a mortuary complex became prominent in the mid-Atlantic states, especially the Delmarva Peninsula and the area around the Chesapeake. This complex appears to be absent from southern Virginia and northern North Carolina. The prominence of this mortuary complex undoubtedly has been overemphasized, since intensive research has been devoted to these aesthetically pleasing and complicated remains.

This complex has been called the Middlesex phase by Ritchie and Dragoo (1960) and the Delmarva-Adena phase by R. A. Thomas (1976a), but since only mortuary sites are known, it is better seen as a complex within the Eastern Mortuary Complex (Dragoo 1976). The sites of this complex consist of pits for burial (or reburial) of human remains with elaborate and often exotic material remains, often indicating extensive trade networks. The presence of these remains has been used to argue for rank stratification within the societies which produced these sites (R. A. Thomas 1976a among others).

A large series of radiocarbon dates is available from a series of these mortuary sites, including the Rosenkrans, New Jersey (H. Kraft 1976), Nassawango Creek, Maryland (Bastian 1975), St. Jones River, Maryland (R. A. Thomas 1976b), and West River, Maryland (Ford 1976) sites. The dates, excluding those made on samples known to be contaminated, range from 2560 ± 120 to 1630 ± 400 B.P., with only four of the 11 dates lying outside the period from 2400 to 2000 B.P. Accordingly, the duration of the mortuary complex seems both brief and moderately well demarcated.

Habitation sites contemporary with this mortuary complex are either unrecorded or unrecognized as such.

3.2.4.6 Middle Woodland Period - Following the decline of complex Early Woodland mortuary practices, burial patterns become simple and remain that way through historic times. The Middle Woodland Period is characterized by specific forms of pottery and stone tools and there is an intergrading of forms with those preceding and succeeding this period. The relative complexity of ceramics from the Middle and Late Woodland Periods has provided a detailed data base from which artifact typologies (see for example, Evans 1955) and cultural phases (such as Wright 1973) have been constructed; unfortunately, that same detail has complicated the task of interpretation and the culture history of this period remains only poorly known.

Middle Woodland culture of the mid-Atlantic subarea appear to resemble their Early Woodland forebears, minus the overlay of complex mortuary practices. Subsistence continued to be based on hunting, gathering, and fishing, as in all previous periods, and tool kits and settlement types reflected this basis. Material culture was similar to that found further north, including pointed-bottomed ceramic vessels, small pentagonal and triangular points (probably used as arrow points, at least in part), and a variety of flaked and ground stone tools.

As judged by style and use of exotic stone materials, the early portion of the Middle Woodland Period saw increasing regionalization (Wright 1973). The later portion, however, reflects apparently close ties to New York and the Midwest, as reflected by the presence of platform pipes, distinctive ceramic decorative motifs, and stone materials (R. A. Thomas 1976a).

3.2.4.7 Late Woodland Period - The distinction between Middle and Late Woodland is more or less arbitrary, the division of a continuum. Certain ceramic styles and lithic forms define the period, but a series of cultural events, taking place at slightly different times in different portions, characterize it.

Immediately following the Middle Woodland Period on the Delmarva Peninsula, cultural interaction with outside areas dropped dramatically. This period, around 900 to 1000 A.D., saw the development of indigenous styles and cessation of long-distance importation of artifacts (R. A. Thomas 1976a).

While this regionalization was taking place, maize, squash, and beans were being introduced into the area, probably from the piedmont. Exact dates are unknown, but Wright (1973) believes that introduction may have occurred around 1000 A.D. Certainly, by 1200 A.D., substantial villages apparently dependent upon horticulture were in existence (R. A. Thomas 1976a). Such villages are the logical outgrowth of horticultural or agricultural dependence, bringing together a sizable labor force and providing storage areas for seasonal surplus.

As elsewhere, the Late Woodland peoples became Historic peoples as European contact was made. Ritchie (1949) has documented the fact that for New Jersey there is no precise correlation between archaeological cultures and ethnographic cultures, the former being defined on the basis of material culture, the latter being self-defined by the community or ethnic group.

3.2.4.8 Historic Period - Historic aboriginal groups in the mid-Atlantic states were many, including Lenape (Delaware), Nanticoke, Pocomoke, Susquehanna, Paschatoway, and many others. As was noted for southern New England, the names applied by early European writers may describe a village, a band, a tribe, a confederacy, or other political units and are not necessarily comparable. All groups spoke languages of the Algonquian family.

Political organization varied from area to area. In general, confederacies were most prominent in Virginia and North Carolina; on the Delmarva Peninsula, the individual tribe was the most common form of organization. Within a tribe or village, a headman directed community activities, but apparently had little or no coercive power (Anonymous 1635); in confederacies, however, the power of leaders may have been somewhat greater (J. Smith 1612).

While maize agriculture is reported as dominating the subsistence economy (J. Smith 1612), hunting, fishing, and gathering of shellfish and plants also were important. Smith (1612) notes that for three of the five seasons into which the Indians of Virginia divided their year, they "live of what the country naturally affordeth from hand to mouth."

The main unit of settlement throughout this subarea in historic times was the village, described as ranging in population from 200 to 1000 (J. Smith 1612). This village typically was situated so as to take advantage both of fish resources and agricultural land, as well as hunting lands (Turner 1978). Seasonal movements took place in most cases, but apparently it was usual only for special work forces to travel to another camp, as with winter hunters among the Susquehanna in Maryland (Alsop 1666). Smith's (1612) "hunting townes" and Bland's (1650) fishing places and shellfish gathering places apparently are analogous sites, occupied by small groups from villages for longer or shorter periods.

As elsewhere, contact with Europeans led to the downfall of these aboriginal cultures, chiefly through population decline. Land purchases, conquest, and more subtle techniques of acculturation completed their demise.

3.2.5 Comparison

The lesson of the first half century of culture historical studies is that there are few abrupt boundaries in space and time. Cultures change gradually through time; interaction through space causes cultures to blend. The transmission and adoption of culture traits do or do not take place because of myriad reasons; if diffusion takes place, it may be at different rates for different items.

Given these caveats, Chart II-4 is a simplified representation of the culture history of the project area, based on the treatment in this section. The textual treatment has dealt with each subarea separately, but Chart II-1 attempts to relate those separate discussions into a coherent whole. The text, for the most part, has omitted the results of highly detailed, controversial, or irrelevant research in an effort to present a simplified classification scheme, yet to hint at the true complexity of the subject. Chart II-4, on the other hand, is designed to serve two purposes: as an integrative device unifying the separately discussed subareas and as a reference guide which includes smaller culture units than the text discusses.

While the Paleo-Indian, Archaic, and Woodland Periods have been defined according to very simple, universally applicable criteria, the same is not true of traditions. Consequently, periods logically would have to cut across all subareas, but traditions would not. The high degree of comparability of traditions in all subareas of the project area (see Chart II-4) underscores a great similarity in the culture history of the Atlantic Slope.

This point has been made by many authors. Ritchie (1965) and Funk (1977b) have noted the similarity of material cultures in the Early Archaic Period, as Dincauze (1972, 1976) has for the Middle Archaic Period. Sears (1954), Dincauze (1968), and Brennan (1967) have noted it for the Late Archaic Period and Kinsey (1974) has documented a similar pattern in Early and Middle Woodland times. Although Turnbaugh (1975) and others have argued for a south-to-north gradient toward more recency, the pattern is far from clear and approximate contemporaneity seems equally reasonable.

The case of the Paleo-Indian Period requires special comment. The "commonsense" argument that more rigorous glacial and early post-glacial conditions in the north would have precluded human occupation as early as it occurred in the south receives little empirical support. Absolute dates presently available suggest comparability of the dates of earliest settlement in all portions of the project area, even if density of population may have differed, suggesting rapid dispersal into the study area.

3.3 Subsistence Patterns

The need for food is one of the most basic and pressing needs which underlie human biological survival. The reliance on hunting, gathering, and fishing which has characterized the greatest part of the aboriginal culture continuum in the study area has forged a strong link between the distribution of food resources and human settlement.

This section discusses the characteristics of the subsistence patterns practiced in the study area in the course of prehistory and pertinent general characteristics of hunting-gathering societies. Section 5, which develops inductive settlement models, will refer back to the discussion and conclusions of this section.

Since the subsistence patterns in the study area share much in common, they will be treated by topic, rather than by subarea. The topics are exploitation of megafauna, generalized hunting/gathering/fishing, coastal and maritime exploitation, and agriculture.

3.3.1 Exploitation of Megafauna

Megafauna are simply large animals, in the case of eastern North America animals associated with the glacial period. While their heyday was during full glacial times, various species persisted into post-glacial times, becoming extinct at different rates and times. Some of the better known of the eastern North America megafauna include mammoth, mastodon, giant beaver, and others. Although not strictly big game, some authors include caribou in areas which now have temperate climate, since they were moderately large, gregarious, and are postulated by some scholars to have formed a food resource comparable to the true megafauna. (Megafaunal resources are discussed further in Section 4).

In western North America, Paleo-Indian artifacts were first recognized as ancient by virtue of their association with long extinct megafauna (H. J. Cook 1927 ; Figgins 1927) and ever since then, kill sites of mammoths and extinct bison have held prominence in the western Paleo-Indian literature. Only recently (Wilmsen 1973), have concerted efforts been made to investigate the inputs which smaller game made into the Paleo-Indian diet, inputs which probably dwarfed the input of megafauna.

Traditional archaeological interpretations (or, in some cases, conjectures) have concluded that the exploitation of megafauna was important during the Paleo-Indian Period in eastern North America (Funk 1976; J. Kraft 1977; Quimby 1958; Ritchie 1965), although some authors accept the possible significance of small game as well (for example, Ritchie 1957). These interpretations focus primarily on mammoth and mastodon, but great sloth, extinct horse, and other species are included by some authors.

Excluding caribou from megafauna for the moment, the evidence for Paleo-Indian exploitation of big game in eastern North America is very slim. Although many presumed associations of Paleo-Indian artifacts and mastodon have been championed (for example, Palmer and Stoltman 1976; Williams 1957; Wittry 1965), none have been demonstrated conclusively. In most cases, poorly recorded nineteenth-century accounts or oral traditions of association are cited as evidence. These poorly documented claims, coupled with indisputably overlapping distributions of megafauna and Paleo-Indians (Funk 1972; J. Kraft 1977) and expectations molded from western North American experience, constitute the only support for eastern Paleo-Indian exploitation of these megafauna. Such exploitation is quite possible, but the absence of clear-cut support, despite hundreds of known mastodon skeletons, argues for the rarity of such hunting.

More recently, attention has focused on caribou as the primary faunal resource (Funk 1972; MacDonald 1968). Caribou bones have been found in association with Paleo-Indian artifacts at the Holcombe Beach site in Michigan (Cleland 1965; Fitting and others 1966) and at the Dutchess Quarry Cave in southern New York (Funk and others 1969; Funk and others 1970; Guilday 1968, 1969).

The context at Dutchess Quarry Cave deserves further attention. The association of a Cumberland style fluted point with an apparently-too-early radiocarbon date at this site has already been discussed. In addition, the faunal assemblage associated with that point appears unusual. Caribou and white-tailed deer normally inhabit quite different environments, and Funk and others (1969) have suggested that their association at Dutchess Quarry Cave indicates mixing of strata, the deer bones intruding from above. Alternatively, the point may have intruded from above or, since deer and caribou can inhabit zones within a short distance of one another (Arthur Spiess, personal communication, 9/4/78), the association may be valid. The association of caribou and artifacts at this site must be considered in light of the vagaries of context.

That eastern Paleo-Indians and megafauna occupied the same areas contemporaneously is unquestionable; that the Paleo-Indians exploited megafauna to some degree is probable and has been documented in the case of caribou. The suggestion that megafauna constitute the primary resource for eastern Paleo-Indians, however, is highly doubtful.

During the Paleo-Indian Period, vegetational reconstructions (see Section 4) suggest that for the Paleo-Indian Period, vegetational succession in the undeveloped soils was very slow, even though plants began to colonize almost immediately. These conditions led to a temporarily unstable and unpredictable environment with limited biomass. Biological studies have produced the generalization that unstable environments - ones subject to drastic annual fluctuations - cannot support animal adaptations based on specialized exploitation of one or a few species (MacArthur 1972). The application of this principle to eastern Paleo-Indians produces a hypothesis that the subsistence base was broad, not keyed to megafauna or any other single category of resources, and that increasing environmental stability on a southward gradient would permit increasing specialization of exploitation. This hypothesis cannot be tested adequately, because of the paucity of Paleo-Indian faunal remains in the East, but the absence of demonstrated megafauna kill sites supports its corollary that exploitation would not focus on megafauna.

For the special case of caribou, Burch (1972) has marshalled a convincing argument that their population was instable and that they presented difficulties for exploitation by human beings, concluding that human specialization in caribou exploitation would be a dangerous strategy. Hoffman (1976) has presented an ethnohistoric study of the Caribou Eskimo which stresses the same point, concluding that the Caribou Eskimo dependence on caribou was an emergency measure occasioned by disastrous culture changes resulting from interaction with Euro-Canadian society.

3.3.2 Generalized Hunting/Gathering/Fishing

Throughout eastern North America, available evidence indicates that the basic pattern of generalized hunting/gathering/fishing characterized the subsistence of most pre-agricultural societies. This pattern includes exploitation of a broad range of available resources (but rarely or never all). The degree of input to diet from various sources has varied from situation to situation, apparently being dependent on the difficulty of procurement and availability of potential resources.

In temperate climates such as the project area, the availability of resources will vary with the season. In response to this and other factors, hunter-gatherers typically appear to have followed a transhumance pattern, a regular and cyclic annual round comprised of a series of sites placed so as to take advantage of locally available seasonal resources. Some of these seasonal sites may have faunal assemblages reflecting heavy reliance on one or a few species, but viewed in perspective of the total year, subsustence remains generalized.

During the last fifteen years, anthropological thought on hunting-gathering-subsistence has undergone profound change, change which has bearing on the modeling of settlement patterns which is the goal of this project. Two topics of importance are the viability of hunting-gathering as a successful strategy and the relative importances of hunting, gathering, and fishing in nonagricultural societies.

Industrial societies typically have viewed hunting-gathering as a "savage" way of life and Western scholarship traditionally has accepted that viewpoint, with its implications of precariousness, hardship, and difficulty. In part, this view was a product of the pushing of hunter-gatherers into marginal environments by Western colonial expansion before ethnographers studied them, leaving representative hunter-gatherers only in the most inhospitable of environments. R. B. Lee's studies (1965, 1969) in just such environments, however, have shown that the per-capita effort required for subsistence by hunter-gatherers is far less than that expended by agriculturalists, although more land is needed per person.

An implication of this finding is that agriculture is less a discovery that releases societies from the burden of hunting and gathering, than a necessity to which people are forced by increasing intensity of exploitation of limited land areas. Accordingly, the strict dichotomy of hunting-gathering <u>versus</u> agriculture now appears to be more of a gradation: hunting, gathering, and fishing are not ignored after agriculture is discovered, but they diminish in importance as agriculture becomes more prominent. Ethnohistoric data from the project area show a variety of positions along this continuum, suggesting that an abrupt shift in subsistence and associated settlement patterns should not necessarily be expected to coincide with the introduction of agricultural practices.

The relative importance of hunting, gathering, and fishing was first studied systematically and cross-culturally by R. B. Lee (1965, 1968). His study of a series of hunting-gathering societies around the world led him to the conclusion that gathering (the collection of non-mobile food, whether animal or plant) was quantitatively far more important than hunting and fishing (the collection of mobile animal food) in all but high latitudes, where scarcity of flora diminished their importance.

This conclusion was a radical departure from earlier thought, but has been accepted generally by the anthropological discipline. Recently, however, Ember (1978) has called Lee's study into question. The results of her study are presented in Tables II-1 and II-2. Briefly, her research shows that gathering does not dominate other sources of food procurement in temperate zones as a rule, but that balanced exploitation among hunting, gathering, and fishing is typical, perhaps with fishing slightly dominant. (Since horse-using hunter-gatherers often are believed atypical, data were tabulated with and without the inclusion of equestrians.)

Ember's study used the same data base as Lee's, the Human Relations Area Files' Ethnographic Atlas, but the results differed greatly. She attributes this to two factors. First, Lee considered shellfish exploitation "gathering," since the resource was immobile; Ember called it "fishing." Second, Lee drastically reduced the number of North American societies in his sample, since there is a more extensive literature on North American hunter-gatherers than on their counterparts elsewhere. By equalizing the samples from different continents, Lee diminished the impact of North American hunting-gathering patterns, which tend toward greater hunting and fishing inputs than do others. Ember argues that such a reduction serves little value.

The controversy over the views espoused by Lee and Ember has just begun and there is no concensus in the discipline. However, for North American studies, Ember's work, with its greater North American input, seems more appropriate. Accordingly, the food resources selected to provide the basis for the deductive model developed in this study are resources which Ember's argument would suggest to be important.

3.3.3 Coastal and Maritime Exploitation

Major controversy surrounds the attractiveness of the coastal zone to human habitation. Osborn (1977) claims that the coast is and always was an environment undesirable from the standpoint of human subsistence. He claims that human expansion into that zone took place only as a result of increasing population pressure inland, forcing the exploitation of unfavorable environments.

Osborn's argument is unconvincing on several fronts. First, he is unable to document or even logically argue for the suggestion that inland population densities were "close to carrying capacity" at the date of documented coastal use. Populations rarely approach the theoretical limit set by resources (carrying capacity) and populations appear to have continued substantial growth inland after the documented development of coastal adaptations. Notably, Osborn's Peruvian test case fails

TABLE II-1. Importance of gathering to hunter-gatherers, based on cross-cultural study by Ember (1978).

Percentage of diet (in calories) (contributed by gathering)	Number of societies: Total hunter-gatherer sample	Omitting equestrians	North American hunter-gatherer sample
Greater than 50%	18 (10%)	15 (10%)	12 (8%)
About 50%	24 (13%)	24 (16%)	20 (13%)
Less than 50%	138 (77%)	109 (74%)	120 (79%)
TOTALS	180 (100%)	148 (100%)	152 (100%)

TABLE II-2. Dominance of food collection techniques among hunter-gatherers, based on cross-cultural study of Ember (1978).

Dominant food collection technique	Number of societies		
	Total hunter-gatherer sample	Omitting equestrians	North American hunter-gatherer sample
Gathering	54 (30%)	51 (34%)	43 (28%)
Hunting	45 (25%)	21 (14%)	38 (25%)
Fishing	69 (38%)	64 (43%)	63 (41%)
Codominance	12 (6%)	12 (9%)	8 (5%)
TOTALS	180 (99%)	148 (100%)	152 (99%)

to demonstrate his contention. Second, by grouping all marine environments together, Osborn claims very low productivity of food. In truth, the most productive ecosystems in earth are coastal (see Section 4); average productivity is lowered by including deep sea environments. Third, Osborn fails to consider adequately the inundation of former coastal zones by rising post-glacial relative sea levels. It is little surprise that documentation for Pleistocene human coastal adaptations is scant when virtually all Pleistocene coastal zones are presently submerged and have had little or no investigation. Osborn's argument is marred by numerous smaller flaws, but those listed above are sufficient to refute it.

Perlman (1978) has argued the opposing case. He cites high productivity of certain coastal zones and especially high caloric return rates. In short, modern coastal zones present resource densities and distributions which can yield a great deal of food for relatively little effort. The case for prehistoric coasts is more complicated.

The oldest known remains of human coastal adaptations in the project area are Early and Middle Archaic shell middens from the lower Hudson Valley (Brennan 1974). These sites were formed in upper reaches of the estuary and, because of a complex interaction of relative sea level rise, sedimentation, and topography, were preserved above water after millennia of relative sea-level rise.

In the rest of the project area, no sites with evidences of coastal adaptation are known before the Late Archaic Period and they become common only in Woodland times. In most of the project area, this may be related to inundation by the sea, but Maine forms a special case. There, local land movements have reduced the effects of eustatic (world-wide) sea-level changes and many near coastal areas remain above present sea level. (See Volume I.)

Snow (1972) has suggested that failure to utilize the coastal zone of Maine was the result of inadequate technology or food taboos. (This notion is strictly analogous to Ritchie's [1969] suggestion that early coastal occupants had not discovered that shellfish could be eaten and that their successors gradually learned that some species were edible. This learning was claimed to be in a logical sequence of ease of discovery, indicated by the sequence in which species first appeared in sites.) Both Snow's and Ritchie's notions presume that the human exploiters displayed considerably greater conservatism than is usually demonstrated by living peoples.

An alternative school of thought, more generally accepted, argues that rising relative sea levels not only obscured possible earlier sites evidencing coastal use, but that the changing sea levels altered the resource endowment of the coastal environments affected. Braun (1974) has presented a convincing case relating the percentages of species of shellfish found in coastal shell middens to the percentages of those species available in the coastal zones.

In Maine, Sanger (1975) has suggested that the low tidal amplitude which Grant (1970) has argued for the Gulf of Maine before 5000 B.P. would have limited the biological productivity of the coastal zone to a level lower than it displayed later. David Yesner (personal communication) has suggested that lower tidal amplitude would have produced a different mix of molluscan species. The engineering and biological considerations involved in evaluating either of these hypotheses are far beyond present capabilities.

In summary, arguments against the early use of the coastal zone are unconvincing. Tests are either impossible with available knowledge or the tests fail to support the contention. In the absence of demonstrations that coastal zones were unattractive and in light of the fact that there are logical (though untested) arguments for early exploitation of coastal zones, it is concluded that such exploitation was likely.

Maritime exploitation - the use of resources available only in the open sea - is documented only very weakly. Up and down the project area, sites occasionally yield remains of species available primarily in the open ocean, but most of these species are also available for short periods in estuaries (Barber 1979b) or are subject to beaching (Snow 1972). Only during the Late Archaic Period in Maine is there consistent, unequivocal evidence of maritime exploitation. There, in sites of the Maritime Archaic tradition, remains of swordfish and other deep sea species have consistently been found.

3.3.4 Agriculture

The term agriculture, as used in this report, refers to the purposeful planting of seeds or cuttings to bring about localized growth of economically important plants. Some authors distinguish between "agriculture" and "horticulture" on the basis of intensity of planting, the type of species planted, or the type of technology employed. While these distinctions have value, they are difficult to use with the incomplete data base available for the study area. Accordingly, "agriculture" has been used as a blanket term to include purposeful planting in general.

The adoption of agriculture was late in the culture continuum in the study area. In eastern North America, agriculture hinged upon the importation of maize from the west and south. Throughout the study area, the earliest known remains of maize date to around 1000 A.D. (Dincauze 1974; Ritchie 1965, 1969; Wright 1973) and there is little reason to believe that crop growing was a significant activity before this date. Indeed, in most of Maine, agriculture had not yet been adopted by aboriginal peoples in historic times.

The ethnohistoric record suggests a pattern of swidden agriculture, where fields are used for crops for a few years, then left fallow in a regular cycle spanning many years. Such a system is necessary to maintain soil fertility when no fertilizers are used (either intentionally or coincidentally, as in dissolved nutrients in irrigation waters).

A swidden system requires a great deal of land, several times the area which could produce an adequate annual crop for a year or so. Given that soils able to be easily and productively tilled by aboriginal techniques have limited distributions, the human population supportable by swidden agriculture is also limited, though probably greater than that which could subsist by hunting-gathering.

Agricultural systems necessitate a certain degree of sedentism, but not necessarily year-round residence at a single site. In the northerly parts of the study area, essentially from New Jersey north, settlement appears to have been semi-sedentary, with agricultural pursuits grafted onto a set of traditional foraging practices. A continuum of increasing sedentism stretched southward.

4.0 SUMMARY OF RELEVANT PALAEONTOLOGY

Human settlers must decide whether to settle within a given area and, if so, at what locations within that area. Those decisions are based on many considerations, but with hunting-gathering economies, the distribution of food resources must exert strong influences on the locations of settlements. Those aspects of palaeontology believed to have the strongest effects on the distribution and density of plants and animals which might have served for human food on the CS are discussed in this section.

There are three basic approaches to the reconstruction of past flora and fauna. First, one may use direct evidence in the form of fossil or subfossil remains of species to infer their presence. This approach is more successful for some species than others and always must be used with care. For example, certain plants and invertebrate animals in particular have few body parts which preserve well; other species may be difficult or impossible to distinguish from one another on the basis of the body parts preserved; and some lived in environments strongly unfavorable to preservation. Because of these problems, the absence of remains of a species indicates little; the presence of remains, if it can be argued that the remains were not carried great distances by wind, water, or predators, indicates the presence of the organism in that area. In general, this approach gives limited but reliable reconstructions in terms of presence of resources. Its application to the CS is limited by the scarcity of recovered remains of species with potential as food for human beings, possibly excepting shellfish.

Second, inferences may be drawn using available evidence on species other than the ones of interest. Certain recurrent combinations of plants and animals, termed "biotic communities," are known from modern and a few ancient examples. The presence of several of these species may be used to infer the remainder. Sufficient data often are available to implement this approach, but there are strong limitations. Biotic communities are not immutable and change as environments change around them. To force all inference into such Procustean categories denies the fact that ancient conditions were in many cases quite different from any known from modern times. When applicable, however, results are moderately reliable.

Third, the presence and density of a resource may be inferred on the basis of conditions known to have affected its distribution. This approach is the most widely applicable of the three, since some evidence is nearly always available, but its reliability is the lowest. Factors affecting extinct organisms are poorly known in most cases and sometimes are little better known for modern species. Further, colonization of a newly utilizable environment may occur much later due to slow migration/transportation rates or geographical barriers separating the earlier range of the species from this newly available environment.

In short, the reconstruction of paleoresources using any one of these three approaches would be either highly incomplete or moderately unreliable, or both. By combining the three approaches - using the most reliable approaches when data are available and plugging information gaps by using the less reliable approaches - an approximate picture of past resources can be obtained. However, the adequacy of that reconstruction must be considered suspect in view of the inadequacy of the present data base. In fact, the reconstruction of paleoresources probably has a poorer or less complete data base than that of any other topic addressed in this volume.

The sub-sections which follow discuss paleoclimates and paleoenvironments on the CS. Then, using the three approaches outlined above, paleoresources are discussed.

4.1 Paleoclimate

4.1.1 Purpose

Given the presence of soils which will support plant life, climate is generally considered the single most important determinant of the biological environment. Many plants have developed moderately narrow climatic limits within which they can live, and animals, ultimately, are limited by the plants or herbivores upon which they feed.

Prehistoric climatic change can be inferred from three basic sources of data: geomorphology, vegetation, and fauna. Geomorphological features, in general, provide only very coarse-grained information about paleoclimates, such as presence or absence of glaciers or permafrost. Accordingly, their value to this project is eclipsed by vegetational and faunal data. In particular, vegetation is studied through pollen remains and fauna through plankton, molluscs, and mammals.

4.1.2 Vegetation

4.1.2.1 Methods and Results - Since identifiable remains of wood, seeds, or other such plant parts are only rarely found in natural prehistoric deposits, they cannot be used with consistency as paleoclimatic indicators. Instead, pollen is the most-studied floral indicator of paleoclimate.

Pollen is not only preserved better than most other plant parts, but is easily carried by the wind. Consequently, a single pollen deposit represents not merely the vegetation within a few meters, but that within miles. This characteristic of the pollen record reduces the likelihood that a single deposit reflects the idiosyncrasies of only a tiny corner of the floral environment, but it also causes a blurring of pollen spectra when samples have received pollen from two or more discrete floral zones.

Another complication in pollen analysis arises from differential production of pollen by different plants. Certain taxa, such as pine, produce vast quantities of pollen, sufficient to mask variations in the percentages of pollen from trees shedding less copious amounts (M. B. Davis 1963 among others). The use of simple percentages of different pollen types, as if these percentages of pollen were proportional to percentages of tree species in the environment, cannot be justified.

Studies (R. B. Davis and Webb 1975; M. B. Davis and others 1973; J. C. Ritchie and Lichti-Federovich 1967; Webb and McAndrews 1976) of modern environments and pollen percentages produced by them, however, have provided approximations of the percentages of different pollens which characterize different environments (Table II-3). The use of pollen percentages can produce a general picture of an environmental type, but it is deficient in two important respects. First, it can only identify gross types of environment. Densities of various species cannot be calculated and the overall density of plant growth can be approximated only by analogy to modern cases. Second, in situations where differential colonization rates have produced environments without modern analogues, percentage pollen analysis will make the environment appear to fit into a pre-established type; variations within that type cannot be described or differentiated.

To avoid these problems, M. B. Davis (1969b) has devised a technique utilizing absolute pollen counts. In this technique, radiocarbon dates are determined in order to obtain sediment accumulation rates, and carefully measured volumes of sediments are taken as samples. When absolute counts of pollen grains are made, these counts can be converted to grains-per-square-centimeter-of-surface-area-per-year. What we know about differential production of pollen by different plants can then be used to calculate the percentages and densities of different plants in the environment. The technique has been applied to modern cases and it has been demonstrated that the pollen counts can be used to infer the vegetation producing them with good accuracy (M. B. Davis and other 1973).

Percentage pollen data have certain utility in reconstructing paleoclimate; absolute pollen data allow refinements and, in some cases, revisions. Unfortunately, the data collected and methods of collection differ between the two methods. It is impossible to transform percentage data into absolute data. Since most pollen analysis has been performed by the percentage method, most of the interpretations in this study are derived by that method. The more reliable absolute count method has been used whenever available to modify or expand the reconstruction derived by percentages of pollen.

Table II-3. Ranges and means (means in parentheses) of absolute pollen percentages in different vegetation types. (compiled from: Ritchie and Lichti-Federovich 1967; R.B. Davis and Webb 1975; Webb and McAndrews 1976)

VEGETATION TYPE	SPRUCE	PINE	SEDGES	GRASSES	OAK	BEECH	HICKORY
TUNDRA	5-15 (10)	5-15 (10)	12-20	5-10	--	--	--
FOREST-TUNDRA	15-40 (30)	10-20 (15)	5-10	1-5	--	--	--
BOREAL FOREST	15-35 (25)	20-30 (25)	1-2	1-2	--	--	--
CONIFER-HARDWOOD	5-10	15-45 (30)	--	--	5-20 (15)	5-10	1-5
DECIDUOUS FOREST	--	10-15	--	--	20-60 (30)	1-5	5-10
OAK-HICKORY-PINE	--	30-45	--	--	15-30	--	1-5

Recently, pollen analysts have expressed increased concern about factors other than climate which might affect vegetational patterns (Butzer 1971; M. B. Davis 1967; Fagan 1978; Wendland and Bryson 1974). Chief among these are edaphic (soil-related) factors and seed-dispersal rates. Different soils favor different vegetation and not enough detailed pollen analyses have been completed to allow the recognition of basic patterns and their soil-induced variants. Differential seed-dispersal and colonization rates can produce lag between a modified climate and the flora indicating it. This lag can produce unique and ephemeral floral associations, serving as a reminder that vegetation types are generalizations drawn from modern cases and may not be strictly applicable to prehistoric cases.

Pollen has been argued to be a valid indicator of vegetation or vegetation type. The final requirement for reconstructing climate is a knowledge of species' requirements. While pine thrives in cool, dry climates, spruce prefers cold, wet climates, and beech prefers warm, moist climates. Cox (1959) has catalogued requirements for the species relevant to the project. The climate characteristics favored by species dominating at a given period are inferred to be the characteristics of the climate at that period. This method derives qualitative characteristics ("warm," "cool") but no quantitative measures of temperature or precipitation.

A large number of pollen analyses have interpreted pollens of the last 15,000 years from the area between Maine and Cape Hatteras. The analyses of 22 localities have been selected for use in this summary, based on geographical location, completeness of sequence, application of radiocarbon dating, and sophistication of methods applied. These localities are listed along with their references in Table II-4 and located in Fig. II-4. Additional pollen sequences have been considered indirectly, since they have been used in the construction of other summaries (for example, Fagan 1978); information on many of those sequences is unpublished and unavailable in other form.

As Fig. II-4 shows, the sites from which the pollen sequences were derived are distributed more or less evenly among the five subareas under consideration. Most of the sites are located near present-day shorelines, but only two (4 and 5) are located on the inundated portion of the Continental Shelf. These samples were taken from a drowned river channel and the analysts (Balsam and Heusser 1976) believe that the pollen had been washed downstream from areas presently above sea level.

Most of the pollen samples are from areas which would have been considerably inland at the time of deposition, at least for the early millennia of the time span under study, and none can be argued to represent a truly coastal environment. This deficiency is unavoidable, since no such samples have been analyzed to date, but it necessitates the assumption that coastal vegetation and climates were similar to inland ones.

TABLE II-4. List of pollen localities and references for analyses. Numbers are keyed to Fig. II-4.

NUMBER	LOCALITY	REFERENCES
1	Rockyhock Bay	Whitehead (in prep.)
2	Dismal Swamp	Whitehead 1972
3	Chesapeake Bay Crossing	Harrison and others 1965
4	V26-176	Balsam and Heusser 1976
5	V24-1	Balsam and Heusser 1976
6	Delmarva Peninsula	Sirkin and others 1977
7	Buckles Bog	Maxwell and Davis 1972
8	Criders Pond	Watts (personal communication)
9	BR 12; SH 29	Sirkin and others 1970
10	Marsh Co.	Martin 1958
11	Longswamp	Watts (personal communication)
12	C149	Sirkin and others 1970
13	Berry Pond	Whitehead (in prep.)
14	Pleasant Street Bog	M.B. Davis 1958
15	Pine Log Bog	Connolly and Sirkin 1973
16	Protection Bog	Miller 1973
17	Tannersville	Watts (personal communication)
18	Barnstable Marsh	Butler 1959
19	Bugbee Bog	McDowell and others 1971
20	Mirror Lake	Likens and Davis 1975
21	Moulton Pond	R.B. Davis and others 1975
22	Rogers Lake	M.B. Davis 1969b

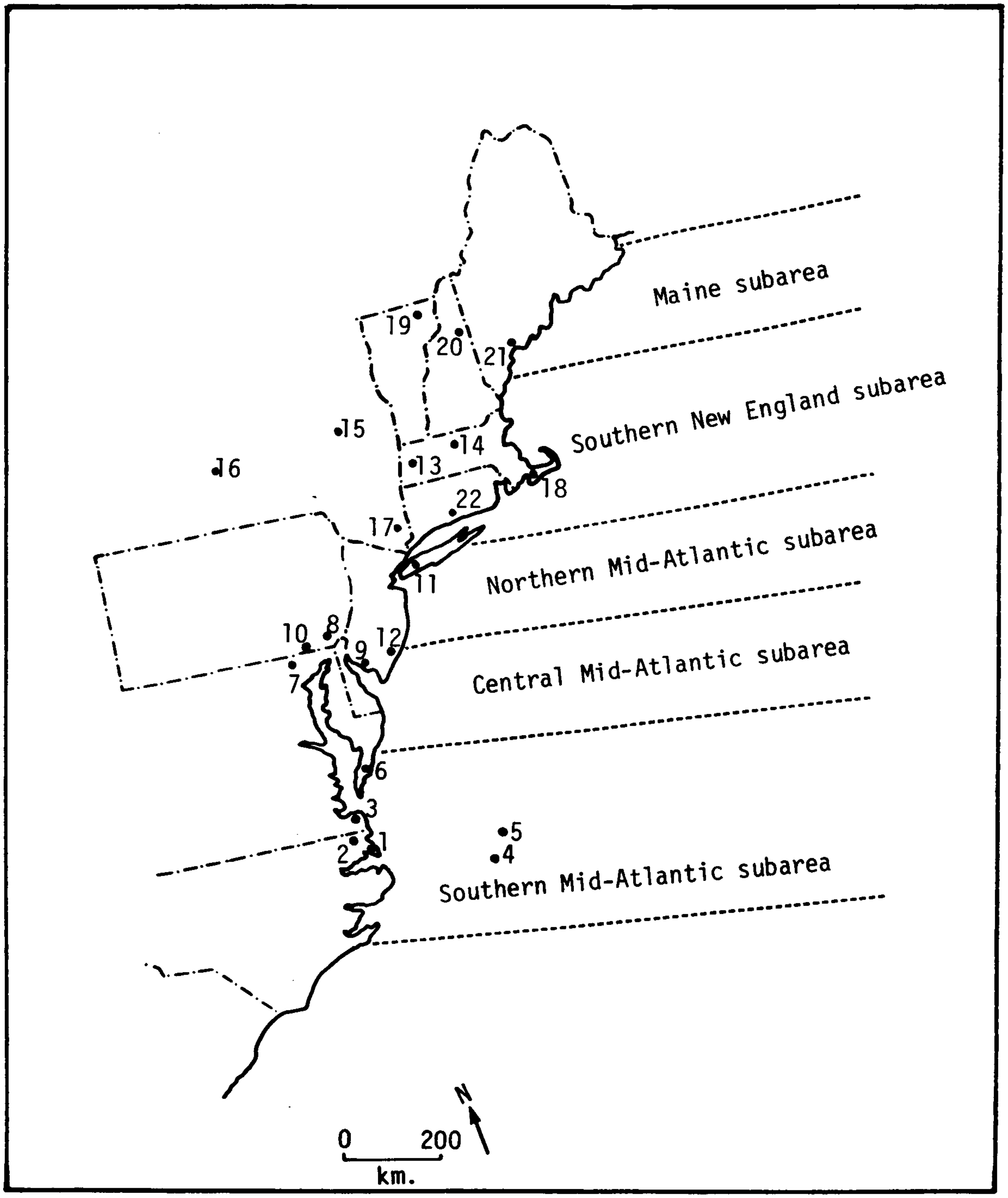


Fig. II-4: Locations of analyzed pollen cores; key and references in Table II-4.

Two major factors have been argued to have made coastal and inland climates differ in late glacial and early post-glacial times. First, Bryson and Wendland (1967) argue that the continental glacier barred low-level cold air from moving over inland eastern North America, channeling it out over the Atlantic Ocean and causing it to strike the coast. Second, Manley (1955) suggests that humid air sweeping up from the south would have produced persistent cloudiness. The coastal zone, therefore, would have been cooler and wetter than inland areas. These factors, it must be remembered, are purely inferential and hypothetical. Neither the existence nor the magnitude of their effects is documented (or refuted) by data.

Maine subarea - The pollen-bearing deposits that provide information about the time periods in the vegetational history of the Maine subarea have been divided into four zones. The first pollen zone, which covers the period from about 14,000 B.P. to about 9700 B.P. represents a time-period of herb-shrub tundra with a spruce woodland appearing at the end of the period. During the time represented by Zone I, pollen influx from Moulton Pond, Maine (R. B. Davis and others 1975) was extremely low. The influx values are considerably lower than the estimated pollen influx values from modern tundra regions in northeast Canada. Percentages of non-arboreal pollen (NAP) are high in this zone, with those of sedges, grasses, shrub birch and alder representing the most common types. The most prevalent tree types at Moulton Pond include spruce, pine, birch, oak and fir. The pollen influx, however, is so low compared to modern influx from tundra areas that R. B. Davis and others (1975) consider it doubtful that forest or tundra-forest even existed in the vicinity of Moulton Pond during the time represented by Zone I.

In the period of Zone I representing a date between 10,500 B.P. and 9700 B.P. at Moulton Pond, the vegetation changed from tundra to a mixed boreal-temperate woodland, quite unlike the boreal forest of today. The presence of temperate taxa in the Moulton Pond profile suggests that deciduous trees had been present in favorable locations some 2,000 years earlier in southern New England. By 10,000 B.P., these deciduous species had migrated, in response to ameliorative edaphic conditions, to northern New England where they had become important consultants of the vegetation (R. B. Davis and others 1975). Spruce, which prefers water-holding soils, would have occurred in the lowland areas such as near bogs, lakes or streams, while other taxa, such as oak, would have grown in the drier, better-drained upland areas (Eisenberg 1978). During the same period further west in Vermont, radiocarbon dated from 10,500 ± 200 B.P. to 9300 ± 200 B.P., an extensive forest of spruce-fir type occurred in the vicinity of Bugbee Bog (McDowell and others 1971). High pollen percentages of spruce and fir together with low percentages of deciduous tree pollen suggest that climatic and/or edaphic conditions were cooler and moister than at present.

Zone II, described in the literature (Bradstreet and Davis 1975; Davis and others 1975; Sanger and others 1977) as the Conifer-Hardwood Period, extends from about 9700 B.P. to about 4700 B.P. and marks the beginning of postglacial times. The lower portion of this zone (subzone 2a), which ends about 7100 B.P. and corresponds to Deevey's (1939) Zone B or "Pine Zone," represents a period of conifer-dominated mixed forests. White pine, birch, and oak were the major constituents of an open forest (R. B. Davis and others 1975). Even though pine pollen percentages are high, R. B. Davis and others (1975) suggest that oak pollen, which attains its highest value for the entire postglacial period around 8000 B.P., may be just as important as pine in the vegetation. Because pine pollen is often overrepresented in the pollen rain, high pollen values may not necessarily indicate that pine was the dominant tree type in the forest. High NAP values suggest that the forests around Moulton Pond were open at this time. The postglacial sequence from Vermont resembles, in many respects, the one described for Maine. The beginning of the postglacial period (Deevey's Zone B), radiocarbon dated at 9300 ± 200 B.P. from Bugbee Bog, is marked by a conspicuous increase in pine pollen percentages and a corresponding decline in frequencies of spruce and fir. Data comparing pollen collected from surface samples on lake bottoms to the existing vegetation convince McDowell and others (1971) that pine is overrepresented in the pollen profile. Relatively dry conditions would have prevailed in both the Moulton Pond, Maine and the Bugbee Bog, Vermont areas during the period represented by subzone 2a.

The upper portion of the Conifer-Hardwood Zone (subzone IIb), dating from 7100 B.P. to 4700 B.P., represents a period of shifting conditions as evidenced by variations in abundance of the different taxa. Hemlock becomes important in the vegetation, reaching its maximum for the postglacial period around 5500 B.P. (R. B. Davis and others 1975). Pine, birch, and oak remained important constituents of the mixed forests. Beech and other northern hardwoods such as maple, ash and elm also became important components in the vegetation at this time. The forests grew in diversity during this period in central Maine. In contrast to the high percentages of pine pollen from Maine, the Bugbee Bog profile in Vermont shows a significant decrease in the abundance of pine pollen. Deciduous trees such as maple, basswood, hickory, and elm would have occurred as important constituents of the forest in the vicinity of Bugbee Bog. Changes in the pollen assemblies, together with low NAP frequencies from both Maine and Vermont, suggest that the forests in northern New England were more closed than they had been during the previous period. Biological and edaphic factors such as migration, succession, and soil development, rather than climate, may provide effective explanations for the changes in vegetation that occurred between 7100 B.P. and 4700 B.P. (R. B. Davis and others 1975).

The third zone, referred to as representing the "Hardwood-Conifer" Period, about 4700 to about 200 B.P., represents a time of hardwood-dominated mixed forests. The beginning of the period, from 5200 to 4300 B.P., marks a significant decline in the proportion of conifers, especially hemlock. A decline in the abundance of hemlock during this period is also recorded from Holland Pond, Maine (Bradstreet and Davis 1975) and Bugbee Bog, Vermont (McDowell and others 1971). At Bugbee Bog, pine, beech, oak, and birch reach maxima between 4000 B.P. and 1600 B.P. In the upper portion of Zone III, representing the period from 3400 B.P. to 200 B.P., hemlock pollen attains a second peak and beech percentages reach a maximum. Pine, spruce and alder pollens reach their lowest postglacial values at this time. A closed temperate hardwood-hemlock forest probably occupied much of northern New England around 3400 B.P. (R. B. Davis and others 1975).

During the final period represented by Zone IV, beginning about 200 years ago, the mesic hardwood and hemlock forests were replaced by a vegetation dominated by spruce, alder, grasses, and ragweed, thus marking the impact of Europeans on the landscape (R. B. Davis 1967).

Southern New England subarea - The vegetational sequence for southern New England, like that for Maine, has been divided into four major zones on the basis of compositional changes in the dominant tree and plant types. In virtually all the pollen profiles documented from southern New England, there exists a Late-glacial basal herb pollen zone where herb pollen is more abundant than tree pollen. This herb pollen zone (Zone I) is believed to have represented a treeless vegetation or tundra which lasted from about 15,000 B.P. to about 12,000 B.P. in southern New England. The tundra zone from Roger's Lake, Connecticut (M. B. Davis 1969a) shows high percentages of pollen from herbacious plants. Willow was the most important shrub-type while pine, spruce, oak, and poplar were the major tree types. A comparison of the fossil pollen assemblages with samples taken from modern tundra regions suggests that the basal herb pollen zone may not represent true tundra conditions. To date, no modern analogue has been found for this herb pollen zone (Zone I).

The tundra zone (Zone I) was followed, around 12,000 B.P. by park tundra or space-oak woodland-type environment (Zone II). This vegetation was succeeded in turn, 10,500 years ago by an open spruce woodland-type environment, which lasted until 9000 B.P. This period, from about 12,000 B.P. to about 9000 B.P. is referred to in the literature as the Spruce Pollen Zone or Zone II (M. B. Davis 1958, 1965, 1967, 1969a; Deevey 1939, 1958). It is divided into four subzones. Boreal species were the most important components of the forest during the period represented by this zone, with spruce representing the dominant tree type in the pollen assemblage. The first pollen subzone - subzone A1 - represents a transition from the Herb Pollen Zone to the Spruce Pollen Zone. This zone is characterized by a maximum for birch pollen, and rising percentages of spruce pollen (M. B. Davis 1969a). The next two subzones - subzones A2 and A3 - correspond to what M. B. Davis (1967) calls the "Spruce-Hardwood Zone." This period, radiocarbon-dated between 11,700 and 10,200 B.P. at Roger's Lake (Davis and Deevey 1964; M. B. Davis 1969a), shows high percentages of spruce pollen and Late-glacial percentage maxima for oak and other deciduous trees such as ash and hornbeam. Although higher than in the previous herb pollen zone, the deposition of oak pollen is still low compared to postglacial values. Pollen deposition, on the whole, is higher during this period than in the previous period. Pine pollen also exhibits high values, reaching a Late-glacial maximum near the upper boundary of subzone A3. Pine pollen grain size suggests that jack and/or red pine were the dominant species at this time.

The last period - that represented by subzone A4 - is radiocarbon-dated between about 10,500 and about 9000 B.P. and corresponds to M. B. Davis' (1967) "Spruce-Fir Pollen Zone." The period is characterized by maximum pollen frequencies for spruce, fir, and larch and decreasing percentage values for oak. Pollen deposition rates for coniferous trees reach a maximum during this period. A comparison of pollen percentages from the Spruce-Fir Zone at several sites in southern New England with pollen percentages from surface samples in norther Quebec suggests that the fossil spruce-fir vegetation represented a park-like boreal woodland.

Differences in opinion permeate the problem of the Late-glacial period in southern New England. The origin of the Spruce-Hardwood Zone (subzones A2 and A3 of the Spruce Zone), for example, has prompted a number of different interpretations. One crew attributes the increase in percentages of hardwood tree pollen during the Late-glacial period to the redeposition of pollen from a former interglacial period. Another view sees the increase in hardwood tree pollen percentages as indicating a reduction in local tree pollen productivity which resulted from a return to a parkland type of environment. Still, a third view, - one which has been traditionally accepted by scholars working in New Enland - sees the increase in hardwood tree pollen as representing an actual increase in the numbers of hardwood trees. This increase in hardwood trees is believed to have been caused by a warming of the climate (M. B. Davis 1967).

Related to this problem in interpretation of the Spruce-Hardwood Zone is the larger question of Late-glacial climatic change in southern New England. Traditionally, scholars have viewed the Late-glacial vegetational sequence in southern New England as representing a period of oscillating climate correlative with Late-glacial climatic fluctuations in northwestern Europe. The maxima of oak and pine percentages in subzones A2 and A3 were interpreted as indicating a shift in climate to conditions that were too warm for the growth of a closed spruce forest. The overlying maxima of spruce and fir percentages were then interpreted as reflecting a reversion to cooler conditions (M. B. Davis 1958; Deevey 1958; Leopold 1956; Ogden 1959). M. B. Davis (1965, 1967, 1969a) working with pollen accumulation rates instead of pollen freqency data, presents an interpretation of Late-glacial climate change that differs significantly from the view traditionally held by palynologists for southern New England. She shows that there was an increase in the deposition rate for conifer pollen at the beginning of the period represented by the Spruce-Hardwood Zone which continued until it reached a maximum in the period represented by th overlying Spruce-Fir Zone roughly 10,000 years ago. She also provides evidence for an increase in the rate of deposition for hardwood tree pollen around 11,800 years ago, thus confirming the interpretation that there was a real increase in the number of hardwoods during the time represented by the Spruce-Hardwood Zone. While pollen percentage values for hardwoods show significant decreases at the boundary between subzones A3 and A4, the deposition rate remains constant throughout the Spruce Zone, showing only a slight decrease at the upper boundary between the Spruce-Hardwood and the Spruce-Fir Zones. This decline in percentage values for hardwoods in the Spruce-Fir Zone, in Davis' view, does not result from a decrease in hardwood pollen but instead from an increase in conifer pollen. Furthermore, the increase in the deposition rate of conifer pollen suggests that the Spruce-Hardwood Zone represents a vegetation transitional between tundra and forest. Thus Davis, in her use of pollen accumulation rates, sees the Late-glacial sequence in southern New England as representing a gradual change rather than a complete oscillation in vegetation and climate correlative with the Late-glacial sequence from northwestern Europe. Conditions during the Late-glacial period would have been generally cold and continental. The succession of Late-glacial pollen assemblages from southern New England generally resembles pollen assemblages from present-day regions of tundra, northern prairie-forest parkland, and boreal parkland (M. B. Davis 1967).

It should be noted that biotic factors (plant, migration, succession and competition) and daphic factors (soil types, drainage, etc.) are as important as climate in explaining changes in the Late-glacial pollen record.

Overlying the Spruce Zone (Zone A) and marking the beginning of the postglacial period is a Pine Zone (Zone B1) which begins about 9000 B.P. and lasts until about 7000 B.P. in southern New England. During the time represented by the lower portion of Zone B, subzone B, a pine-birch forest with scattered distributions of oak and other deciduous trees would have occurred in southern New England. Subzone B1 is generally characterized by sharp decreases in the deposition rates as well as in the percentages of spruce, fir, and larch pollen and a commitant rise in the deposition rates and percentages of pine and deciduous tree pollen. An analysis of pollen size indicates that red and/or jack pine were the dominant species in the forests. The decline of spruce pollen together with low percentages of deciduous tree pollen suggest that conditions were still cool and dry during the period represented by subzone B1. During the time represented by the upper portion of subzone B, extensive forests of pine and oak would have occupied southern New England. Data collected from central Massachusetts (M. B. Davis 1958) indicate that white and pitch pine, rather than jack and/or red pine, were the dominant species. Deposition rates for popular, birch, alder, hornbeam, oak, and hemlock pollen attain maximum values during this time (M. B. Davis 1969a). Similar increases for these species in the frequency diagrams, however, are masked by the abundance of white pine. Thus, in response to conditions warmer and drier than those prevailing at present, stands of pine and oak would have occurred on well-drained soils of upland areas while hemlock and other deciduous trees would have occupied the wetter lowland areas (M. B. Davis 1958).

According to M. B. Davis (1967), the pine-birch fossil assemblage of subzone B1 shows many similarities to modern pollen assemblages found 100 km south of the border between the boreal forest and the mixed coniferous-deciduous forest in central Canada and northern Minnesota. The fossil assemblage of subzone B2 resembles modern pollen assemblages from southern Ontario. This association suggests that a mixed conferous-deciduous forest existed in southern New England during the time represented by subzone B2.

The final postglacial pollen zones, representing periods from 7900 B.P. to the present, mark the advance of deciduous trees into the southern New England region. These zones are defined as C-1, oak and hemlock; C-2, oak and hickory; C-3, oak and chestnut. This zonation, which was originally described by Deevey (1939) from five profiles in Connecticut, has since been used by investigators to represent the postglacial vegetational sequence for southern New England as a whole. The first zone, C-1, is generally characterized by maximum values for both oak and hemlock. Beech attains a maximum at the upper C-1/C-2 boundary. Radiocarbon dates obtained from Roger's Lake, Connecticut (M. B. Davis 1969a) place this zone between 7900 B.P. and 5000 B.P. Climatic conditions during the time represented by C-1 would have been moister than those described for the previous pine zone. The next zone C-2, dated between 5000 B.P. and 2000 B.P., represents the warmest part of the postglacial as evidenced by minimum values for elm and hemlock and a maximum for hickory. Beech reaches a second maximum in the upper portion of this zone. The successive maxima of beech has been attributed to migration waves from glacial refuges farther south (M. B. Davis 1958, 1965; Deevey 1939). In the last zone, C-3, oak remains constant while hickory values decrease and chestnut and hemlock percentages increase. These changes in pollen frequencies are believed to have resulted from a shift in climate from warm, dry to cool, moist conditions.

It is important to note that, while similar, in general sequence profiles from southern New England are not exactly contemporaneous because of differences in soils, rates of migrations and variations in climatic conditions. In fact, there are some localities in southern New England where changes in pollen frequencies are quite differen from the ones originally recorded by Deevey from Connecticut. For instance, hickory, which reaches a percentage maximum in Connecticut, attains only minor levels for the same period from profiles in central Massachusetts (M. B. Davis 1958, 1965). A profile from eastern Massachusetts, on the other hand, shows substantial increases in oak, hickory, and birch in association with a radiocarbon date of 5480 ± 100 B.P. (Butler 1959). The rise in chestnut, diagnostic of zone C-3 in Connecticut, is virtually absent from eastern Massachusetts. This zone in eastern Massachusetts is generally recognized by increased values for pine and hemlock and decreased percentages for hickory and oak pollen. An increase in grass pollen, ash, hickory and birch and the top of the profile from Barnstable Marsh has been attributed to human influence on vegetation over the past 300 years (Butler 1959). In addition to oak and chestnut, hemlock, elm, sugar maple, birch and ash were important constituents of the forest in central Massachusetts during C-3 (M. B. Davis 1958). At Roger's Lake, chestnut appeared only sporadically throughout the postglacial but not with any abundance until 2000 B.P.

Like beech, the sudden increase in chestnut has been attributed to a migration from glacial refuges.

The vegetational sequence established for southern New England shows a number of important differences from the one described for northern New England. For instance, the transition from tundra to forest occurs earlier in southern New England. Spruce and other boreal tree species were important in the vegetation of southern New England from about 12,000 to about 9000 B.P., a time when south-central Maine was still covered with a tundra-type environment. Influx values for spruce and total tree pollen were considerably lower at Moulton Pond than they were in the same period at Roger's Lake in southern New England. Another important difference is that the postglacial period of white-pine-dominated forests starts earlier in the north than in southern New England. Finally, oak, an important consituent of the postglacial forests in southern New England, never attains such dominance in the postglacial vegetation of northern New England. The postglacial forests of southern New England, after about 7000 B.P., were dominated by oak in combination with hickory, beech and chestnut (M. B. Davis 1965, 1969a). Only beech attained levels in the north that were comparable to those found in southern New England.

<u>North and central mid-Atlantic states</u> - The vegetational sequence presented for the northern and central portions of the mid-Atlantic subarea comes from a number of documented pollen studies - Buckles Bog, located in the ridge and valley topography of the Allegheny Plateau, Maryland (Maxwell and Davis 1972); the marsh profiles from the piedmont of southeastern Pennsylvania (Martin 1958); sample SH29 from a spot near Ravitan Bay in northeastern New Jersey and sample BR12 from the east bank of the Delaware River in western New Jersey (Sirkin and others 1970); and the Saddle Bog profile from Kittatinny Mountain in northwestern New Jersey (Sirkin and Minard 1972). The pollen sequence from Buckles Bog (Maxwell and Davis 1972) begins around 19,000 B.P. with what may be interpreted as a park-tundra-type environment which occupied the Allegheny Plateau until 12,700 B.P. when the tundra-like vegetation was replaced by a spruce-woodland. This Basal "Sedge" Pollen Zone predates, in part, 15,000 B.P. the date established for the beginning of the Herb Pollen Zone (T Zone) in southern New England. During the period represented by this zone, at Buckles Bog, nonarboreal pollen (NAP) exceeds 50%. Sedge dominates the NAP types while spruce and pine represent the dominant arboreal pollen types. Deciduous tree pollen occurs only in very small amounts. Trees presumably would have grown along river valleys 10 to 25 km from Buckles Bog. The Roger's Lake site in Connecticut, on the other hand, would have been located a considerably greater distance from the nearest forest. The Sedge Pollen Zone from Buckles Bog resembles the F Zones from the marsh profiles in southeastern Pennsylvania. According to Martin (1958), the area within the vicinity of the marsh sites would have been occupied by a tundra-taiga with scattered distributions of spruce and pine during the times represented by zones F2 and F4. NAP reaches a maximum with spruce, pine and, fir being the only important tree types. The upper portion of the F Zone

(zones F3 and F4) also compares well with the lower part of the Herb Pollen Zone (T Zone) from sites in southern New England on the basis of similarities in the pollen spectra and a comparison of radiocarbon dates.

Park-tundra conditions have also been inferred from pollen profiles in western and northern New Jersey. The Late-glacial Pollen Zone from sample BR12 (Sirkin and others 1970), characterized by high percentages of pine, grasses, and birch and a corresponding date of 16,700 ± 420 B.P., correlates with the basal Herb Pollen Zone (Zone W) from Long Island (Sirkin 1967) and the F Zones from southeastern Pennsylvania (Martin 1958). The basal level from sample SH29 (Sirkin and others 1970) dominated by pine, spruce, and herbs corresponds to pollen zones from sites in the end moraine regions of the eastern United States. Significant amounts of pine, spruce, and birch pollen, together with pollen from alder, willow, grass, and sedge, indicate the occurrence of a park-tundra vegetation during Late-glacial times in the vicinity of Kittatinny Mountain, northwestern New Jersey (Sirkin and Minard 1972).

Within the vicinity of Buckles Bog, around 12,700 B.P., tundra was replaced by an open spruce woodland which lasted until 10,500 B.P. Both influx and percentage values for tree pollen increase sharply at the lower boundary of this zone. Spruce, red and/or jack pine, and sedges represent the dominant pollen types. After an initial period of increase, however, spruce and pine decrease steadily in both influx and percentage values throughout the rest of the zone. Fir, ash, hornbeam, and oak show increases in the upper levels of the zone; elm, maple, hickory, and beech appear consistently for the first time in the upper part of the zone. This vegetational change from tundra to forest would have been caused by an amelioration in climatic conditions. According to Maxwell and Davis (1972) the lower levels of the spruce-pine zone show some similarities with the A1, A2 and A3 subzones of southern New England. The pattern of increasing influx and frequency values for deciduous tree pollen and decreasing values for nonarboreal pollen is believed by the authors to represent a vegetation transitional between tundra and forest. These trends, they say, do differ from the influx patterns established for the Spruce Pollen Zone from Roger's Lake, Connecticut. Unlike Budkles Bog, influx rates for conifers at Roger's Lake increase steadily throughout the spruce zone, with spruce reaching a maximum in the upper part of the zone. Influx rates for deciduous tree pollen, after an initial period of increase, remain constant throughout the rest of the zone. A comparison of radiocarbon dates from the two sites shows that the changes from tundra to woodland occurred 1,000 years earlier in Maryland than in Connecticut. The abrupt increase in depositional rates for deciduous tree pollen is attributed by Maxwell and Davis (1972) to changing atmospheric circulation patterns and the long-distance transport of pollen from the central plains area of North America.

No comparable Spruce-Pine Zone has been documented from southeastern Pennsylvania as the peak in spruce pollen was found in association with high values for NAP. However, Spruce Pollen Zone with a radiocarbon date of 12,300 ± 300 B.P. from the upper level, has been reported from the Saddle Bog site in northwestern New Jersey. The zone is generally characterized by increases of pollen fromspruce, pine, and alder. High NAP values in the lower Spruce Zone (subzone A1) followed by a spruce maximum and declining NAP values in subzone A4 suggest that a succession of spruce-park and spruce forest occurred in northwestern New Jersey during Late-glacial times. A high percentage value for oak in the upper part of the zone indicates that stands of oak grew mixed or near the spruce forest.

Around 10,500 B.P., a mixed coniferous-deciduous forest dominated by white pine replaced the spruce woodland at Buckles Bog on the Allegheny Plateau. The pollen spectra corresponds quite closely to the B Zone from southern New England. Birch pollen and pine pollen attain maximum values during this period. Fir, ash, hornbeam and oak frequencies decrease in the lower part of the zone and remain low throughout the rest of the zone. Hemlock appears consistently in the diagram for the first time. Influx values for white pine at Buckles Bog are the same as those from Roger's Lake, Connecticut. A comparison of radiocarbon dates may indicate a chronological discrepancy of as much as 1,000 years between the two sites. A sharp increase in pine pollen has been documented from southeastern Pennsylvania. In addition to pine, oak and hemlock represent important species in the vegetation. In contrast to the Pine-Birch Zones from Maryland and southern New England, however, birch is virtually absent from the marsh diagrams. A pollen zone dominated by pine has also been reported from northwestern New Jersey. Pine peaks in the lower portion of the zone with birch and alder pollen also exhibiting high frequencies. Oak pollen frequencies increase sharply in the upper levels of the zone at the same time that pine and birch percentages show significant decreases.

The Post-Glacial Pine-Birch Zone from Buckles Bog is followed by a pollen zone that is dominated by deciduous-tree pollen. The Post-Glacial "Oak-Chestnut" Pollen Zone lacks reliable radiocarbon dates, that section of the pollen core having been heavily truncated. The zone, however, believed to have extended from an age greater than 5000 B.P. to about 150 B.P. The zone is characterized by high values for oak and successive maxima for beech, chestnut, and hickory. Spruce and pine are found only in low frequencies. Hemlock decreases throughout the zone after an early maximum at the base of the zone. The stratigraphic position of chestnut distinguishes the Postglacial Pollen Zone at Buckles Bog from the C Zones of southern New England. Chestnut, which shows significant percentages in the central section of the zone of Buckles Bog, does not attain a maximum in southern New England until the upper part of the zone. Thus, the vegetational changes associated with the C Zones from southern New England may not be explained strictly in terms of changes in climatic conditions. These changes may, in part, be attributed to the late arrival of certain tree species migrating from regions further south. Postglacial Pollen Zones similar to the first two C Zones of southern New England - subzones C-1 (oak and hemlock) and C-2 (oak and hickory) - have been documented from southeastern Pennsylvania. However, no Chestnut Zone comparable to subzone C-3 of southern New England has been recorded from the marsh profiles.

Southern mid-Atlantic states - The vegetational sequence presented in this section for the southern mid-Atlantic region comes largely from five sources - 1) the Dismal Swamp profiles from southeastern Virginia (Whitehead 1965, 1972), 2) the Chesapeake Bay borings (Harrison and others 1965), 3) the Delmarva-Peninsula diagrams (Sirkin and others 1977), 4) marine cores V26-176 and V24-1 taken from the continental rise between Chesapeake Bay and Cape Hatteras (Balsam and Heusser 1976) and 5) a summary of pollen studies in the southeast by Whitehead (1965).

During full glacial times, bracketed by radiocarbon dates between 25,000 and 15,000 B.P., significant differences in vegetation existed between southeastern Virginia and southeastern North Carolina (Whitehead 1965). The forests of Virginia consisted mainly of boreal species with spruce and fir representing the dominant tree types. The full glacial forests of North Carolina, on the other hand, were dominated by pine, spruce and fir being much less abundant (Whitehead 1965). Whether these vegetational differences between the two regions reflect distinct climatic differences or differing edaphic conditions remains open to question. Samples from the central Delmarva Peninsula further north, show that taiga and tundra shrubs and herbs, along with spruce, pine, birch and alder, were abundant at various times in the pollen record between 21,000 and 13,000 B.P. (Sirkin and others 1977). Spruce, which was an important constituent of the spruce-pine-birch-alder association, continued to be important in the central Delmarva Peninsula vegetation until 9000 B.P. The tundra-like conditions inferred from pollen samples in the central Delmarva Peninsula show affinities with the Late-glacial pollen assemblages from the region between the Allegheny Plateau and southern New England.

From southeastern Virginia, there is evidence for a Late-glacial forest type dominated by spruce and pine between 15,000 and 11,000 B.P. The lower spectra from Chesapeake Bay are characterized by maxima of pine and spruce and smaller percentages of fir pollen. Birch and alder also exhibit high percentage values during this period. A similar vegetation is inferred from the lowest zone, radiocarbon dated between 12,000 and 10,700 B.P., at Dismal Swamp in southeastern Virginia. This zone provides evidence for the existence of cold conditions during Late-glacial times. High percentages of pine, rising percentages of spruce, maxima for birch and alder and high percentages of herb pollen characterize the zone. The high frequencies of herb pollen are interpreted as indicating the local growth of grasses and sedges in moist inhabitats. Beginning around 11,000 B.P. at the Chesapeake Bay sites, there was a shift in vegetation from a pine-spruce-birch-alder forest to a hemlock-northern hardwood-white pine forest (Harrison and others 1965; Whitehead 1965). This zone correlates well with Zone II from Dismal Swamp (Whitehead 1972). The Lake-glacial Zone is represented at Dismal Swamp by declining percentages of pine and spruce, rising oak percentages and maxima for beech, hemlock, birch, and alder. The presence of aquatic species provides evidence for a rising water table throughout the swamp at this time. Thus, the pollen profiles from Dismal Swamp and Chesapeake Bay indicate that there was a gradual change from a boreal forest type to a hemlock-northern hardwood forest association during Late-glacial times.

This forest type was replaced at both Dismal Swamp and Chesapeake Bay, around 9000 B.P. by a post-glacial forest dominated by oak, hickory, and sweet gum. This zone (Zone III), radiocarbon dated between 8300 B.P. and 3500 B.P. at Dismal Swamp, has been divided into two subzones on the basis of fluctuations in the curves of shrubs, herbs and, aquatic species. Open water would have covered much of Dismal Swamp during the period represented by subzone 3A as the pollen spectra exhibit high frequencies of pollen from grasses, sedges, and aquatic species. Oak, hickory, and sweet gum would have grown on ridges elevated slightly above the swamp surface. During the period represented by the next subzone, 3B, deeper-water aquatic species were replaced by plants well wuited to growth on peaty soils (Whitehead 1965). High percentages of cypress, red maple, black gum, and swamp shrubs suggest that the open water and ridge habitats of Zone III were replaced in the next zone by a swamp forest. The pollen spectra from Dismal Swamp probably reflect the local conditions of the swamp itself and therefore cannot be extended to the edaphically different habitats that comprise the remainder of southeastern Virginia.

The replacement of boreal vegetation by a thermophilous vegetation around 10,000 B.P. has been inferred from two marine cores taken from the continental rise between Chesapeake Bay and Cape Hatteras (Balsam and Heusser 1976). A Late-glacial vegetation dominated by pine, spruce, fir, and herbs gave way to a pine-oak forest in which hemlock and birch were also important constituents. Deciduous-tree pollen increases throughout the Postglacial Zone until 3500 B.P. when pine again assumes an important role in the vegetation. It is reasonable to assume that these two marine cores might possess great potential for deriving information about paleoenvironmental conditions on the Continental Shelf. But because pollen can be transported over great distances to the ocean by rivers, the authors believe that the cores reflect, not the paleoenvironments of the Continental Shelf, but instead, regional vegetational changes from the Chesapeak River basin drainage.

Summary - Table II-5 provides a summary of the vegetational sequences for different portions of the study area based on the sources given in Table II-4. These generalized sequences were derived by comparison of individual sequences, attempting to factor out local changes. For example, the large amount of grass and sedge pollen at Dismal Swamp around 10,000 B.P. was almost certainly the result of the locally changing water table, which would have discouraged tree survival. After factoring out such anomalies as could be discovered, the patterns remaining were summarized. Table II-3 provides the

TABLE II-5: Summary of major vegetational sequences from the Bay of Fundy to Cape Hatteras.

1,000-year intervals	Maine and Vermont (Bradstreet and Davis 1975; Davis and others 1975; McDowell and others 1971; Sanger and others 1977)	Southern New England (Butler 1959; M.B. Davis 1958, 1965, 1967, 1969; Deevey 1939, 1958; Leopold 1956)	Southeastern Pennsylvania (Martin 1958)	Maryland (Maxwell and Davis 1972)	Southeastern Virginia (Whitehead 1965, 1972; Harrison and others 1965)
1	mixed hardwood-conifer forest (oak, beech, pine, birch)	hardwood forest (dominated by oak and chest-nut)	NO DATA		swamp forest (cypress, red maple, blackgum and swamp shrubs)
2		hardwood forest (dominated by oak and hickory)			
4			hardwood forest (dominated by oak, hickory and chestnut)	hardwood forest (dominated by oak with successive maxima of hemlock, beech and hickory)	hardwood forest (dominated by oak, hickory and and sweetgum)
5	mixed conifer-hardwood forest (hemlock, pine, birch, oak, beech)	mixed hardwood-conifer forest (dominated by oak and hemlock)			
7	mixed conifer-hardwood forest (white pine, birch, oak)	mixed conifer-hardwood forest (dominated by pine and birch, some oak)	mixed conifer-hardwood forest (dominated by oak and hemlock)		
8			mixed conifer-hardwood forest (dominated by pine, with some oak and hemlock)	(undefined boundary)	
9		spruce woodland (dominated by spruce, fir and larch)		mixed conifer-hardwood forest (dominated by pine and birch with some hemlock)	mixed conifer-hardwood forest (hemlock, hardwoods, pine)
10	mixed boreal-temperate woodland (spruce dominant)	spruce woodland (dominated by spruce with some hardwoods)		spruce woodlands (spruce, pine and hardwoods)	
11	tundra (herbs, grasses, shrub birch, alder)		taiga-tundra (sedges, pine, spruce, fir)		conifer forest (spruce, pine, birch, alder)
12		tundra (herbs, willow, some pine and spruce)			
13				park-tundra (sedge, spruce, pine)	
14	glaciated		tundra		
15		glaciated	taiga-tundra		boreal forest (spruce, fir)

criteria for interpretation of vegetational type; other entries in the sequence tables were taken from the reports of the pollen analyses.

In Maine, the general vegetational sequence begins with tundra (grassland) at around 12,000 B.P., with deglaciation. By 9000 B.P., a mixed conifer-hardwood forest has developed and will persist through modern times. The dominance of different species, however, shifts over time, with conifers in the ascendant except in the period 6000 to 3000 B.P., when hardwoods attained their maximum representation. This sequence is in agreement with the summaries presented by Bradstreet and Davis (1975) and Sanger and others (1977) for the region.

For southern New England, the vegetational sequence is similar but changes took place slightly earlier and differed in significant details. Immediately following deglaciation, a tundra of sorts but with no modern analogue (M. B. Davis 1969a) was the initial vegetation type, followed shortly by an open spruce woodland-parkland (patches of woodland scattered through grasslands). This latter vegetation lasted until approximately 9000 B.P., later in some portions of the region.

During this period, there appears to have been great local variation in dominant tree species, apparently reflecting differential seed transportation and colonization rates. This pattern lends support to the idea that temperate species survived the glacial period as rare species in small pockets at various locations, some quite northerly (M. B. Davis 1976; Whitehead, personal communication), rather than in large refugia far to the south. This irregularity of surviving species added to the unpredictability of dominant species in different locales.

Beginning after 9000 B.P., mixed conifer-hardwood forests established themselves in southern New England, but the dominant species continued to vary greatly locally. Pine generally was prominent. With time, the areal heterogeneity of dominant species became less, apparently because sufficient time had elapsed to allow tree colonization to be determined more by climate and edaphic conditions than by proximity to refugia. Oak and other hardwoods became dominant throughout the region by 6000 B.P. and persist through the present.

This vegetation sequence for southern New England agrees substantially with that of Fagan (1978); the classic sequences of Deevey (1952, 1958) differ in a major respect. Deevey interpreted the largely coniferous pollens from about 10,000 to 7000 B.P. as indicative of "subarctic spruce alder forest," synonymous with boreal forest. Such a forest would be dense and very inhospitable to human occupation. Subsequent studies, however, through the analysis of absolute pollen counts and greater emphasis on non-arboreal pollen, have revised this picture of a boreal forest, resolving it into the patterns described above.

The vegetation sequence for the northern mid-Atlantic subarea is very similar to that for southern New England. The tundra begins earlier, by 15,000 B.P., and lasts until around 11,000 B.P., when the incidence of spruce and other conifers increases. The vegetation type passes through an open woodland-parkland and into a more closed coniferous forest. This closed forest appears to have been brought about by local edaphic factors (Eisenberg 1978) and passed by 9000 B.P. into a mixed conifer-hardwood forest which would persist through modern times. The early dominance of pine passed by 6000 B.P. to oak and other hardwoods.

In terms of vegetation types, sequence, and dates, the central and southern mid-Atlantic subareas are comparable, though dominant species differ. Open spruce woodland-parklands prevailed from 15,000 to about 10,000 B.P., when hardwoods began to increase in numbers. The forests were hardwood or hardwood-dominated mixed conifer-hardwood until about 3000 B.P., when pine began to dominate the mixed conifer-hardwood forest.

These sequences for the various portions of the mid-Atlantic subarea are comparable to those presented in summaries by Sirkin (1977) and Eisneberg (1978). Sirkin, however, sees a more closed spruce forest between 15,000 and 10,000 B.P. than has been described here. Following the criteria of Table II-4, this reconstruction interprets the pollen spectra as indicating greater openness.

Using modern data on climatic factors affecting the distribution of different plant species, several climatologists have reconstructed relative temperatures at different periods. These temperatures then may be plotted against time to produce temperature curves, concise graphic summaries of temperature change. These curves have several limitations: inferred temperatures are relative and may be inexact, numbers of dated pollen spectra may be small, and edaphic and historical factors may affect the results. Nonetheless, they provide an effective means of presenting the best climatic reconstructions possible from pollen analysis.

Figure II-5 shows paleotemperature curves depicting inferences drawn by a series of investigators. Curves are presented for Maine, southern New England, and the mid-Atlantic area and another curve (from the Upper Great Lakes area) is included to emphasize the basic similarity among all of these curves. Basically, cold glacial climates gave way to considerably warmer climates around 10,000 B.P. Around 5000 B.P., maximum temperature was reached (the "climatic optimum"); between 4000 and 2000 B.P., temperature dropped to modern levels. This pattern characterizes all of the curves in Fig. II-5, which, given the crudeness of the methods of their derivation, must be considered indistinguishable from one another.

This discussion has ranged beyond strict climatological reconstruction, considering also the vegetation produced by climate and other factors. This treatment will be augmented with further discussion of vegetation in the "paleoresources" section of this chapter.

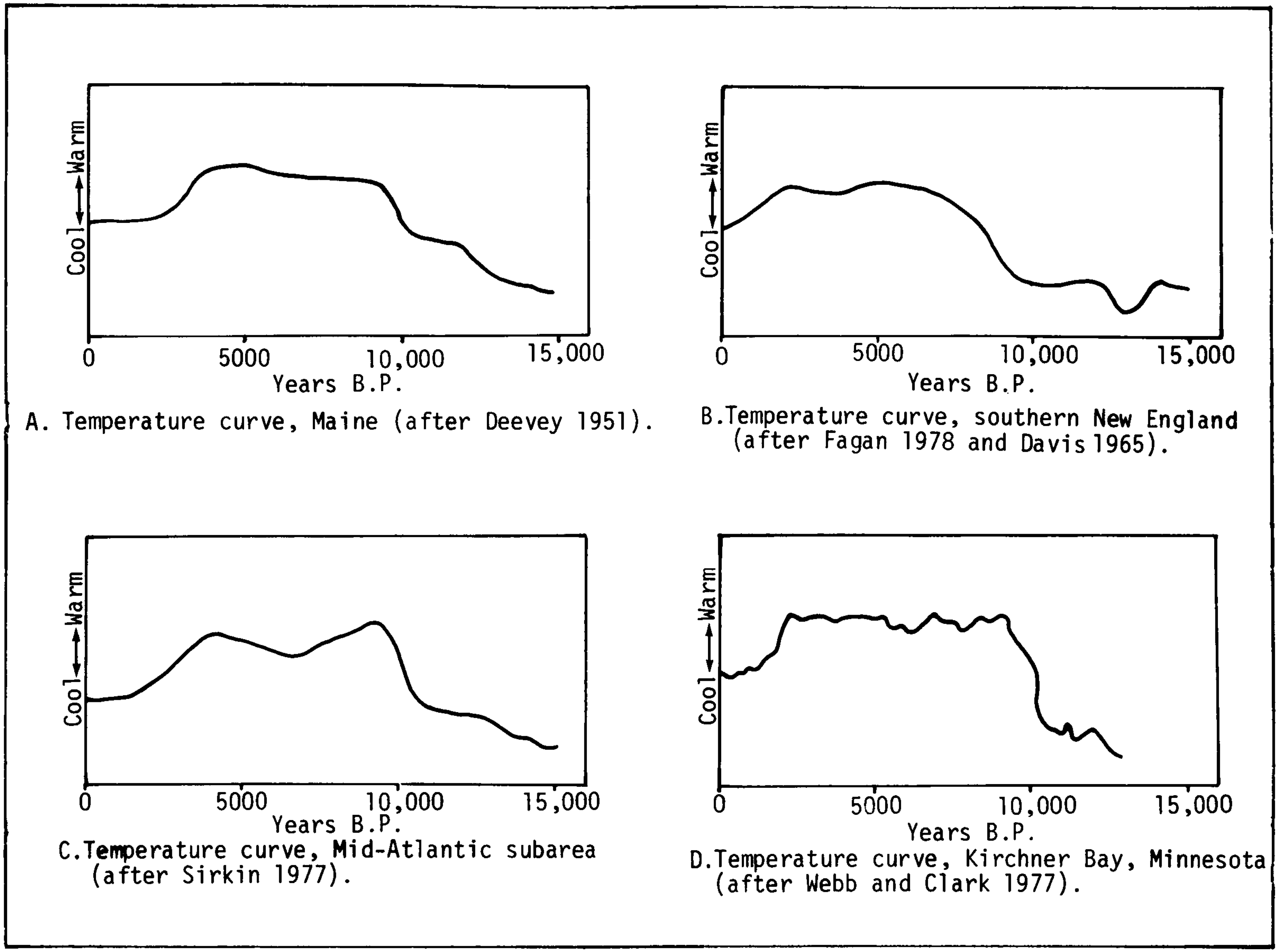


Fig. II-5. Palaeotemperature curves based on pollen analysis.

4.1.3 Fauna

4.1.3.1 Methods - The types of fauna used as paleoclimatological indicators are largely restricted to plankton, molluscs, and mammals. Of these groups, the first two are very useful, mammals less so. Mammals, in most cases, can tolerate relatively broad ranges of climatic variation and indicate little about specific environments they may have inhabited. In a few cases where species' tolerances are strict and well known, however, mammalian remains can be calibrated to climate.

Plankton are tiny creatures carried about by ocean current. Foraminifera, one taxon of plankton, have carbonate exoskeletons and are tolerant only of extremely narrow temperature ranges. They live near the surface of the ocean and accordingly form a powerful data base regarding surface-water temperatures. Upon death, their exoskeletons settle to the ocean floor where, barring unusual disturbances, deposits of their remains form a sensitive record of past temperatures.

Two methods of interpreting foraminaferal evidence are available. The first, the micropaleontological method, involves estimating paleotemperatures on the basis of relative abundances of species with known tolerances (Murray 1973). The second method uses the carbonate from the exoskeletons, regardless of species, to determine the ratios of various isotopes of oxygen. These ratios are fixed by temperatures at the time of carbonate formation and can be measured with an accuracy corresponding to 1° C. Importantly, each method yields quantitative results and the two have been shown to produce comparable paleotemperature curves (Broecker and others 1960).

Molluscs also form indicators of paleoclimates, in some cases with excellent specificity. Land snails, while possessing great utility for paleoclimatological inference, have received so little attention along the Atlantic coast of North America that any systematic reconstruction would be impossible. Marine molluscs, on the other hand, have received considerable attention as climatic indictors.

Hall (1964) has described modern shallow-water marine climates of the Atlantic Ocean and has found a marked relationship between seasonal duration of various water temperatures and zonation of molluscan communities. In particular, Table II-6 gives the characteristics of the provinces he has defined that are relevant to this study and Fig. II-6 shows present distribution of the provinces.

Since upper and lower limits of water temperature are critical for survival and especially critical for reproduction of molluscs, these molluscan provinces can be recognized by their associated faunas. In theory, the broader the spectrum of molluscs identified, the more reliable the documentation of a past shift of the molluscan provinces; in practice, however, usually only one or two species may be used as evidence.

TABLE II-6. Characteristics of Atlantic molluscan provinces (from Hall 1964).

Molluscan Province	Temperature Characteristics
Outer Tropical	Water is 20°C. for only 4 months, 18°C. for about 6 months, and never cooler than 10°C.
Mild Temperate	Water is nearly or slightly below 15°C. for 3 to 4 months and cooler than 10°C. for nearly 6 months.
Cool Temperate	Water is 10°C. for only 3 to 4 months and cooler than 10°C. for remainder of year.
Cold Temperate	Water is colder than in any of the above provinces; may correspond to area of winter sea ice.

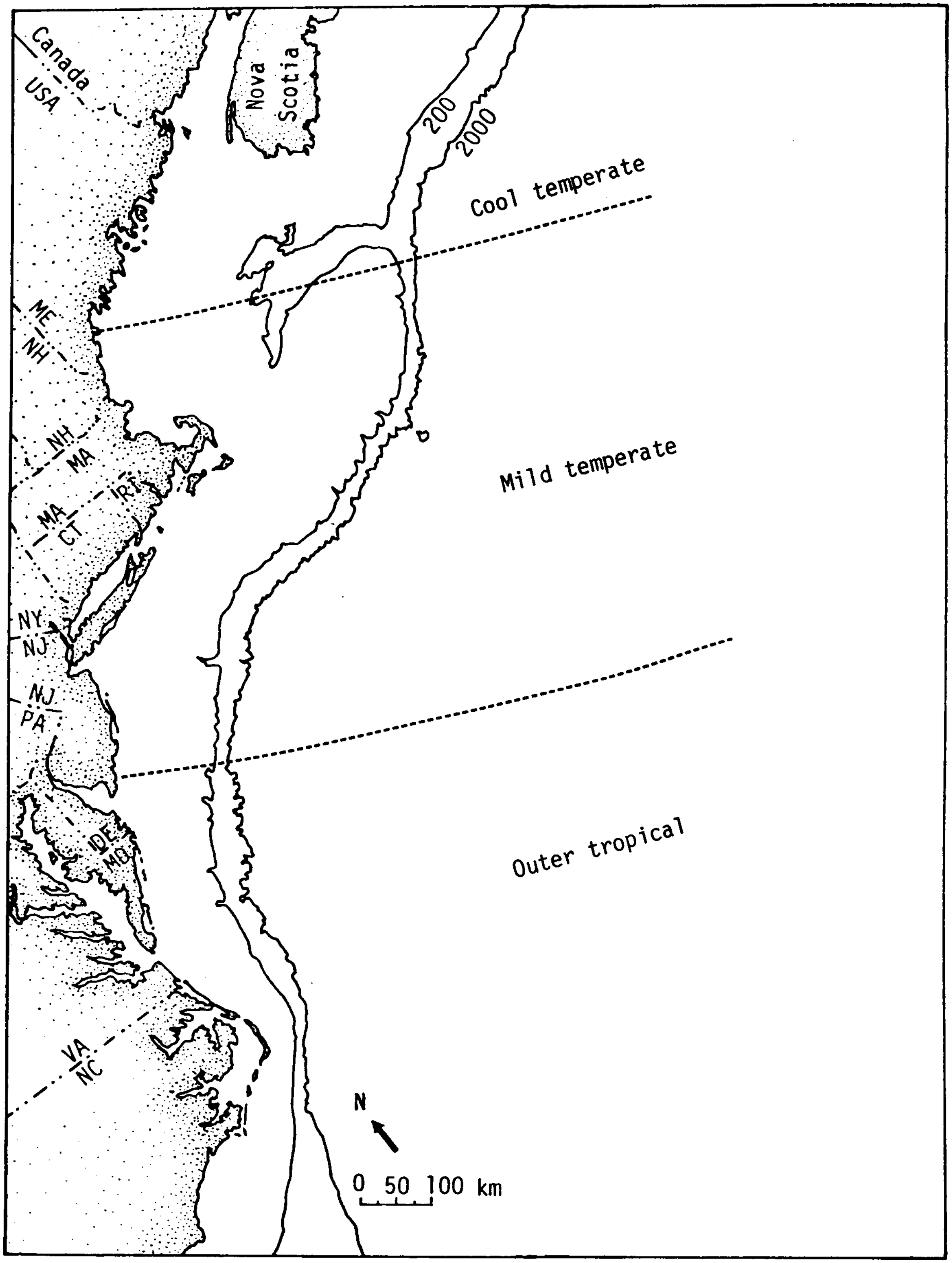


Fig. II-6: Atlantic molluscan provinces, modern distribution (after Hall 1964).

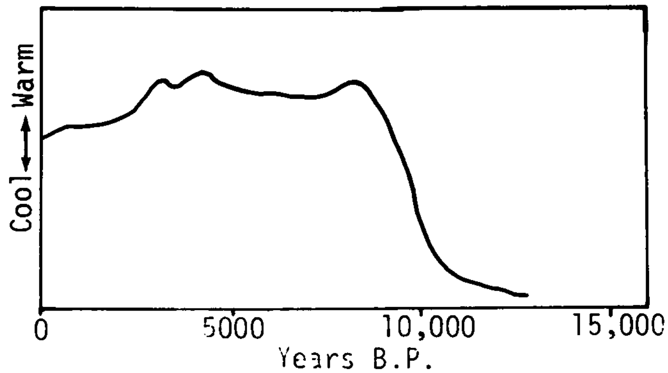
4.1.3.2 Results - Plankton studies in the northwest Atlantic have been few and none has been directed toward nearshore sediments. Fig. II-7 presents temperature curves derived by both the micropaleontological and oxygen isotope methods. The former is taken from the northwest Atlantic, but oxygen isotope studies from the same area have not been conducted, so a tropical Atlantic curve has been substituted, minus its temperature scale which would be incorrect for the study area. The shallowness of the tropical curve is to be expected, since glacial conditions never depressed temperatures in these regions as they did to further north. The pattern of temperature change, however, is similar and comparable to the pattern found through pollen studies.

CLIMAP Project Members (1976) have mapped surface-water temperatures for the period 18,000 B.P., using plankton studies. Their synthesis, of necessity, contains much extrapolation and estimation, but it gives an estimation of full glacial marine climate. For all four seasons, there was a narrow steep thermal gradient, nearly coincident with 42° N. North of this thermal front, surface water temperatures remained below 2° C.

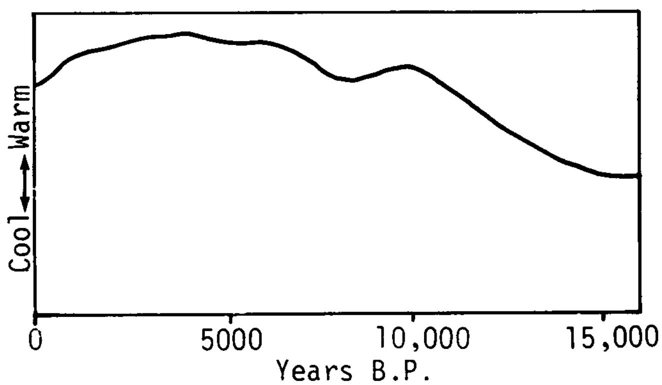
McIntyre and others (1976) have demonstrated that water mass and current distributions were considerably different at 18,000 B.P. than they are today. While glacial summer conditions were much colder than they are now, winter temperatures were almost the same. Off Cape Cod, for instance, winter temperature was only 2° C colder, but summer temperature was 16° C colder than that which is experienced today (McIntyre and others 1976). In the Northeast, autumn and winter would have been dominated by sea ice. Low-salinity waters of spring and summer would have been displaced in late summer by warmer, more saline waters. Seasons would have been short and marked by strong variations.

South of Cape Cod, the Gulf Stream has affected climate. The Gulf Stream is a warm current trending northeastward across the Atlantic and carrying warm waters. Using foraminifera, Balsam and Heusser (1976) charted the changing position of the Gulf Stream in post-glacial times. Around 12,000 B.P., the Gulf Stream moved northward and inward, creating an abrupt temperature rise of 10° C. Its maximum influence was around 8000 B.P. and by 4000 B.P., it had begun to move southward and offshore again.

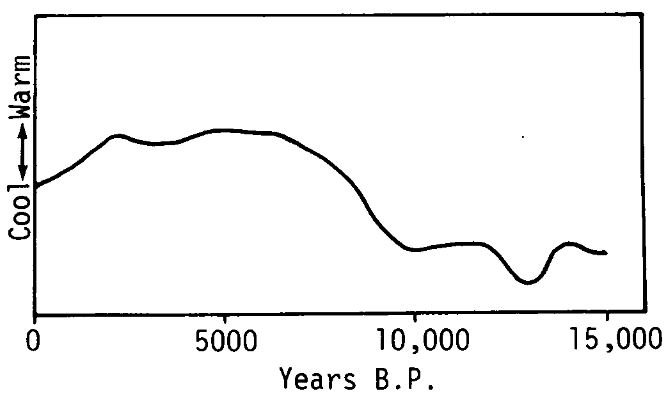
Further north and east of Cape Cod, the Labrador Current had a major effect on water temperatures (Balsam, personal communication). Balsam has found that around 12,000 to 10,000 B.P., sea surface temperatures were warmer than they are today, resulting from the absence of the Labrador Current. Somewhat later, with glacial melting, water temperatures dropped 10 to 12° C in winter and 6 to 8° C in summer; the date of this event is unclear. There also is evidence of episodic cooling north of Cape Cod, perhaps about every 2,500 years. Based on preliminary analysis of 16 cores taken along the Continental Slope, Balsam estimates the sea-surface temperatures from Cape Cod to Long Island



A.
Temperature curve, derived from foraminifera by the micropalaeontological method (after Wollin, Ericson, and Ewing 1971).



B.
Temperature curve, derived from foraminifera by the oxygen isotope method (after Emiliani and Geiss 1957).



C.
Temperature curve, southern New England (after Fagan 1978 and Davis 1965).

Fig. II-7: Temperature curves, surface ocean water (pollen derived curve for comparison).

rose 8 to 10° C from maximum glaciation to present, while from Long Island to Cape Hatteras they rose about 4° C.

Using these inferences and Hall's characteristics for molluscan provinces (Table II-6), Edwards and Merrill (1977) have placed the boundaries of these provinces at 18,000 B.P. Figure II-8 shows their estimated locations, shifted about 8 minutes of latitude southward, relative to their modern distribution. Edwards and Merrill (1977) believe that around 12,500 B.P. the molluscan provinces would have been distributed approximately as they are today.

The distribution of scallops at Sable Island Beach, Nova Scotia (Clarke and others 1967) and of three associated bivalve species from eastern Long Island (Newman 1977) indicate that the period between 7500 and 2000 B.P. saw considerable northward shifting of the provinces, relative to their positions today. Fig. II-9 shows the estimated distribution of molluscan provinces at this period, based on this slender evidence.

Finally, the distribution of walrus remains on the Continental Shelf reinforces the interpretations of very cold water in the Atlantic Ocean north of Cape Hatteras during glacial times. Edwards and Merrill (1977) have mapped known finds of walrus from the Continental Shelf, recovered primarily in surf-clam and scallop dredging. The finds are concentrated between Chesapeake Bay and Long Island, partly because of dredging patterns and probably partly because of the range of walrus distribution. None of the finds are dated, but they are presumed to be between 12,000 and 10,000 B.P.

4.1.3.3 Summary - The reconstruction of paleoclimates is fraught with difficulties and the absence of critical data has necessitated a great deal of estimation and extrapolation. In particular, the lack of sophisticated pollen analysis on the Continental Shelf itself is a severe handicap, as is that of nearshore plankton analysis. The scarcity of usable information has made it impossible to reconstruct precipitation patterns.

What is clear, however, is that a consistent pattern of temperature change characterized the study area. Cold temperatures warmed very rapidly around 10,000 B.P. and oscillated around means warmer than today's until about 3000 B.P., reaching maximum temperatures about 5000 B.P. Following 3000 B.P., temperatures cooled to modern levels.

On land, these temperature changes have been reflected in vegetation changes, passing through a general sequence of tundra near glacier margins, parklands as glaciers retreated, and forests as tree species colonized newly available areas at different rates. The composition of these early forests was determined as much by proximity to extant trees and speed of seed dispersal as by climate or edaphic factors. After some millennia, by 7000 B.P. in most places, trees had reached

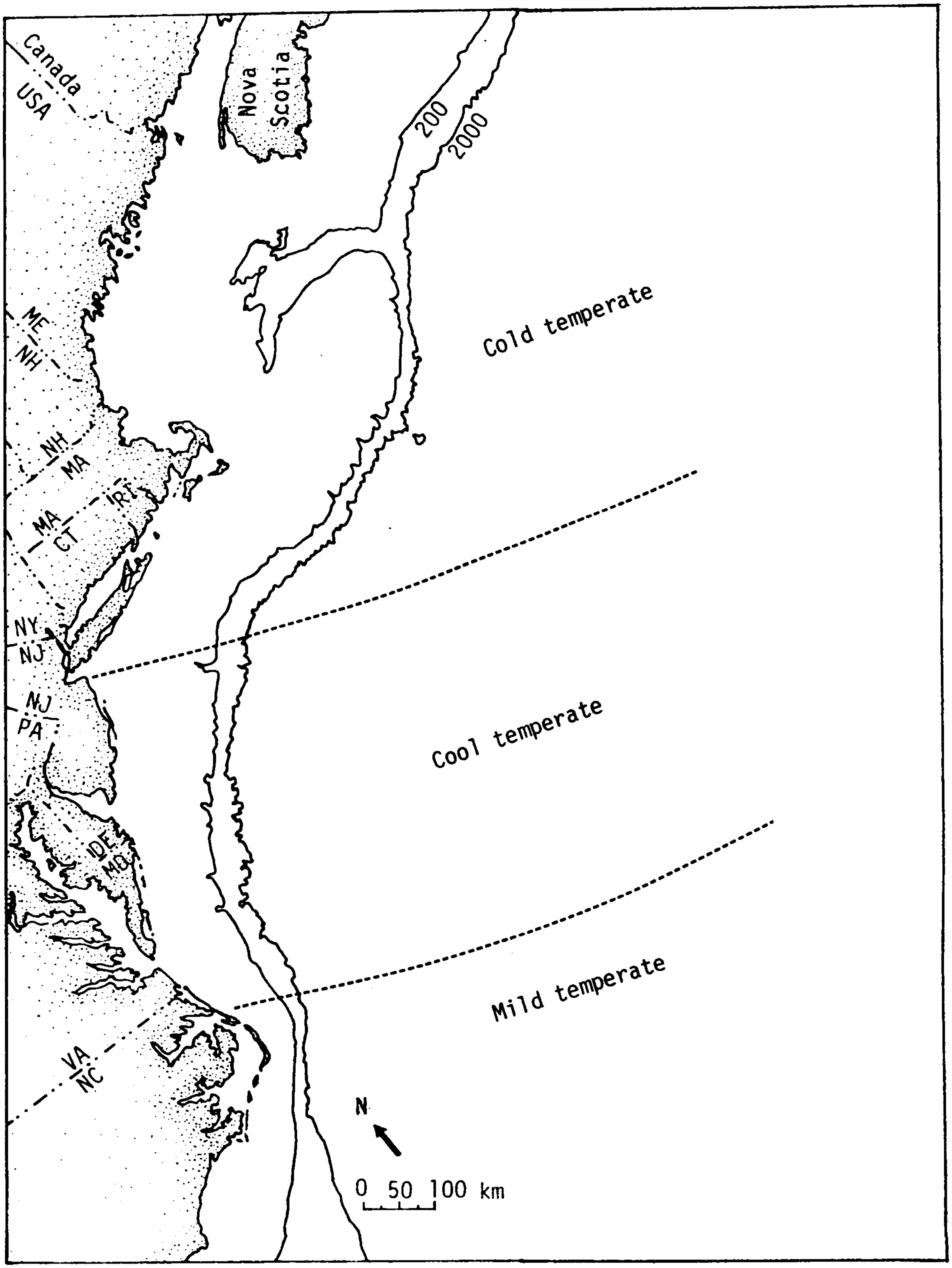


Fig. II-8: Atlantic molluscan provinces, estimated distribution at 18,000 B.P.

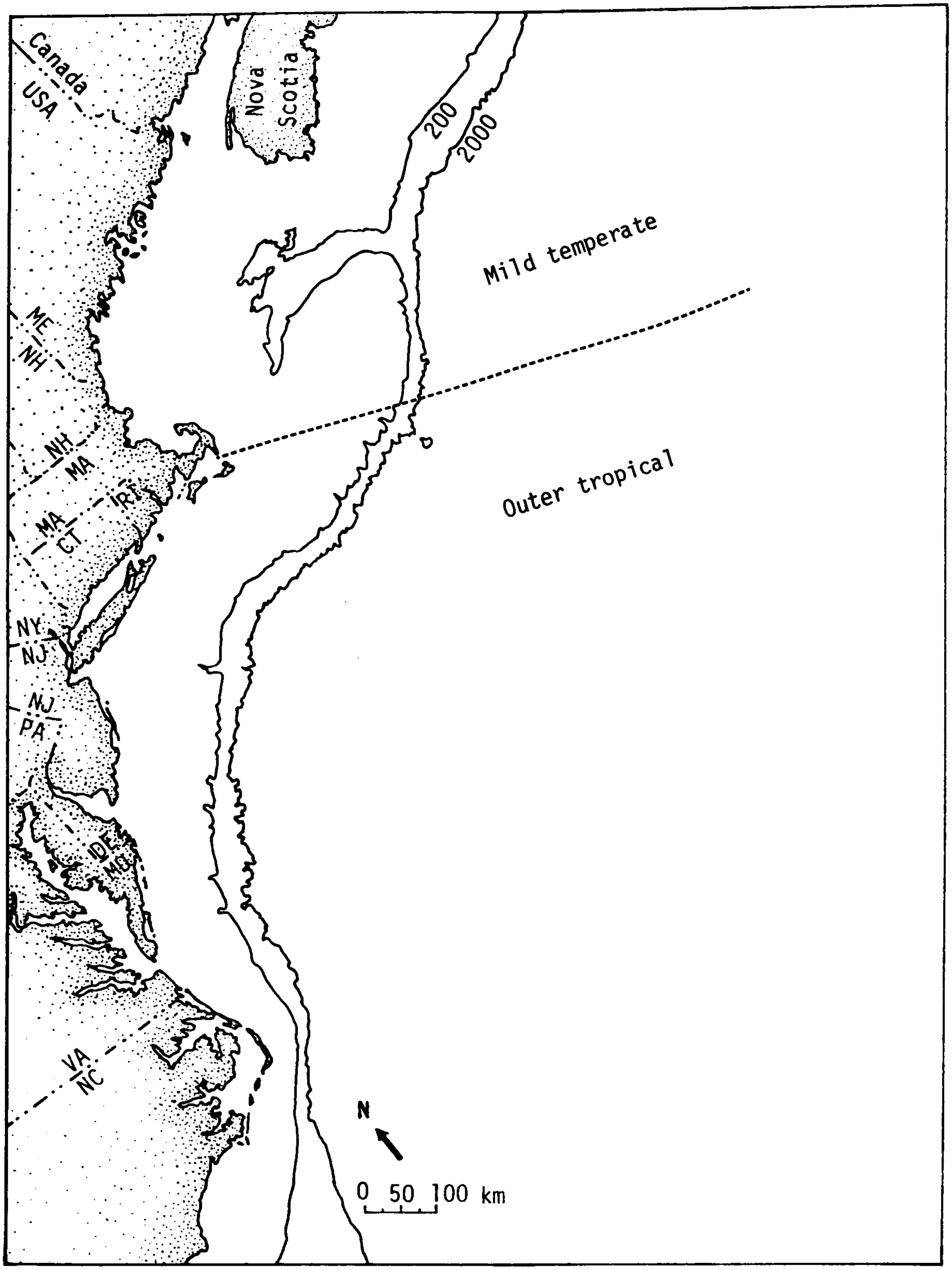


Fig. II-9: Atlantic molluscan provinces, estimated distribution at 7500 to 2000 B.P.

areas which would support them and vegetation and forest types analogous to modern types were formed. The exact composition of these forests was determined by climate and edaphic factors, and minor shifts in species composition occurred with minor climatic fluctuations.

In the ocean, temperature change was reflected in long-distance shifts of molluscan communities, which migrated as much as 8° of latitude. Along with the shifts of molluscs, other shifts of animal distribution no doubt took place.

4.2 Paleoenvironments

Volume I of this study was presented a detailed examination of the geology of the Continental Shelf in the study area. In the course of that presentation, much information relevant to the reconstruction of the physical environments of the past was given. The re-documentation of those data would be wasteful and unnecessary, but a summary of the possible interpretations, enriched by consideration of biological factors, will be presented here.

The geological treatment divided the study area into two sections: the Gulf of Maine (Bay of Fundy to the Hudson Valley) and the mid-Atlantic Bight (Hudson Valley to Capte Hatteras). The discussion of archaeology, however, is facilitated by the use of three subdivisions, which will be used in this section. The Gulf of Maine equates with the Maine and southern New England subareas used in the discussion of archaeology, and the mid-Atlantic Bight equates with the mid-Atlantic subarea.

Time was divided into non-arbitrary periods, defined primarily by rapidity of eustatic sea-level rise: 18,000 to 15,000, 15,000 to 12,000, 12,000 to 7000, 7000 to 3000, and 3000 to 0 B.P. These periods equate moderately well with the periods used for paleoclimatic reconstruction and those used for archaelological discussion. The primary divergence lies in the 12,000 to 7000 B.P. period, which was subdivided in the treatments of paleoclimates (12,000 to 9000 and 9000 to 6000 B.P.) and of archaelology (12,500 to 10,000, 10,000 to 8000, 8000 to 6000 B.P.). The chronological disparity of a mere 1,000 years is relatively minor, considering the scale of time and the vagaries of dating. The various periods used for different analyses are not believed to be sufficiently dissimilar to preclude their use together.

This presentation makes it possible to classify all paleoenvironments into four types: full coastal, estaurine, inland valley, and inland uplands. Full coastal environments are defined as those immediately adjacent to the ocean, including lagoonal environments. Estuarine environments are only those environments near the zone of saltwater intrusion in the lower stretches of rivers. Inland environments are divided between valley environments (near major rivers, along flood plains or terraces) and upland environments (at higher elevations, in the areas between major river systems). The scale at which reconstruction is possible means that "upland" environments may include small valleys, too small to be detected. In addition to these types is the category of land under glaciers. It is assumed that these areas would have been uninhabitable by human beings.

Clearly, each type includes great potential diversity and should be discussed thoroughly. The discussion which follows, although lengthy, is necessary to the knowledgeable prediction of the distribution of paleoresources.

4.2.1 Maine subarea

4.2.1.1 18,000 to 12,000 B.P.

Glaciers - Fig. II-10 maps one reconstruction of the approximate locations of the glacier front at different periods. At the beginning of the period under discussion, glaciers covered the entirety of Maine, including both areas presently exposed and areas presently inundated. Around the middle of the period, the glaciers retreated, but were followed immediately by the rising sea, which rose rapidly enough to maintain itself in contact with the wasting glacier. Only by 12,500 B.P. was any of Maine's land surface exposed.

4.2.1.2 12,000 to 7000 B.P.

Coastal:full coastal - Because of local factors such as crustal movement, the coastal area north of Boston, including all of the Maine subarea, was emerging from the sea until around 10,000 B.P., when relative sea level began rising and land areas began submerging.

The coastal zone was one of very high relief. Islands became numerous during costal submergence. The high wave energy beaches of Maine were not conducive to the development of spits and barrier islands which would protect lagoons. Such unprotected areas could not have developed extensive salt marshes, since erosion would have precluded colonization (Redfield 1965). Marshes probably would have been restricted to sheltered coves on the landward side of islands on the irregular coast.

Coastal:estuarine - Very few data pertaining to early estuaries in the Gulf of Maine are available and the situation is difficult to reconstruct. Tidal amplitude appears to have been considerably lower than at present (Grant 1970), so salinity intrusion would also have been less. High coastal relief would further have lessened the length of estuaries. Rapid sea-level changes, especially oscillation, would shift estuary location frequently enough to inhibit the typical widening of a mature estuary and the development of extensive salt marshes.

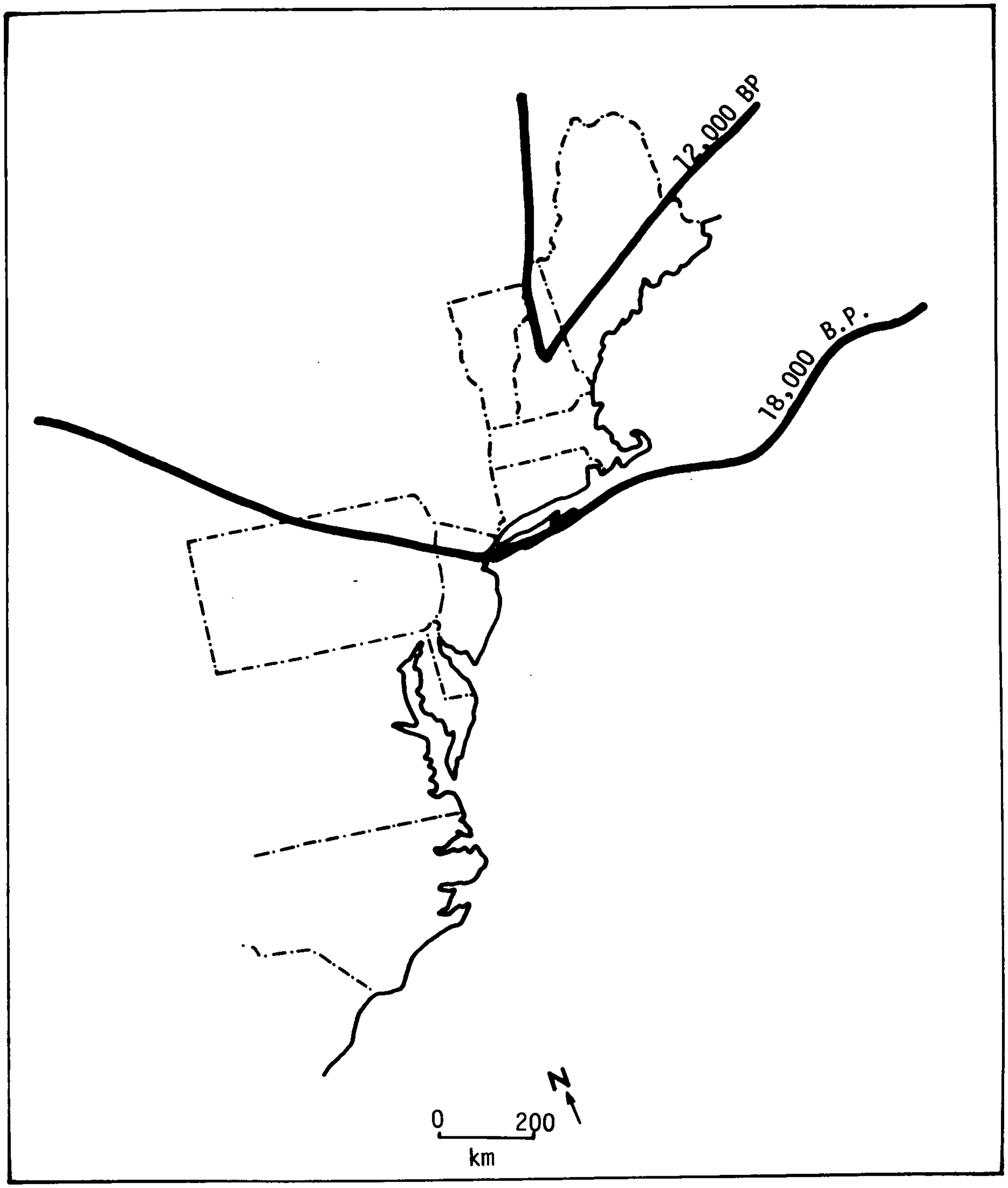


Fig. II-10: Speculative reconstruction of glacial fronts (after Prest and Grant 1969).

Inland:valleys - During the earlier portion of this period, rivers would have been swollen by glacial melt water. Their positions, however, would have been essentially the same as today. Frequent waterfalls and rapids mark their courses.

Flood plains would have developed and silt would have produced moderately fertile soils in the valleys. These flood plains were neither so frequent nor so extensive as further south. Vegetation in the valleys probably would have been tundra-like and characterized by spruce parkland in the early period, followed around 9000 B.P. by mixed conifer-hardwood forest.

Inland:uplands - The upland areas between major rivers reflected recent glaciation. Relief was varied, drainage was generally poor, and swamps and lakes abounded. Soils were poorly developed initially, having been stripped of fertile topsoil by the glaciers, and only gradually became more developed and fertile. Vegetation was probably similar to that in the valleys, with changes lagging slightly behind as a result of colder climates in the uplands. Overall density of vegetation was probably lower in the uplands.

Discussion - Fig. II-11 maps environmental types for Maine during the period from 12,000 to 7000 B.P. Costal environments comprise a moderate-sized area, but most of that area was made up of biologically relatively unproductive high-energy beaches. Inland, valleys were minor and uplands made up the majority of area.

4.2.1.3 7000 B.P. to present

Coastal:full coastal - During this period, the distinctive characteristics of the modern coastal environment of Maine developed. Tidal amplitude became great, the high wave energy of the coast persisted, and today's irregular coastline took form. Parts of the coast remain open beach with little vegetation; lagoons and coves are the major area of salt marsh formation.

Coastal:estuarine - The combination of slow relative-sea-level rise and increasing tidal amplitude made estuaries during this period become longer and more mature. Salt marshes flank the lower portion of most estuaries. The modern estuary is the most productive and extensive it has ever been in Maine.

Inland:valley - Physiographically, valleys changed little in Maine since the preceding period. River flows diminished and soils matured slowly. Waterfalls and rapids persisted. Vegetation grew more varied, but always within the context of mixed conifer-hardwood forest.

Inland:upland - As in the valleys, changes from the preceding period were minor and gradual. Soils matured but remain thin today. Lakes

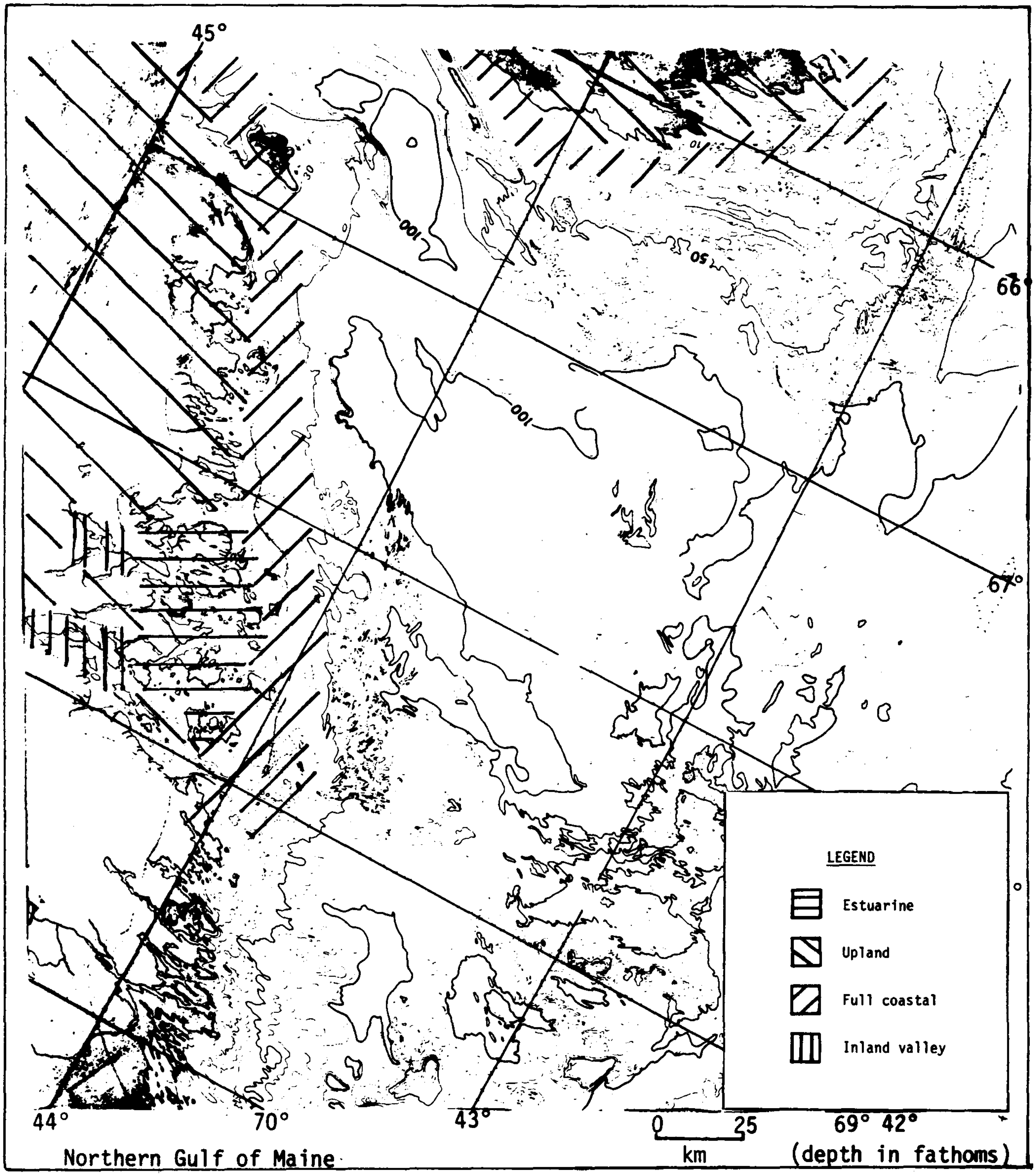


Fig. II-11a: Distribution of environmental types at 12,000 B.P.

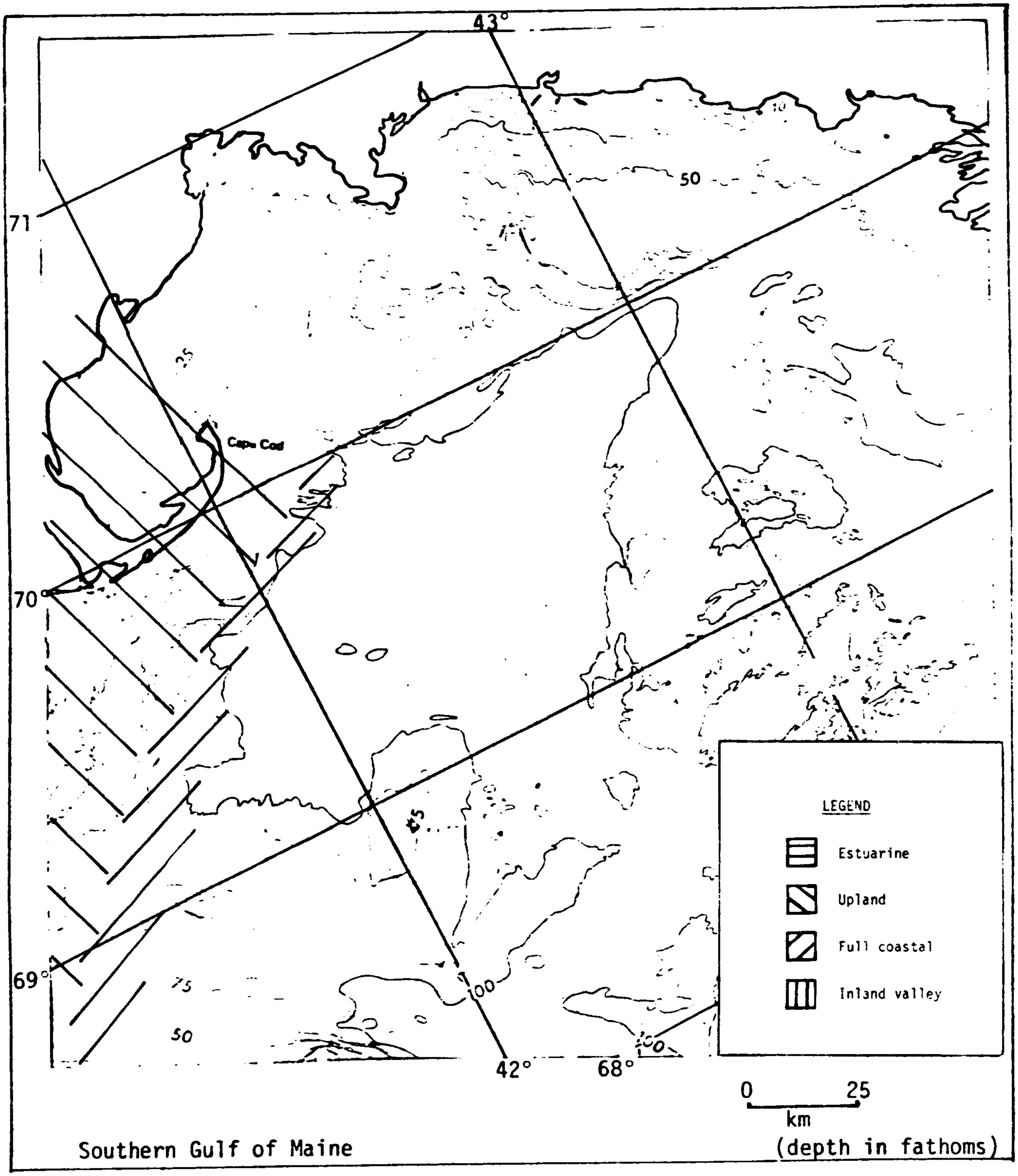


Fig. II-11b: Distribution of environmental types at 12,000 B.P.

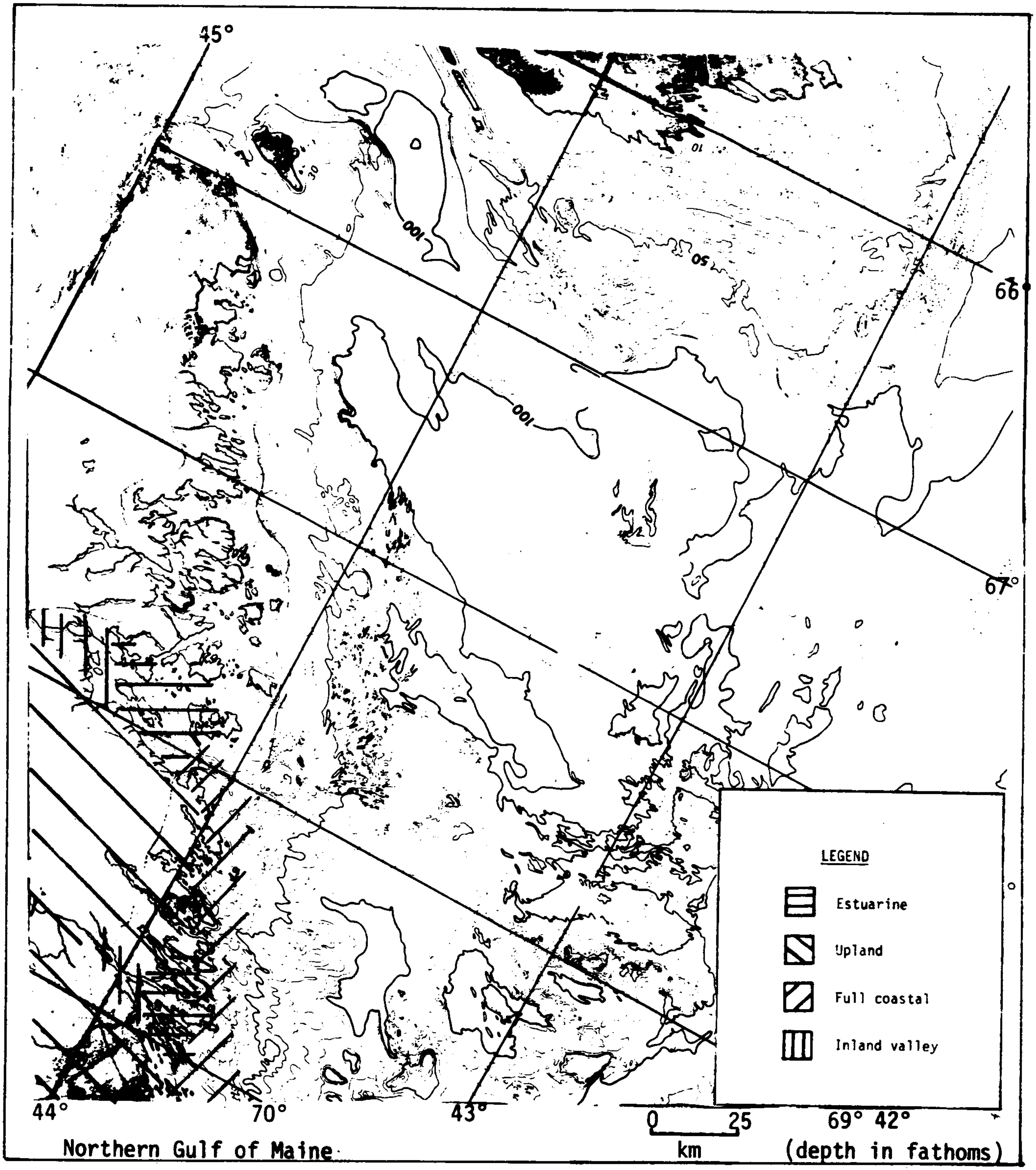


Fig. II-11c: Distribution of environmental types at 9000 B.P.

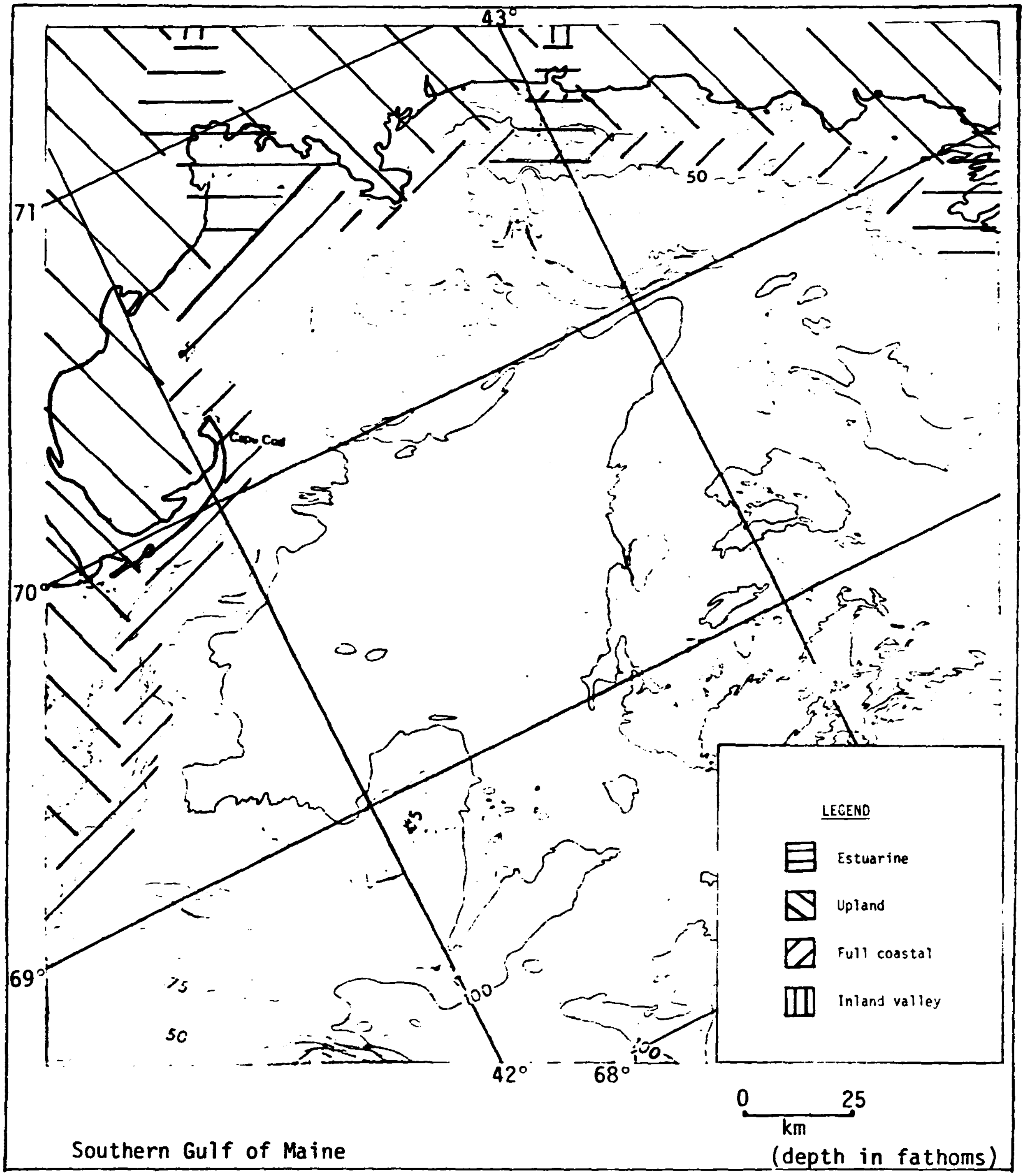


Fig. II-11d: Distribution of environmental types at 9000 B.P.

shrank and swamps silted in slightly. Vegetation approximately parallels that of the lowlands.

Discussion - Fig. II-12 shows the distribution of environmental types during this period. The coastal zone expanded from earlier times in terms of area and particularly in terms of biological productivity. The inland zones maintained about the same distribution and the soils became slightly more fertile.

At around 7000 B.P., the beginning of this period, the area between southern Maine and the tip of Georges Banks began following the patterns of environmental change seen for the rest of southern New England and no longer shared a common pattern with Maine.

4.2.1.4 Summary - The Maine subarea, in both portions presently inundated and those presently above sea level, was beneath either ice or ocean waters until about 12,500 B.P. Since then, its coastal zone has been becoming increasingly more mature and biologically productive. Inland areas, too, have been increasing in fertility, but at a much slower rate.

4.2.2 Southern New England subarea

4.2.2.1 18,000 to 15,000 B.P.

Glaciers - During much of this period, a major portion of southern New England was covered by glaciers. Fig. II-10 maps positions of the glacier front at different periods and shows that only Georges Banks and areas offshore from Long Island would have been free from the ice sheet during any of this period. It is possible that a trough of cold fresh water extended along the glacier front.

Costal:full coastal - Topographic relief was high, both in nearshore and terrestrial areas. As a result, spits, barrier islands, and other features which could protect the shore and allow lagoon formation were rare to absent. Salt marshes were very small in area, as were tidal flats.

The primary types of interfaces between ocean and land were mainland beaches and deltas. Mainland beaches with little protection from storms and wave action would have dominated the shoreline between major rivers. Deltas were extensive at the mouths of the Hudson, Block, and Long Island River systems; smaller deltas may have occurred alone the Georges Banks coastline.

Mainland beaches would have had sparse vegetation. Deltas are more difficult to characterize. Their sediment composition would have been conducive to plant growth, but the salt water permeating much of the soil would have reduced the number of potential species. Numerous small ponds, probably both fresh and salt, would have dotted the deltas.

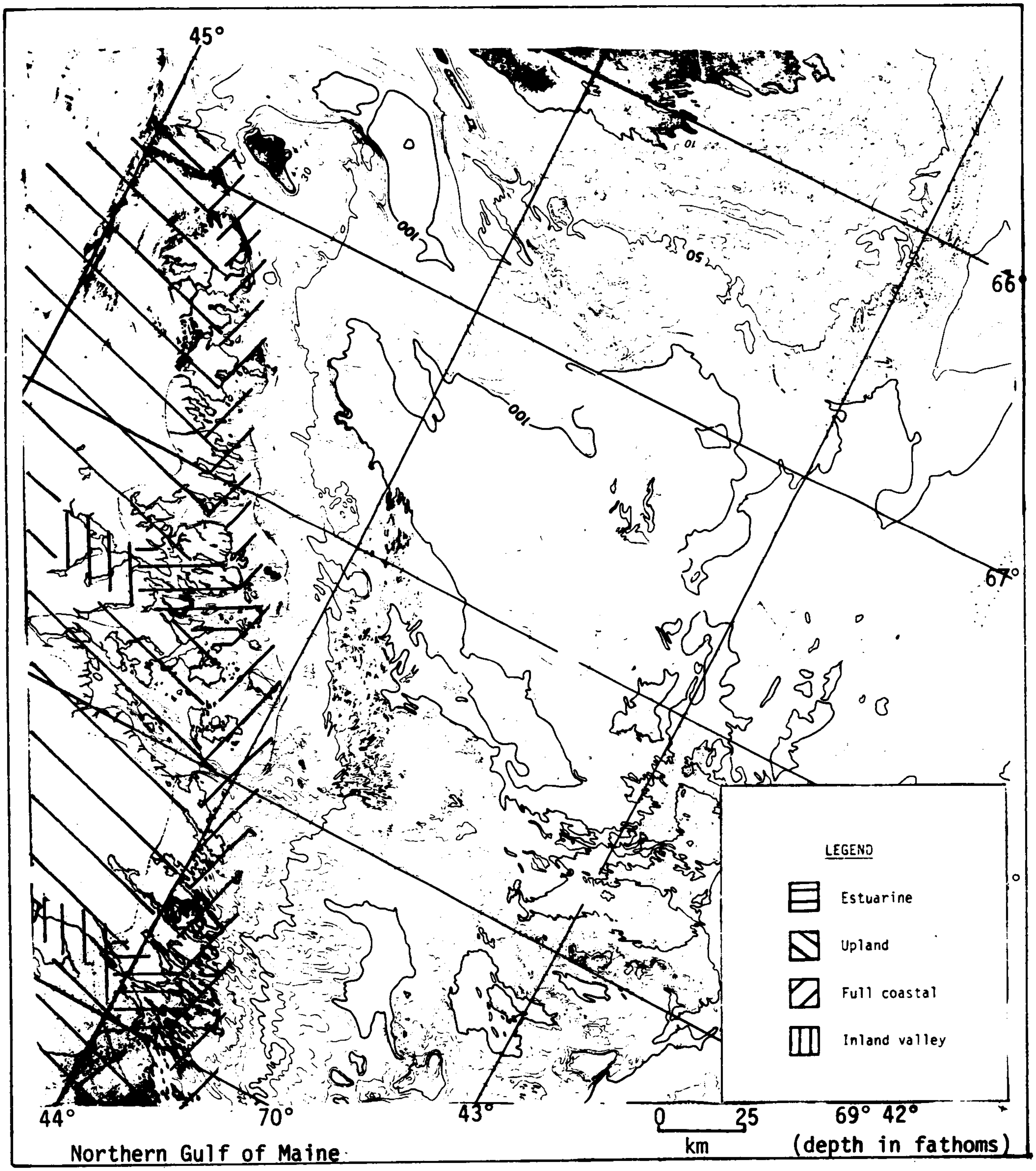


Fig. II-12a: Distribution of environmental types at 6000 B.P.

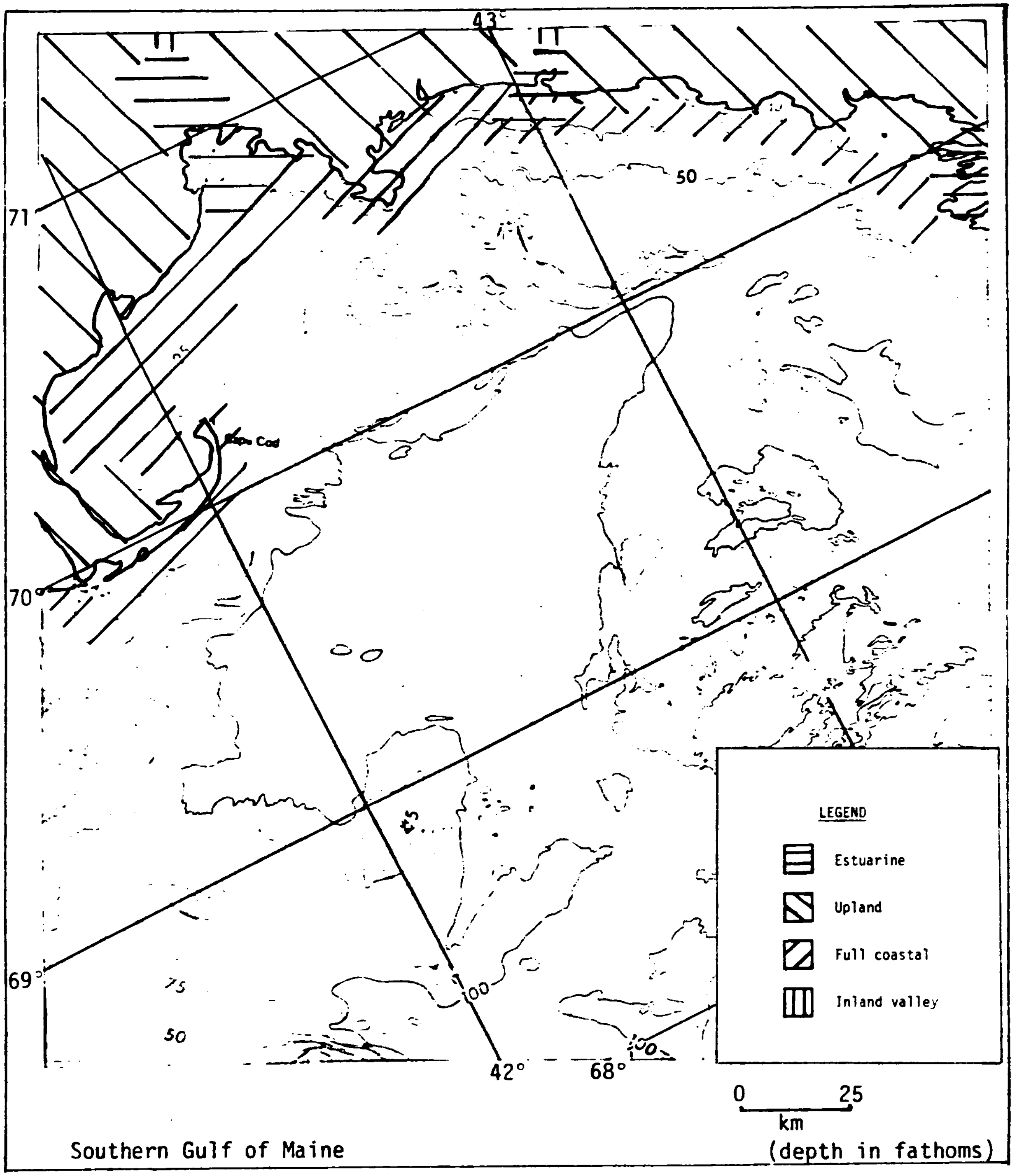


Fig. II-12b: Distribution of environmental types at 6000 B.P.

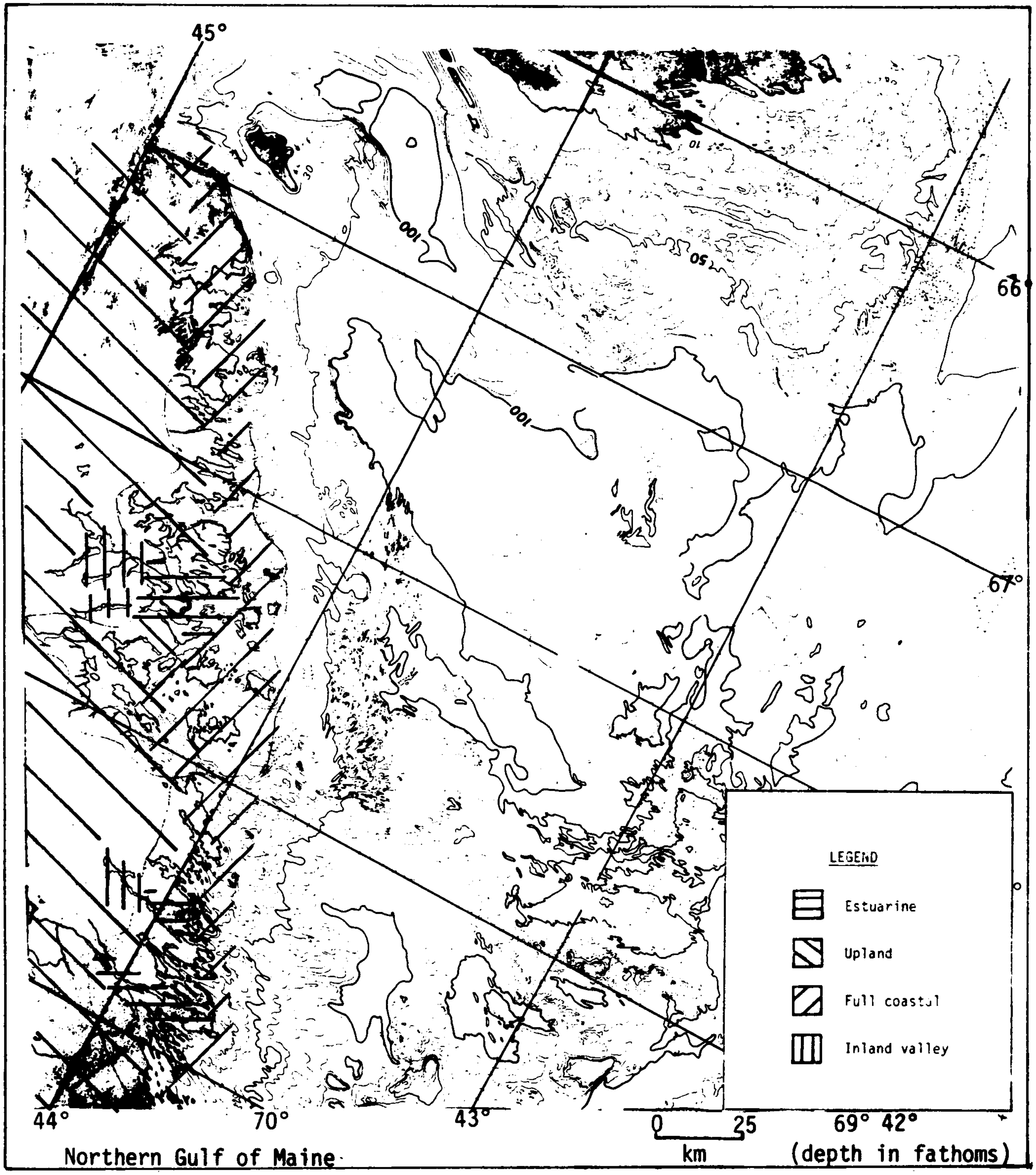


Fig. II-12c: Distribution of environmental types at 3000 B.P.

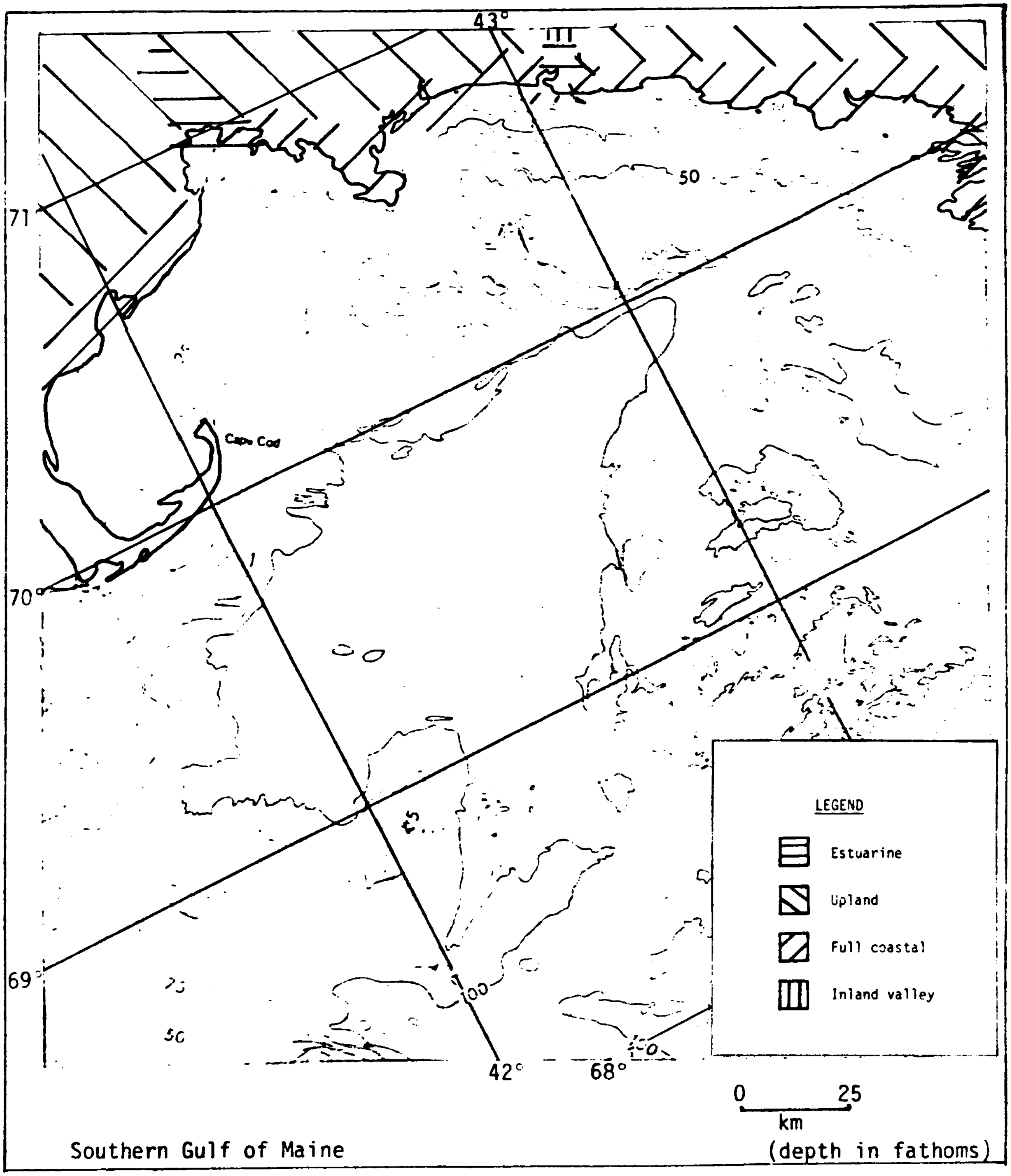


Fig. II-12d: Distribution of environmental types at 3000 B.P.

Salt marshes well may have surrounded salt ponds, other vegetation would have been at fresh ponds. Degree and composition of tree cover is unknown.

Coastal:estuarine - The high topographic gradient reduced the extent of tidal salt-water intrusion into rivers, limiting estuary length. Since rivers were swollen by glacial melt water, estuarine intrusion would have been limited further. Steep gradient also would have precluded the widening typical of mature lower estauries.

Salt-marsh development in estuaries was probably limited, as may be concluded from the small overall areas and low salt-water inputs involved.

Inland:valleys - Large rivers were common in this area and time period. At least eight major rivers flowed northeast of the Hudson Valley, all with large volumes of discharge per unit area. These large discharges created downcutting which exposed bedrock sills as rock outcrops. It also produced well-developed flood plains with fertile silty soils. No major lakes have been identified, although they may have been present.

These large river valleys would have been ideal for many types of vegetations, including both trees and non-arboreal vegetation, depending primarily on climate and rates of seed transportation. Vegetation probably was either tundra-like or spruce parkland, but large stands of trees may have been present.

Inland:uplands - Inland valleys formed on smooth outwash plains and had low relief. Upland areas, however, exhibited the variable relief characteristic of glaciated uplands. Soils and drainage varied greatly with locale. Swamps and small lakes were common in low areas. Streams were smaller but more frequent than in unglaciated areas further south.

The vegetation in such an area would be variable. Climate would be slightly cooler than in lower and more protected valleys, so tree development is expected to be less than in valleys. Tundra-like and spruce-parkland environments are likely.

Discussion - Fig. II-13 shows the approximate distribution of environmental types for the period 18,000 to 15,000 B.P. in the southern New England area. Coastal environments comprise only a small percentage of the area. Inland valleys compose a substantial portion of the area, but uplands dominate.

4.2.2.2 15,000 to 12,000 B.P.

Glaciers - Fig. II-10 shows that glaciers had retreated from the Continental Shelf by the end of this period. Different reconstructions give various dates and locations for the glacier front, but are in agreement that glacial retreat from the study area was substantial and nearly

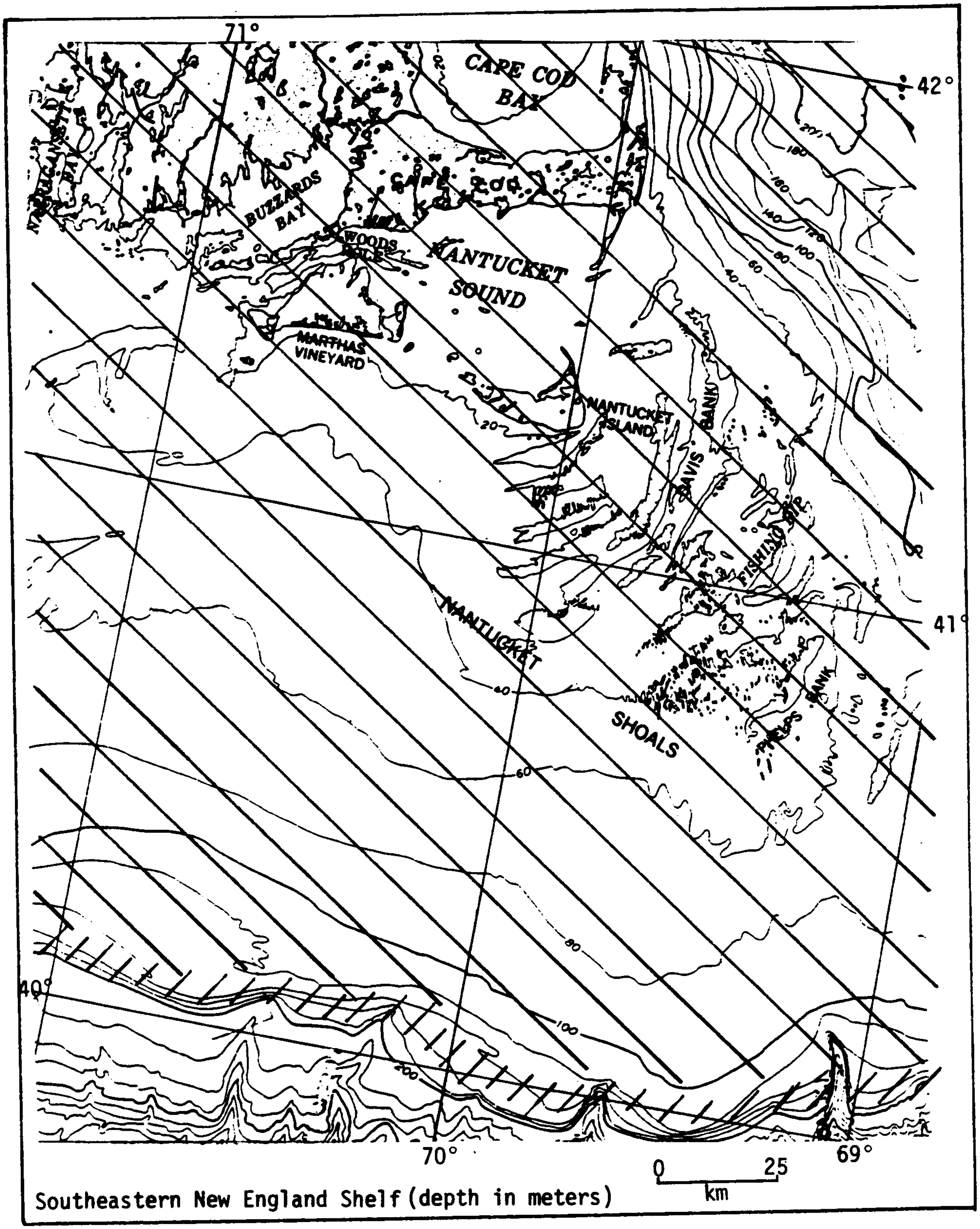


Fig. II-13a: Distribution of environmental types at 18,000 B.P. (See Fig. II-13b for legend.)

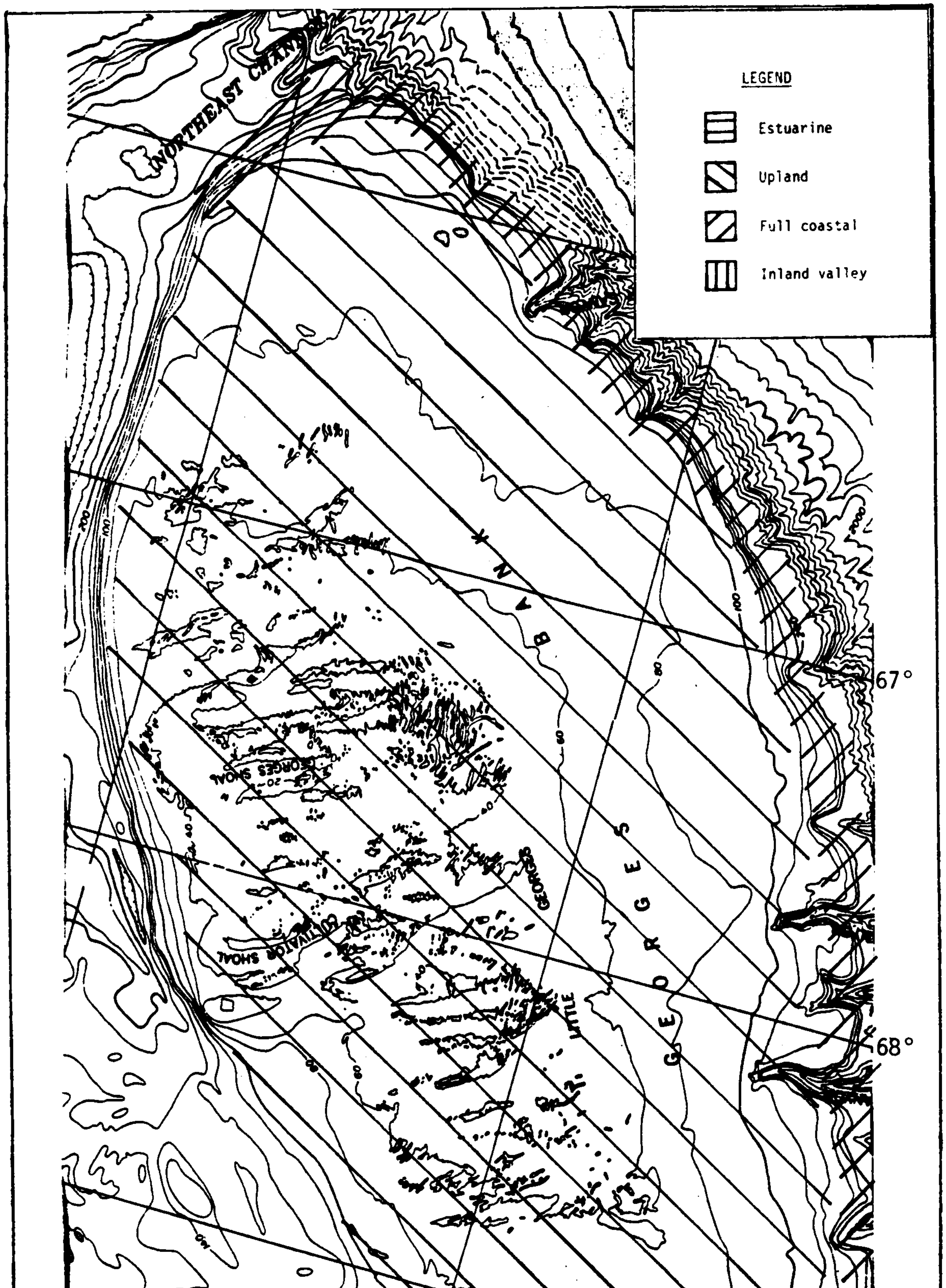


Fig. II-13b: Distribution of environmental types at 18,000 B.P.

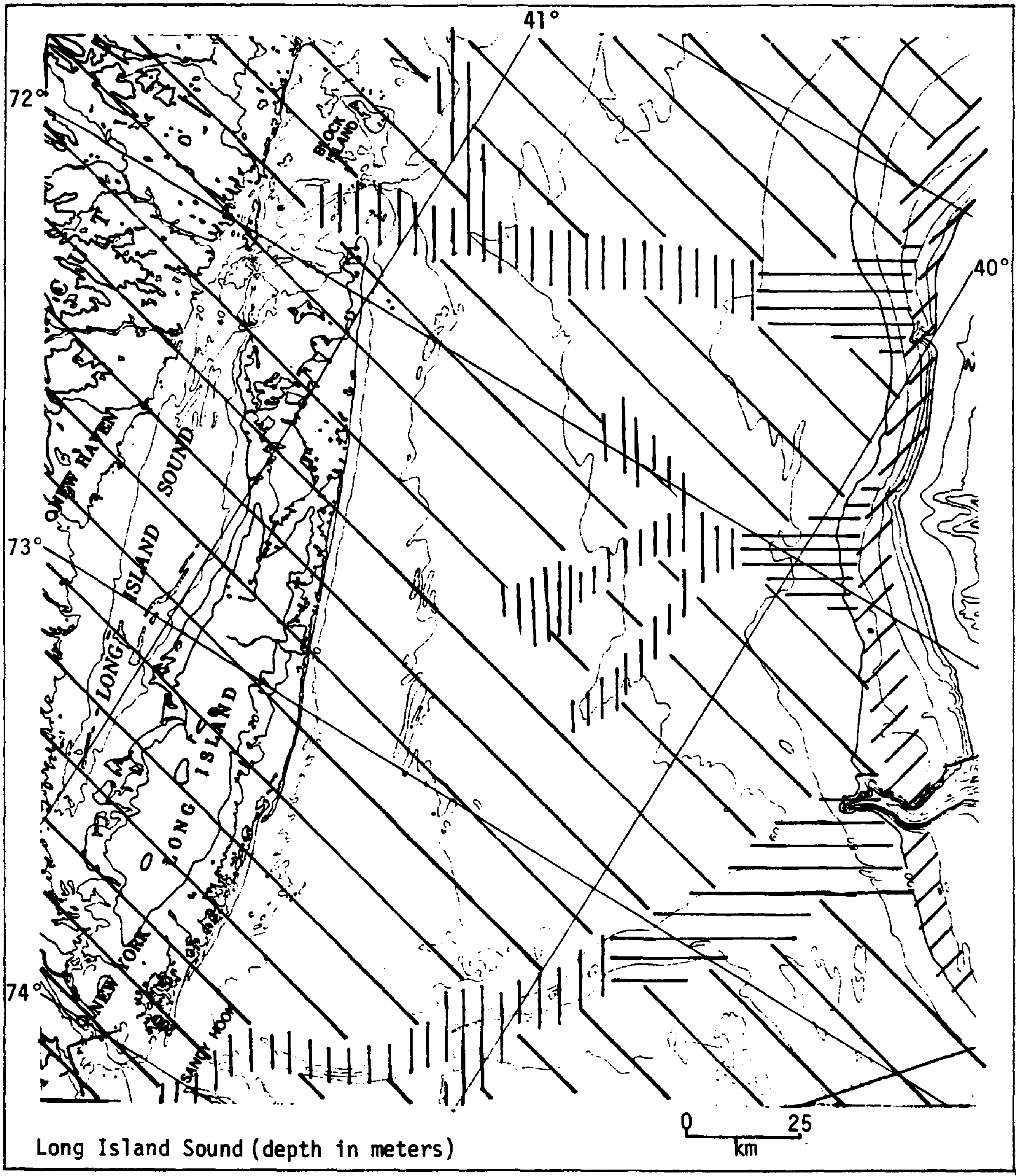


Fig. II-13c: Distribution of environmental types at 18,000 B.P. (See Fig. II-13b for legend.)

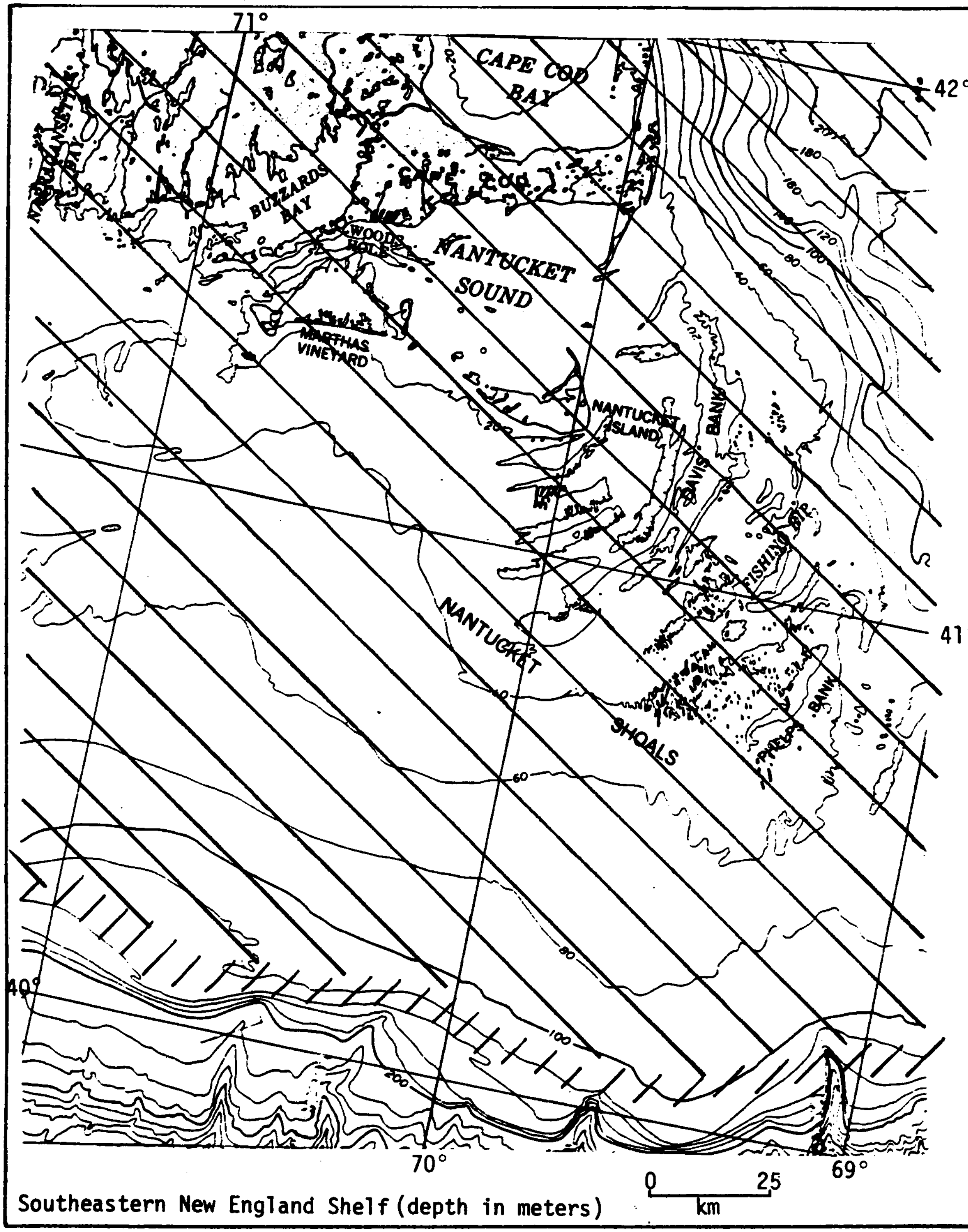


Fig. II-13d: Distribution of environmental types at 15,000 B.P. (See Fig. II-13e for legend.)

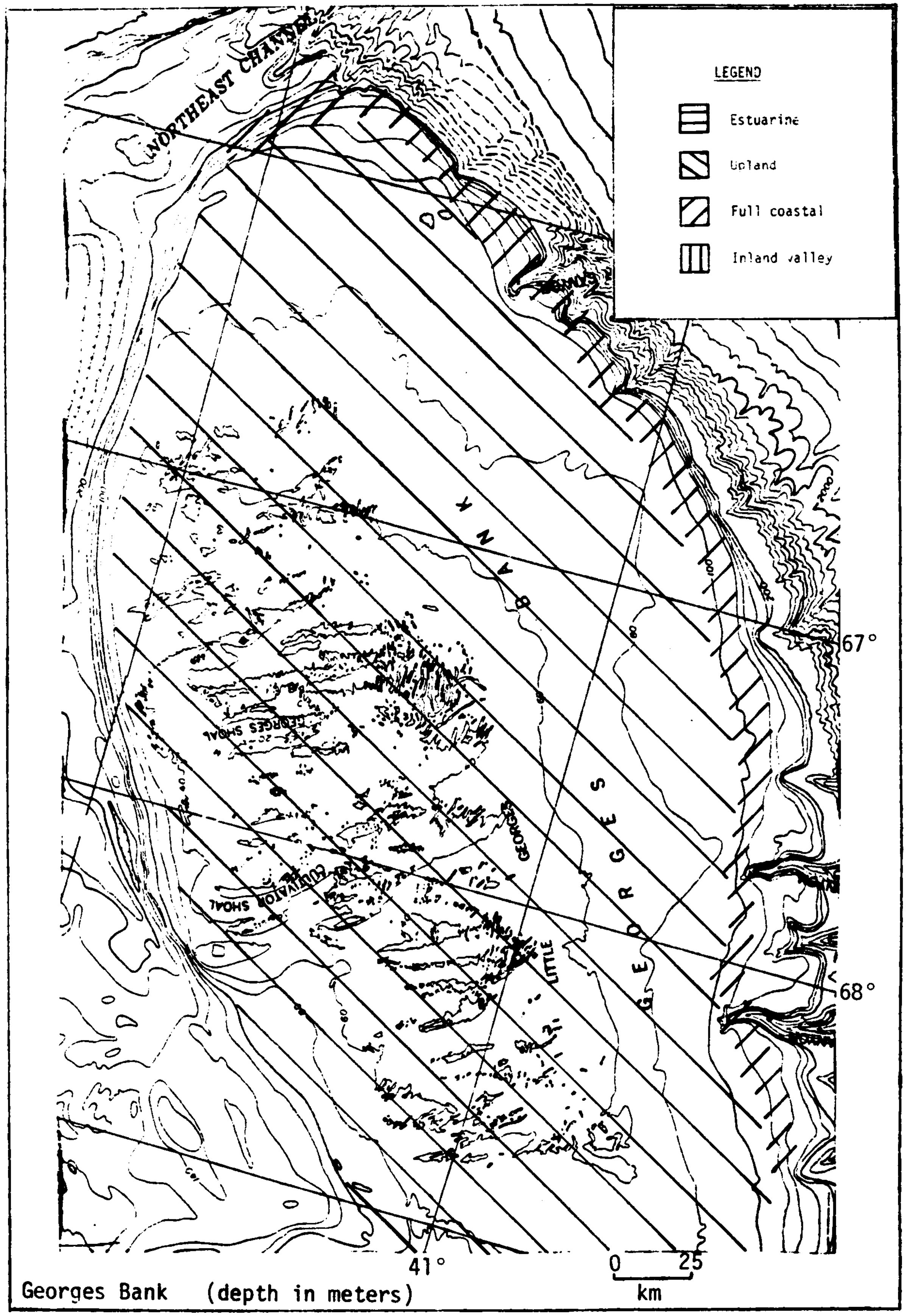


Fig. II-13e: Distribution of environmental types at 15,000 B.P.

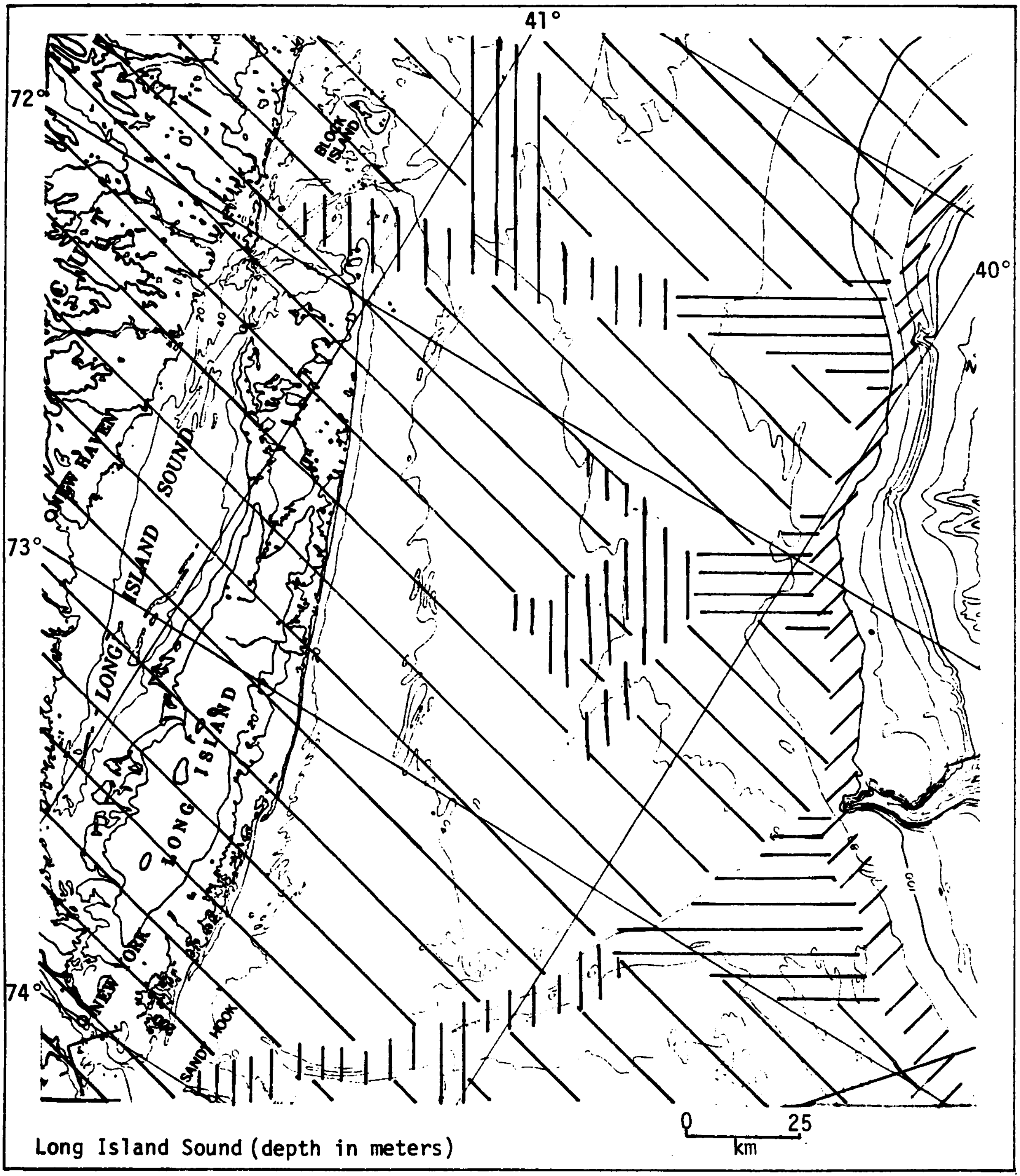


Fig. II-13f: Distribution of environmental types at 15,000 B.P. (See Fig. II-13e for legend.)

complete. By the next time period, the ice front had retreated northward well into Canada. North of about Boston, however, the rising sea inundated previously glaciated areas immediately upon glacial retreat. Only at around 12,500 B.P. did these areas become exposed.

Coastal:full coastal - With eustatic and relative rise in sea level, the ocean margin during this period rose above the steepest portion of the Continental Shelf, the Continental Slope. Relief at the beginning of this period was great to moderate, but was steadily being reduced.

Rise in sea level inundated deltas, but sedimentation probably preserved these features in the form of broad salt-marsh and mud-flat environments at the mouths of major rivers. Lacking any protecting shoreline feature, the seaward portion of these deltas probably was eroding constantly and extensively. Vegetation in that portion would have been minimal.

As in the earlier period, spits, barrier islands, and lagoons were infrequent and poorly developed. Consequently, salt-marsh formation was hindered or prevented by wave and storm erosion. Mainland beaches on stretches of the shoreline between major rivers continued to be the major full-coastal environment.

Coastal:estuarine - As relief diminished, the importance of estuaries grew. Length of the estuaries remained short, but their width was increasing. With increasing width, salt-marsh development probably increased. During this period, more of the smaller rivers were developing significant estuaries.

Inland:valleys - Major river valleys and their environments remained quite similar to those found in the preceding period. Tributary streams, however, developed larger flows, and the valley environments became more widespread. These tributary channels remain largely unlocated. Vegetation may be presumed similar to that of the previous period.

Inland:uplands - The upland zone was characterized by varied topography with rolling hills and depressions, the latter sometimes filled with swamps or shallow lakes. Soils, as in the previous period, were variable, but soil fertility was gradually increasing as the available period for (postglacial) soil development increased. There was also a coastal-to-inland gradient of increasing soil fertility as a result of the longer period of soil development on the more inland portions of the Continental Shelf, where emergence above the ocean had taken place earlier. (These soil patterns over space and time characterize all subsequent periods discussed.)

Vegetation of the uplands during this period probably remained similar to that of the earlier period, with a gradually increasing complement of trees.

Discussion - Fig. II-14 maps the approximate extent of these zones during the period 15,000 to 12,000 B.P. The coastal zone gradually is increasing in area, but more important is its increasing ability to support intensive vegetation. The rapid sea-level rise of this period brought relative sea levels above the Continental Slope, reducing coastal relief. Inland, stream systems and soils were maturing, with a resultant increase in fertility and the ability to support life.

4.2.2.3 12,000 to 7000 B.P.

Coastal:full coastal - During this period, two different patterns of relative sea-level rise characterized southern New England. North of Boston, relative sea level fell, then rose again after about 10,000 B.P. This pattern paralleled that for Maine, and paleoenvironmental reconstructions for the two areas are also similar. The following discussion treats only the remainder of southern New England, from Boston to the Hudson Valley, where relative sea levels rose constantly during this period.

By this time, the ocean had transgressed over the steepest part of the Continental Shelf and coastal relief was very low. Accordingly, shallow water features such as spits and barrier islands formed extensively, creating a profusion of protected lagoons. Within these lagoons, salt marshes and mud flats developed extensively. During the last phase of inundation of Georges Banks, around 8000 B.P., the entire area of Georges Banks was an extensive salt marsh and mud flat.

From this time forward, deltas were no longer of importance, having been overwhelmed by rising relative sea levels at rates too rapid to allow their reestablishment. Mainland beaches, too, become uncommon, as barrier islands and spits become more frequent. Deltas and mainland beaches, from this time forward, were exceptional rather than typical.

Coastal:estuarine - The low gradient on this portion of the Continental Shelf produced long estuaries, probably the longest of the postglacial period. Width of estuaries, too, was at its maximum.

Salt marshes and mud flats expanded rapidly along the edges of estuaries. For the first time in this area, extensive marsh-mud-flat systems developed probably on a scale nearly comparable to that of their modern counterparts.

Inland:valleys - Inland valleys during this period remained similar physiographically to the inland valleys of the preceding period. Broad flood plains flanked the major rivers, and soils were silty as a result of sediments washed down by rivers swollen with glacial melt water.

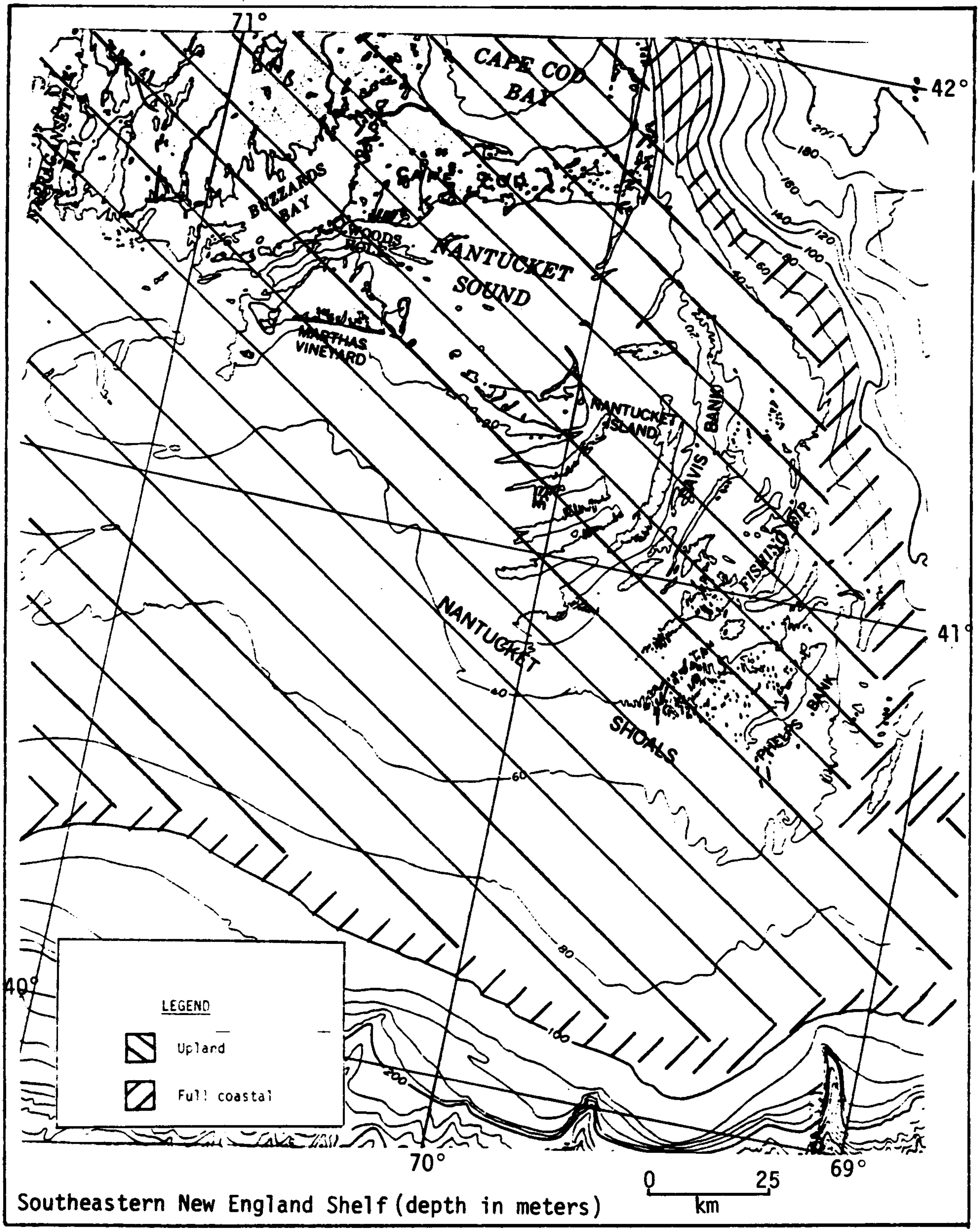


Fig. II-14a: Distribution of environmental types at 12,000 B.P.

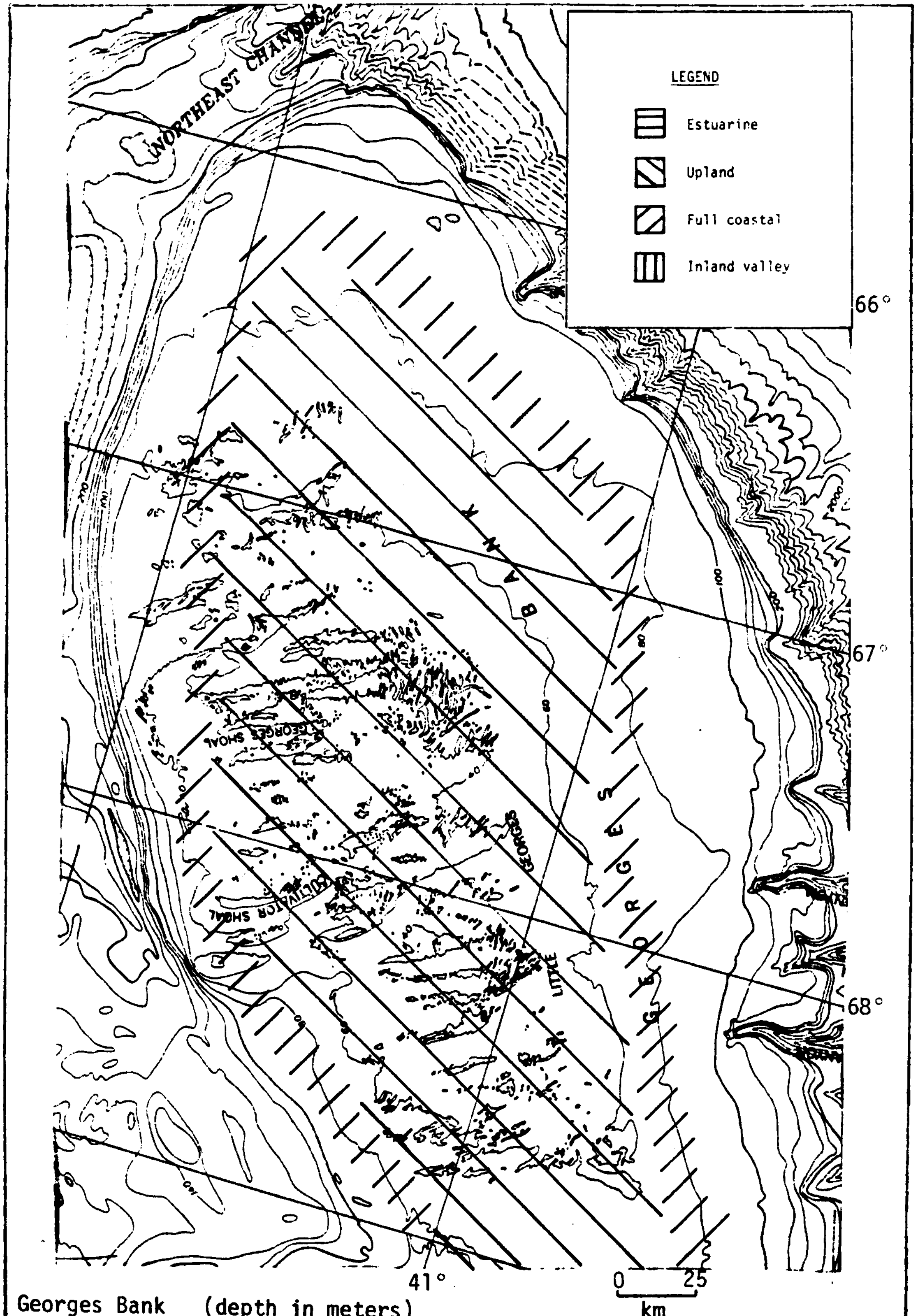


Fig. II-14b: Distribution of environmental types at 12,000 B.P.

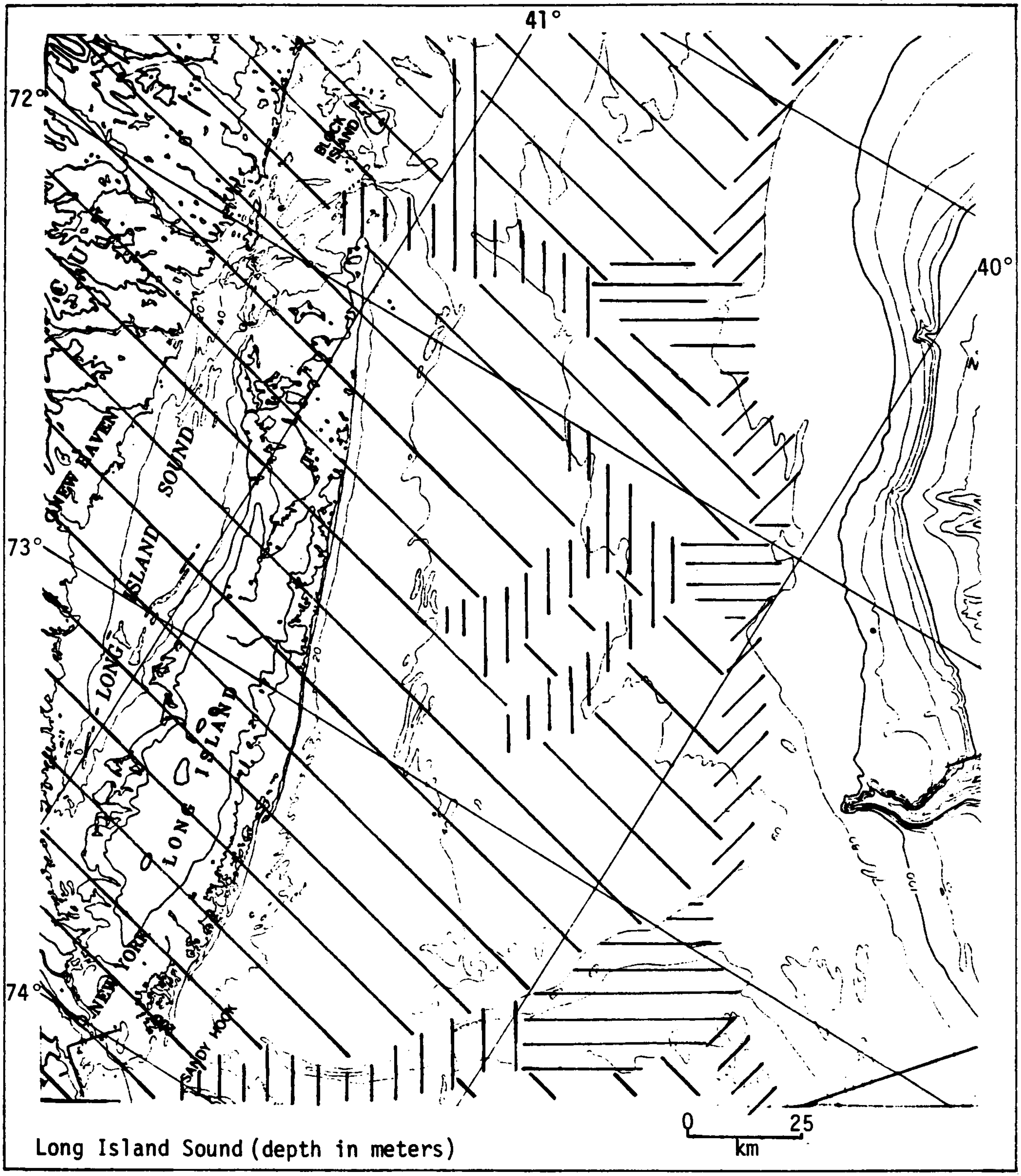


Fig. II-14c; Distribution of environmental types at 12,000 B.P. (See Fig. II-14b for legend.)

The stream systems of this period were ramifying and maturing. Consequently, the number of swamps developed in glacially formed topography was diminishing.

Vegetation was probably spruce parkland early in the period and mixed conifer-hardwood forest later.

Inland:uplands - In the upland zones between major river valleys, soils were dominated by sand and gravel left by the regressing ocean before 18,000 B.P. The glacially modified landscape included rolling hills (relatively low), swamps, and shallow lakes. Around 9000 B.P., the maturing stream system began draining more of the swamps, and drainage improved.

Vegetation was probably spruce parkland early and mixed conifer-hardwood forest late in the period. The sandy soils in the uplands would have given pines a competitive advantage over hardwoods, producing higher percentages of pines in the mixed forest of the uplands than in their valley counterparts.

Discussion - Fig. II-15 maps the distribution of the various environmental types during the period from 12,000 to 7000 B.P. The coastal zone has become considerably larger and immensely more productive in terms of its ability to support life. Inland, the upland and valley zones have matured and are becoming more fertile. They are also probably differentiated somewhat in terms of vegetation.

4.2.2.4 7000 to present

Coastal:full coastal - By this period, the frequencies of various environmental features and zones became very similar to modern frequencies. Rates of relative sea-level rise slowed, so that entensive marshes and mud flats developed. At the same time, the Slope, the portion of the Continental Shelf that was undergoing transgression, was increasing. One result was that a given sea-level rise would shift environmental zones a shorter distance inland.

Increasing Slope also slowly reduced the extent and frequency of barrier islands and lagoons. These various factors affecting salt-marsh development probably resulted in an approximate stability of extent of salt marsh and mud flats.

Coastal:estuarine - The increased Slope would have reduced the length of estuaries, although they would remain moderately long through modern times. The slowness of inland shift of environmental zones would produce wide estuaries and extensive salt marshes and mud flats.

Inland:valleys - By this period, rivers had shrunk as a result of two factors. First, glaciers had retreated far enough northward to drain their melt waters into other river systems. Second, as the Continental

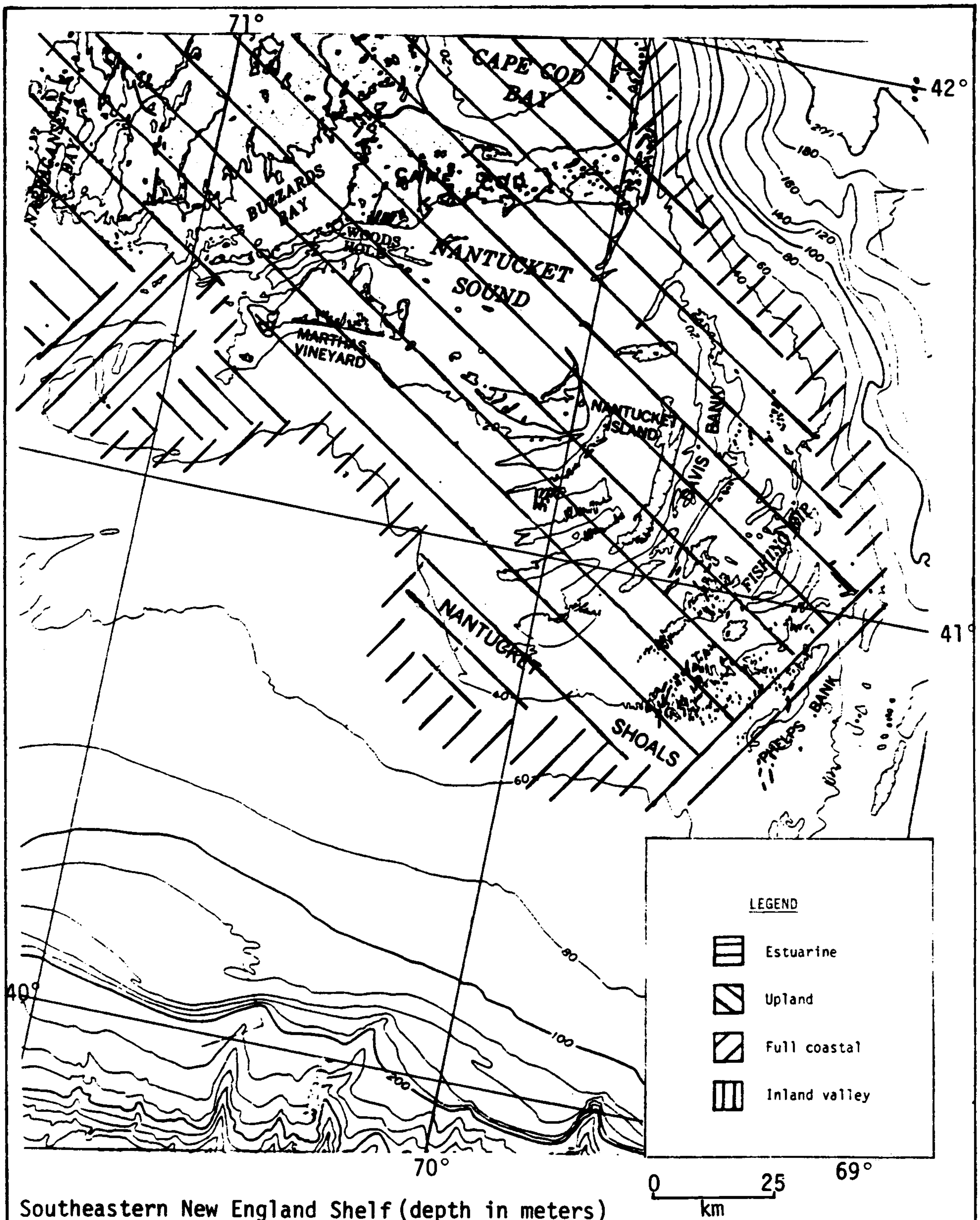


Fig. II-15a: Distribution of environmental types at 9000 B.P.

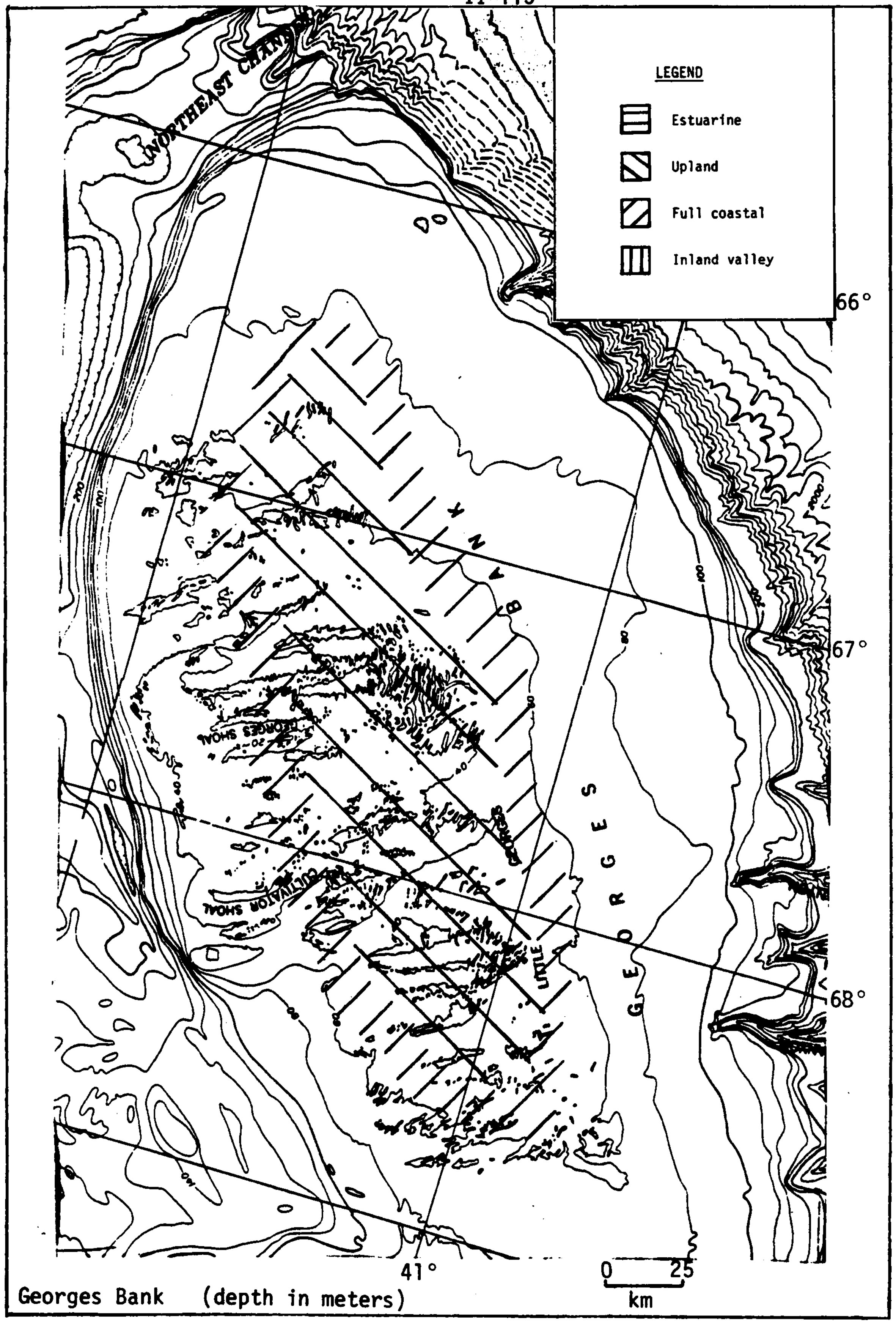


Fig. II-15b: Distribution of environmental types at 9000 B.P.

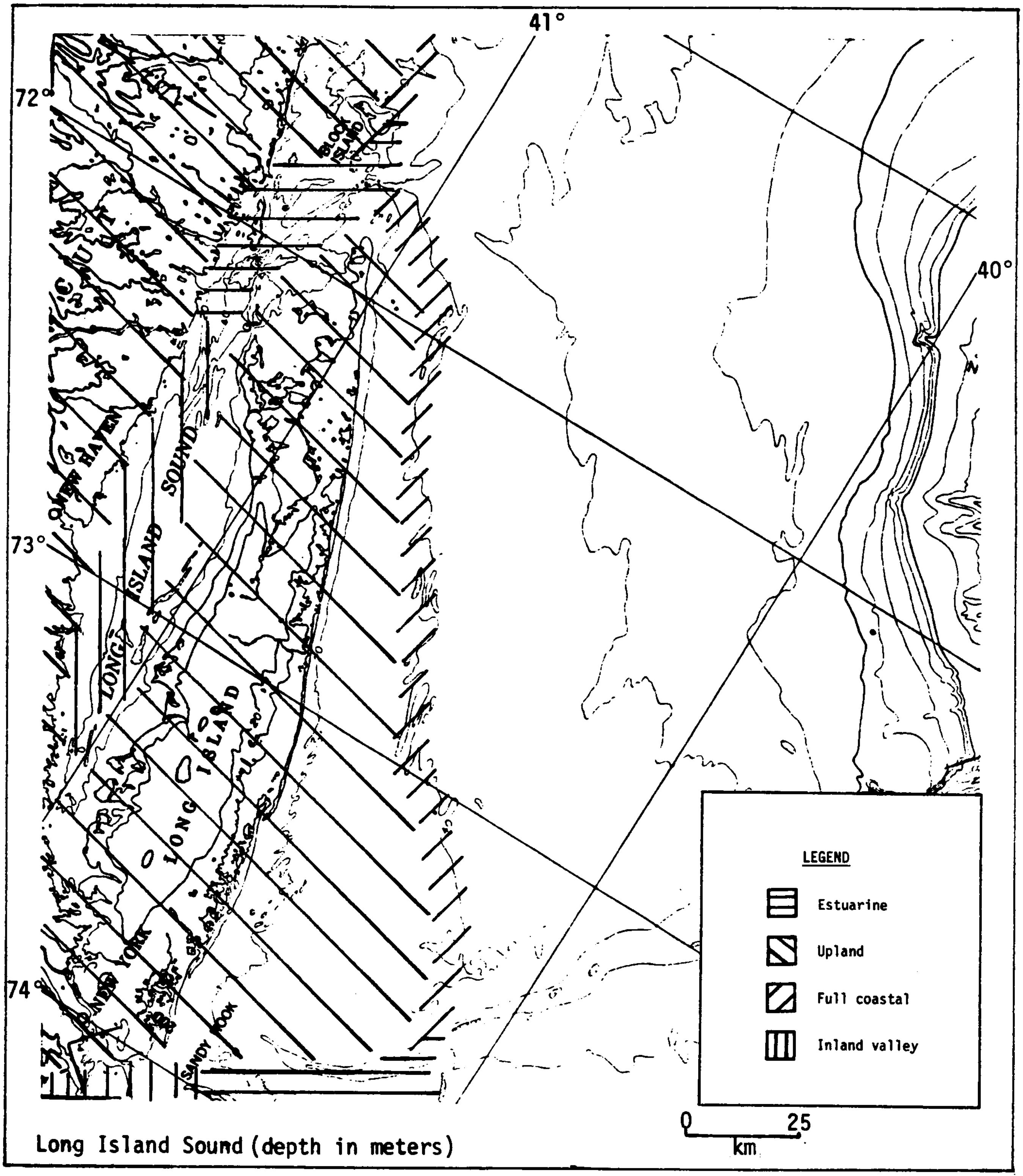


Fig. II-15c: Distribution of environmental types at 9000 B.P.

Shelf was inundated, the lower portions of very large rivers were drowned, so that their tributaries flowed directly into the ocean. By this period, all major rivers in southern New England were merely seaward-extended versions of modern rivers.

The environmental characteristics of these major river valleys were much like those of modern valleys. Broad flood plans with rich silty soils lay along valley bottoms. With increasing time since glaciation, drainage matured, draining many swamps, shrinking lakes, and increasing the number of streams per unit area.

Vegetation was dominated by hardwood forests.

Inland:uplands - The areas between major river valleys were characterized by rolling hills, with somewhat greater relief than in the preceding period. Soils had developed more mature horizons, but were not nearly so fertile as in valleys. The maturing stream system had continued to drain swamps and shrink lakes, but abundant evidence of the glacially modified topography and drainage remains today.

Vegetation was and is dominated by hardwood forests.

Discussion - Fig. II-16 shows the distribution of environmental types during the period 7000 B.P. to present. The coastal environments are reduced slightly from the preceding period, but remain moderately extensive and quite productive. Inland zones continue to become more fertile.

It is during this period, around 7000 B.P., that the area from extreme southern Maine to the Hudson Valley takes on basic environmental uniformity largely because of the similar rates and sequences of relative sea-level change.

4.2.2.5 Summary - Prior to 12,000 B.P., coastal zones were small and relatively unproductive. Following that date, they became much more extensive and productive. Inland, valley and upland zones became gradually more fertile as soils and drainage matured.

4.2.3 Mid-Atlantic subarea:

4.2.3.1 18,000 to 15,000 B.P.

Glaciers - As Fig. II-10 shows, glaciers never covered this portion of the study area and their effects are only indirect.

Coastal:full coastal - As in subareas discussed earlier, this period saw moderate-to-extensive relief along the coast. As consequences, barrier islands and spits were infrequent, mainland and cliff-banked beaches were common, and salt marshes and mud flats were smaller and less frequent than at later periods.

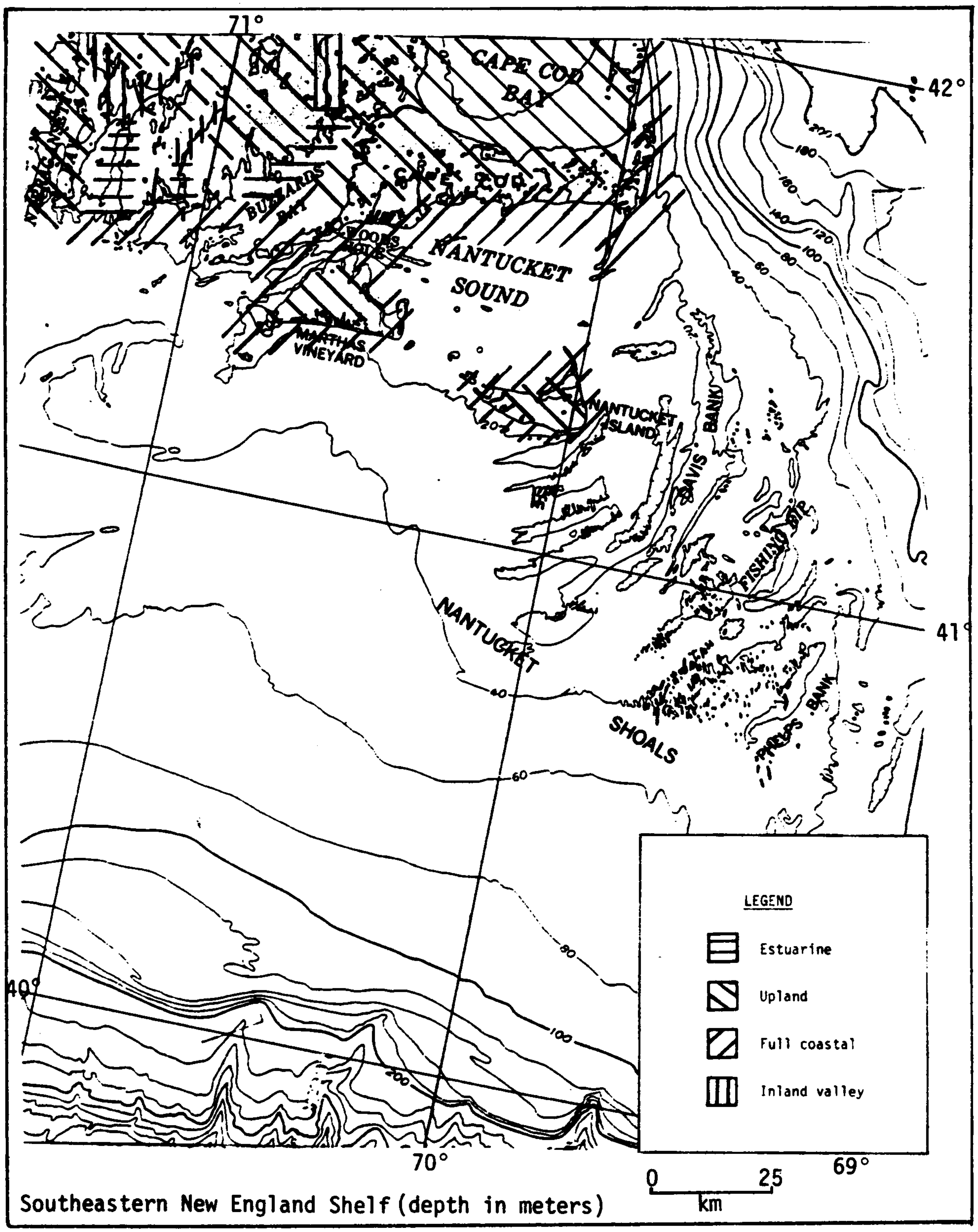


Fig. II-16a: Distribution of environmental types at 6000 B.P.

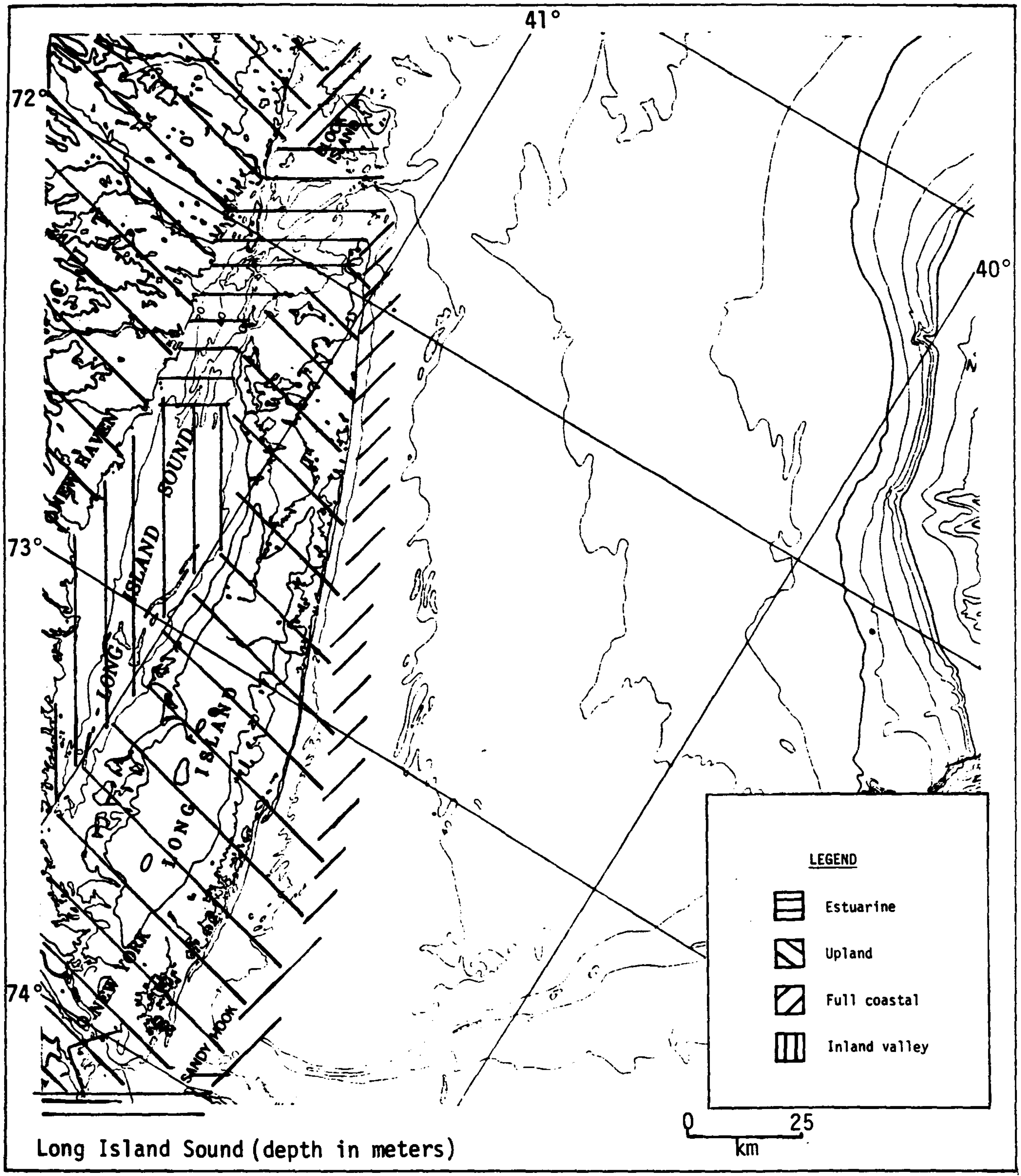


Fig. II-16b: Distribution of environmental types at 6000 B.P.

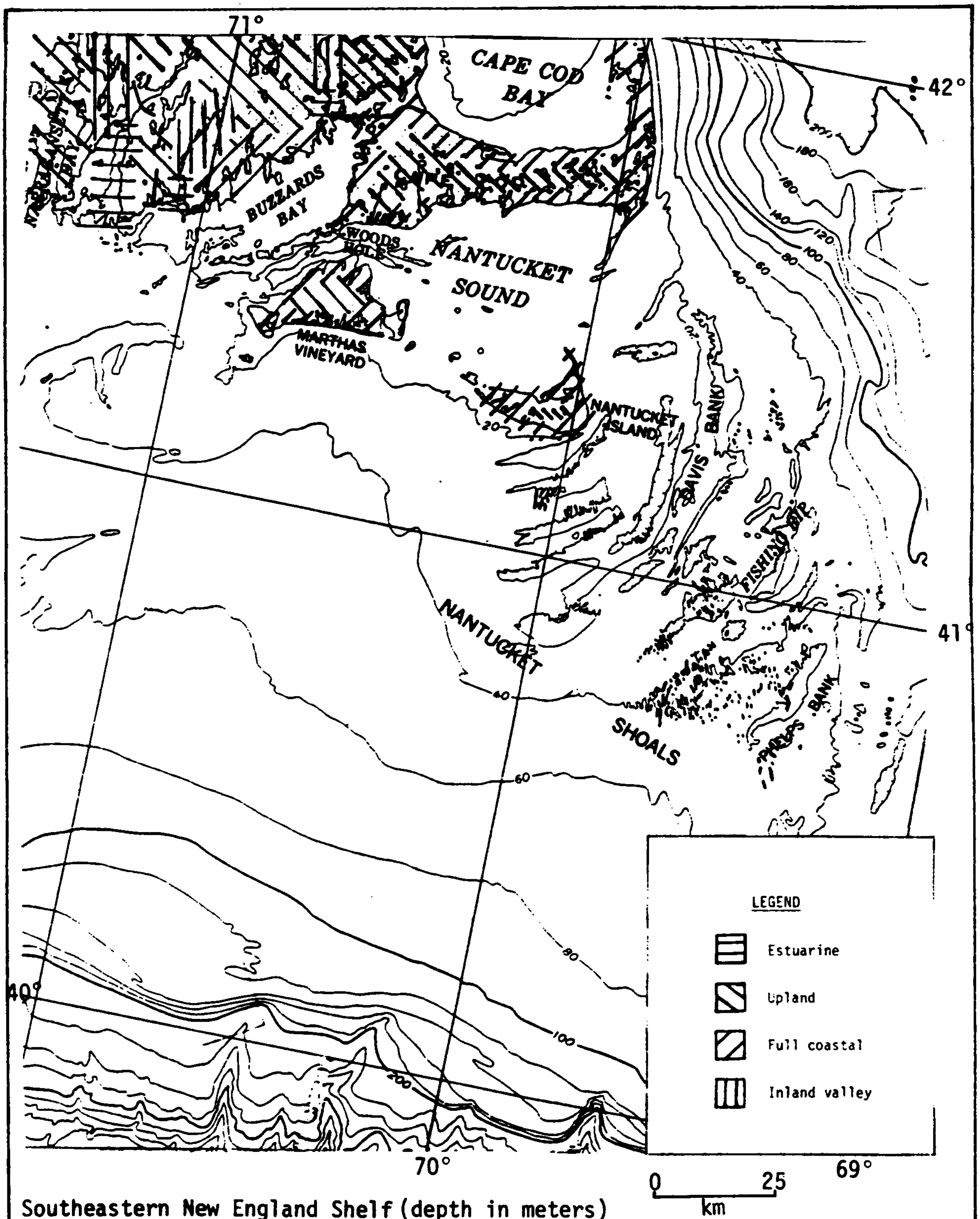


Fig. II-16c: Distribution of environmental types at 3000 B.P.

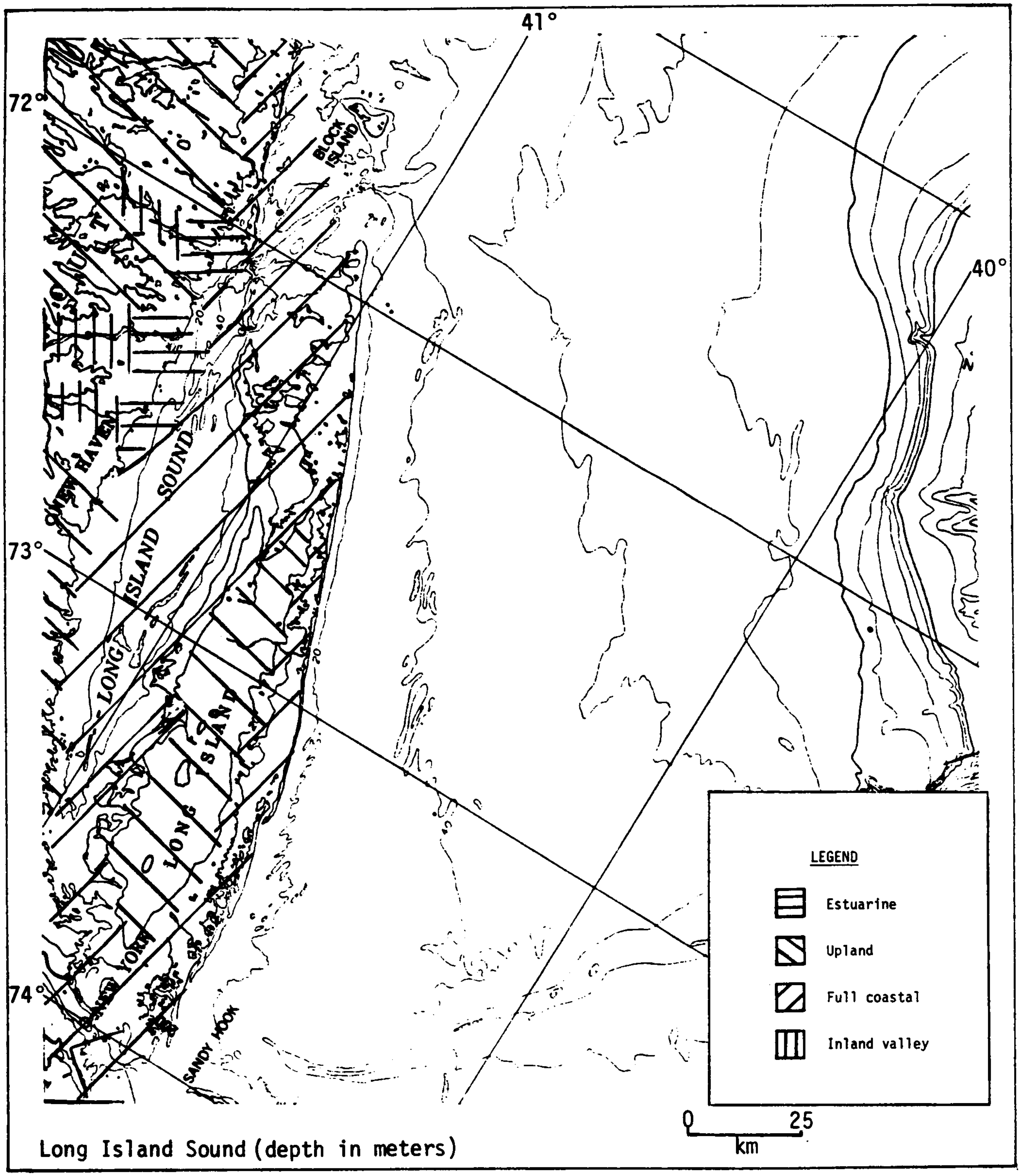


Fig. II-16d: Distribution of environmental types at 3000 B.P.

Deltas formed the only large area of salt marshes. These deltas formed at the mouths of all major rivers and included marshes, salt and fresh ponds, and distributary channels. Islands occasionally occurred near beaches, but were rare elsewhere.

Vegetation along mainland beaches was uncommon; along cliff-banked beaches, vegetation was rare if the cliffs were low, but as common as in upland zones if the cliffs were high enough to be unaffected by spray and storms. The salt-marsh vegetation probably included only grasses and other low flora, in contrast to the water-tolerant trees of later salt marshes in the southern mid-Atlantic subarea. The deltas may have had trees around some of the fresh ponds in the southern portion of the subarea (spruce or jack pine), but not in the northern portion.

Coastal:estuarine - Estuaries of this period were shorter than in subsequent periods, but very wide, as a consequence of the great size of the major rivers. Mud flats and salt marshes, however, were very poorly developed.

Inland:valleys - The major rivers produced very broad flood plains along the interior portions of the Continental Shelf, where relief was very low. In extreme inland portions of the Shelf, river terraces restricted the development of flood plains. On the flood plains, fertile silty soils dominated.

The major rivers themselves had very great flows, chiefly because of the huge areas from which tributaries gathered water to feed them. The width of rivers, coupled with their strong flows, might have made them a strong impediment to transportation and contact between human groups which might have been living on the Continental Shelf. Rivers were moederately deeply incised into the coastal plain, making it possible that they would encounter bedrock sills and develop waterfalls. Lakes occasionally occurred in these major valleys, but were infrequent elsewhere inland.

Vegetation along the valley floors was tundra-like in the northern section, spruce and jack-pine forest in the southern section.

Inland:uplands - Upland portions of the inland Shelf in the mid-Atlantic subarea were characterized by very low relief, probably on the order of a few meters over several kilometers' distance. Soils were sand-dominated.

The uplands between major river valleys were cut by myriad streams, slightly more dense than on the modern mid-Atlantic coastal shelf. The streams were mostly small, and drainage tended to be immature, in the trellis pattern characteristic of recently emerged land. Lakes were rare.

Vegetation was probably similar to that in valleys, although the sandy upland soils would have favored pine more than the silty valley soils did. The trivial elevation difference between valley and upland would have reduced climate differences between zones.

Discussion - Fig. II-17 presents approximate distributions of environmental types in the mid-Atlantic subarea between 18,000 and 15,000 B.P. The coastal environments, possibly excepting deltas, were poorly developed, relatively unproductive, and not extensive. Upland and valley zones were differentiated primarily by soil differences.

4.2.3.2 15,000 to 12,000 B.P.

Coastal:full coastal - During this period, relative sea level rose very rapidly. Deltas were inundated, forming mud flats, salt marshes, and low, marshy islands. Salt water probably permeated these islands, precluding growth of tree species adapted to the climate.

Barrier islands and spits continued to be uncommon and lagoon development was scanty. As a result, salt-marsh development along the coast also was scanty. Mainland and cliff-bank beaches continued as dominant coastal features.

Coastal:estuarine - During this period, estuaries stretched far up major rivers, deep into the coastal plain. Estuary width increased correspondingly and salt marshes developed in long ribbons along these valleys. The extent of salt marshes in a given locale is unassessed, but the number of locales with salt marshes increased dramatically.

Inland:valleys - Greatly increased estuarine intrusion ate into the area formerly considered inland valley environment. While marshes developed along the shore, the terrestrial portion of the environment remained much as it had earlier. The incision of the rivers into the coastal plain was slowed by elevated relative sea levels.

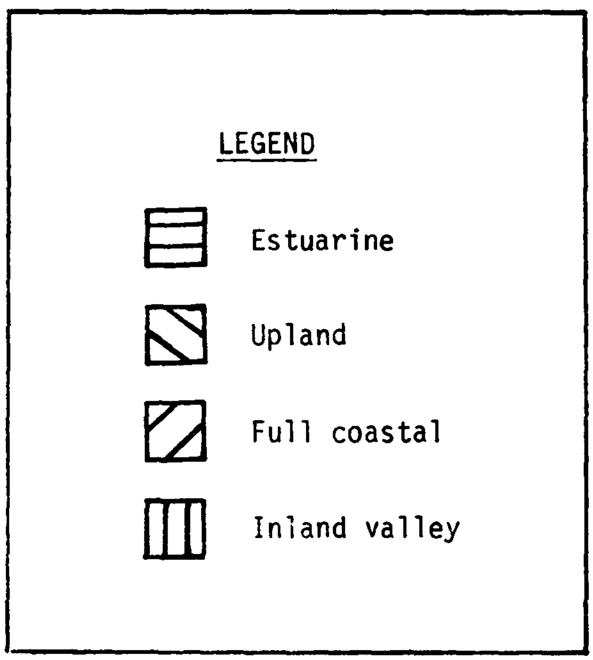
Vegetation in southern portions of the subarea was spruce parkland; in norhtern portions, a tundra-like vegetation dominated.

Inland:uplands - Upland areas changed little from the preceding period. The trellis stream pattern matured and drainage became more dendritic. Frequency of lakes and swamps remained low.

Discussion - During this period, estuaries extended far onto the coastal plain, but extensive development of salt marshes in any locale is unlikely. Inland and full-coastal environments remained much as in the previous period, but deltas were overwhelmed by the rising sea.

4.2.3.3 12,000 to 7000 B.P.

Coastal:full coastal - The rapid relative sea-level rise began in the preceding periods and continued here; soon the ocean transgressed beyond



Legend for Fig. II-17

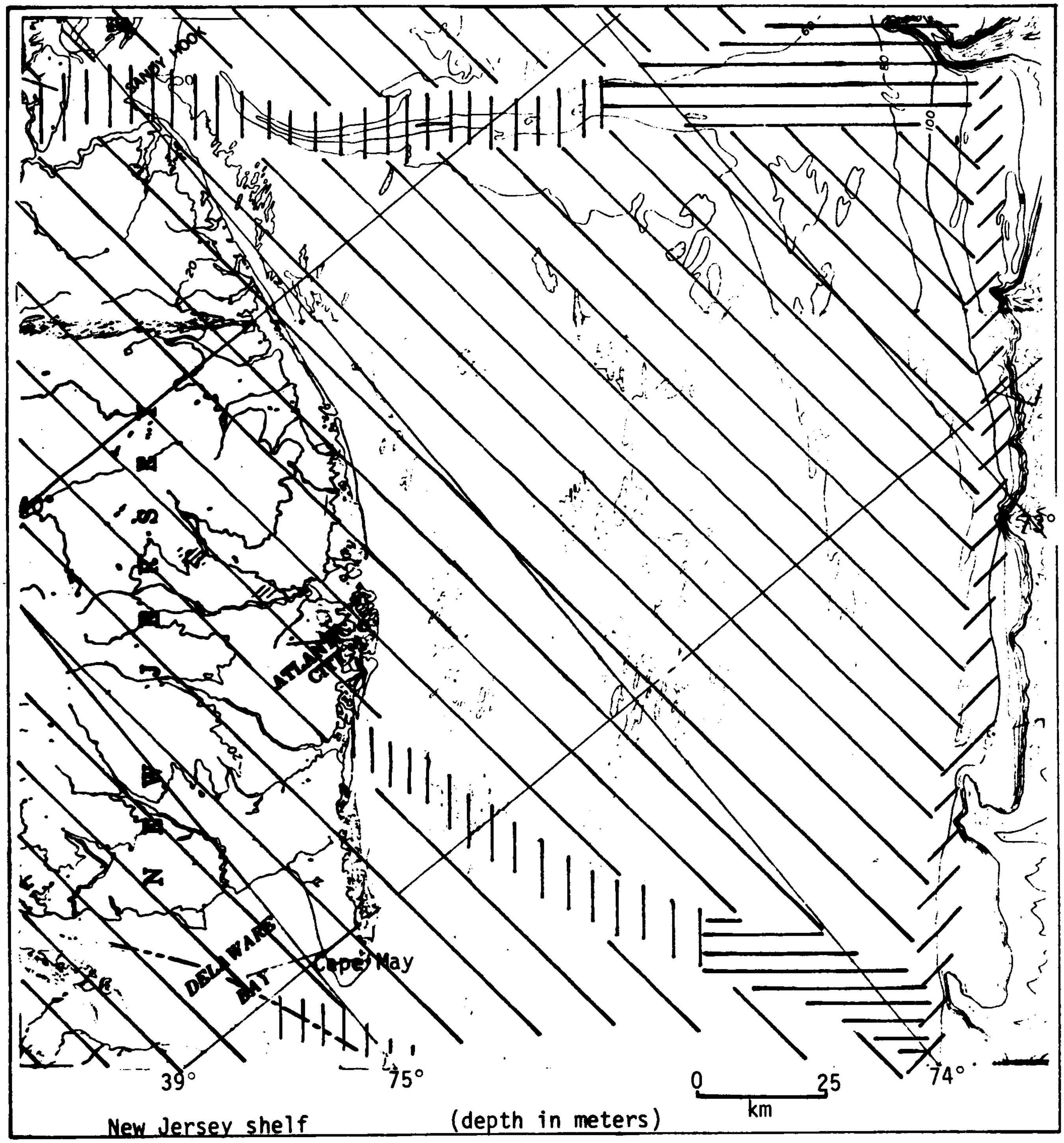


Fig. II-17a; Distribution of environmental types at 18,000 B.P.

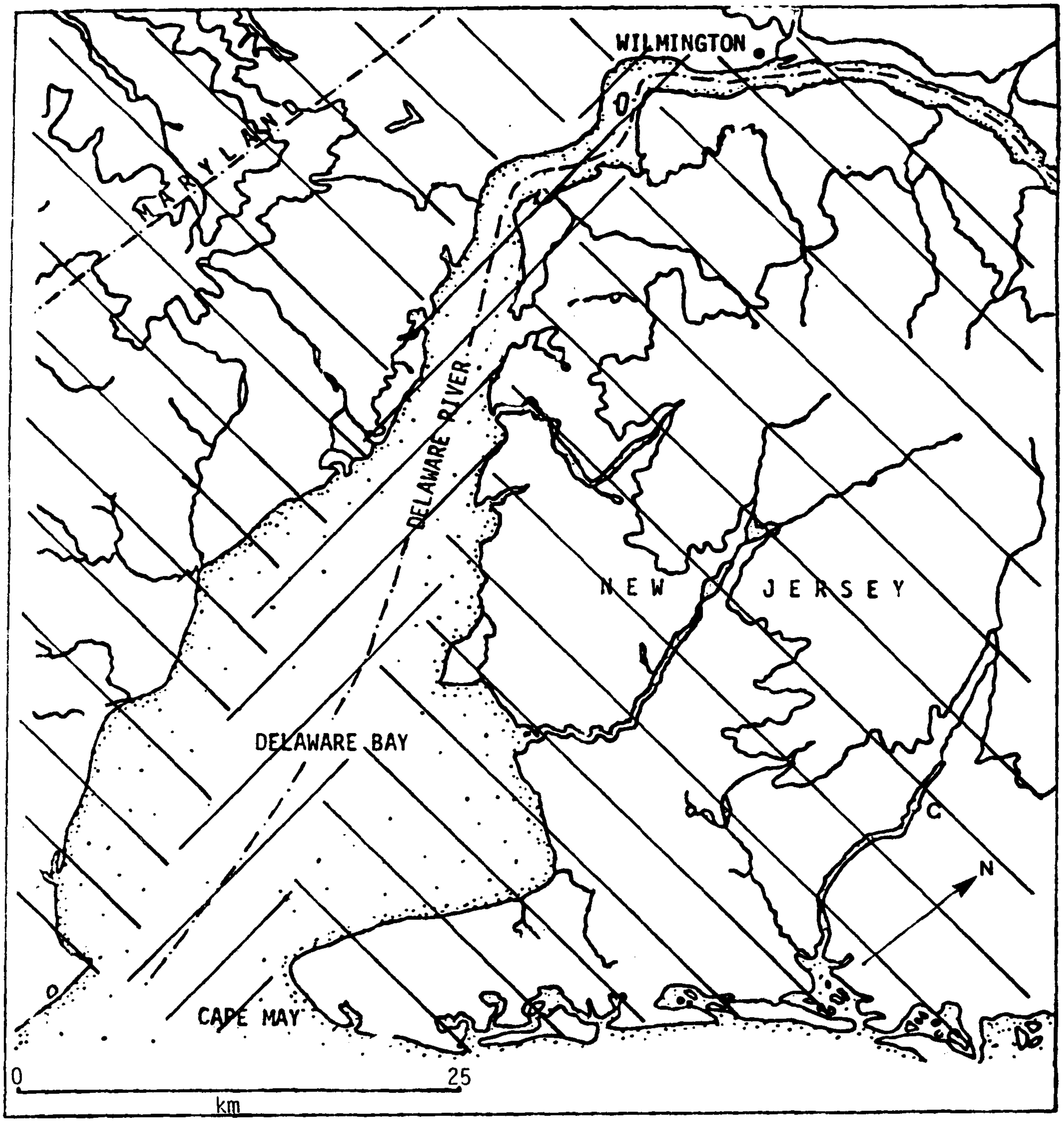


Fig. II-17b: Distribution of environmental types at 18,000 B.P.

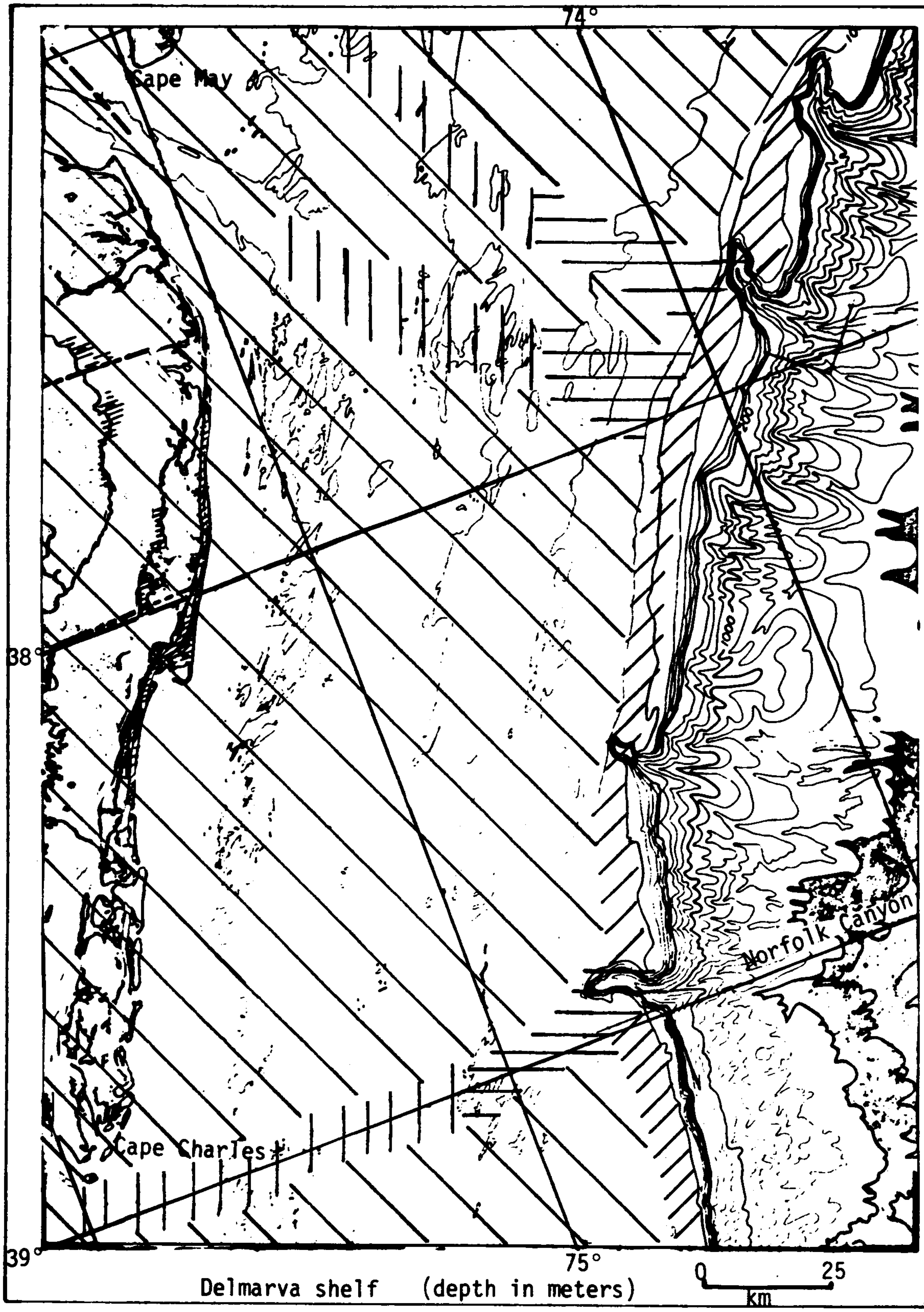


Fig. II-17c: Distribution of environmental types at 18,000 B.P.

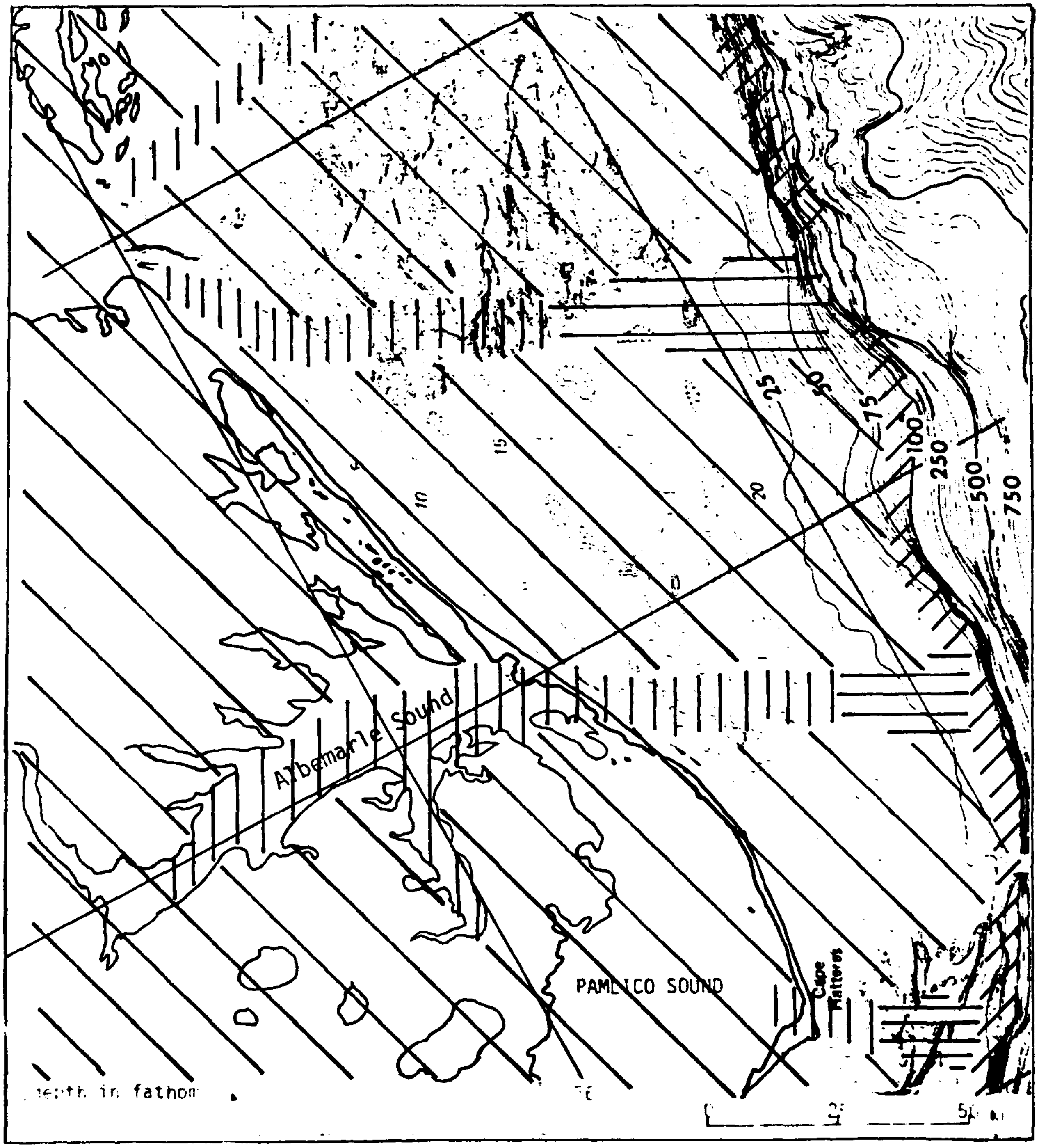


Fig. II-17d: Distribution of environmental types on the northern North Carolina - southeastern Virginia Shelf at 18,000 B.P.

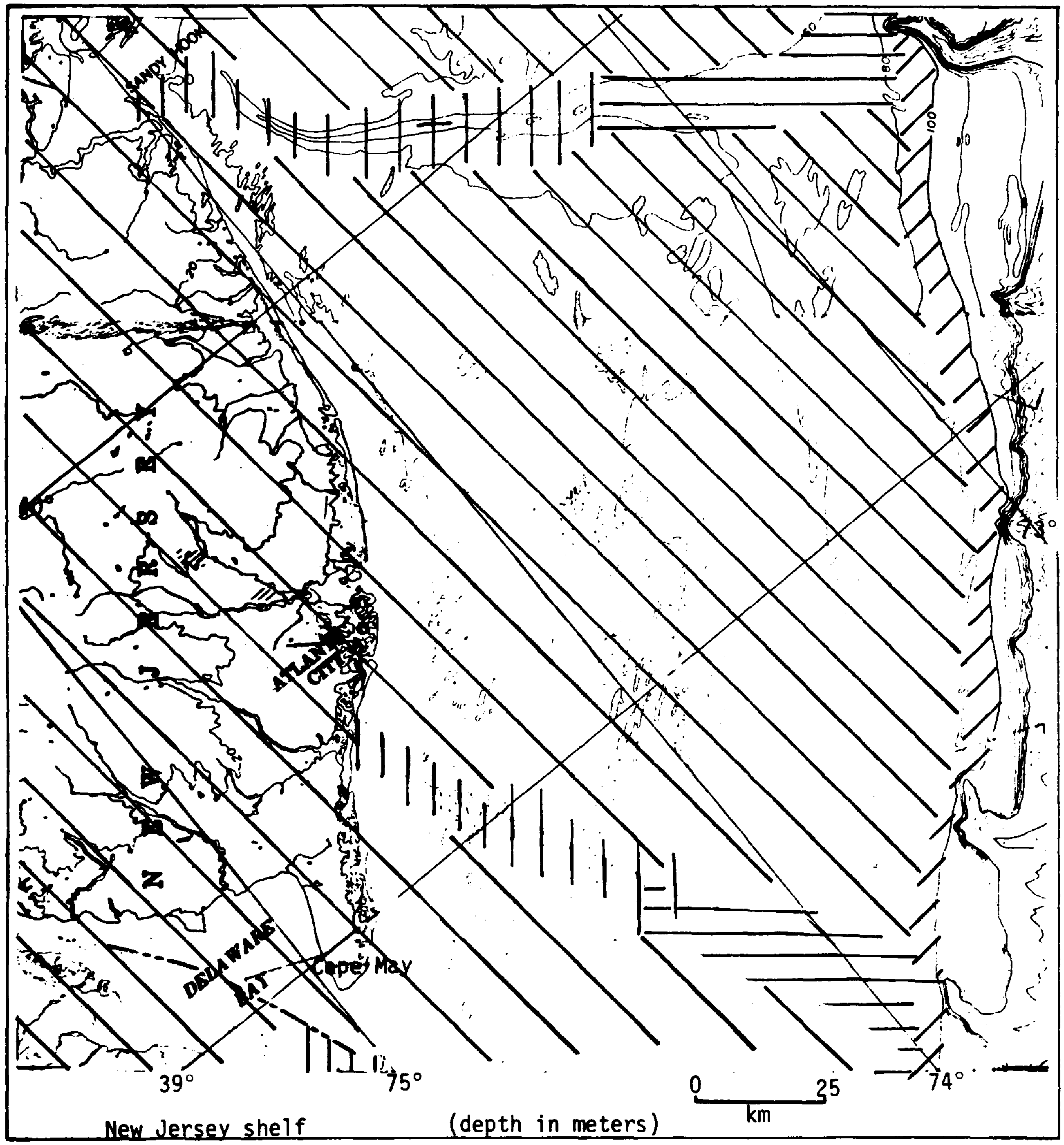


Fig. II-17e: Distribution of environmental types at 15,000 B.P.

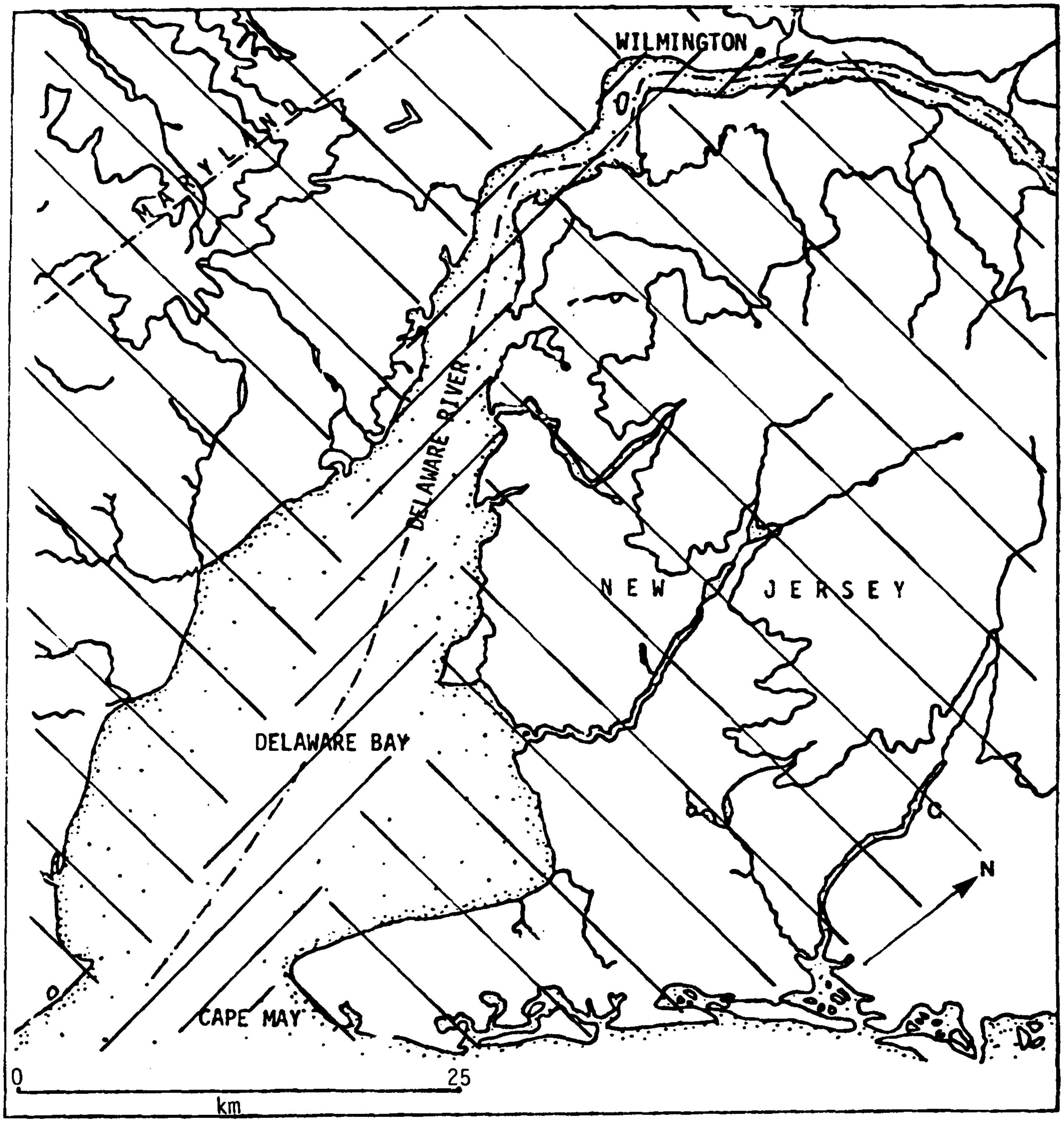


Fig. II-17f: Distribution of environmental types at 15,000 B.P.

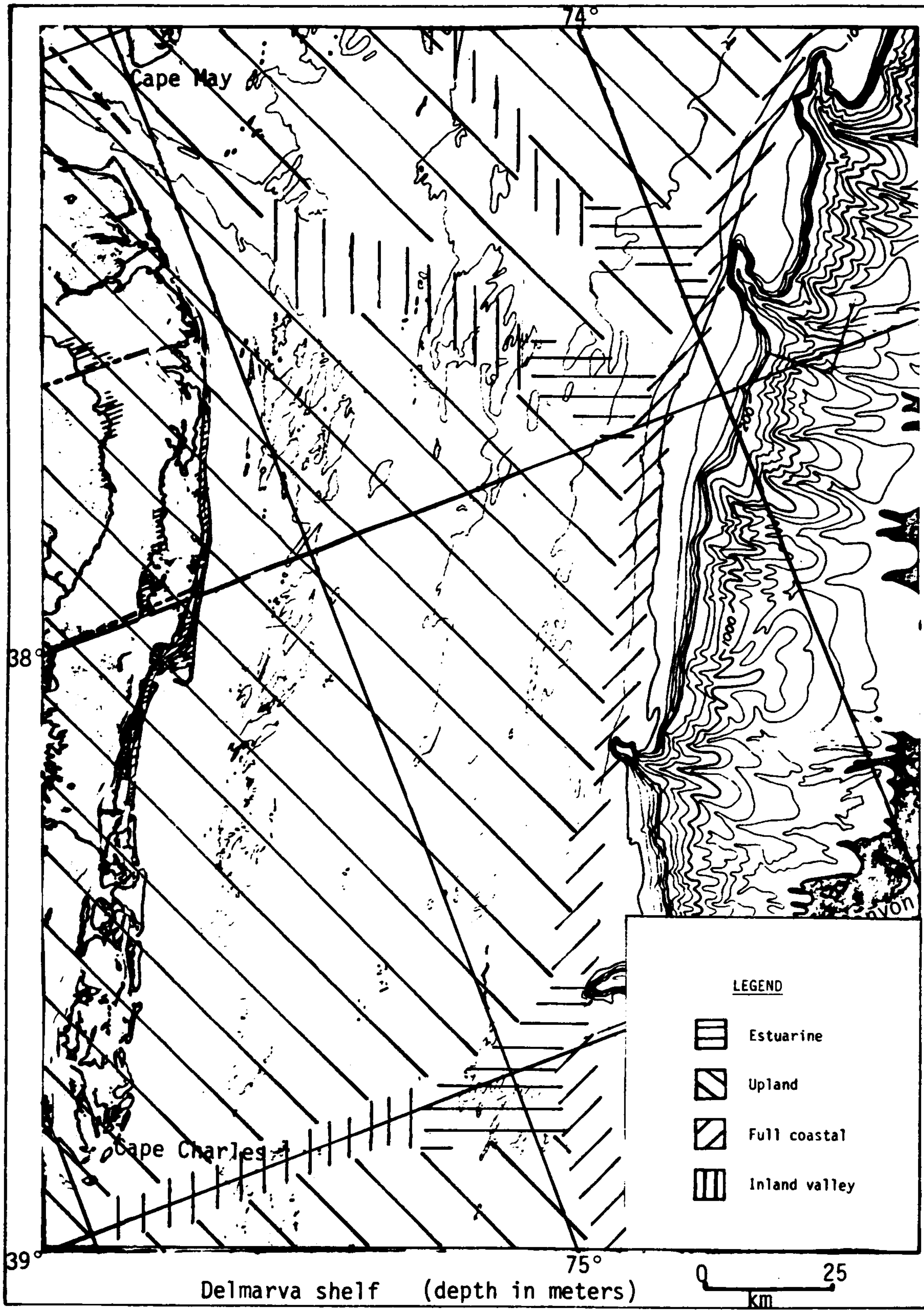


Fig. II-17g: Distribution of environmental types at 15,000 B.P.

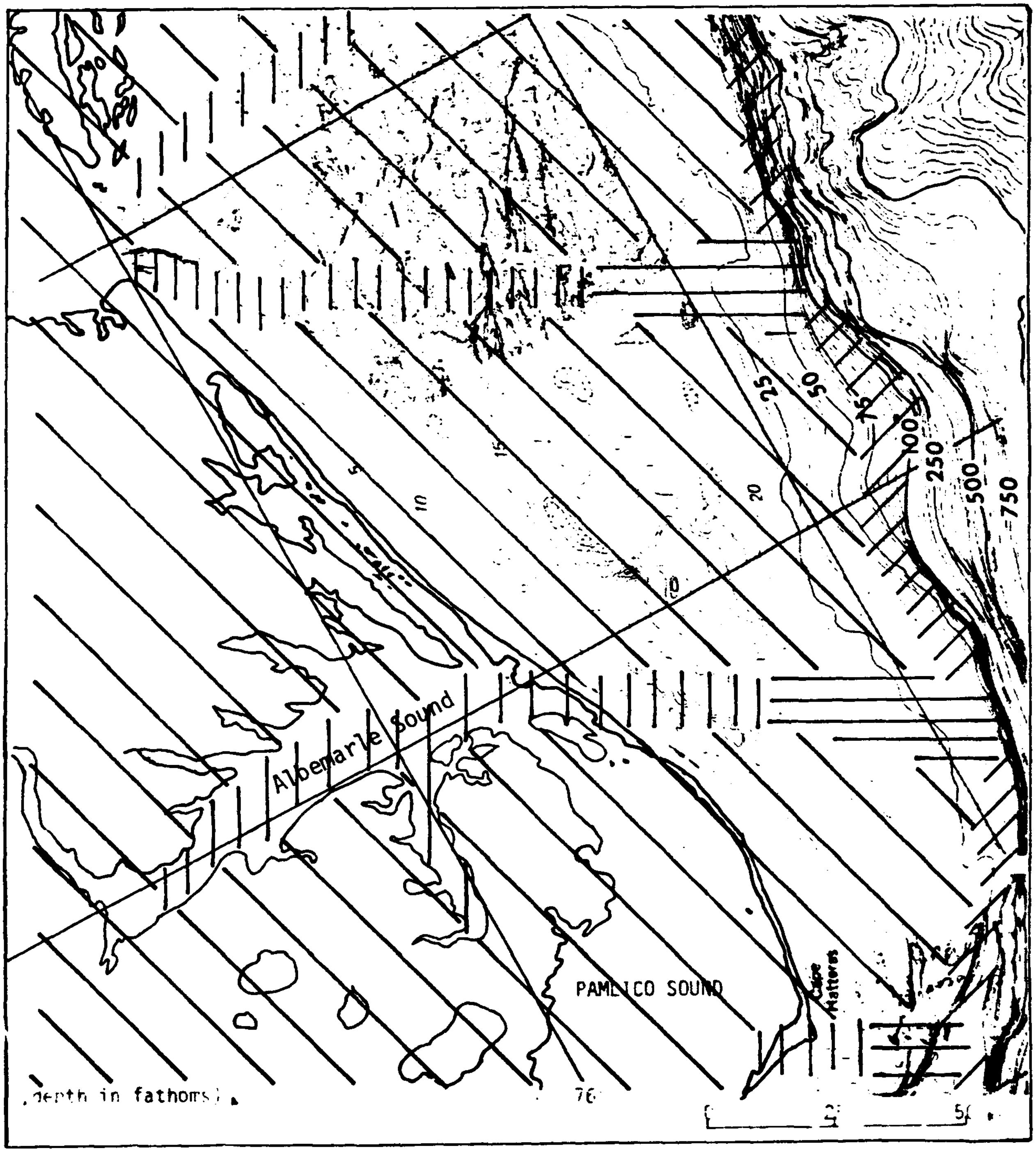


Fig. II-17h: Distribution of environmental types on the northern North Carolina - southeastern Virginia Shelf at 15,000 B.P.

the steep Continental Slope. The development of barrier islands and spits began and by 9000 B.P., many were present. The lagoons which they enclosed largely replaced the mainland and cliff-bank beaches, which became far fewer and smaller than before. Deltas disappeared completely. Coastal relief was very low and salt marshes and mud flats become very extensive.

Coastal:estuarine - During this period, estuaries reached their greatest sizes, both in length and width. Fringing salt marshes and mud flats became much more extensive. Continued rapid relative sea-level rise and extremely shallow gradient together produced a moderately rapid inland shift of environments, however, which probably limited the development of salt marshes somewhat.

Inland:valleys - Valley environments remained very similar to those of earlier periods. Depending on latitude, dominant vegetation ranged from spruce parkland to mixed conifer-hardwood forest to hardwood forest.

Inland:uplands - Upland environments also changed little, mostly toward more mature drainage and soil development. The highly sandy soils in these zones would have favored greater pine growth than was found in the valleys.

Discussion - Fig. II-18 shows the approximate extents of the environmental types for this period. The coastal zones have become very extensive and productive during this period. The inland zones, in contrast, have seen few changes other than climate-induced changes in vegetation.

4.2.3.4 7000 to 3000 B.P.

Coastal:full coastal - In this period, relative sea level rise decreased dramatically. There was a slight reduction in typical lagoon size, but other features were similar to those of the preceding period. Barrier islands and spits remained prominent,and mainland beaches were rare. Cliff-bank beaches were virtually absent. Salt marshes and mud flats remained extensive.

Coastal:estuaries - During this period, estuaries became somewhat narrower and shorter than before, but were still considerably wider and longer than they are today. Developed salt marshes flanked their margins.

Inland:valleys - By this time, most of the fertile silty soils of the valleys had been inundated by the rising ocean and lay under estuaries or salt marshes. Valleys were considerably narrower than in earlier periods and were confined by terraces.

Vegetation was mixed conifer-hardwood forest.

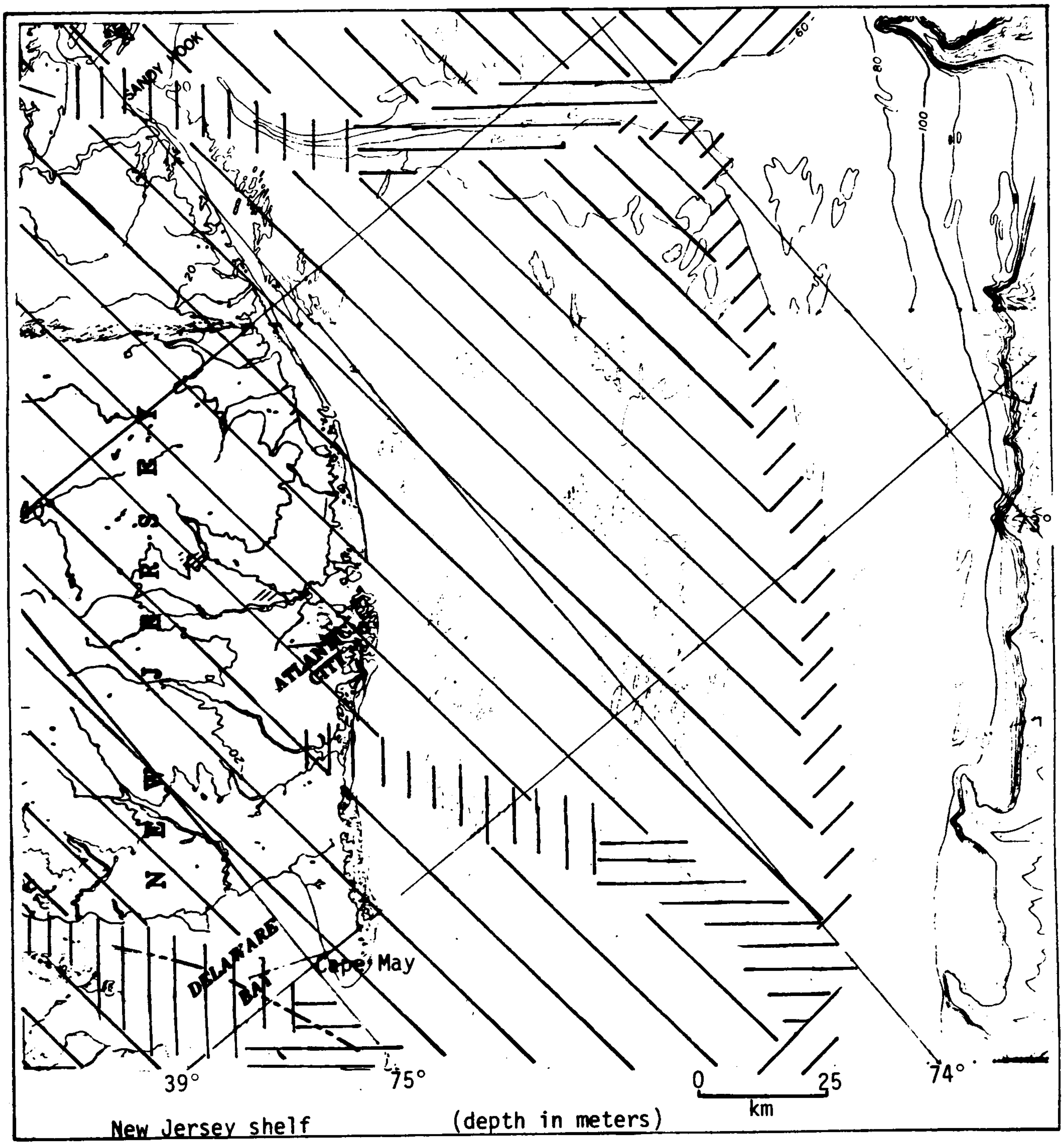


Fig. II-18a: Distribution of environmental types at 12,000 B.P. (See Fig. II-18c for legend.)

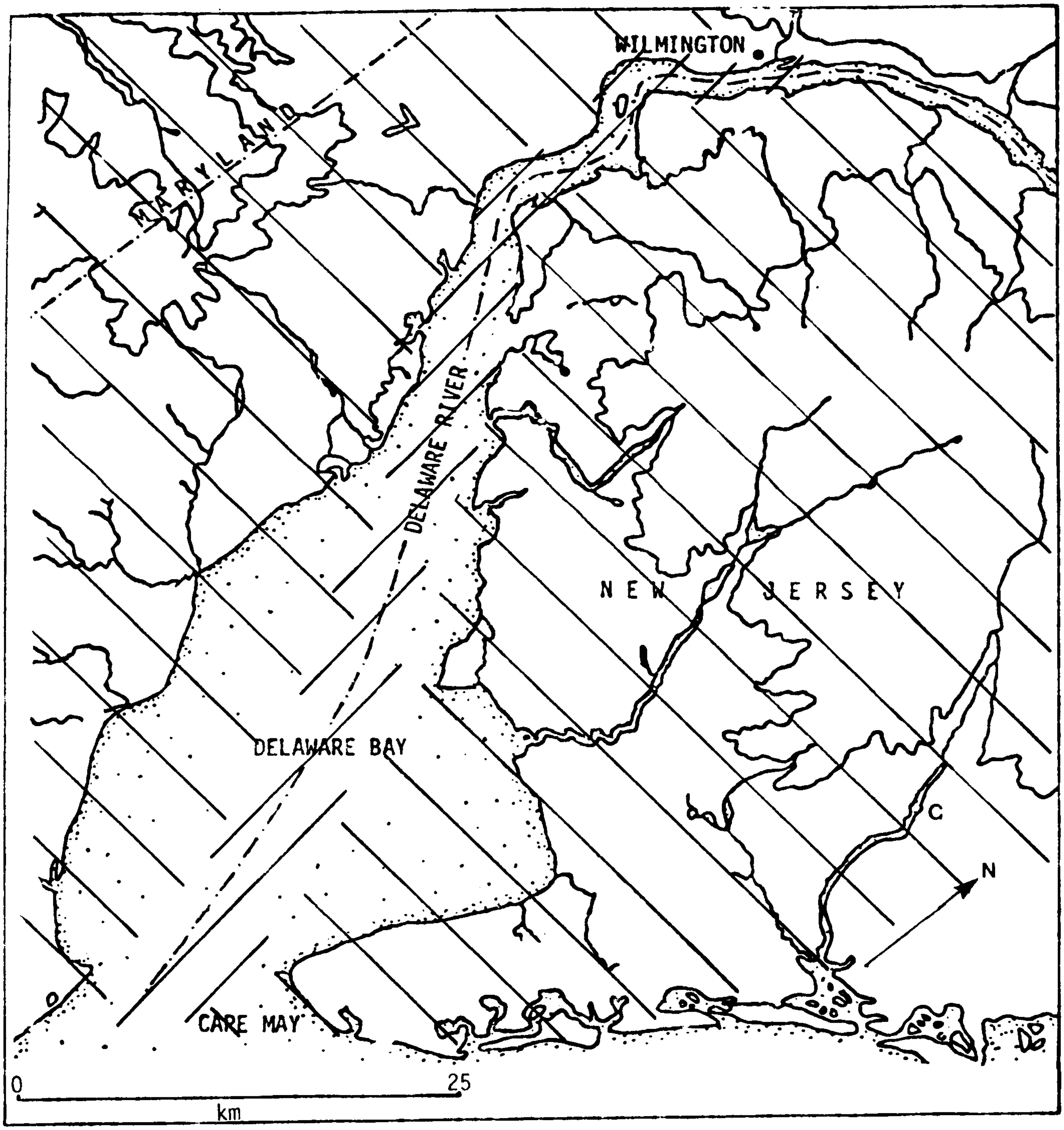


Fig. II-18b: Distribution of environmental types at 12,000 B.P.
(See Fig. II-18c for legend.)

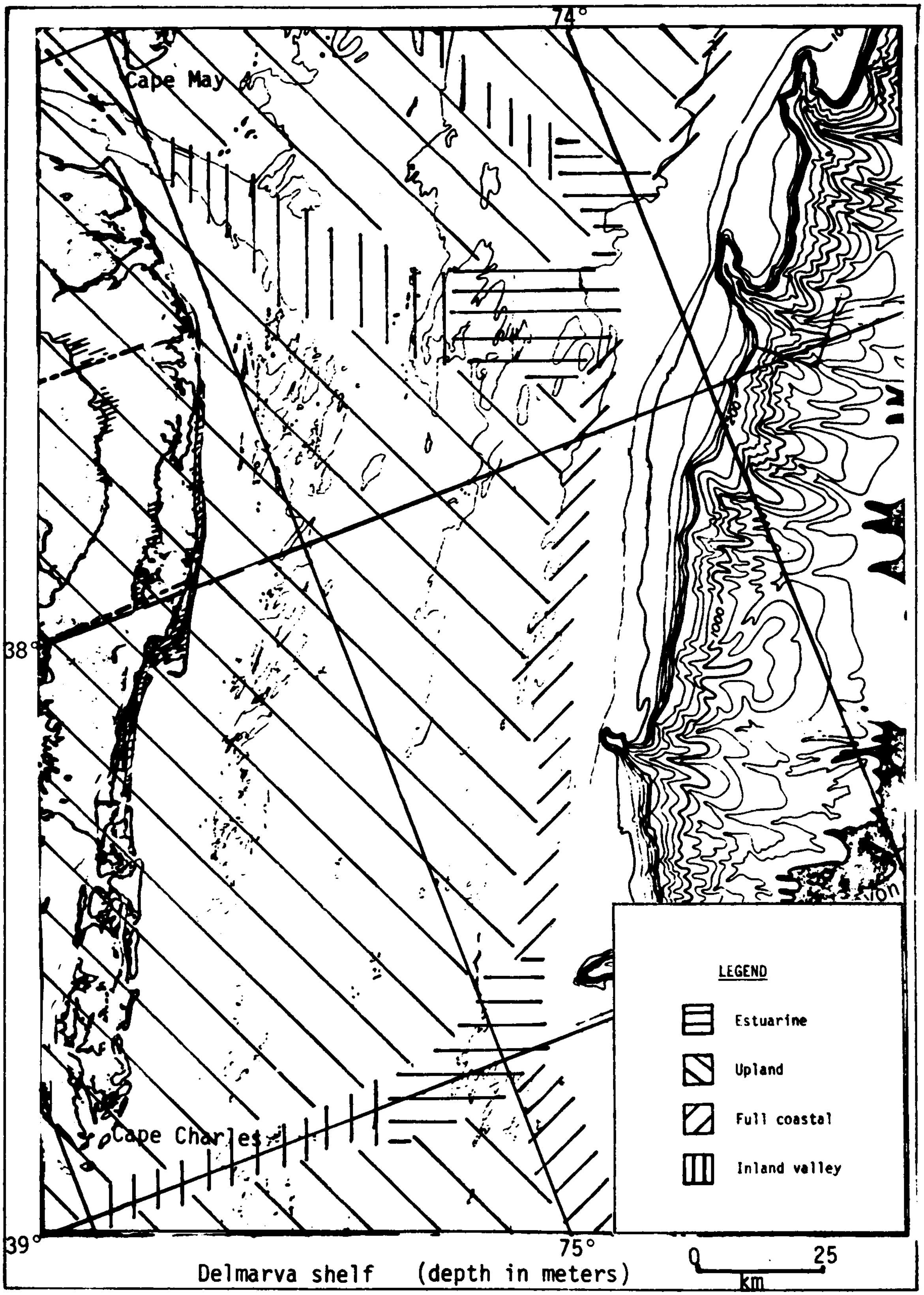


Fig. II-18c: Distribution of environmental types at 12,000 B.P.

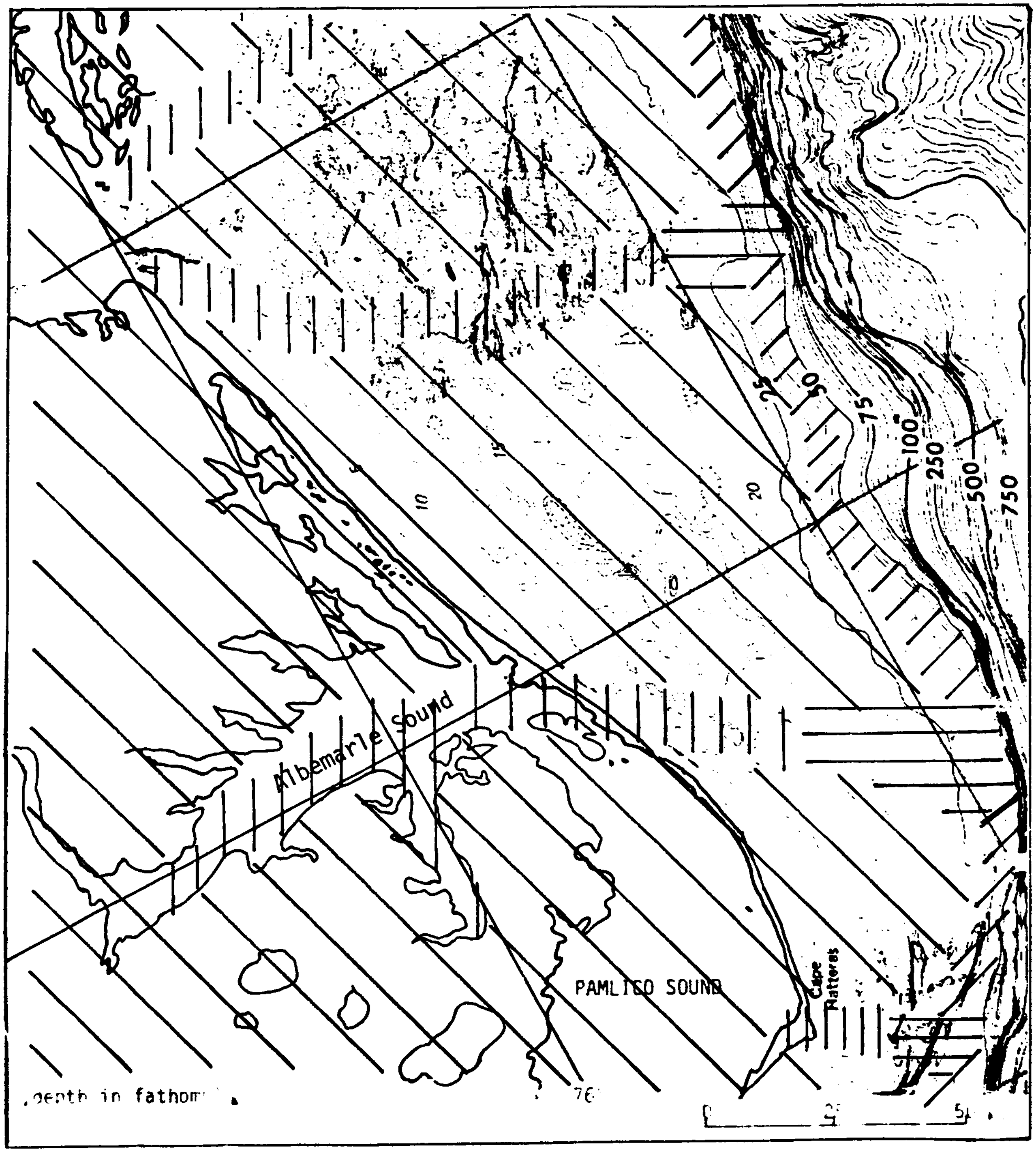


Fig. II-18d: Distribution of environmental types on the northern North Carolina - southeastern Virginia Shelf at 12,000 B.P. (See Fig. II-18e for legend.)

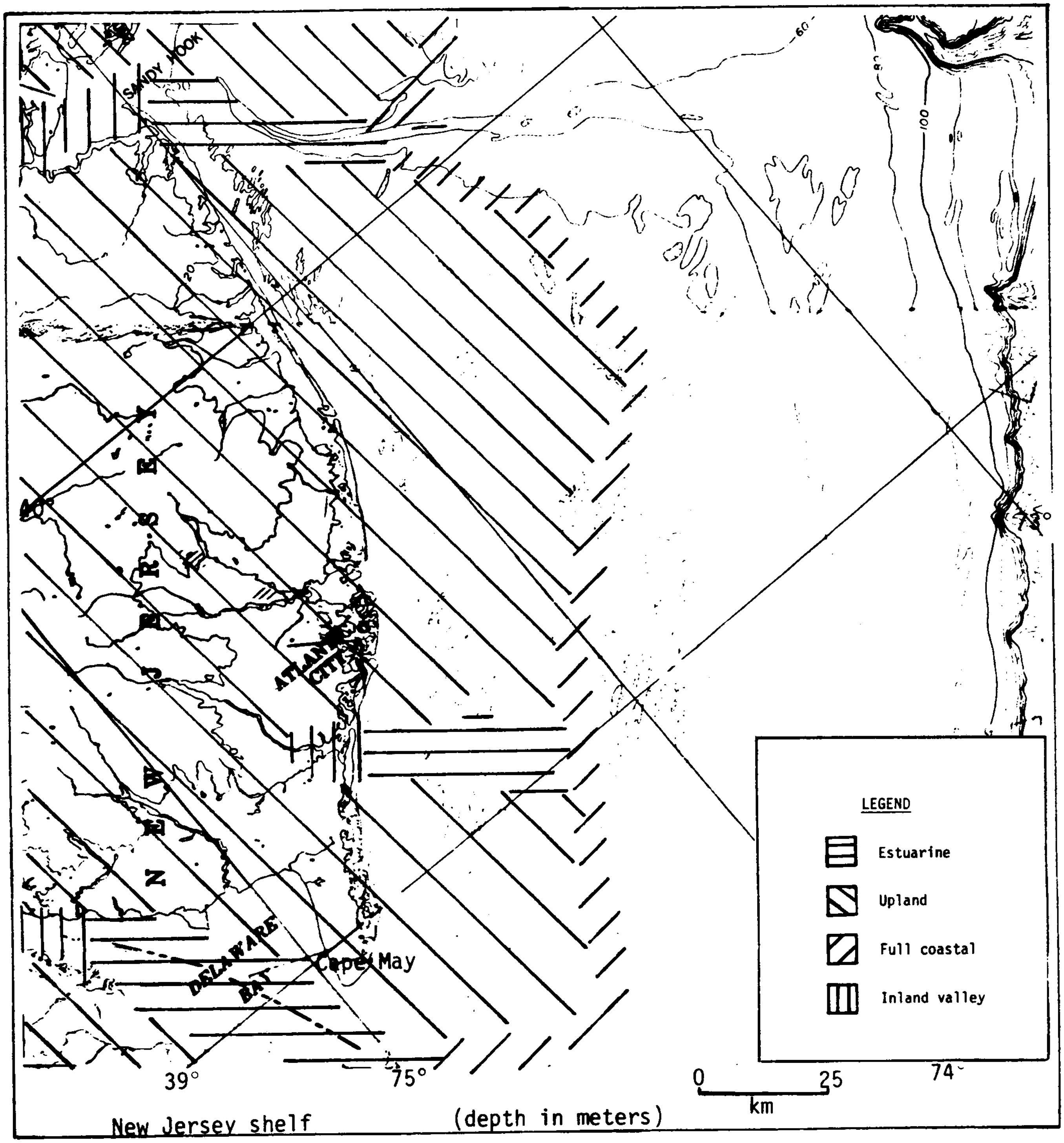


Fig. II-18e: Distribution of environmental types at 9000 B.P.

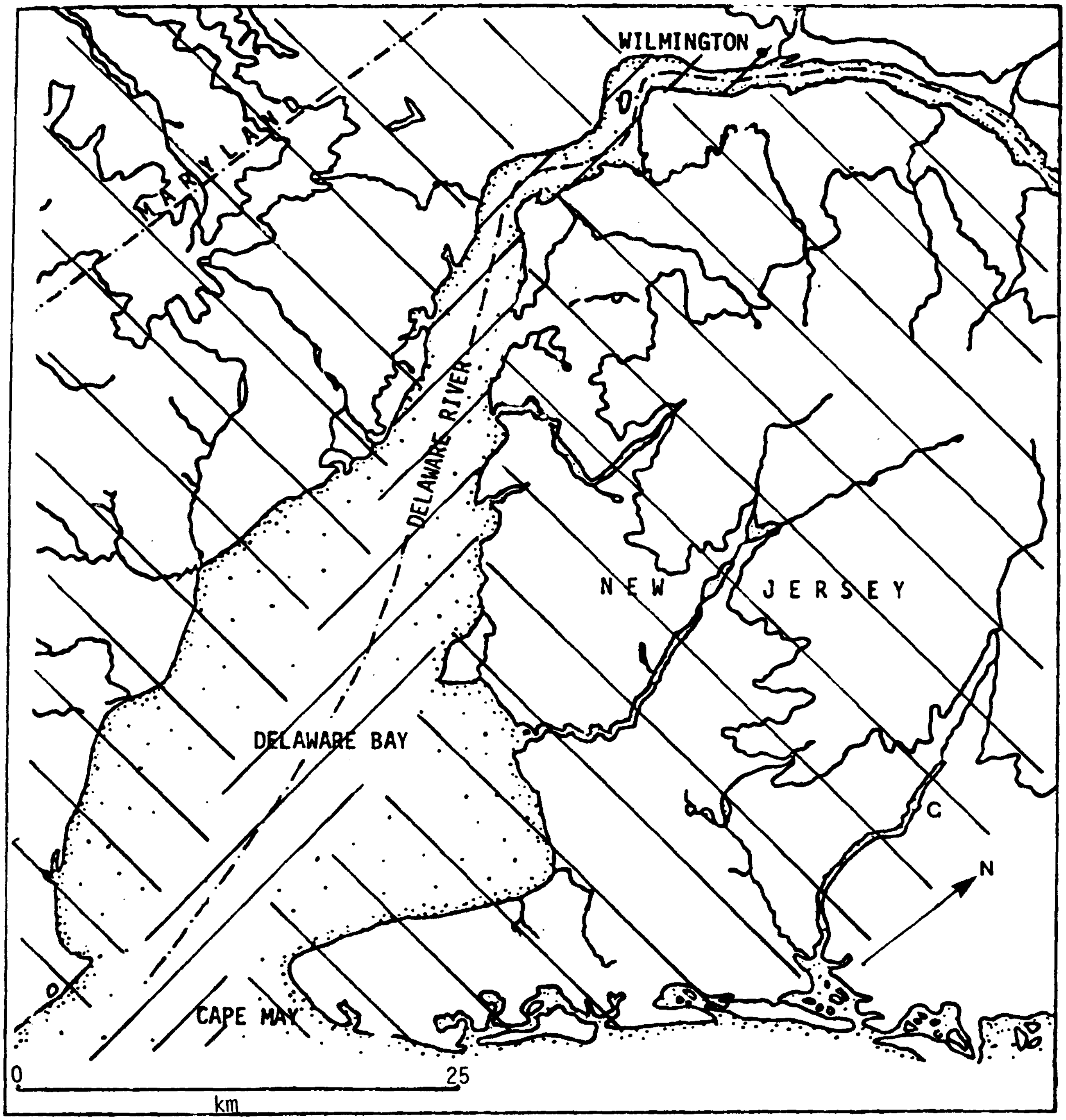


Fig. II-18f: Distribution of environmental types at 9000 B.P.
(See Fig. II-18g for legend.)

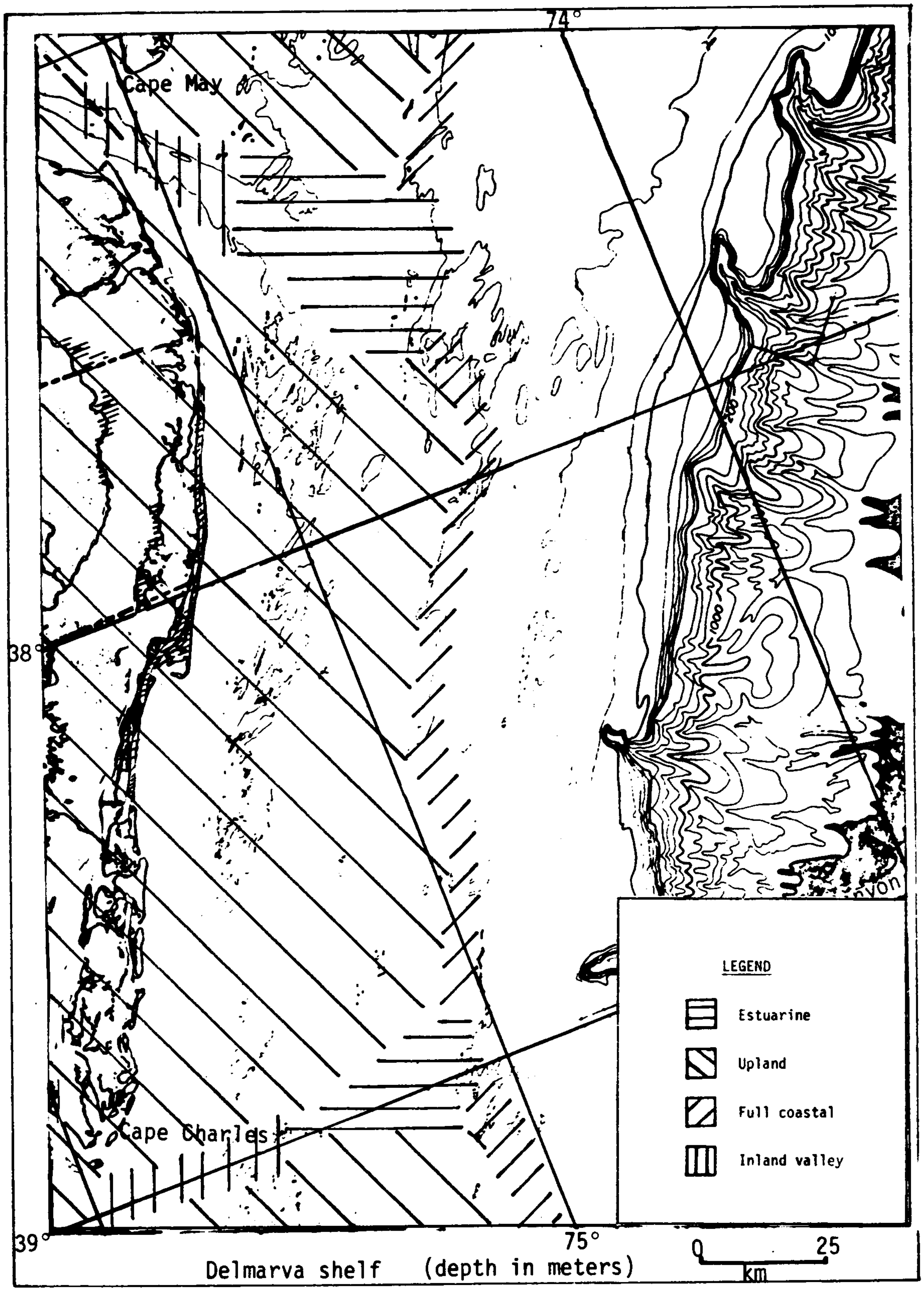


Fig. II-18g: Distribution of environmental types at 9000 B.P.

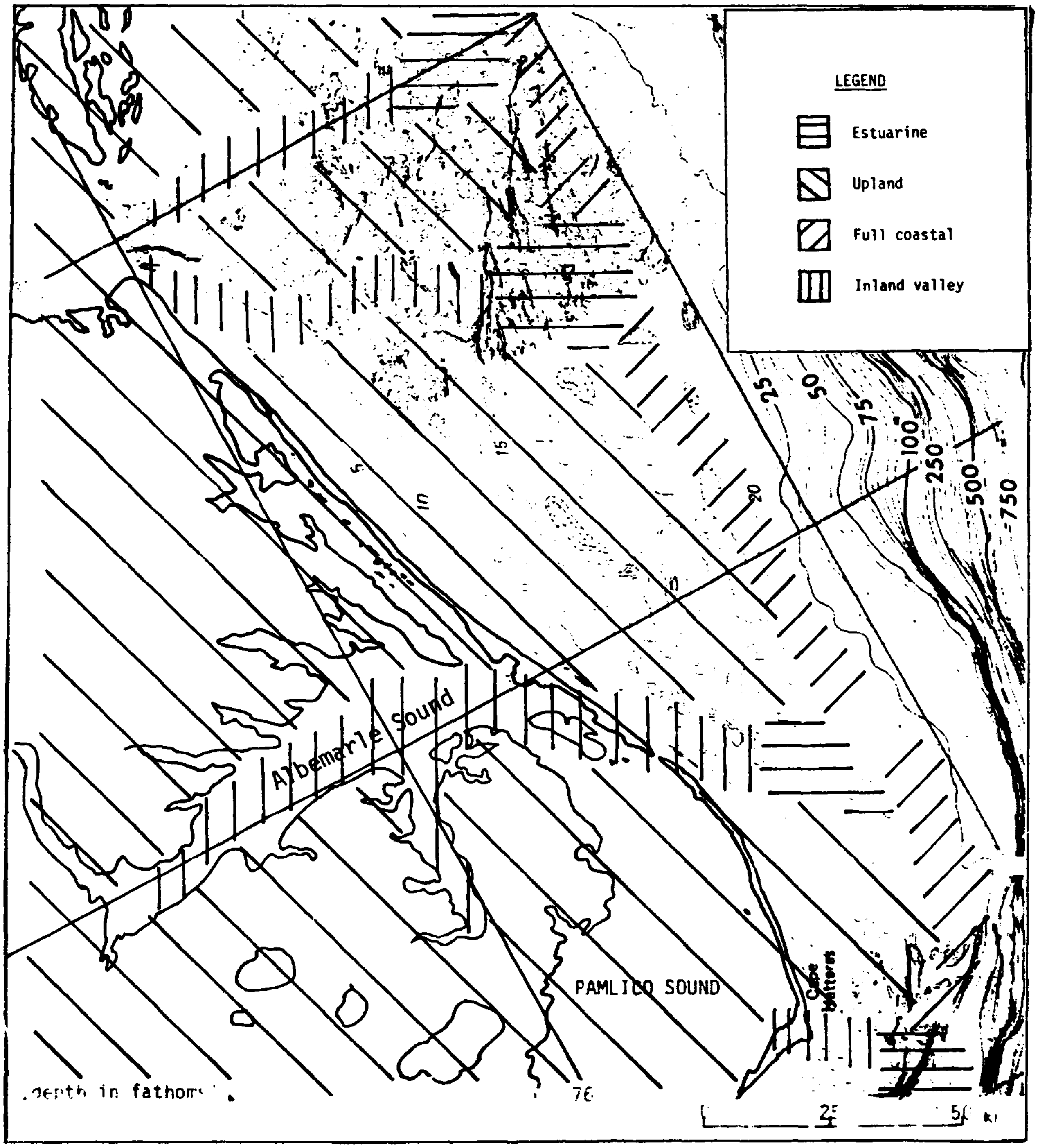


Fig. II-18h: Distribution of environmental types on the northern North Carolina - southeastern Virginia Shelf at 9000 B.P.

Inland:uplands - The uplands in this period displayed higher relief than they had earlier. Restriction of valleys placed upland zones close to estuaries and salt marshes.

Vegetation was mixed conifer-hardwood forests, but sandy soils and slightly cooler climates than in the valleys probably favored a greater percentage of pine in the uplands than at lower elevations.

Discussion - The development of estuaries and salt marshes had regressed slightly. Expansion of these environments had vastly reduced the inland-valley environment and upland and coastal zones were juxtaposed. Fig. II-19 shows the approximate distribution of environments during this period.

4.2.3.5 3000 B.P. to present

Coastal:full coastal - Relative sea-level rise decreased even further during this period. Lagoons shrank somewhat, as did salt marshes. Mud flats may have been slightly larger than they are today during most of the period. Barrier islands and spits predominated and other beach types occurred only infrequently.

Coastal:estuaries - Estuaries were slightly larger than modern ones during most of this period, but the dominant trend was for very slow reduction of estuary length and width, with concommitant reduction of salt-marsh development.

Inland:valleys - During this period, inland valleys remained much as they had been in the preceding period, which is also much as they are today.

Inland:uplands - Upland zones remained much as in the previous period and today.

Discussion - The only major environmental changes during this period were slight reductions in the extent and productivity of the coastal environments. Fig. II-19 maps environmental types at 3000 B.P.

4.2.4 Paleoenvironmental conclusions

The preceding pages have been devoted to a detailed reconstruction of the physical environment over space and time on the northern portion of the Continental Shelf. The reason for this rather lengthy treatment is that there are subtle differences in the characteristics of various environments which cannot be described adequately by a terse phrase on a chart. To avoid obscuring these subtleties, textual treatment is necessary. In addition, minor differences in the dates of events and periods from area to area, easily obscured by charts, can be important in interpretation.

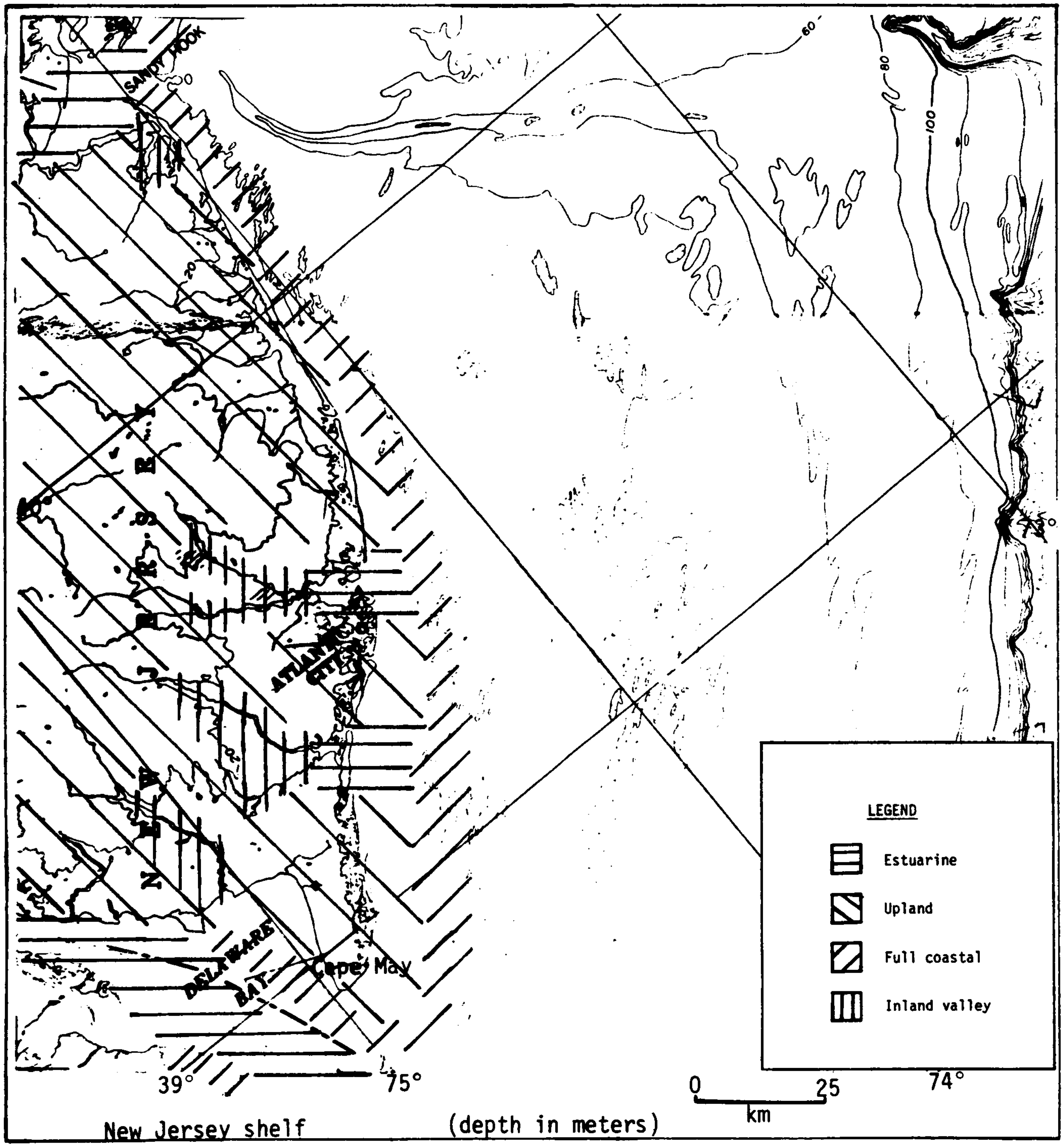


Fig. II-19a: Distribution of environmental types at 6000 B.P.

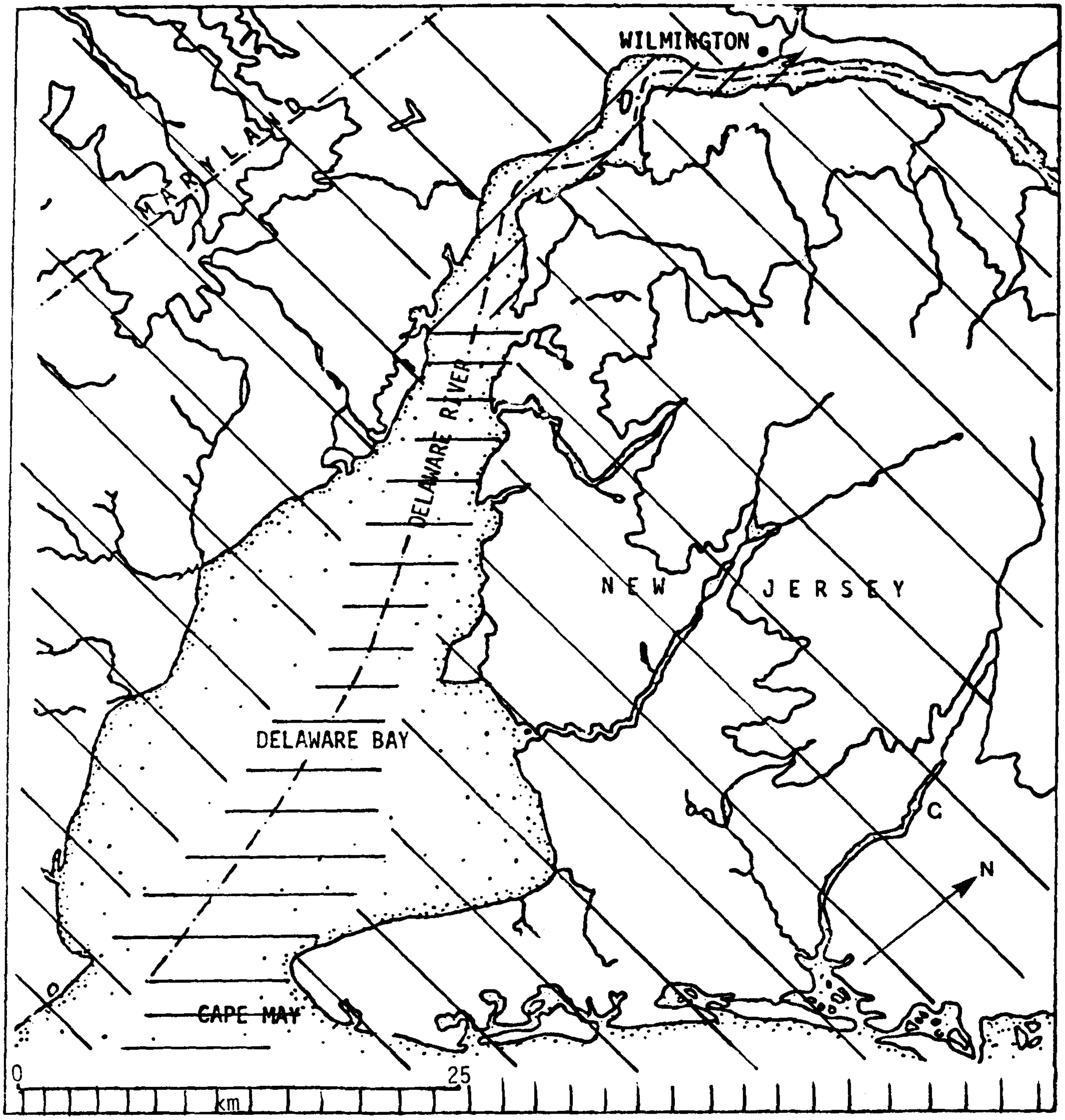


Fig. II-19b: Distribution of environmental types at 6000 B.P.
(See Fig. II-19a for legend).

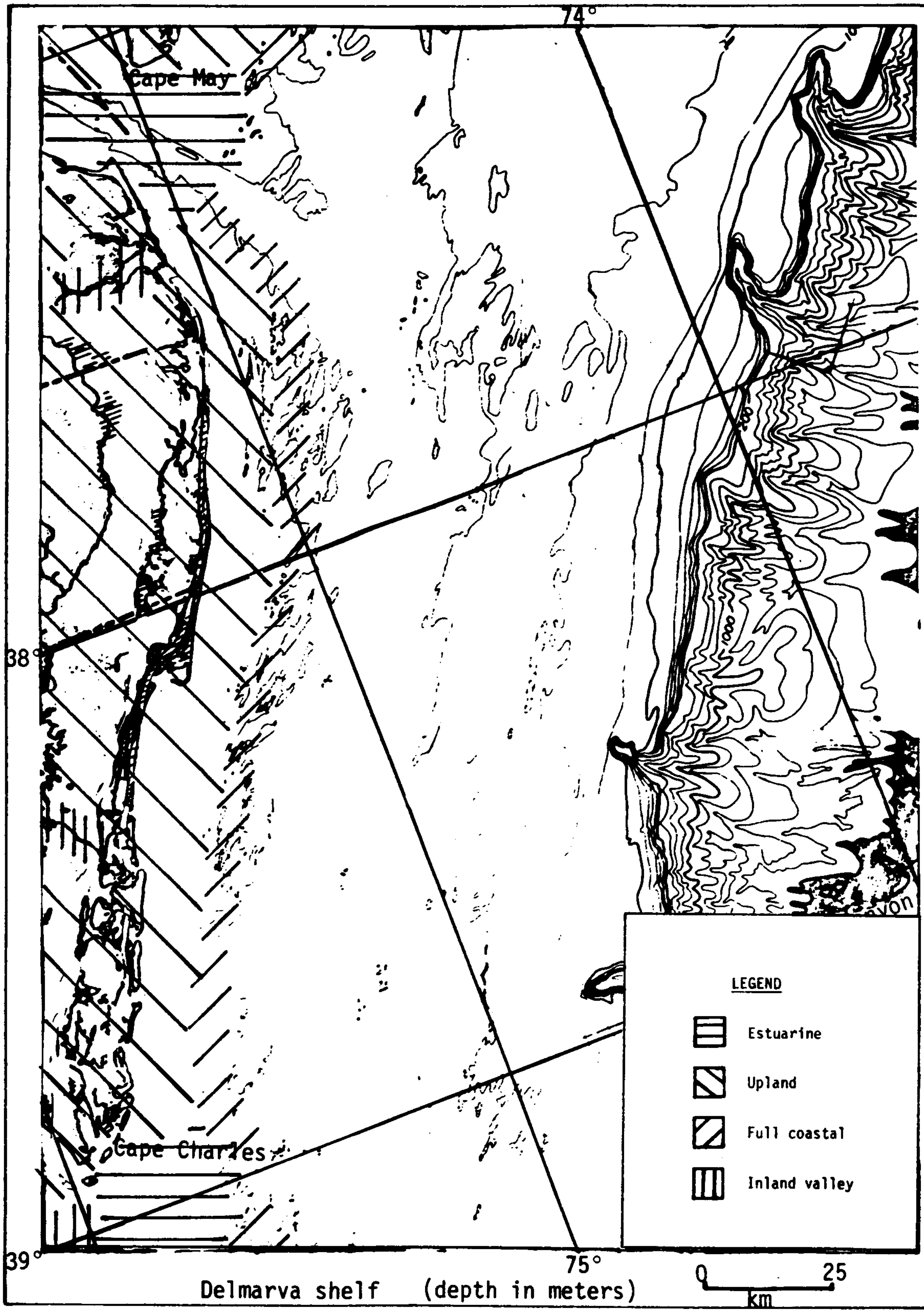


Fig. II-19c: Distribution of environmental types at 6000 B.P.

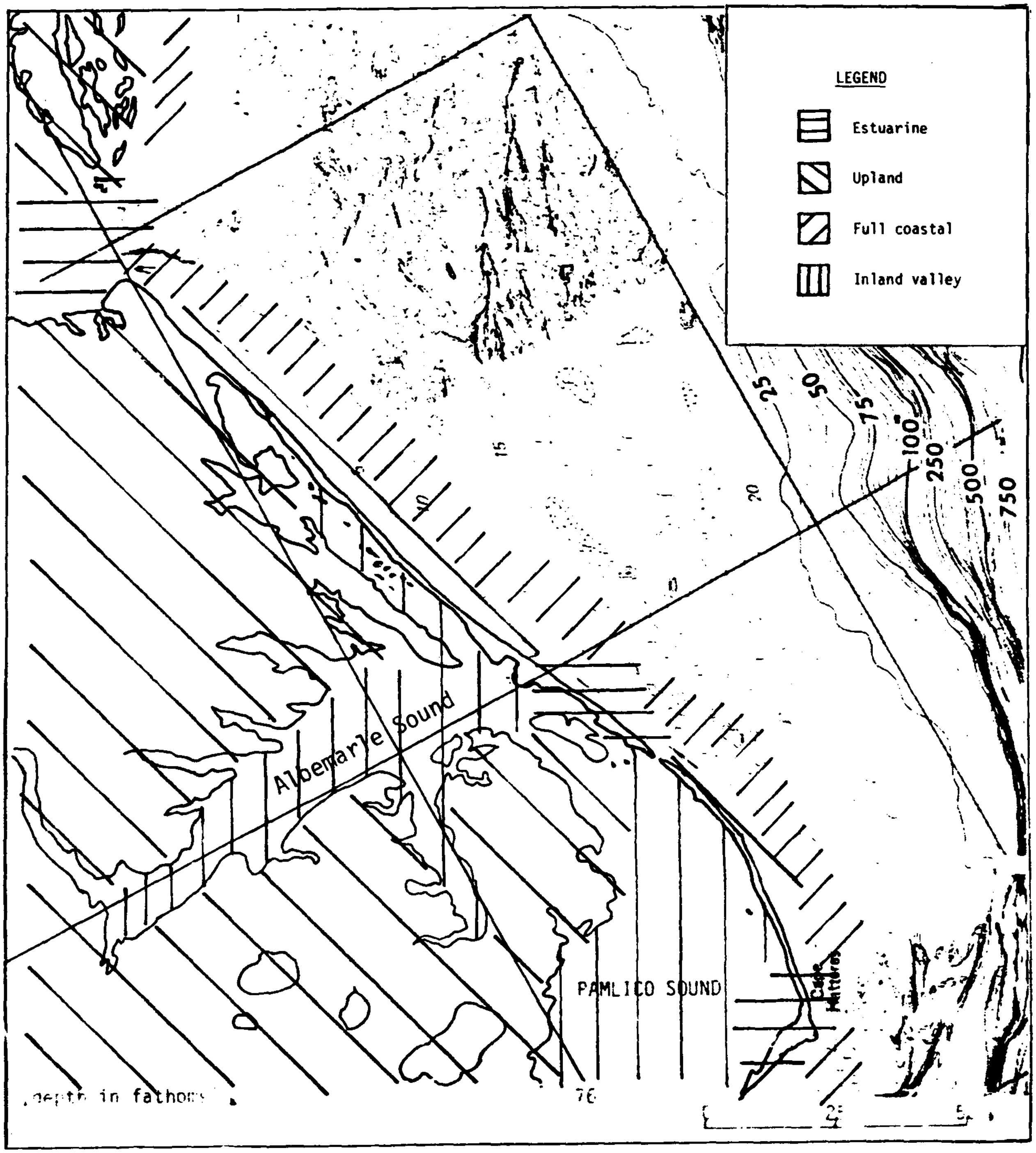


Fig. II-19d: Distribution of environmental types on the northern North Carolina - southeastern Virginia Shelf at 6000 B.P.

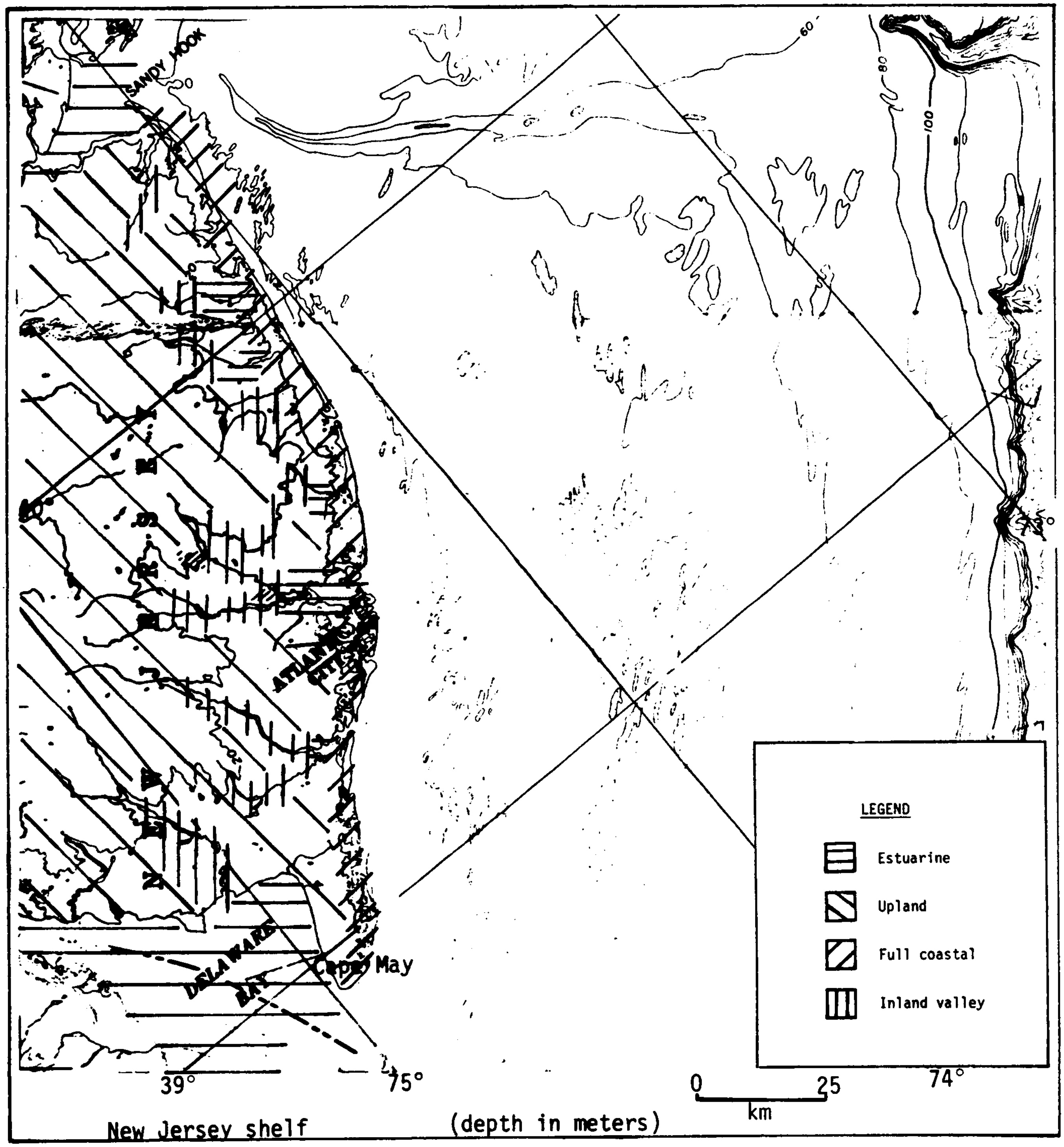


Fig. II-19e: Distribution of environmental types at 3000 B.P.

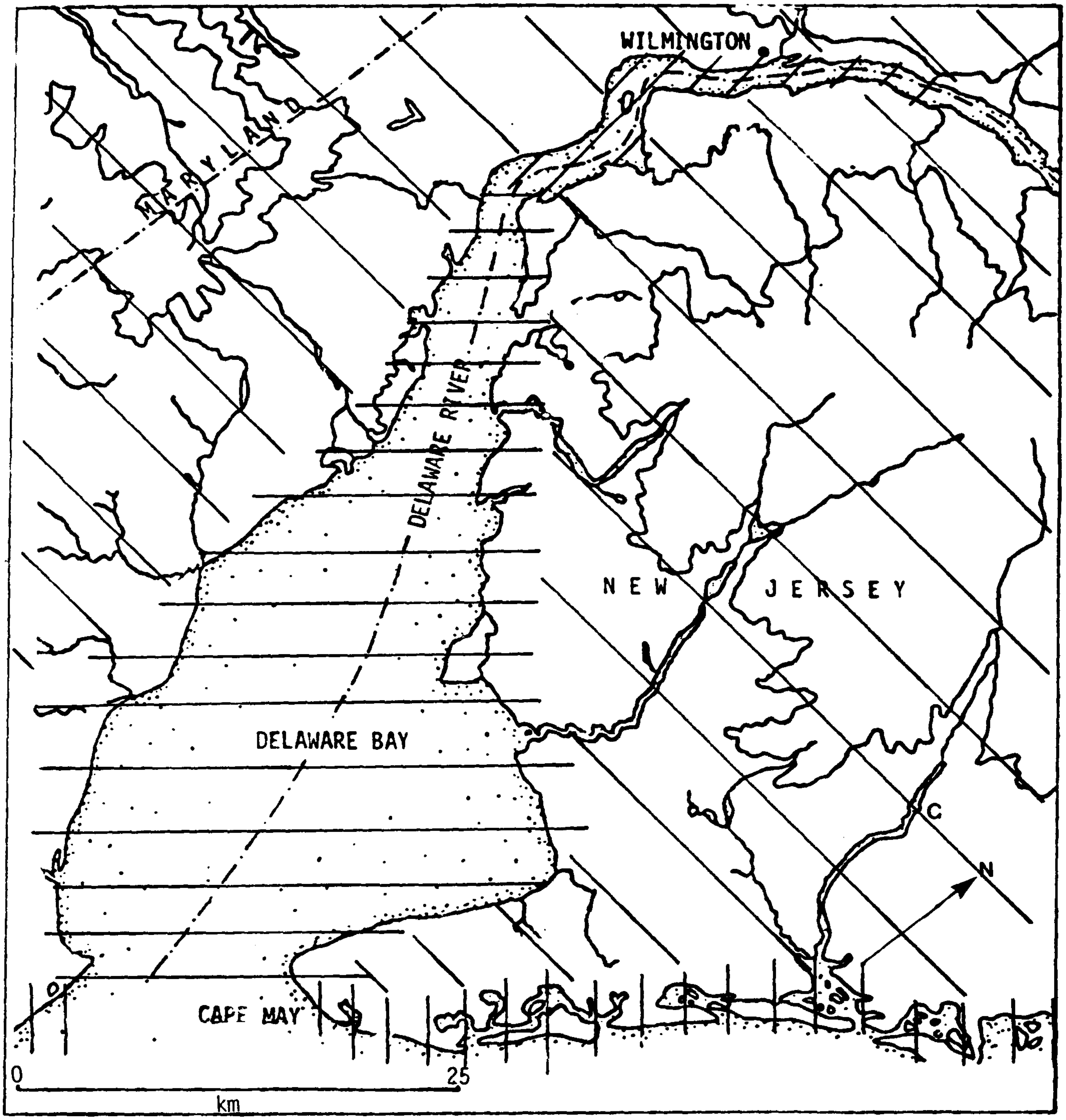


Fig. II-19f: Distribution of environmental types at 3000 B.P. (See Fig. II-19g for legend.)

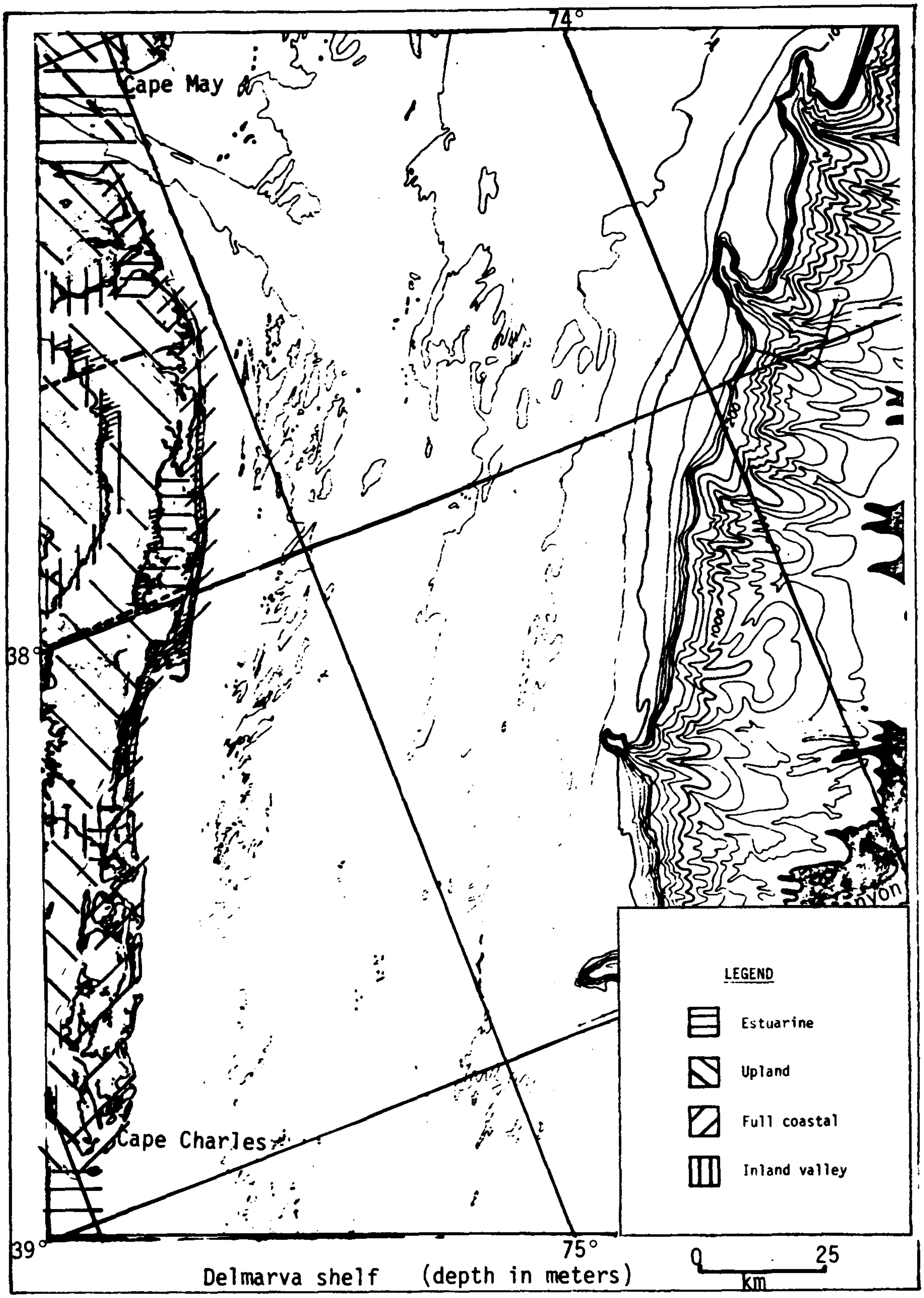


Fig. II-19g: Distribution of environmental types at 3000 B.P.

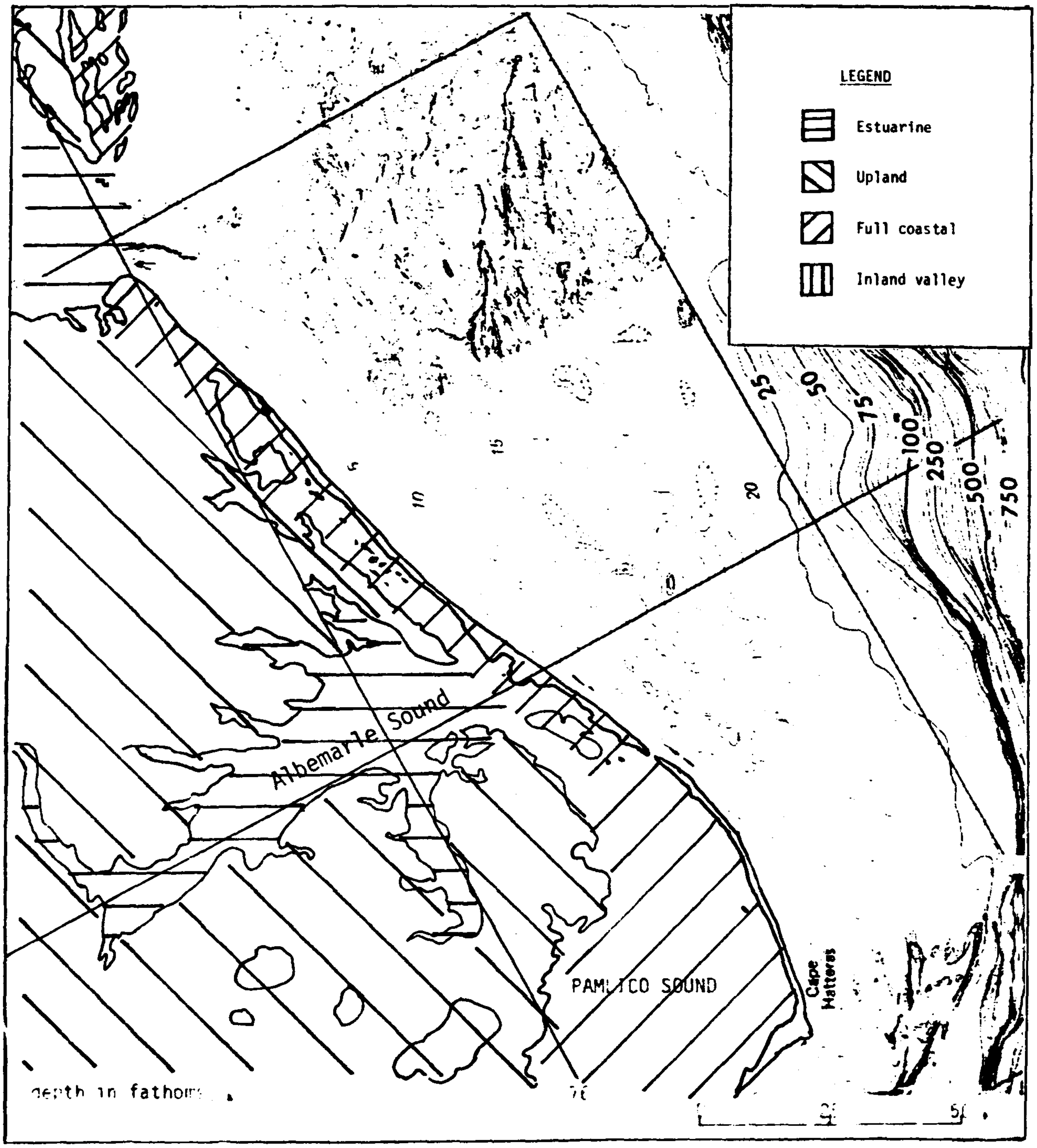


Fig. II-19h: Distribution of environmental types at 3000 B.P.

Several generalizations can be drawn from this reconstruction. First, sea-level rise, itself a result of climate change, is a primary element in environmental change. In the coastal zone, where sea-level rise has a direct effect, changes are massive and relatively rapid; in inland zones, environmental change results basically from slow processes such as soil and stream development. As relative sea-level change slows, the magnitude and rate of environmental change also diminishes.

Second, gradient mediates sea-level rise. The extent of coastal environmental zones is directly controlled by this factor. Shallow gradient produces broad effects.

Third, lagoon development is very important in terms of increasing the biological productivity of the full coastal zone. Fourth, the sequence of environments in Maine is very different from that in the rest of the project area, which forms an environmental gradient.

4.3 Paleoresources

4.3.1 Approach

By definition, resource usually refers to a naturally occurring organsim or substance which is usable by humans. Implicit in this definition is human recognition of an item's utility, both abstractly and practically. Clearly, a discussion of paleoresources must relax this criterion, since a modern research cannot know patterns of human cognition from prehistoric times. In this report, "resource" always refers to an organism or substance with potential utility for human beings, given known levels of technology.

By this definition, the list of paleoresources available at any given time is quite large. To limit it to a manageable size, several categories have been omitted. Non-food resources have been omitted, partly because of the difficulty of modeling them through time, partly because of a conviction that food resources have a more important effect on human settlement patterns. Resources available only on the open sea have been omitted because of the infrequency of their utilization other than when beached. (The Late Archiac Period in Maine provides the only known exception within the space and time limits of this study.) For most areas and periods, it is unclear whether technology adequate for full maritime exploitation was ever developed.

The resources selected for reconstruction are foods which would have yielded large amounts of caloric value for relatively little effort. They include terrestial and aquatic, coastal and inland, and plant and animal categories. Plants are represented less thoroughly than animals because their dietary input probably was less (Ember 1978) and because their distributions and densities are so difficult to reconstruct. Resources modelled are nuts, mammoth and mastodon, caribou, moose, white-tailed deer, seals, walrus, anadromous fish, other fish, and marine and estuarine molluscs.

The realiability of the following reconstructions relates directly to the methods used. As discussed earlier, direct fossil and subfossil evidence is most reliable; biological-province and habitat-preference reconstructions are less reliable.

4.3.2 Nuts

Important nut-bearing trees of the Atlantic coastal plain since the last glaciation are oak (*Quercus* sp.), hickory (*Carya* sp.), chestnut (*Castanea dentata*), walnut (*Juglans* sp.), and beech (*Fagus* sp.). Hazelnut (*Corylus* sp.) has been less important. Of these trees, reconstructions of past distributions or densities are available for oak, hickory, chestnut, and beech.

4.3.2.1 Oak - Both in modern and prehistoric times, different species of oak dominated in northern and southern portions of the project area. In the north, white (*Q. alba*), black (*Q. velutina*), northern red (*Q. rubra*), scarlet (*Q. coccinea*), and chestnut (*Q. prinus*) oaks have predominated. In the south, live (*Q. virginiana*), overcup (*Q. lyrata*), swamp white (*Q. bicolor*) and chestnut (*Q. prinus*) oaks have been most common. These species tend to associate with one another in a stand of trees, usually with two or three species represented (Larson 1970; Ogden 1961; Robichard and Buell 1973; Shelford 1968). The most important and numerous species (white and live oaks) prefer loamy bottomland soils, but other species can live on sandy upland soils. In Illinois, Zawacki and Hausfater (1969) have shown that upland nut production outstrips lowland production considerably.

Bernabo and Webb (1977) have compiled a series of maps, plotting percentages of oak pollen for different periods (Fig. II-20). The presence of oak pollen in quantities of 20% or more of the pollen spectrum was used as a criterion for inferring that oaks were sufficiently numerous for acorns to be a significant resource. Higher percentages indicate greater density of acorn resource (20%=low; 30%=medium; 40%=high).

By 11,000 B.P., the 20% oak isopoll was at Cape Henry, Virginia; by 9000 B.P., it ran through Massachusetts. By 7000 B.P., it ran approximately along the boundary between the Maine and Southern New England subareas; since then, it has receded slightly southward.

4.3.2.2 Hickory - Of the several hickory species, only shagbark hickory (*Carva ovata*) attains high densities. It prefers moist bottomlands.

Data comparable to those of oak are unavailable, but M. B. Davis (1976) has plotted appearance dates for hickory pollens (Fig. II-21). At

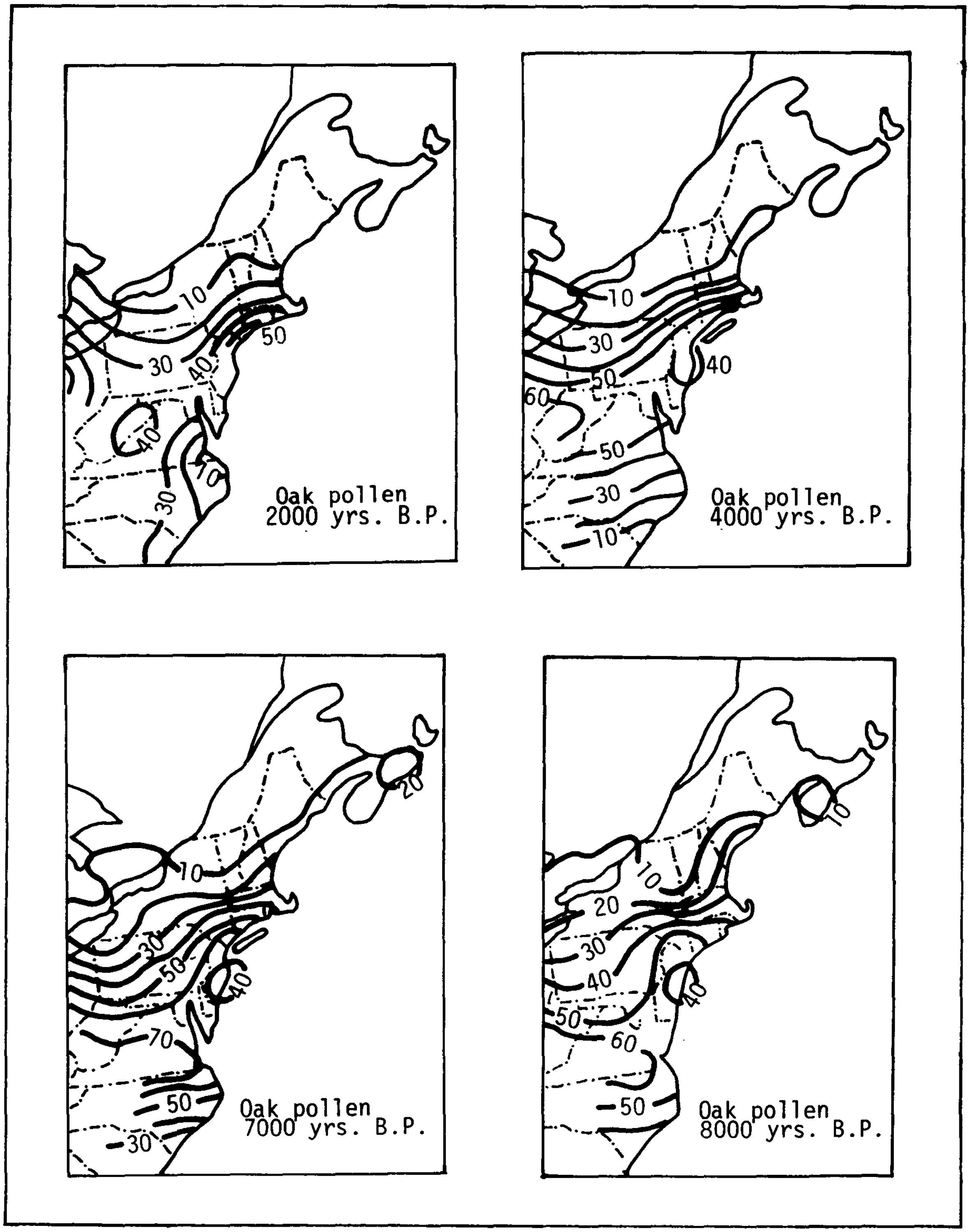


Fig. II-20: Percentages of oak pollen in northeastern North America, 11,000 to 2000 B.P. (after Bernabo and Webb 1977).

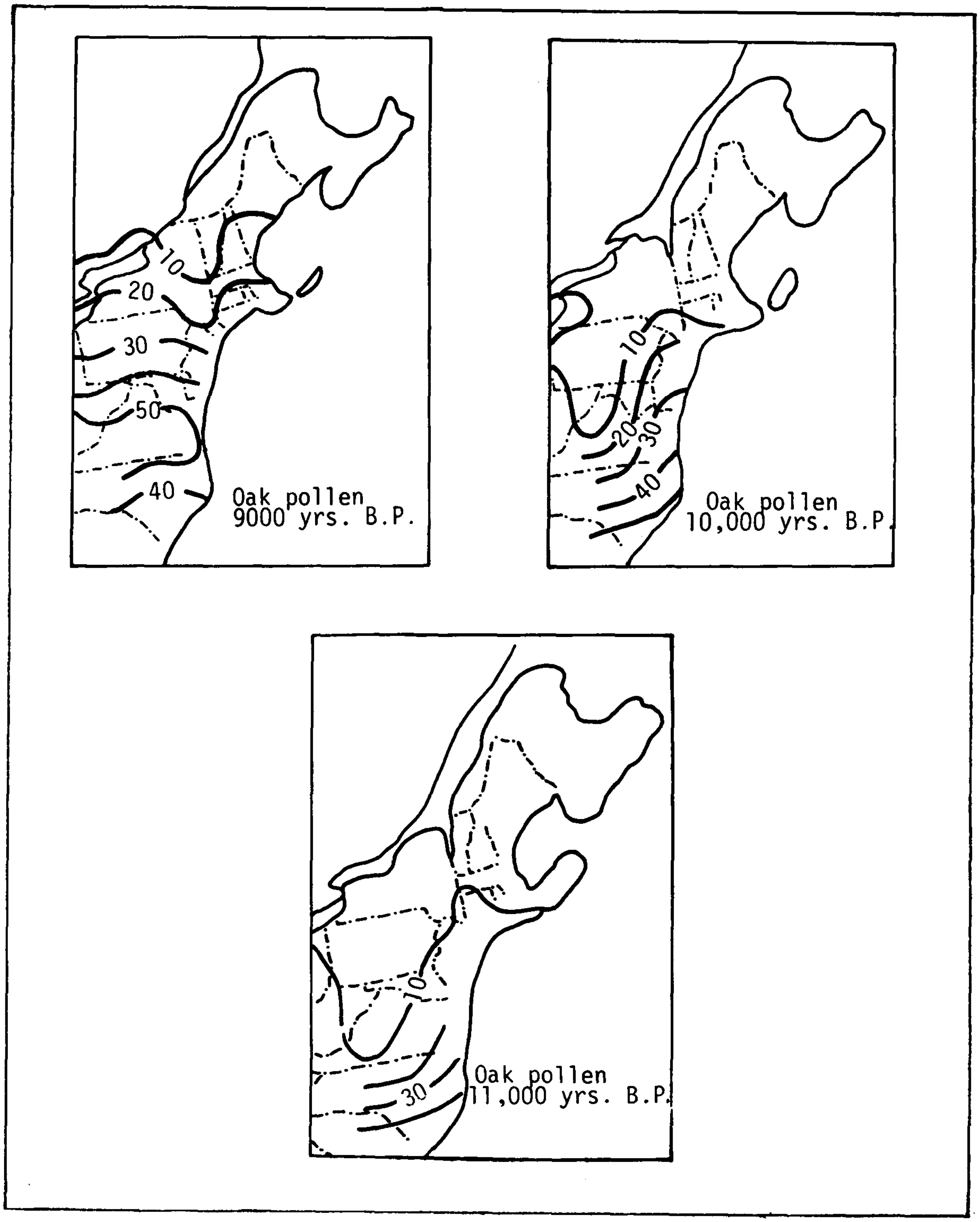


Fig. II-20 (continued).

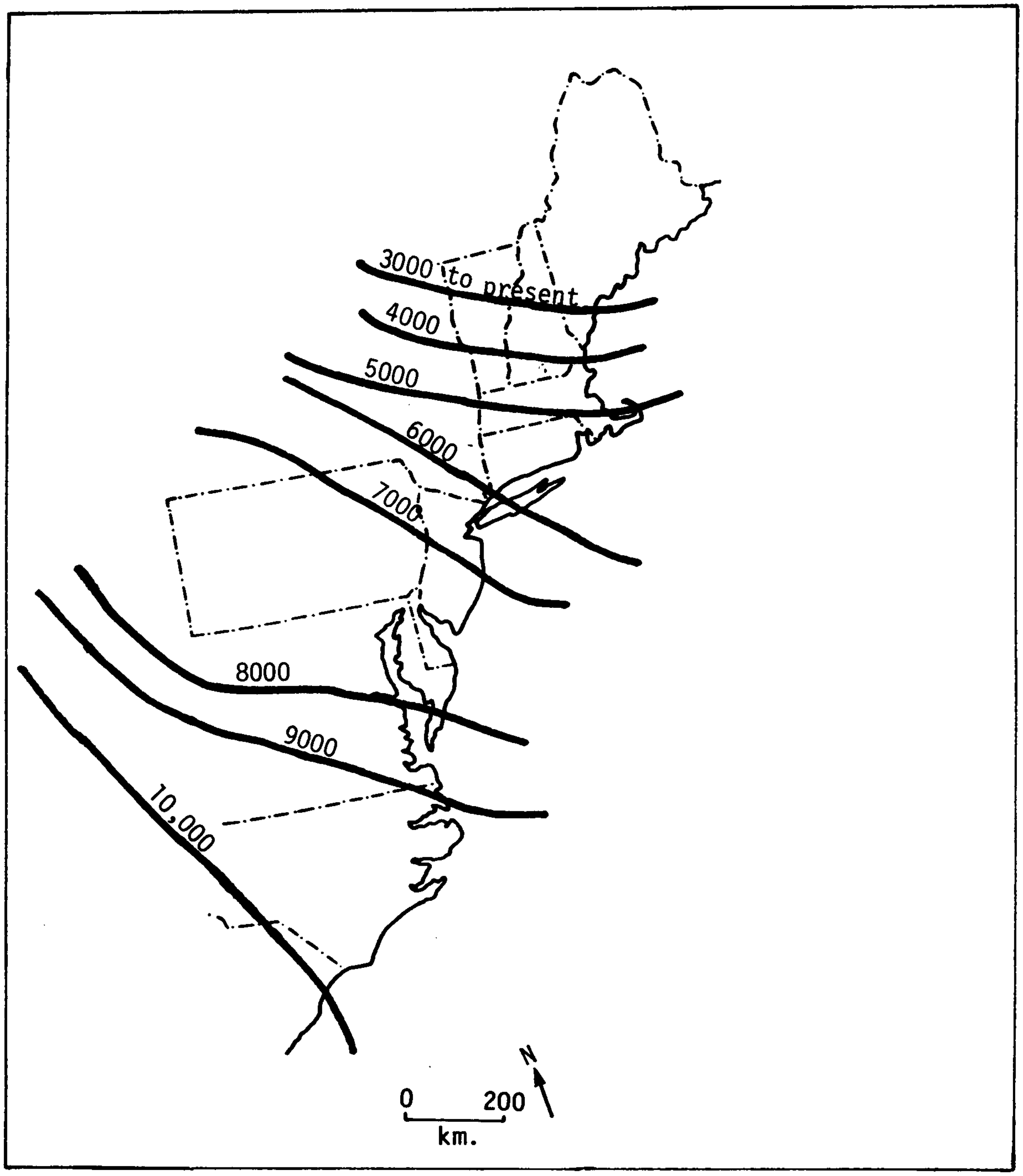


Fig. II-21: Dates of appearance of hickory pollen, in years B.P. (after M.B. Davis 1976).

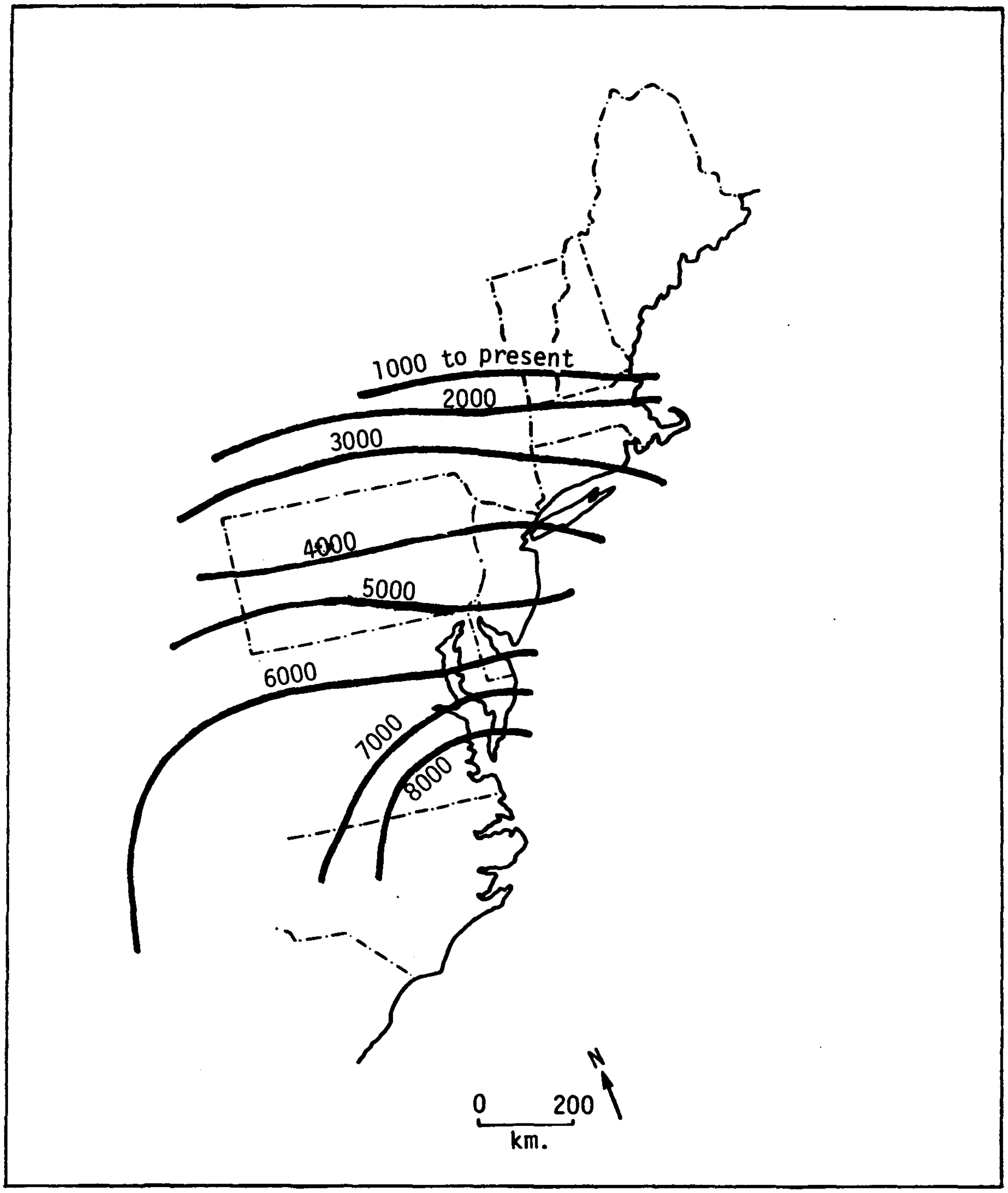


Fig. II-22: Dates of appearance of chestnut pollen, in years B.P. (after M.B. Davis 1976).

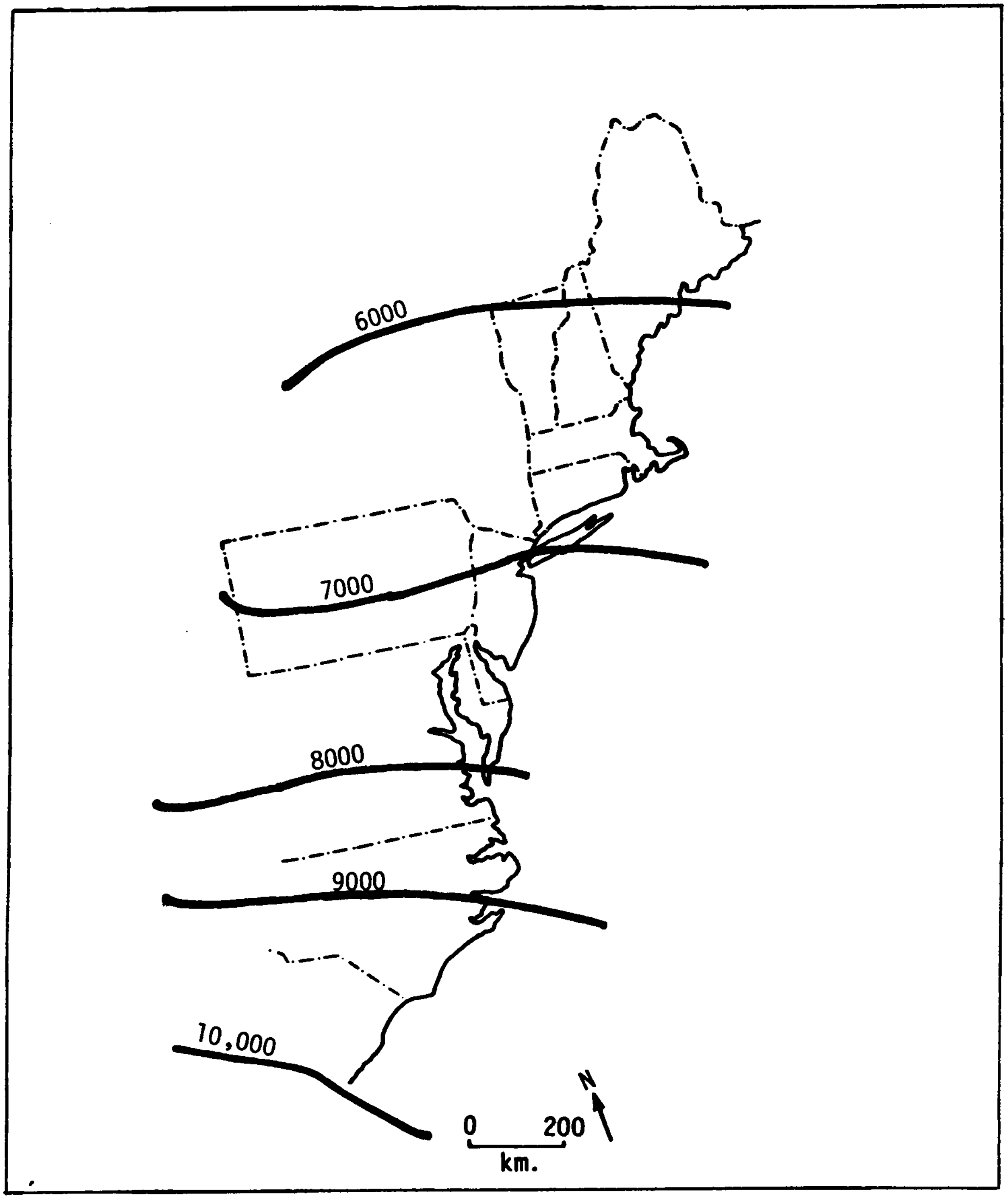


Fig. II-23: Dates of appearance of beech pollen, in years B.P. (after M.B. Davis).

9000 B.P., hickory is present at Cape Henry, Virginia; by 6000 B.P. it has spread to the mouth of the Hudson River; and by 3000 B.P. it reached its approximate present position at the Saco River, Maine.

4.3.2.3 Chestnut - The only species of chestnut in the project area (*Castanea dentata*) prefers dry, well-drained soils. Translated into environments on the Continental Shelf, this means a preference for the sandy soils of uplands.

Using M. B. Davis' (1976) appearance data (Fig. II-22), chestnut reached the central Virginia coast around 8000 B.P., northern Virginia only around 5000 B.P., Rhode Island by 3000 B.P., and its present range to northern Massachusetts by 1000 B.P.

4.3.2.4 Beech - The single species of beech in the project area, *Fagus grandifolia*, thrives in both uplands and lowlands. Unlike the other trees discussed, beech produces small nuts and the efficiency of human exploitation is questionable. Nonetheless, beech nuts have been recovered from the Susquehanna tradition graves at the Turner's Farm site, Maine (Bruce Bourque, personal communciation).

M. B. Davis' appearance data (Fig. II-23) show beech at Cape Hatteras at 9000 B.P., rapidly spreading as far as central Maine by 6000 B.P.

4.3.2.5 Summary and assessment of nut resources - Data on the post-glacial distribution of four of the five important nut trees in the project area have been presented, including data on oak, probably the most important genus. Based on known ecological preference of the species and extrapolations of distribution and density data from the dry-land portion of the Continental Shelf to the inundated portion, estimates of the density of nuts are possible. Tables II-7 through II-9 give those estimates for the different periods, areas, and environmental types on the shelf.

Nuts were not a significant resource in Maine except briefly around 6000 B.P., and then only in valleys and as a minor resource. In southern New England and the mid-Atlantic states, nuts became steadily more available, peaking around 5000 B.P. in the mid-Atlantic states and a bit later in southern New England, with the appearance of chestnut. Nuts would have been densest in uplands and less dense in valleys.

4.3.3 Mammoth and Mastodon

Mammoth and mastodon were prehistoric elephants represented by several species in North America. Mammoths became extinct around 12,000 B.P. and mastodons about 10,000 B.P. (Finison 1978).

Mammoth, the larger of the two, were primarily grazers, eating grasses and sedges (Guthrie 1968, among others). In the eastern United States, their remains have been found in areas which were open spruce parkland-woodland in the lowlands. This association and their apparent grazing

TABLE II-7. **Summary of densities of paleoresources,** Continental Shelf, Maine subarea. (-= absent, 1= low, 2= medium, 3= high, G= under glacier or ocean, P= present)

Periods and Environments	Nuts	Mammoth	Mastodon	Caribou	Moose	White-tailed deer	Seals	Walrus	Anadromous fish	Other fish	Marine molluscs
18,000 to 15,000 B.P.	G	G	G	G	G	G	G	G	G	G	G
Full coastal											
Estuarine											
Valleys											
Uplands											
15,000 to 12,000 B.P.	G	G	G	G	G	G	G	G	G	G	G
Full coastal											
Estuarine											
Valleys											
Uplands											
12,000 to 9000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	-
Estuarine	-	-	-	-	-	-	-	-	3	1-2	1
Valleys	-	-	-	1-2	-	-	-	-	3	1-2	-
Uplands	-	-	-	1-2	-	-	-	-	1	1	-
9000 to 6000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	2
Estuarine	-	-	-	-	-	-	-	-	3	1-2	2
Valleys	1	-	-	-	1-2	1-2	-	-	3	1-2	-
Uplands	-	-	-	-	2	1	-	-	1	1	-
6000 to 3000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	-	-	-	-	1-2	1-2	-	-	3	1-2	-
Uplands	-	-	-	-	2	1	-	-	1	1	-
3000 B.P. to present											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	-	-	-	-	1-2	1	-	-	3	1-2	-
Uplands	-	-	-	-	2	-	-	-	1	1	-

TABLE II-8. Summary of densities of paleoresources, Continental Shelf, southern New England subarea. (-= absent, 1= low, 2= medium, 3= high, P= present)

Periods and Environments	Nuts	Mammoth	Mastodon	Caribou	Moose	White-tailed deer	Seals	Walrus	Anadromous fish	Other fish	Marine Molluscs
18,000 to 15,000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	-
Estuarine	-	-	-	-	-	-	-	-	3	1-2	1
Valleys	-	P	-	-	-	-	-	-	3	1-2	-
Uplands	-	P	-	-	-	-	-	-	2	1	-
15,000 to 12,000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	-
Estuarine	-	-	-	-	-	-	-	-	3	1-2	1
Valleys	-	P	-	-	-	-	-	-	3	1-2	-
Uplands	-	P	-	-	-	-	-	-	2	1	-
12,000 to 9000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	P	-	-	-	-	-	3	1-2	3
Valleys	1	-	P	1-2	-	-	-	-	3	1-2	-
Uplands	-	-	P	1-2	-	-	-	-	1	1	-
9000 to 6000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	1	-	-	-	2	1-2	-	-	3	1-2	-
Uplands	1-2	-	-	-	2	1	-	-	1	1	-
6000 to 3000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	2	-	-	-	-	2	-	-	3	1-2	-
Uplands	3	-	-	-	P	1-2	-	-	1	1	-
3000 B.P. to present											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	2	-	-	-	-	2	-	-	3	1-2	-
Uplands	3	-	-	-	P	1-2	-	-	1	1	-

TABLE II-9. Summary of densities of paleoresources, Continental Shelf, Mid-Atlantic subarea. (-= absent, 1= low, 2= medium, 3= high, P= present)

Periods and Environments	Nuts	Mammoth	Mastodon	Caribou	Moose	White-tailed deer	Seals	Walrus	Anadromous fish	Other fish	Marine molluscs
18,000 to 15,000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	-
Estuarine	-	-	-	-	-	-	-	-	3	1-2	1
Valleys	-	P	P	-	-	-	-	-	3	1-2	-
Uplands	-	P	P	-	-	-	-	-	2	1	-
15,000 to 12,000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	-
Estuarine	-	-	-	-	-	-	-	-	3	1-2	2
Valleys	-	P	P	-	-	-	-	-	3	1-2	-
Uplands	-	P	P	-	-	-	-	-	2	1	-
12,000 to 9000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	P?	-	-	-	-	-	3	1-2	3
Valleys	1	-	P	1-2	-	1-2	-	-	3	1-2	-
Uplands	1-3	-	P	1-2	-	1	-	-	1	1	-
9000 to 6000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	2	-	-	-	2	2	-	-	3	1-2	-
Uplands	3	-	-	-	1	1-2	-	-	1	1	-
6000 to 3000 B.P.											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	2	-	-	-	-	2	-	-	3	1-2	-
Uplands	3	-	-	-	-	1-2	-	-	1	1	-
3000 B.P. to present											
Full coastal	-	-	-	-	-	-	-	-	-	1	3
Estuarine	-	-	-	-	-	-	-	-	3	1-2	3
Valleys	1-2	-	-	-	-	2	-	-	3	1-2	-
Uplands	2-3	-	-	-	-	1-2	-	-	1	1	-

habits suggest that their preferred habitat was parkland.

Mastodon, on the other hand, were more generalized browsers, eating leaves, twigs, and grasses. Brown and Cleland (1968) document mastodons' preference for open conifer woodlands, ideally with high spruce and low pine percentages. The identification of fragments of spruce in mastodon teeth documents their exploitation of that tree for food (Bert Salwen, personal communication). The mastodon apparently preferred more closed woodlands than the mammoth. The later extinction date for mastodon may reflect the later passing of its preferred vegetation type.

The tundra-like and parkland environments frequented by these elephants were probably more productive than their nearest modern analogues (which are in the arctic) as a result of greater solar absorption in the Paleo-Indian environments at lower latitudes. As a consequence, a greater biomass of elephants could have been supported than one might assume by analogy to arctic tundra environments. Standing-crop biomass of large herbivores ranges from 17,000 kilograms per square kilometer in African savanna to 17 kilograms per square kilometer in Canadian arctic tundra (Bliss 1975), providing extreme limits for the Continental Shelf of glacial and postglacial times.

Fig. II-24 locates known mammoth and mastodon remains from the Continental Shelf. The locations are quite approximate, since nearly all were recovered by commercial shellfish dredging and no records were made until later; none have been dated. With these caveats in mind, there is a strong correlation between elephant remains, especially those of mastodons, and river valleys. How may fossils are secondary deposits, washed downriver and deposited in the estuary, is unassessable.

In general, mammoth remains are found in deeper water than mastodon remains, clustering around 80 m below present sea level for the former and around 40 to 50 m for the latter. Edwards and Emery (1977) suggest that this pattern reflects the later persistence of mastodons as relative sea levels rose, and the greater cold adaptation of mammoths.

In summary, mammoths preferred grassy portions of tundra-like or parkland environments and mastodons preferred more wooded zones, especially those with spruce (Fig. II-25). Distribution of remains on the Continental Shelf suggests that mastodon may have preferred valley to upland zones. Densitites cannot be estimated with any reliability.

Using these habitat preferences, Tables II-7 through II-9 assess the presence or density of mammoth and mastodon as resources. By the time Maine was dry land, mammoths were extinct. In the rest of the study area, they are predicted to have been present in valleys and uplands any time before 12,000 B.P. Mastodons might have been present in Maine between 12,000 and 10,000 B.P., but absence or rarity of spruce would have limited their density and value as a resource predictable enough to affect settlement. In southern New England, the same scarcity of

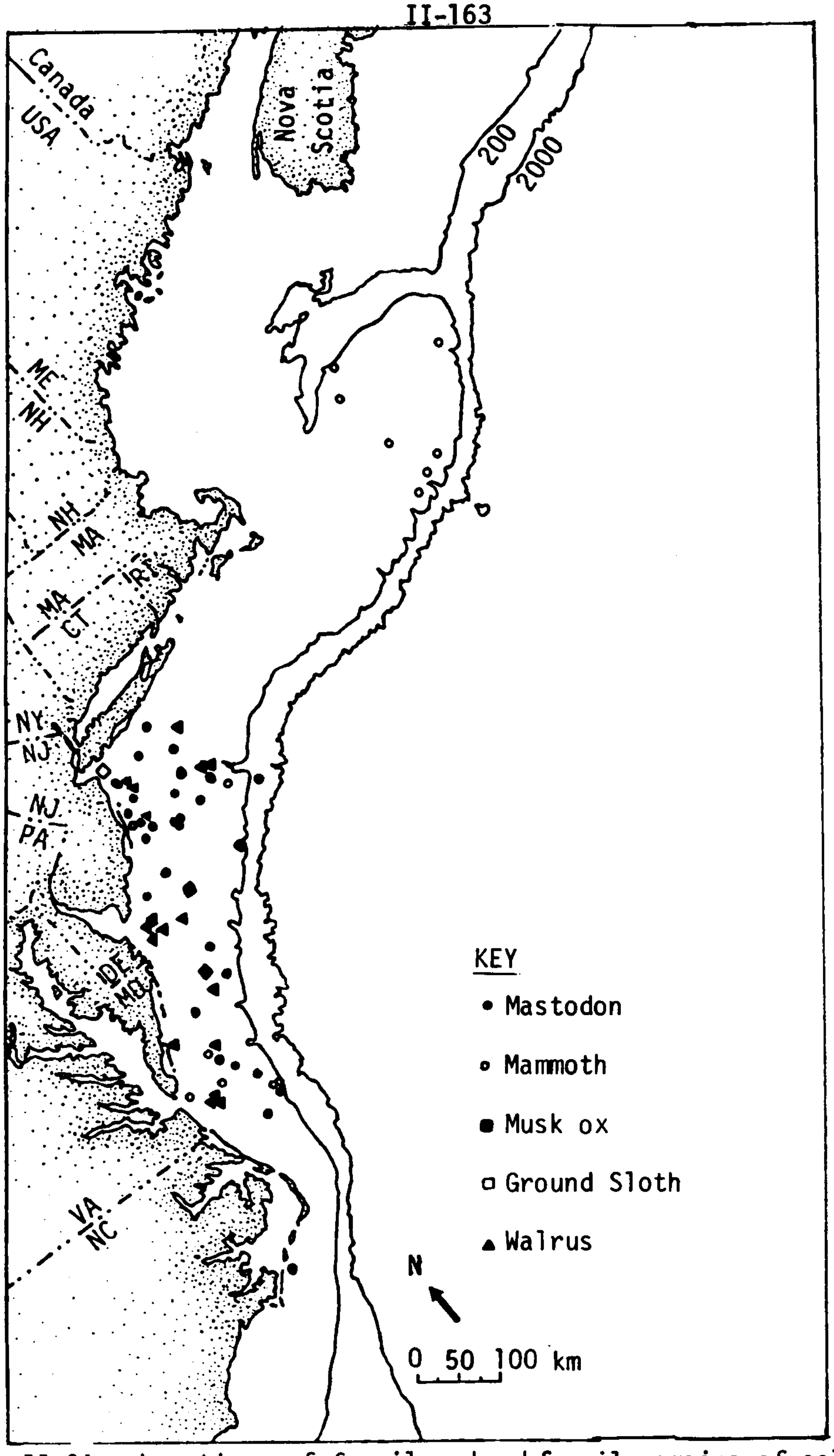


Fig. II-24: Locations of fossil and subfossil remains of selected mammals on the northern portion of the Continental Shelf. (Compiled from data in Edwards and Emery 1977; Edwards and Merrill 1977; Tucholke and Hollister 1973; and Whitmore, Emery, Cooke, and Swift 1967.)

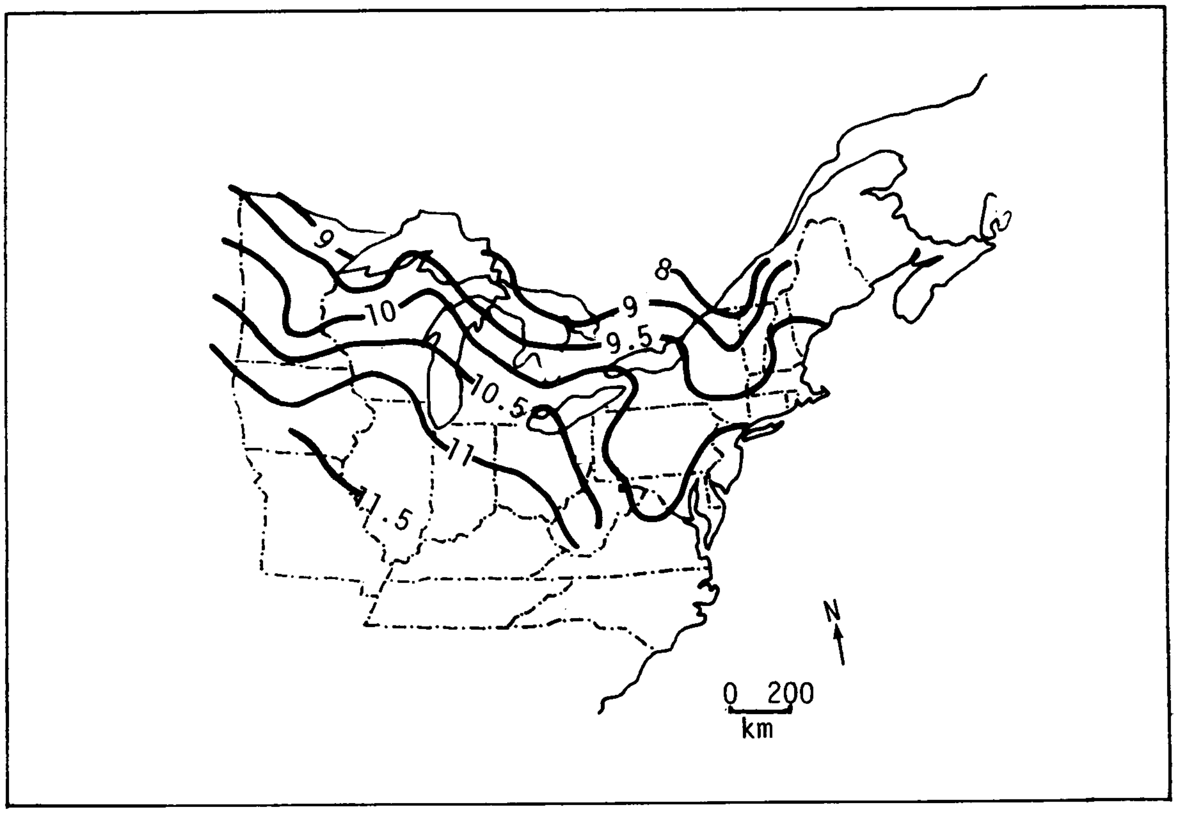


Fig. II-25: Isochrones for the decline of spruce in eastern North America (after Bernabo and Webb 1977).

spruce would have limited mastodons until around 12,000 B.P. In the mid-Atlantic subarea, mastodons were probably present until extinction around 10,000 B.P.

4.3.4 Caribou

Caribou (Rangifer sp.) are grazers which prefer tundra or open parkland. Some time in the late glacial or early postglacial period, caribou began expanding at the expense of mammoth. The date of this expansion is unclear, but it was probably not long before mammoth extinction (12,000 B.P.). No caribou remains are reported from the Continental Shelf.

Today, in arctic and subarctic areas, caribou spend summers on the tundra and winter on the taiga, or coastal plain. During each of these periods, they stay in small groups, but may congregate into herds as large as 100,000 during migration. Density per square kilometer ranges from 1.7 to 4.6 individuals (Bergerund 1974).

Caribou move almost constantly, feeding extensively. Consequently, their habitat preference is broad, so long as the grasses and sedges they require are available. Using this criterion, Tables II-7 through II-9 describe the probable distribution of caribou in the now-inundated Continental Shelf. Caribou would have been available in inland areas of all three subareas within the span from 12,000 to 9000 B.P.; the southern edge of caribou distribution is unknown.

4.3.5 Moose

Moose (Alces alces) are browsers, preferring more wooded habitats than caribou. Present habitats occupied by moose include forest-tundra, boreal forest, and mixed conifer-hardwood forests. Moose from small groups, usually composed of two to five individuals, and do not migrate in large herds. Densities range from less than 0.1 individual per square kilometer in Canadian boreal forest to 0.8 per square kilometer in Minnesota dense mixed conifer-hardwood forest and 1.4 per square kilometer in Alaskan forest-tundra (Jochim 1976; Peek and others 1974).

No moose remains have been identified from the Continental Shelf. While evidence is lacking, it is presumed that moose succeeded mastodon in a similar environment shortly after 10,000 B.P.

As shown above, moose can tolerate wide variations in environment as long as significant woodland is available. Denser forest, however, lowers moose density; optimal feeding areas are recently burnt or disturbed areas and floodplains or wetlands, where forest cover is thinned. Using these criteria, Tables II-7 through II-9 estimate moose densities and distribution on the Continental Shelf.

In Maine, moose continued as an important resource through modern times (Godin 1977). The heavily glaciated landscape offered abundant wetlands, especially in the uplands. In southern New England and the mid-Atlantic subarea, increasing density of the forest would restrict moose and favor white-tailed deer. Moose were present historically in upland southern New England (Godin 1977), but not in the mid-Atlantic states.

4.3.6 White-tailed deer

White-tailed deer (Odocoileus virginianus) will, if possible, make the bulk of their fall and winter diet on acorns (Downs and McQuilkins 1944). Deer occur almost exclusively where high acorn yields will be available. This single factor is a valid predictor of deer habitat, but the highest densities of deer are not necessarily in the areas with the greatest acorn yields. Instead, highest densities are in open woodlands and disturbed areas, where the leaves that form the bulk of the rest of deer diet are most plentiful.

Deer densities in terms of individuals per square kilometer average eight individuals in relatively closed forest (Hirth 1977; Perlman 1976) and range from 16 to 23 individuals in more open forest (Hirth 1977; Larson 1970; Shelford 1968). Except when sheltering together in protected areas during the winter, group size rarely is large.

Tables II-7 through II-9 estimate deer distribution and density on the Continental Shelf using the 10% oak isopoll as a criterion. Low nut densities in Maine kept deer densities moderately low except for a slight rise between 7000 and 4000 B.P. In the southern New England and mid-Atlantic subareas, deer become important around 10,000 and 9000 B.P. respectively. Valley densities in all cases are higher than upland densities.

4.3.7 Seals

Seals of various species constitute a resource with moderately high caloric returns. Species presently ranging as far south as Cape Cod include harbor seals (Phoca vitulina) and gray seals (Halichoerus grypus); ringed seals (Phoca hispida) are an arctic species that appear to have been utilized most extensively when occurring and which may formerly have ranged into the study area. Fast ice (sea ice frozen in place against land) is directly related to high-density ringed seal populations and forms most extensively on irregular coasts (McLaren 1961).

Seals have seasonal rounds, traveling from one habitat to another at different times; they can be captured with differing degrees of difficulty and success at different seasons. These rounds vary amond species.

Populations densities of seals on fast ice (in late spring) average 25.9 per sq km; on open coasts without fast ice, they average 90.6 sq km (McLaren 1961). Ellis (157) calculated that between two and three times as many seals will inhabit a unit area on an irregular coast as on a straight and open coast.

No seal remains are known from the Continental Shelf.

Seals frequent a broad range of environments, considering all species and all seasons. Accordingly, seals probably constituted a resource of moderate importance in areas where they occurred. The relatively more complex shoreline in the Gulf of Maine and along southern New England, coupled with the cooler temperatures of these subareas, suggests that sizable seal populations occurred in these subareas, but probably not further south.

4.3.8 Walrus

Walrus are larger than seals, averaging about 500 lbs for females. (Males rarely are hunted since the difficulties of butchering are so much greater - Freeman 1967.) They are gregarious and tend to congregate on land during summer and during warm weather. Much of the cold months they spend in shallow water. Population densities are unavailable for the period before serious human reduction of walrus numbers.

Fig. II-24 maps the distribution of known walrus remains on the Continental Shelf. None of these remains has been dated.

While evidence is scanty, walrus may have been present in the study area, at least in its northern portions during early periods, in quantities sufficient to make them a significant resource.

4.3.9 Anadromous fish

Anadromous fish - marine fish which spawn in fresh water - form an exceptionally dependable resource. For some species, seasonal runs always occur within a few days of the same date at a given locality. For many species, vast numbers of fish pass through estuaries and rivers in very short periods. Different species spawn in different stretches of the river at different distances from the sea. The spawning periods are different for different species and, along the present coast of eastern North America, span the warm months.

The physical requirements for spawning by anadromous fish are proper water salinities, water temperatures, channel gradient, and river flow. Knowledge of water temperatures and salinities in either nearshore or riverine locations is too meagre to merit discussion.

Fladmark (1975) has drawn archaeological attention to the hypothesis that anadromous fish runs developed relatively late on the Northwest Coast of North America because gradients at earlier dates were too steep. Present information on the northern portion of the Atlantic Continental Shelf indicates that gradient would not have inhibited fish runs in the period after 18,000 B.P. Incision of major rivers into the Shelf would have lowered gradient sufficiently to allow migration of many species at least. Whether this incision encountered resistant bedrock sills, creating insurmountable obstacles to spawning or perhaps smaller obstacles which might have eased human exploitation, in unknown. Smaller rivers draining directly into the ocean may not have incised their channels deeply enough to allow spawning runs. When relative sea level began rising after 18,000 B.P., gradients lessened in all rivers draining directly into the ocean.

The great flows of early rivers were distributed over wide channels and may have been little impediment to spawning fish. On the other hand, smaller or weaker species may have been unable to oppose the flow successfully. Stronger species probably spawned effectively. Increased sediment loads may have forced spawning upriver to smaller streams carrying less sediment.

Concluding that anadromous fish probably were spawning on the Continental Shelf from at least 18,000 B.P. on, Tables II-7 through II-9 summarize expected distributions and densities. In Maine, fish runs probably began shortly after deglaciation. As elsewhere, all fish, regardless of the stretch of river in which they spawn, must pass through the estuary; consequently, density during runs is greatest there. Similarly, major river valleys have greater densities than do upland streams. During early periods of massive flow in the two more southerly subareas, flow in major rivers may have forced spawning into smaller upland streams. With decreased flows later, spawning could occur in major rivers. In general, anadromous fish probably were an important resource at most times and places.

4.3.10 Other fish

Rostlund (1952) has documented that fresh-water fish population densities in high latitudes are considerably lower than densities in lower latitudes. Nonetheless, fresh-water fish attain significant densities in arctic and subarctic waters (Scott and Crossman 1973). The effects of glacial obstacles to movement and massive melt-water flows on fish populations cannot at present be assessed.

In the absence of data to the contrary, all fresh-water bodies will be considered to have supported fish from at least 18,000 B.P. onward. (See Tables II-7 through II-9.) While non-migratory fish do not attain the temporary densities of anadromous fish, they are a dependable resource and probably were utilized regularly.

4.3.11 Marine molluscs

Four physical factors are of primary importance to the distribution of marine molluscs: salinity, temperature, substrate, and wave energy. Certain species require brackish water, others cannot tolerate it, and still others thrive in brackish or fully saline water. Molluscs in the estuaries of rivers with small flows (in climates with dramatic seasonal variation) are subject to catastrophe if spring floods lower salinity beyond tolerances.

Temperature does not control the distribution of economically important marine molluscs as much as is generally supposed. Table II-10 is a compilation of distributional data on the marine molluscs most commonly encountered archaeologically between Labrador and Florida (compiled from Marrinam 1976; Painter 1977; Salwen 1962; Waring and Larson 1977; Ritchie 1969). Most species (9 of 11, 81%) are found in several molluscan provinces and can tolerate some temperature variation; a species successful enough to be exploited heavily must be able to survive the occasional temperature variations which a mollusc will encounter if it lives close enough to the water surface to be collected. The species upon which molluscan provinces were based are more delicate and susceptible to temperature change, so their population densities usually are low.

Table II-10 points out another general pattern of molluscan distribution: economically important species typically live in similar habitats in the various provinces. If a temperature change should make a havitat intolerable for a species, a similar economically valuable species would take over its habitat.

Substrate, the material upon or in which a mollusc lives, is shown in Table II-10. The sandy bottoms of bays or lagoons and mud flats are the most important substrates, although oysters require a hard substrate.

Wave energy directly affects molluscs. In high-wave-energy environments, the substrate is eroded rapidly and the mollusc is detached and vulnerable. Of the 12 species in Table II-10, only two (Ensis directus and Mytilis edulis) occur in high-wave-energy environments. The other species discussed all require a barrier island, spit, salt marsh, or estuary flanks to protect them from storm and wave damage.

Tables II-7 through II-9 summarize the reconstruction of molluscan resources along the Continental Shelf. In Maine, high wave energy restricts mollusc importance along the coast to localities where protective features have developed. By 9000 B.P. such areas probably existed; by 6000 B.P., they were probably extensive. Oysters would be stressed by cold glacial meltwater, since they would be near the northern end of their range, and would gradually grow in importance as meltwater disappeared. By 6000 B.P., full coastal and estuarine environments would have dense economic mollusc distributions. In the southern New England and mid-Atlantic subareas, the unsheltered coast before 12,000 B.P. would keep mollusc densities low. With the development of lagoons after that time, mollusc densities on the coast would be high. In estuaries, as fresh-water flows become warmer, oyster densities would increase steadily becoming very high after 12,000 B.P.

Subfossil oyster beds are well known from the Continental Shelf off southern New England and the mid-Atlantic states (Emergy and Garrison 1967; Emery and Milliman 1970; Emergy and others 1967; Merrill and others 1965; and others). Edwards and Merrill (1977) note the high frequency of oyster beds in areas whose depths would have made them probable oyster habitat around 10,200 and 8700 B.P., suggesting that

TABLE II-10. Marine molluscs most frequently found in archaeological sites along the Atlantic coast, distribution summary.

Species	Molluscan Provinces	Habitat
Crassostrea virginica (oyster)	Cool Temperate, Mild Temperate, Outer Tropical	Brackish water, hard substrate
Ensis directus (razor clam)	Cool Temperate, Mild Temperate, Outer Tropical	Intertidal sand beach
Mercenaria mercenaria (hard-shell clam, quahog)	Cool Temperate, Mild Temperate, Outer Tropical	Bays and lagoons, sandy bottom
Mesodesma arcatum (arctic wedge clam)	Cold Temperate, Cool Temperate, Mild Temperate	Bays and lagoons, sandy bottom
Mercenaria campechiensis (clam)	Outer Tropical	Bays and lagoons, sandy bottom
Rangia cuneata (cockle)	Outer Tropical	Bays and lagoons, sandy bottom
Argopecten irradians (scallop)	Cool Temperate, Mild Temperate, Outer Tropical	Bays and lagoons, free-swimming
Mya truncata (clam)	Cold Temperate, Cool Temperate, Mild Temperate	Intertidal mudflats
Mya arenaria (soft-shell clam)	Cold Temperate, Cool Temperate, Mild Temperate, Outer Tropical	Intertidal mudflats
Geukensia demissus (mussel)	Cool Temperate, Mild Temperate, Outer Tropical	Intertidal mudflats
Mytilis edulis (blue mussel)	Cold Temperate, Cool Temperate, Mild Temperate, Outer Tropical	Intertidal, hard substrate

relative-sea-level stillstands at those periods might have favored high oyster densities. MacIntyre and others (1978) have questioned whether these beds are secondary deposits, but Emergy and Merrill (in press) mount a case that the beds are substantially intact deposits, left in situ after death. Oyster shells dated before 12,000 B.P. are uncommon. (See, for example, MacIntyre and others 1978:Table 1. Of 38 dated oyster beds later than 18,000 B.P., only five [18.2%] are earlier than 12,000 B.P.)

4.3.12 Conclusions

Tables II-7 through II-9 summarize a reconstruction of the most significant resources on the Continental Shelf. The assessment of various resources has been based on different approaches and has included several subjective judgments and assumptions. The assignment of high, medium, and low density values has been especially difficult, but is critical.

It must be remembered that this reconstruction has dealt only with resources with high caloric-return rates and biomasses, presumably the resources most important to settlement location. There also would have been more or less continuous distributions of small game during many periods. Taken together, these species could form a significant resource, but one whose reconstruction is beyond the scope of our present data.

5.0 INDUCTIVE MODELS OF SETTLEMENT PATTERNS

5.1 Introduction

This section presents settlement data on known archaeological sites in or adjacent to the study area and attempts to derive models of settlement by generalization. Since all of the known sites are on what is now dry land, and the sites at lowest elevation are only partially inundated, this data set is considerably different from the set of sites expected to lie on the outer Continental Shelf itself. A further limitation to this approach resides in the biases of the set of known sites, including geographical, temporal/cultural, and other biases. These are discussed more fully in Section 2.

Two sets of generalizations will be presented for each unit of space and time. The first will include either historic or current settlement notions which have appeared in the literature and have affected current archaeological thought. These will be evaluated critically. The second set will be generalizations that have been derived from study of the archaeological site-inventory compiled for this project. Finally, out of these various generalizations, the inductive models will be synthesized.

For the purpose of this presentation, the project area is divided into the three subareas: Maine, southern New England, and the mid-Atlantic states. Within each of these treatments of a subarea, there are further divisions by period. The period divisions follow those outlined in Section 3, but different periods are in some cases grouped together for discussion. For example, the entirety of the Woodland Period for Maine is discussed as a unit because data distinquishing periods within that span are either unavailable or have not been recognized.

Probably because of the superficial similarity of fluted points wherever they have been found, there is a tendency to extrapolate interpretations of the Paleo-Indian Period widely. That tendency is understandable, considering the scarcity of these early remains, but the result can be confusing and unreliable. Settlement patterns, in particular, are linked intimately with environment and resources and will not necessarily be similar in disparate places, even if material cultures are similar. Following this reasoning, care has been taken not to overextend the applicability of settlement pattern studies from one area to another. In some cases, an author has argued for wide applicability which this study believes unwarranted. To consider what broad generalizations do seem warranted for the Paleo-Indian Period, a separate section has been added. A similar approach has been taken with ehtnohistoric patterns, also treated in a special section.

For each unit of space and time, a distribution map showing known sites and find spots is included. A site is known (or inferred) to include an assemblage of materials reflecting functions at a locus of previous human activity; a find spot, on the other hand, carries no such implication. A find spot may (and often does) indicate an area where a single artifact was used and discarded or was lost. In the absence of other information, a location where a single artifact has been found should be considered a find spot. These two categories are differentiated whenever possible. In general, find spots have been documented in records only for early remains: Paleo-Indian and sometimes Early and Middle Archaic. For each unit for which a map has been included, a tabulation sheet summarizes recorded frequency of various environmental features among the sites included in that time and place.

A summary of the inductive models produced appears at the end of the section.

The site types used in the section have been taken from the literature of archaeology in the study area. They do not form a systematic set of categories, since they are drawn from the work of many scholars who have striven toward slightly different goals over considerable periods of time. Fortunately, the definitions of these site types are more or less standard and will be given below.

In some cases, it has been necessary to differentiate similar site types occurring in different zones or locations, in order to not obscure differences in typical site size, frequency, or locational attributes. In these cases, prefixes and suffixes have been added. For example, the basic site type "camp" has been subdivided into a number of types, named for locational or functional attributes: upland camp, fishing camp, other camp I, and other camp II.

A camp is a habitation site, usually presumed to be more or less temporary. There often is a connotation of special purpose, as in "fishing camp." A rock shelter is defined as a site located in a cave or under a rock overhang providing shelter. Rock shelters are usually small and often connote impermanence. A farmstead is a small habitation site, associated with agricultural fields and associated with but separate from larger sites. A village is a permanent or semi-permanent habitation site of considerable size. Habitation is a residual category, embracing sites where human occupation took place, but where none of the other categories apply; it is also used when data are insufficient to justify assigning a class of sites to one or another type.

A black earth midden is a deposit of organic refuse with little or no shell included. A shell midden is a similar deposit, but with a higher density of shell. With both types of midden sites, habitation may have taken place at the site or it may have been a work area, where only restricted functions took place. A midden or organic refuse deposit may occur as an element of another site type (such as a village) and should not be confused with a midden site. A <u>fish weir</u> is a specialized site, without habitation, where a system of stakes, mats, nets, and/or other materials was placed in a river for the purpose of capturing fish.

5.2 Maine Subarea

5.2.3 Paleo-Indian Period

The Paleo-Indian Period in Maine is only very poorly known and there have been no attempts to define settlement patterns. Sanger (1975) has suggested that lowered tidal amplitudes in the Gulf of Maine would have lowered the productivity of the coastal zone during the period before about 5000 B.P. The biological implications of lower tidal amplitude are difficult to derive, but it is likely that the size of the intertidal zone would have decreased to a greater or lesser extent depending on local physiography. There is no compelling argument for the case that it would have lowered productivity sufficiently to have discouraged human exploitation of the varied resources of the coast.

Fig. II-26 and Table II-11 plot and describe the known occurences of Paleo-Indian remains in Maine. None of the occurrences has been investigated thoroughly and all must be considered find spots. Paleo-Indian remains, though rare, are scattered throughout the area; the sample size is too small to permit discussion of clustering. The absence of coastal sites is meaningless, since the coastline of the Paleo-Indian Period now is under water.

The only striking generalization is that most finds are from fossil beaches around fresh-water lakes. Such locations would have afforded ready access to fresh-water and terrestrial food sources. Ethnographically known tundra-forest caribou hunters such as the Chipewyan, for example, typically have winter camps at lakes just within the wooded zone, then move into the tundra during the warmer months, camping along lakes or rivers. Spiess (1979) has reviewed these ethnographic patterns and suggests (1978) that they are probably analogous to Paleo-Indian patterns in Maine. If that suggestion is accurate, one would expect that small camps would be distributed along lakes and rivers, in both the tundra and forest zones.

Spiess's proposition, however, is built on two assumptions which are suspect. The first is that the Paleo-Indian adaptation in Maine had no developed coastal aspect, is based on Sanger's (1975) hypothesis of lowered productivity, which we have criticized earlier as naive. The second is that the Paleo-Indian adaptation in Maine was analogous to modern adaptations and focused on caribou hunting. It has been argued

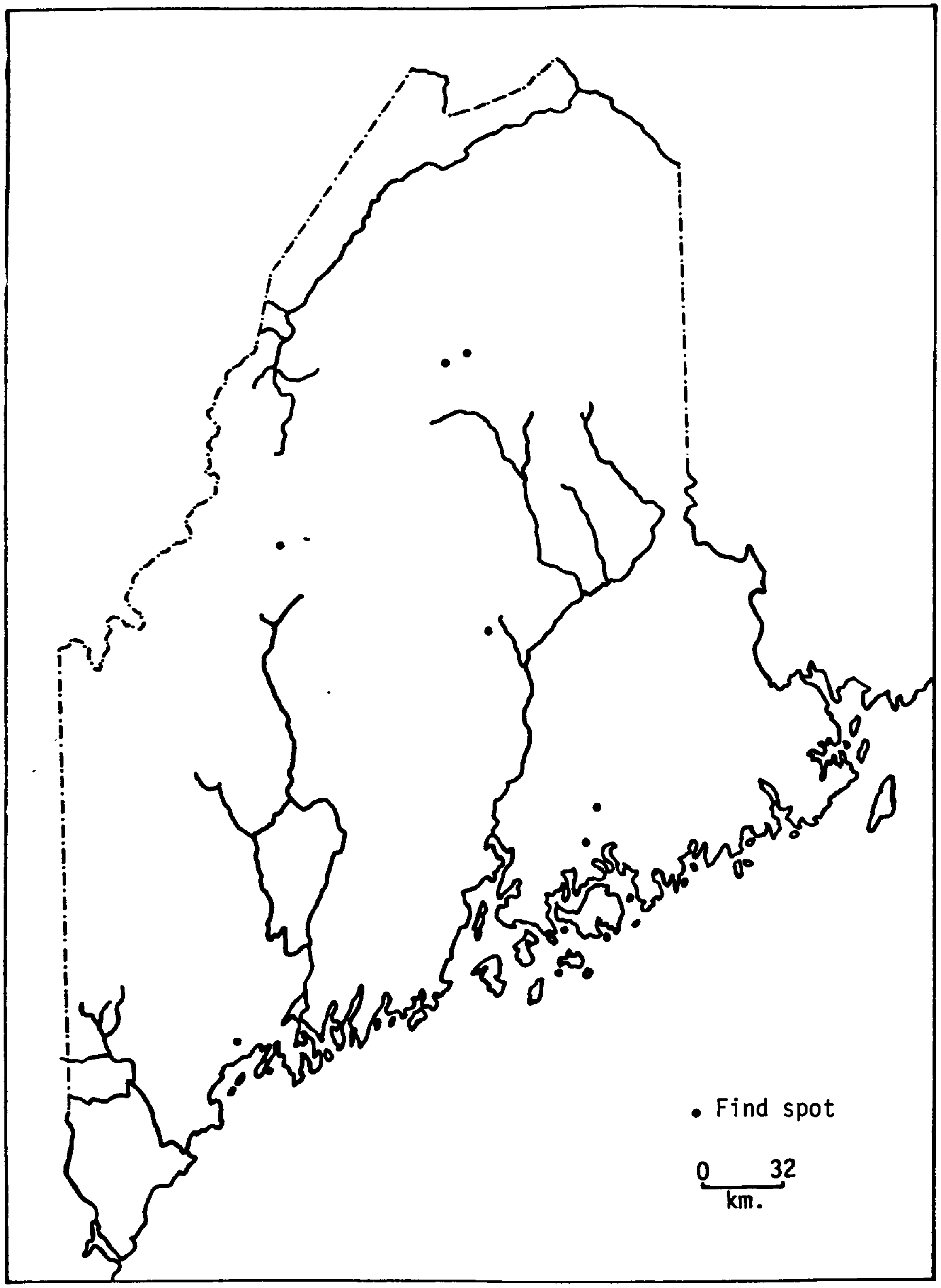


Fig. II-26: Distribution of known sites, Maine subarea, Paleo-Indian Period.

TABLE II-11: Tabulation of site data, Paleo-Indian Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: PALEO-INDIAN

Total sites:	8
Coastal sites:	
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	1
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	1
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:	1	W:		NW:	1	OTHER:			

TYPE OF WATER SOURCE:

Spring:	
Brook or stream:	
Small river:	
Major river:	
Lake:	6
Swamp:	
Salt marsh or estuary:	

L. I. Sound:	
Ocean:	
Bay:	
Harbor:	
Sites inundated:	
Sites at confluences:	

LANDFORM TYPE:

Fossil beaches	4
Outwash Plain	1

that such a specialized economy would be maladaptive to the unstable ecosystem of the Paleo-Indian tundra or forest-tundra and would only be an adaptation resorted to under outside pressure (Barber 1979a).

If Spiess's proposition is incorrect, sites might be expected in a wide variety of settings: the data are insufficient to permit valid generalization. In the absence of confirming evidence for Spiess's proposition, it is concluded that Paleo-Indian sites may be expected in any setting, although lakesides may have been preferred, and that there will be a variety of site sizes, functions, and seasonal occupations.

5.2.4 Early Archaic Period

Evidence for the Early Archaic Period in Maine is even scantier than for the Paleo-Indian Period there. This may be a reflectionof decreased population in Early Archaic times, of the fact that the remains of this period are less aesthetically pleasing to collectors, or of a failure to recognize artifact types dissimilar from contemporary types to the south.

Fig. II-27 and Table II-12 summarize extant data on Early Archaic remains in Maine. Only two locations are known, one a find spot and the other a multicomponent site. The find spot is a (presently) intertidal mud flat and may be a secondary deposit, the point having been deposited after water transportation. The site, unexcavated, lies on a terrace overlooking an excellent stretch of river for anadromous fish exploitation. Sanger and Bourque (1977) have suggested that this latter location indicates exploitation of migratory fish, but evidence other than location is lacking.

No generalization about site location, size, function, or seasonality is possible from this small data set. It is likely, however, that site density during this period in Maine was quite low, apparently indicating low population.

5.2.5 Middle Archaic Period

From this period, six sites and find spots are known (Fig. II-28 and Table II-13). Their distribution in southern Maine appears to reflect patterns of research and may bear little relationship to the overall distribution of settlement in Middle Archaic times.

Of the six known Middle Archaic sites and find spots in Maine, three are in locations advantageous to the exploitation of anadromous fish runs: adjacent to shallow rapids in the lower reaches of streams and rivers. Sanger and Bourque's (1977) case for early anadromous fish exploitation is somewhat stronger for Middle Archaic subsistence in Maine and is bolstered by Dincauze's (1976) inference of anadromous fishing during the Middle Archaic occupation of the Neville site, New Hampshire.

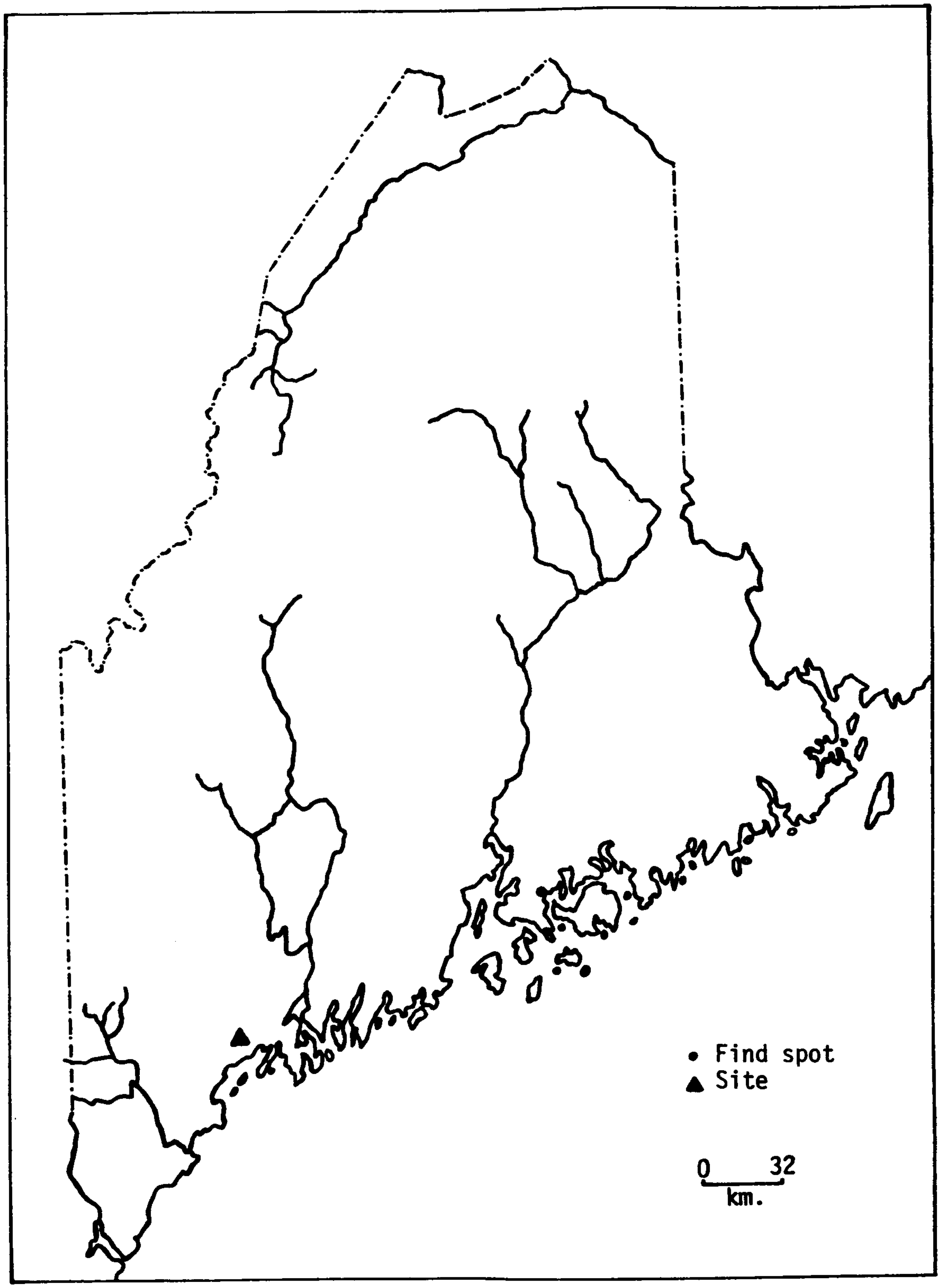


Fig. II-27: Distribution of known sites, Maine subarea, Early Archaic Period.

TABLE II-12: Tabulation of site data, Early Archaic Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: EARLY ARCHAIC

Total sites:	2
Coastal sites:	
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	1
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	1
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:		Ocean:	
Small river:	1	Bay:	
Major river:		Harbor:	
Lake:		Sites inundated:	
Swamp:		Sites at confluences:	
Salt marsh or estuary:			

LANDFORM TYPE:

High sandy terrace 1

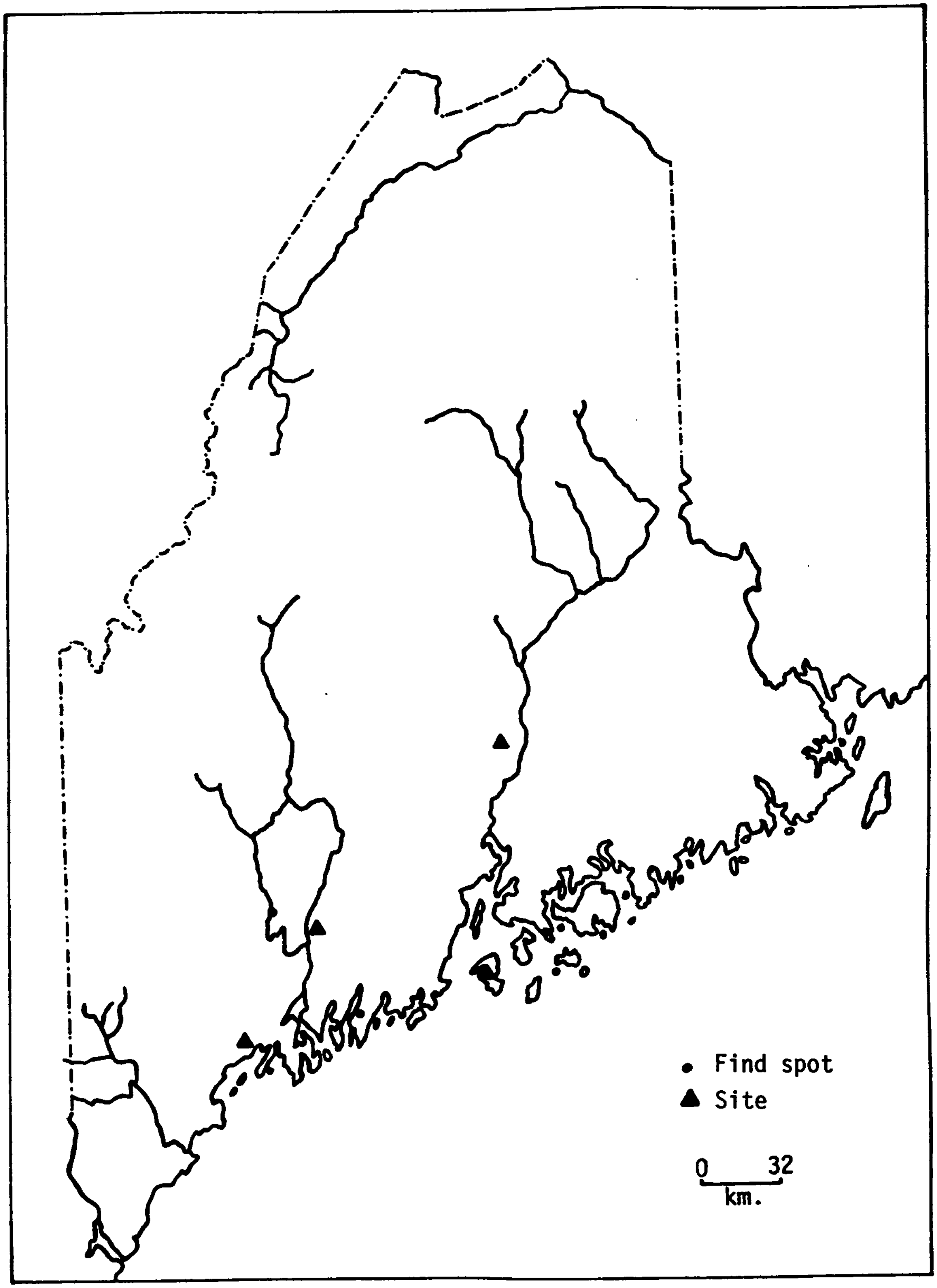


Fig. II-28: Distribution of known sites, Maine subarea, Middle Archaic Period.

TABLE II-13: Tabulation of site data, Middle Archaic Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: MIDDLE ARCHAIC

Total sites:	8
Coastal sites:	1
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS: 3

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	3
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	3
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	3
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	1	Ocean:	
Small river:	2	Bay:	
Major river:		Harbor:	
Lake:	3	Sites inundated:	
Swamp:		Sites at confluences:	1
Salt marsh or estuary:			

LANDFORM TYPE:

Nickpoint	1
Island	2
Flood plain	1
River terrace	2

One of these six sites, the Basin site on Vinalhaven Island (Bates 1903) is especially important. It is the earliest known Maine site which was on the coast during its period of occupation. While there are no recorded faunal remains recovered from the site, it is extremely unlikely that occupants of a coastal site failed to exploit marine or estuarine resources.

In summary, site density in Maine apparently increased markedly between Early and Middle Archaic times. While no Middle Archaic sites are recorded in northern Maine, so little work has been done there that it would be premature to claim that the area was utilized little or not at all in this period. Human settlement was both on the coast and inland, although the magnitude of the coastal occupation is difficult to assess. Inland, favored locations included streamsides and riversides where anadromous fish capture was facilitated. These sites appear to have been generally small, probably occupied in spring to capitalize on fish runs. The smallness of the sample probably obscures further variety in the settlement-subsistence system.

5.2.6 <u>Late Archaic Period</u>

Most recent workers have seen fish as the key resource for subsistence during the Late Archaic period in Maine (for example, Bourque 1975; Sanger and others 1977). The locations of Late Archaic habitation sites, regardless of cultural tradition, support this generalization.

The habitation sites of the Late Archaic Period fall into two categories. First, coastal sites, near relatively large waterways leading to the ocean and capable of floating relatively large canoes (Spiess 1978). These sites are presumed to have been the base camps from which sorties were launched onto the open sea for the purpose of exploiting maritime resources. These coastal sites often incorporate shellfish utilization and, in the case of groups not utilizing resources of the open sea, were probably situated where they were largely for the use of this resource. In either case, these sites are formed partly of shell middens, as at the Turner Farm, Taft's Point, Nevin, and other sites. Since shell deposits accumulate more rapidly than refuse from foodstuffs with a lower refuse percentage, these sites sometimes become quite large, but nearly all have been reduced by unknown increments by coastal erosion. It is not possible, however, to deduce whether the group utilizing a site was large or small.

Second, there are interior sites at positions near favorable fish capture locations along rivers and streams or at the mouths of lakes. Such locations include narrows, rapids, falls, and rills. Examples include the Ellsworth Falls, Emerson, Mason, Hathaway, and Hirundo sites. Such sites may offer archaeologists the opportunity to estimate Late Archaic populations, but, since these favorable locations usually have been used for millennia, careful excavation is need to sort out the various components. Preliminary evidence from the Hirundo site, however, suggests that these sites will be considerably smaller than their coastal counterparts.

Bourque (1975) has expressed the belief that most Late Archaic sites in Maine fit one of these two categories. Working on this assumption, he has reasoned that the inland fishing camps were utilized during spring and/or fall to exploit seasonal fish runs and that the coastal sites were utilized in the summer, when maritime exploitation would be possible. As a result of recent analysis of deer bone from the Moorehead phase component at the Turner Farm site by Arthur Spiess, Bourque (personal communication) has expanded his list of site types to include early fall to spring occupation of large coastal sites.

Fig. II-29 and Table II-14 summarize the data collected on Late Archaic sites in Maine. The number of sites has increased dramatically from earlier periods, and coastal and inland sites are about evenly represented. The dearth of sites in northern Maine is probably an artifact of the small amount of research that has been done there. The majority of inland sites are at desirable fishing locations; the majority of coastal sites lie near shellfish beds (nearly half have recorded shell middens) and most lie near the ocean, connected by sizable watercourses. The number of lakeside sites is unexpectedly large, although most of these sites lie at junctions of lakes and rivers and would have been good spots for the use of weirs or other fish capture techniques. Many of these lakeside sites may prove to be winter camps. Data on site size are missing, but if this latter suggestion is correct, they can be expected to be small.

These interpretations are based on somewhat limited data, but with the completion of analysis of the Turner Farm and hirundo sites, knowledge of the Late Archaic Period in Maine should increase by an order of magnitude and interpretations should become more secure.

The preceding discussion has dealt with habitation sites, but the Late Archaic Period in Maine also saw spectacular burial ceremonialism. The specialized cemeteries of the Moorehead complex are the earliest known ceremonial sites in Maine. The prediction of cemetery location is always difficult, probably because the needs of the dead are more easily satisfied than those of the living. That is, a habitation may be situated to minimize travel time to a shellfish bed or to provide well drained dwelling floors which will remain moderately dry after rain. Burial of bodies, however, regardless of how ritualized, need not concern itself with such matters. Certainly cases exist where specific landscape features appear to have been sought for cemeteries (as with the Glacial Kame complex, for example - Cunningham 1948), but these features cannot be assumed *a priori*.

With Moorehead complex cemeteries, no simple set of attributes is obvious. They may occur in different landforms and near different

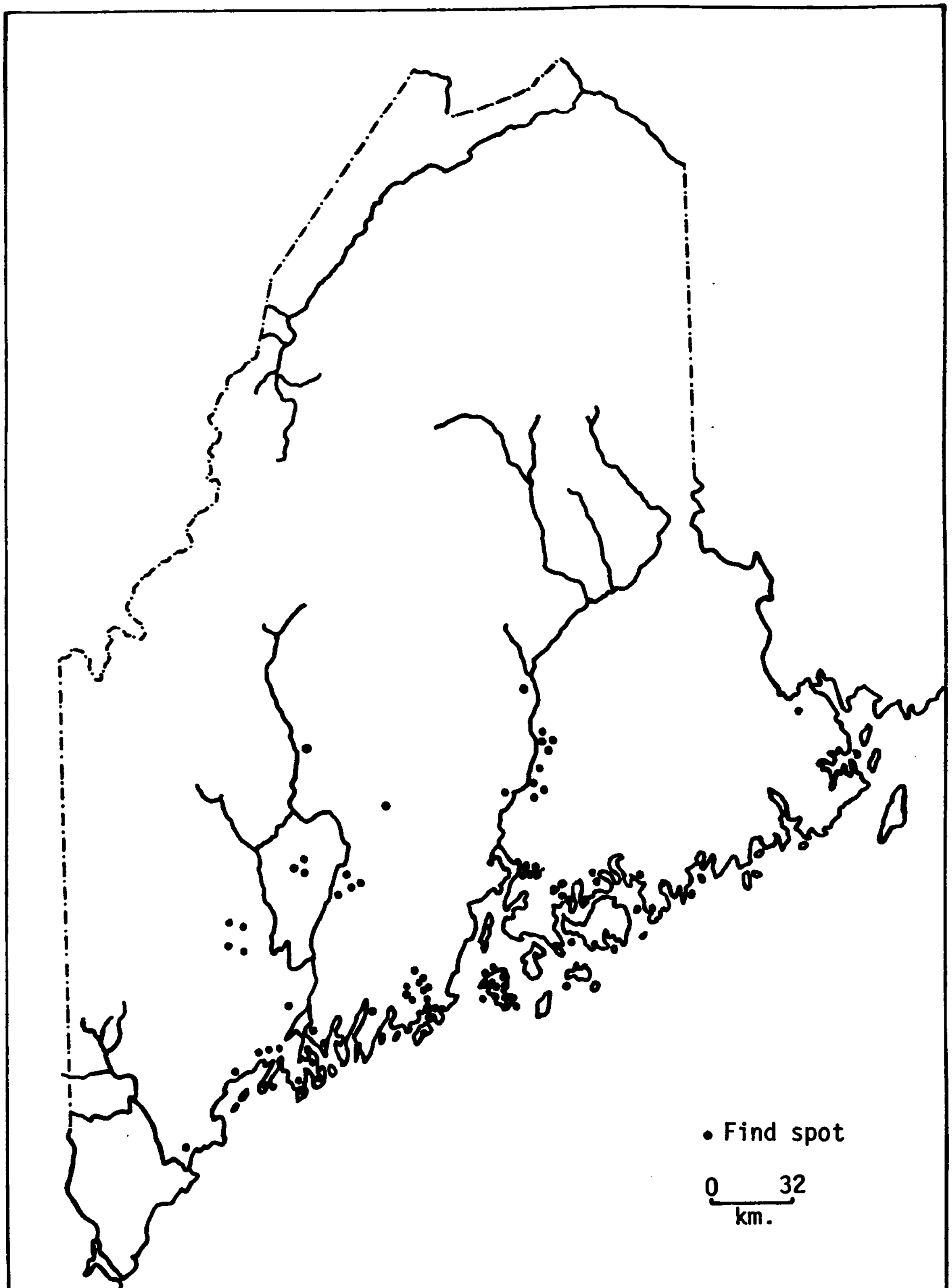


Fig. II-29: Distribution of known sites, Maine subarea, Late Archaic Period.

TABLE II-14: Tabulation of site data, Late Archaic Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: LATE ARCHAIC

Total sites:	115
Coastal sites:	20
Shell heaps:	13

SITES WITH MULTIPLE COMPONENTS: 27

Type of component evident:

Paleo-Indian:	
Early Archaic:	1
Middle Archaic:	2
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	26
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	3
Sites at 3-8%:	1
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:	1	NE:		E:	11	SE:	1	S:	1
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	9	Ocean:	
Small river:	25	Bay:	
Major river:	5	Harbor:	
Lake:	33	Sites inundated:	
Swamp:		Sites at confluences:	4
Salt marsh or estuary:			

LANDFORM TYPE:

Hill	1	Peninsula	1
Knoll	2	Terrace	1
Nick point	1	Esker	1
Ridge	2	Sandy Knoll	1
Island	1	Sandy soil	1
Bluff	2	Shingle beach	1

types of waterways; they occur both on the coast and inland. Snager (1973) has argued that their distribution cross-cuts various ecological zones. These cemeteries, however, never occur more than about 50 km (30 mi) from salt water, despite intense searches by Moorehead (1922), attempting to locate them further inland. Bourque (1975) has noted that many cemeteries have apparently contemporary habitation sites nearby and he believes that every cemetery may have had an associated habitation. This pattern suggests that the distribution of Moorehead complex cemeteries indeed may correlate with the distribution of groups exploiting the coast at least seasonally. The precise adaptations along the coast of Maine and New Brunswick, however, certainly must have varied with geography and ecology and none have been recorded west of the lower Kennebec drainage.

The other noteworthy mortuary complex of the Late Archaic Period in Maine, that associated with the Susquehanna tradition, apparently has not been found in specialized sites, but is found associated with habitation sites.

A better documented possibility (Bourque 1975) for additional site types lies in black earth middens. These middens, containing no shell, are reported from several coastal localities. One of them, the Goddard site, has been found to contain 70% seal bone, suggesting its function as a specialized seal hunting station; the faunal analysis suggests spring occupation. Other black earth middens have not been analyzed and it is unsafe to consider all of them to be seal hunting stations.

In summary, burgeoning population has greatly increased Late Archaic site density over that found in earlier periods. Both the coast and inland areas were used extensively. Coastal sites can be expected near shellfish beds and waterways giving access to the sea. These sites will range from large to small and contain shell in about half the cases. Inland sites are most common at waterfalls, rills, rapids, and narrows, where anadromous-fish exploitation would have been advantageous. These sites are usually relatively small, but they seem to occur near habitation sites. Other types of sites are hinted at, but cannot be characterized adequately with present information.

5.2.7 Woodland Period

Most students of the Woodland Period in Maine have seen it as one of little change, particularly in settlement and subsistence patterns. Bourque's (1973) sutdies have shown this picture to be not entirely accurate, and further refined studies no doubt will discover further differences in adaptations over time and space. There is, however, an essential comparability of Woodland Period cultures in Maine. This fact, coupled with the typical lack of differentiation between Early, Middle, and Late Woodland in site records, has resulted in the treatment of the Woodland Period as one category.

Figs. II-30 through II-33 show the locations of known Woodland sites in Maine and Tables II-15 through II-18 tabulate environmental characteristics. As these figures and tables show, these sites are predominantly coastal. If only Woodland sites are considered, 91% of the known sites are coastal; including sites of unknown period (Fig. II-34 and Table II-19), most of which are probably Woodland, 87% are coastal. These high percentages reflect several factors, including the strength of Woodland coastal adaptation, the areas where research has been directed, and the ease with which shell middens can be located.

The establishment of generalizations about coastal settlement patterns in Maine's Woodland Period is not a recent innovation. Mercer (1897) wrote:

> Notable facts in connection with the shell heaps are: that they invariably front the water to the south or east [and] that they lie conveniently near to clam-beds and water.

Moorehead (1922) elaborated:

> They are always near a good clam-flat, never upon a bold rocky shore. Often they occupy a long point, occasionally a sheltered cove, and sometimes they are just back from a straight shoreline. They are seldom located more than five meters above high tide. The surface has often been plowed and used for raising crops, as the buried shells make a wonderfully rich and productive soil.

These describtion, derived from impressions, will be improved upon only slightly by this report.

Clearly, shell middens will be located near good supplies of shellfish, but changing conditions (including historic alteration by human agencies) may have made a once productive area devoid of molluscs. For example, the locale of the Whaleback Shellheap in the Damariscotta Estuary has not supported oysters for several centuries, but the oyster production was so great at one time that it made possible the accumulation of what is probably the largest shell midden on the Altantic coast of North America (Snow 1972).

Clams (Mya arenaria) and oysters (Crassostrea virginica) were mainstays of the occupants of Woodland shell middens and Snow (1972) has argued that at least some of these sites were specialized stations for the collection of shellfish, much of which would be consumed elsewhere. Other shell middens with large quantities of bone may have been more general purpose sites (Bourque 1971). Under such circumstances, clam flats and oyster beds must have been prime factors in settlement location. Estuaries, lagoons, and salt ponds - sheltered areas with

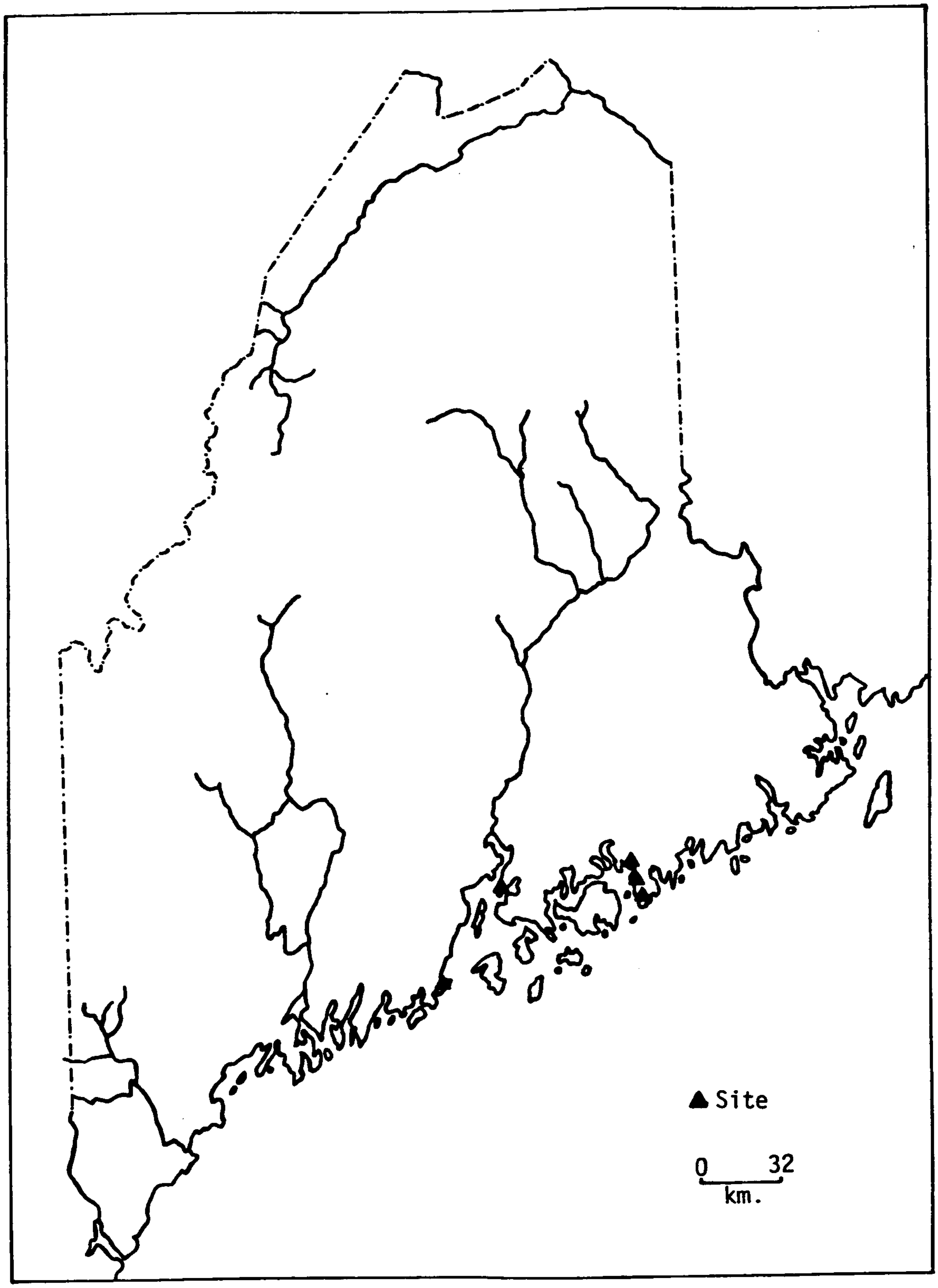


Fig. II-30: Distribution of known sites, Maine subarea, Early Woodland Period.

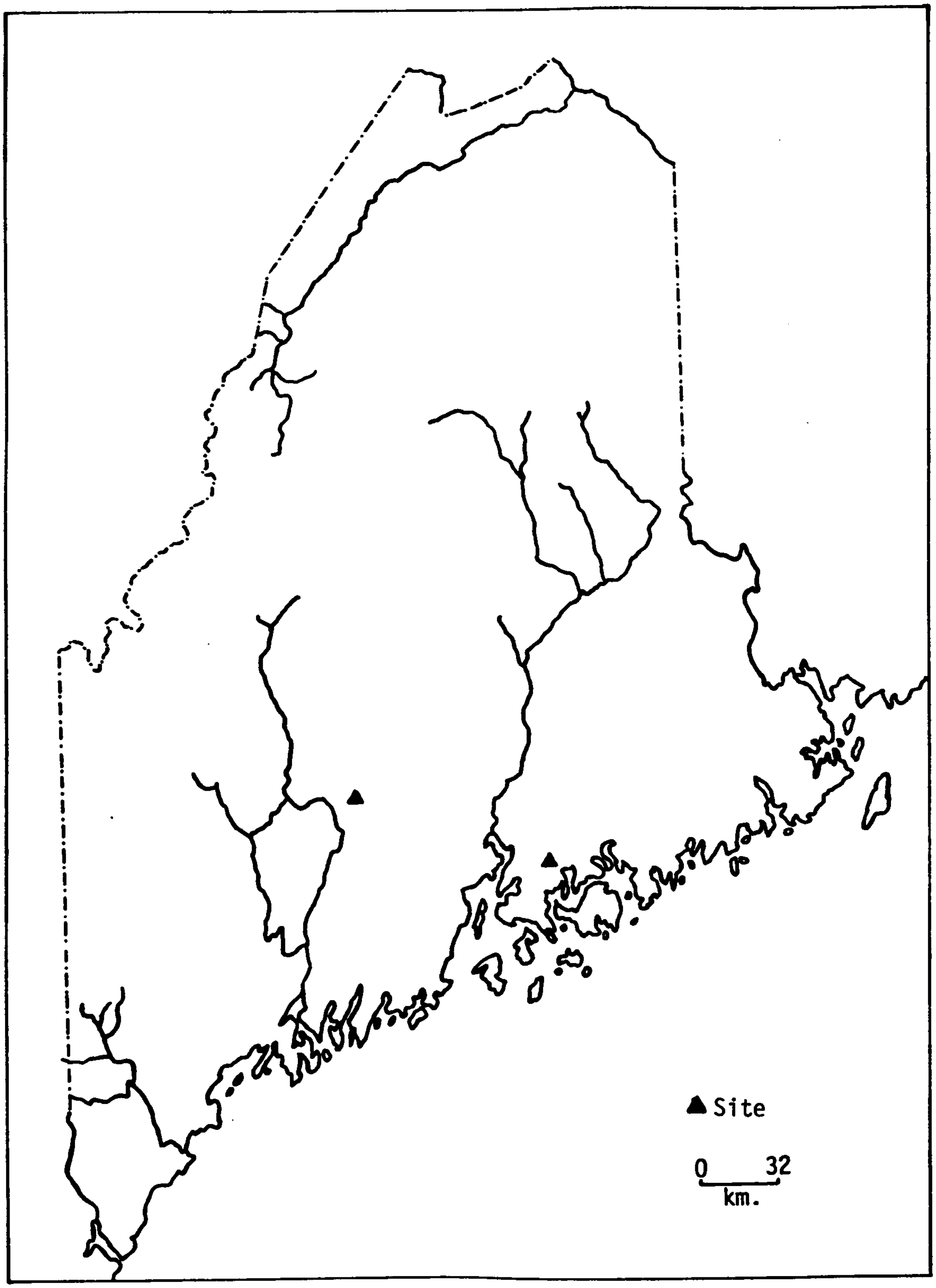


Fig. II-31: Distribution of known sites, Maine subarea, Middle Woodland Period.

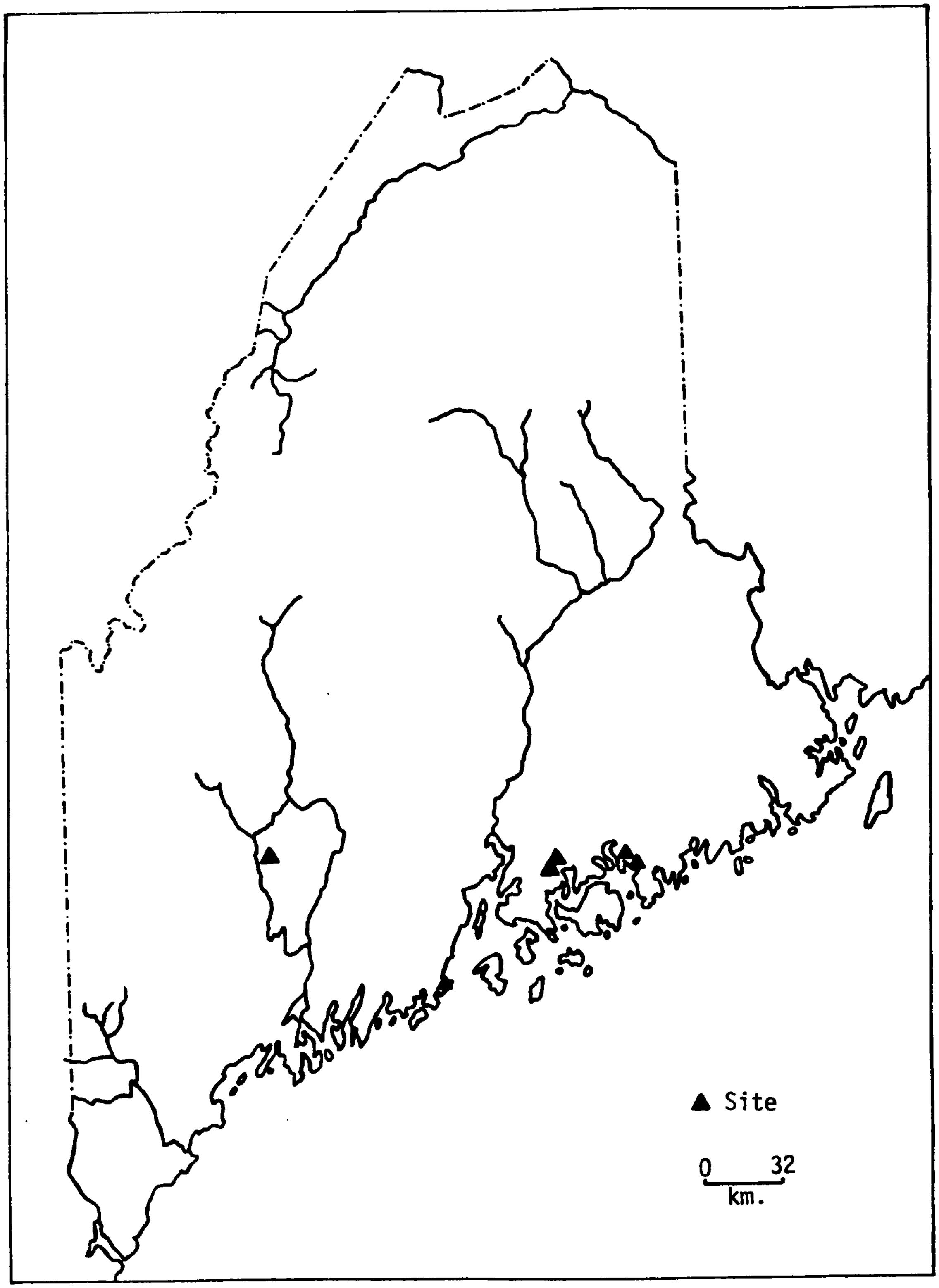


Fig. II-32: Distribution of known sites, Maine subarea, Late Woodland Period.

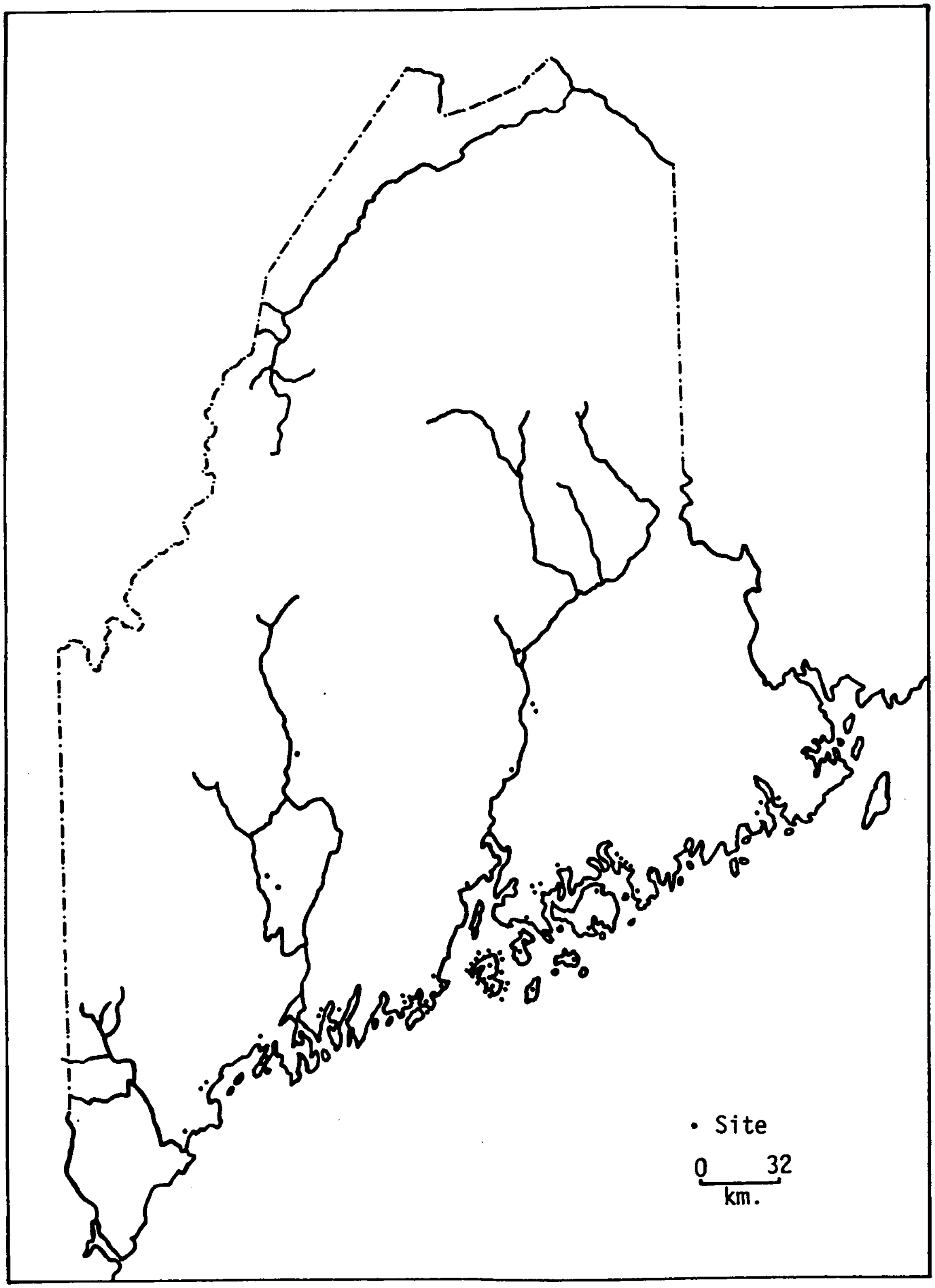


Fig. II-33: Distribution of known sites, Maine subarea, Woodland Period in general.

TABLE II-15: Tabulation of site data, Early Woodland Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: EARLY WOODLAND

Total sites:	2
Coastal sites:	2
Shell heaps:	2

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	1
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	1
SW:	4	W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	
Brook or stream:	
Small river:	
Major river:	
Lake:	
Swamp:	
Salt marsh or estuary:	
L. I. Sound:	
Ocean:	
Bay:	2
Harbor:	
Sites inundated:	
Sites at confluences:	

LANDFORM TYPE:

TABLE II-16: Tabulation of site data, Middle Woodland Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: MIDDLE WOODLAND

Total sites:	2
Coastal sites:	2
Shell heaps:	2

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	1
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	1
SW:	1	W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	
Brook or stream:	
Small river:	
Major river:	
Lake:	
Swamp:	
Salt marsh or estuary:	

L. I. Sound:	
Ocean:	
Bay:	
Harbor:	
Sites inundated:	
Sites at confluences:	

LANDFORM TYPE:

TABLE II-17: Tabulation of site data, Late Woodland Period, Maine subarea.

Site Data Tabulation Chart

PERIOD: LATE WOODLAND

Total sites:	6
Coastal sites:	6
Shell heaps:	4

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	1
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	1
SW:	4	W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:		Ocean:	
Small river:		Bay:	5
Major river:		Harbor:	
Lake:		Sites inundated:	
Swamp:		Sites at confluences:	
Salt marsh or estuary:			

LANDFORM TYPE:

TABLE II-18: Tabulation of site data, Woodland Period in general, Maine subarea.

Site Data Tabulation Chart

PERIOD: WOODLAND

Total sites:	121
Coastal sites:	50
Shell heaps:	57

SITES WITH MULTIPLE COMPONENTS: 34

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	1
Late Archaic:	33
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:	4	NE:	4	E:	7	SE:	30	S:	9
SW:	5	W:	3	NW:	2	OTHER:			

TYPE OF WATER SOURCE:

Spring:	1	L. I. Sound:	
Brook or stream:	9	Ocean:	
Small river:	14	Bay:	
Major river:	3	Harbor:	
Lake:	21	Sites inundated:	
Swamp:	58	Sites at confluences:	2
Salt marsh or estuary:			

LANDFORM TYPE:

Cove	1	Terrace	6
Nick point	1	Esker	1
Small peninsula	1	Shingle beach	1

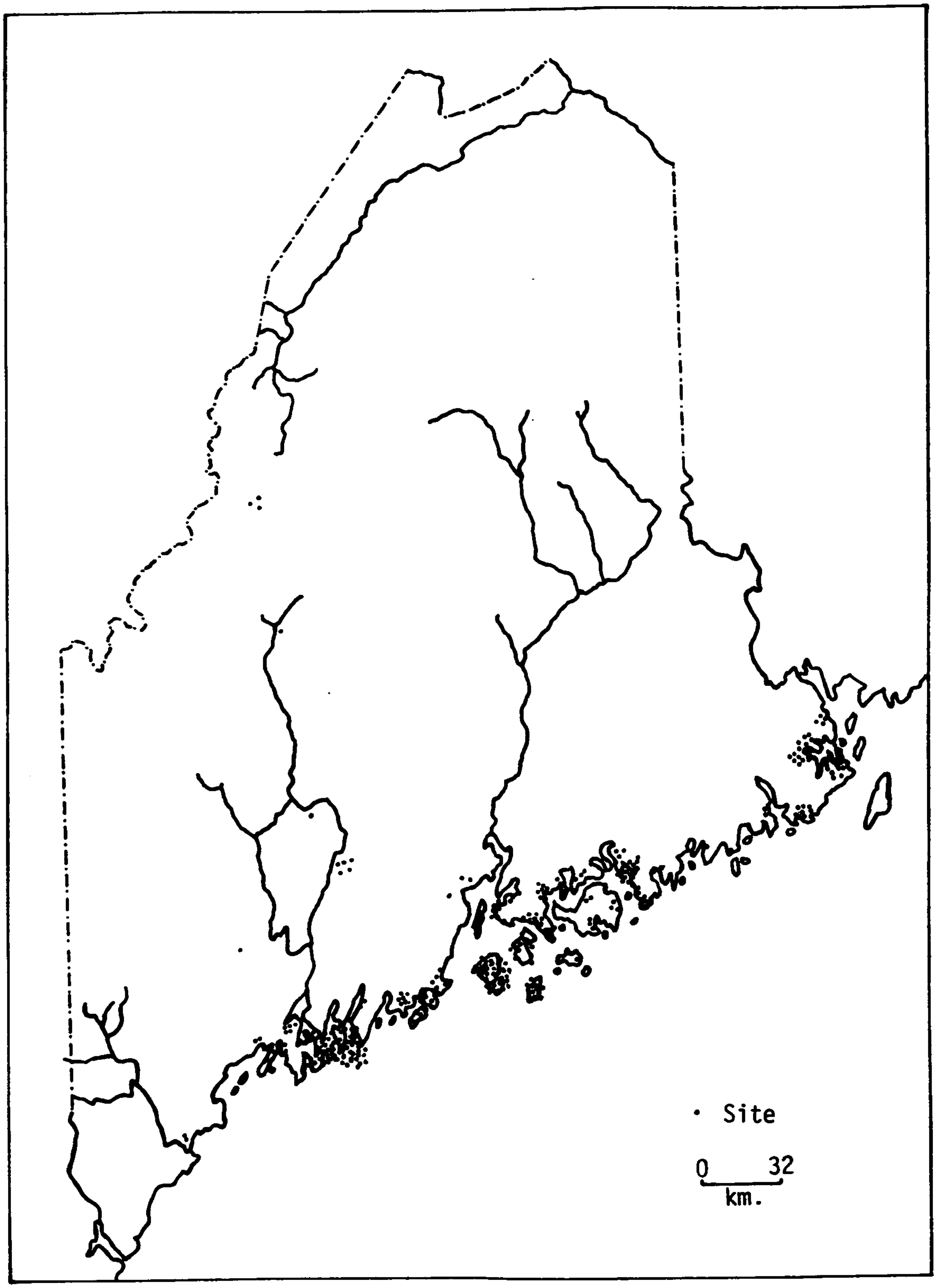


Fig. II-34: Distribution of known sites, Maine subarea, unknown period.

TABLE II-19: Tabulation of site data, unknown period, Maine subarea.

Site Data Tabulation Chart

PERIOD: UNKNOWN

Total sites:	459
Coastal sites:	358
Shell heaps:	337

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	8
Sites at 3-8%:	10
Sites at 8-15%:	22
Sites at 15-22%:	
Sites over 25%:	1

ASPECT:

N:	9	NE:	17	E:	4	SE:	121	S:	62
SW:	63	W:	22	NW:	25	OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	6	Ocean:	
Small river:	21	Bay:	
Major river:	2	Harbor:	
Lake:	14	Sites inundated:	
Swamp:	1	Sites at confluences:	1
Salt marsh or estuary:			

LANDFORM TYPE:

Island: 2

Terrace: 1

reduced salinities - are the habitats where these flats and beds are found in greatest profusion and these areas were the most favored site locations. The high energy shore of Maine will not support clams or oysters unless they are afforded shelter.

This study shows that coastal Woodland sites occur at low elevations, over 90% below five meters above mean high water. Their size can vary tremendously. In the York Estuary, Mercer (1897) reported shell middens ranging from 80 feet long by 20 feet wide, with a depth of 32 inches to two feet in diameter with a maximum depth of three inches. (The Whaleback Shellheap, mentioned above, was originally 347 ft long by 123 ft wide and 16 ft deep [Snow 1972].) Reliable size estimates are rarely available, but Mercer has provided data on all 11 of the undestroyed Woodland shell middens he located in the York Estuary. Providing the York Estuary is typical for Maine, these sites should give a reasonable estimate of the expectable size of coastal shell middens from the Woodland Period in Maine. These satistics appear in Table II-20. The ranges are great and standard deviations exceed the means, indicating that the variability is great, but that small middens are far more common than large ones. Bruce Bourque (personal communication) believes this range probably to be a bit low, partially because of coastal erosion.

Aspect, or direction toward which a site on a slope faces, predominantly is toward the south and east. Table II-21 presents data on aspect from the site inventory, using first Woodland sites, then Woodland sites and sites of unknown period (mostly Woodland). Clearly, southeast was the preferred orientation, with the three south-facing categories including 72.2% and 75.3% of the sites for which aspect was recorded. The possible reasons for this pattern include predominance of shellfish on north sides of rivers (resulting in nearby sites facing southward), an interest in maximizing sunlight, or accidental factors (such as systematic differential destruction of sites on north and south sides of watercourses). Although the overall trend of Maine's coastline faces southeast, its irregular shore creates ample opportunity for substantial settlement on slope facing other directions.

Bourque has determined that coastal occupation of a series of Woodland shell middens spanned late winter through early summer; where occupations were located at other seasons is unknown. Bourque (1971; 1973; personal communication) has been unable to find evidence of shell middens occupied later than 1150 A.D. at several locations along the Maine coast, indicating the probability that coastal shellfish exploitation diminished in importance after that date.

Knowledge of Woodland settlement patterns for sites other than shell middens is very sketchy. Black earth middens continue to be found from this period on, and the Late Woodland component at the Goodard site has produced abundant seal bone. As with the Late Archaic component, however, no parallel studies at similar sites have confirmed or refuted the

TABLE II-20. Size measures of shell middens in the York Estuary, Maine (calculated from data in Mercer 1897).

	Maximum Horizontal Dimension, Feet	Area, Square Feet	Thickness, Feet
Mean	19.45	306.82	0.68
Standard Deviation	21.79	459.52	0.74
Range	2 to 80	4 to 1,600	0.2 to 2.7

N=11

TABLE II-21. Site aspect, Maine subarea, Woodland period, by percentages.

	Sites of the Woodland Period	Sites of Woodland and Unknown Periods
Southeast	42.3	38.3
South	15.5	18.5
Southwest	14.1	18.5
(Sum of south categories)	(72.2)	(75.3)
West	4.2	6.3
Northwest	2.8	6.9
North	5.6	3.3
Northeast	5.6	5.3
East	9.9	2.8
TOTALS	100.0	99.9
	N=71	N=394

generality of that pattern. Inland sites during the Woodland Period continue to occur at prime fishing spots and the distribution on different types of waterways remains comparable to Late Archaic figures (Table II-18).

The only specialized ceremonial sites from the Woodland Period are the Early Woodland cemeteries, such as that at Bradley (W. B. Smith 1930). Virtually nothing is known of these sites, but what was said about Moorehead complex cemeteries is probably true for them: they can be expected near contemporary habitation sites, but not necessarily in locations with a specific combination of environmental attributes.

In summary, shell middens of the Woodland Period in Maine are expected at low elevations near protected shores or estuaries where shellfish would have flourished. They are most common southeast-facing slopes, but also occur on other generally south-facing slopes or rarely in north-, east-, or west-facing slopes. Shell-midden sizes vary greatly, but average about 20 ft across and 300 sq ft in area. Coastal sites are very common for the Woodland Period, but become rarer after about 1150 A.D. Inland sites continue to be situated at rills, falls, rapids, and narrows where fish runs can be exploited effectively. Other site types are known, both on the coast and inland, but not well enough to generalize about patterns. Specialized Early Woodland cemeteries occur, probably rarely, but cannot be linked with specific environmental characteristics.

5.2.8 Unknown Period

Fig. II-34 and Table II-19 locate and tabulate data on sites of unknown period. Unhappily, these sites comprise 66.1% of the 608 sites in the site inventory. Archaeologists active in Maine archaeology feel that most of these sites are of the Woodland Period (Bruce Bourque, personal communication; Arthur Spiess, personal communication) and the patterns are quite similar in terms of aspect, percentage coastal, and nearby water sources. These data have been included in the discussion of Woodland data and will receive no further attention here.

5.2.9 Discussion

Initially it was hoped that the data from the inventory could be used to obtain estimates of relative population, or at least site density, per period in Maine. The data, however, have proven totally inadequate to the task. The great percentage of sites of unknown period would make any such effort hazardous. With more than ten sites only in the Late Archaic and the entire Woodland Period, the effort would be ludicrous. It can be stated, however, that the failure to locate substantial numbers of Paleo-Indian, Early Archaic, and Middle Archaic sites, despite attempts, indicates a far lower site density in those periods in succeeding periods.

5.3 Southern New England Subarea

5.3.1 Paleo-Indian Period

Traditionally, archaeologists concerned with Paleo-Indian settlement patterns in southern New England and adjacent New York have seen exploitation of the tundra or tundra-like zone as the primary factor determining those patterns (Funk 1972, 1976; Ritchie 1965). They have been impressed that sites frequently occur on rises which have been interpreted as overlooks used to spot herd animals.

Curran and Dincauze (1977) offer a different notion, arguing that spruce parkland was the most important zone exploited by Paleo-Indians. This conclusion is based on the distribution of sites and find spots in the Connecticut Valley, where they tend to occurr on what once was the floor of glacial Lake Hitchcock. If the chronological and ecological reconstructions are accurate, these locales would have been within the spruce parkland zone at the time of occupation.

Fig. II-35 and Table II-22 present locations and tabulated data on Paleo-Indian sites and find spots in the Southern New England subarea. A total of 101 localities have been included, 31 of which are known to be sites and 70 of which are find spots. Data from Vermont and inland New Hampshire have been incorporated for this period only in order to increase the sample size.

The concentrations in the Middle Connecticut, Hudson, and Champlain Valleys are apparently the result of intensive research in those areas (Curran and Dincauze 1977; Funk 1976; Loring 1978), since the boundaries of the clusters are more-or-less aritrary and do not correspond with ecozones. For example, the clustering of sites to the east of Lake Champlain and corresponding dearth to the west reflects the fact that Loring (1978) studied only the eastern half of the drainage basin.

On the basis of the inventory, most Paleo-Indian sites and find spots in this subarea are located below the present 400-ft elevation contour. Of the 93 locations determinable, 55 (59.1%) are below 200 ft, 19 (20.4%) are between 200 and 400 ft, 11 (11.8%) are between 400 and 600 ft, and only eight (8.6%) are above 600 ft. This places about 80% of these sites physiographically on the Atlantic Coastal Plain.

Information on landform on which a site is located was usually absent and when described, was usually too impressionistic to be useful for comparison. There is, however, a tendency for sites to be found on landforms which rise above most of the local terrain; whether this tendency lies in settlement patterns or recording patterns, conditioned by an expectation of overlook sites, is unknown.

Table II-22 summarizes data on water bodies near Paleo-Indian sites, but requires additional comment. The categories used refer to modern watercourses, which often differ from watercourses in Paleo-Indian

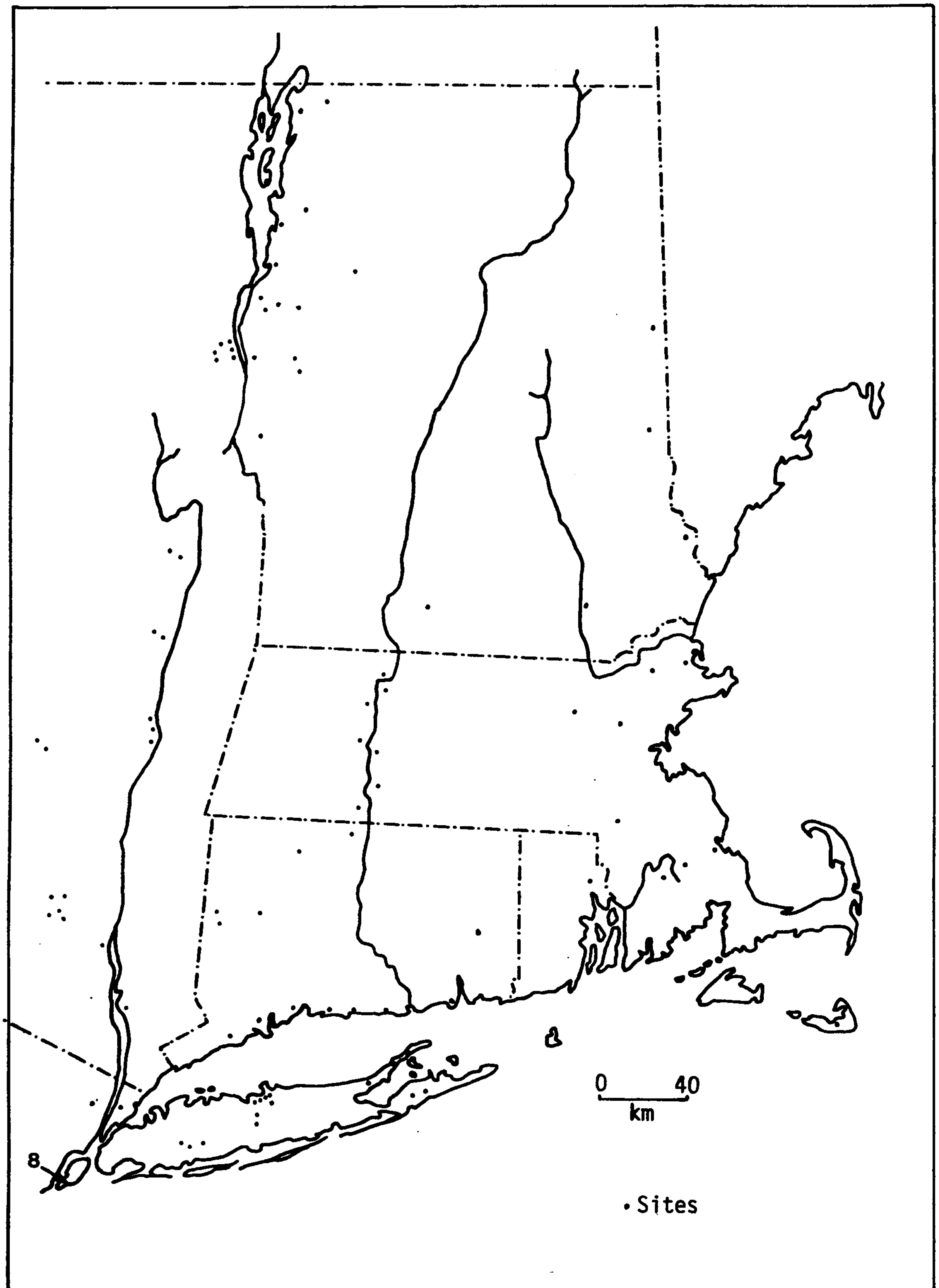


Fig. II-35: Distribution of known sites, southern New England subarea, Paleo-Indian Period.

TABLE II-22: Tabulation of site data, Paleo-Indian Period, southern New England subarea.

Site Data Tabulation Chart

PERIOD: PALEO- INDIAN

Total sites: 101
Coastal sites: 16
Shell heaps: ____

SITES WITH MULTIPLE COMPONENTS: 18

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	5
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	9
Sites at 3-8%:	1
Sites at 8-15%:	2
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N: ____ NE: ____ E: ____ SE: ____ S: ____
SW: ____ W: ____ NW: ____ OTHER: ____

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	50	Ocean:	
Small river:	44	Bay:	
Major river:	11	Harbor:	
Lake:	30	Sites inundated:	1
Swamp:		Sites at confluences:	13
Salt marsh or estuary:	1		

LANDFORM TYPE:

Terrace: 7	Flint ridge: 1
Drumlin: 1	Low rise: 1
Sand dune: 1	High hill: 1

times. None of the coastal sites was near the ocean at the time of occupation, only one of the lakeside sites (Dutchess Quarry Cave) seems to have been contemporary with a glacial lake, and water sources near the two sites presently without water nearby may have vanished in the intervening millennia. In only a few cases has the detailed work necessary to reconstruct a site's paleoenvironment been conducted.

It is clear, however, that settlement was directed more toward rivers and streams with relatively small flows (small river, brook or stream categories) than large flows (large river category). Of the 29 riverine sites, 24 (82.8%) are on small waterways and only five (17.2%) on large waterways. This pattern may result from several factors. First, the total length of small waterways is much greater than that of large rivers. Second, stream flow was augmented by large volumes of glacial melt water during this period, particularly when ocean levels were below the fall line on the Continental Shelf. These factors would have produced the same environmental effect as increased stream gradient (Donald Swift, personal communication), perhaps affecting aquatic resource density or distribution. Third, erosion and sedimentation in later periods was greatest in large river valleys and may have destroyed or hidden many sites which would have been easier to locate elsewhere.

Perhaps too much has been made of the small percentages of Paleo-Indian sites along large rivers, since similar percentages obtain for later periods. (See Tables II-23 through II-31.) The small area of major river valleys, relative to the area of valleys from smaller streams, in part dictates this relationship.

Size, function, and seasonality of Paleo-Indian sites in southern New England is poorly known. Faunal remains which might shed light on the latter two topics are rarely found and have even more rarely been analyzed. Size is very difficult to quantify. Number of artifacts is a poor criterion, since numbers can vary greatly with different site function, duration of site occupation, or technique of recovery during excavation. The areal extent of sites is a reasonable measure, but one which is rarely given the attention necessary to be reliable. Sites described as large have usually been excavated professionally while those described as small have usually been excavated by amateurs, suggesting that size estimations refer more to area excavated than area of the site. A further complication arises from sites with overlapping occupations, such as at the Bull Brook site. At that site, concentrations of artifacts seem to indicate dwellings, but it is unclear how many and which of these dwellings may have been occupied during a single occupation.

There are large sites, such as Debert (MacDonald 1968) and Bull Brook (Byers 1954), and small sites, such as Shepaug Valley (Moeller 1977) and Swanzey (Mary Lou Curran, personal communication). These different sized sites probably indicate a settlement pattern including different functions and community sizes during different seasons. Beyond this statement, few data are presently available.

In summary, Paleo-Indian sites in the southern New England subarea are usually found below the present 400-ft elevation contour. Often on landforms higher than surrounding terrain. Small rivers and streams were the most common nearby water, but settlement rarely was near large rivers or lakes. Various reconstructions suggest that tundra-like or spruce parkland environments were favored settlement zones. Precise inference about seasonality, site functions, and site size is not presently possible, but both large and small sites are known. (See the discussion of general Paleo-Indiana settlement factors for a discussion of data from the Champlain Valley and their significant for southern New England.

5.3.2 Early Archaic

Until recently, it was believed that settlement in the Northeast during Early and Middle Archaic times was very sparse, since the boreal forest believed to cover that region could support only low densities of food resources for humans (Fitting 1968; Funk 1972; Salwen 1975). Pollen analysis by M. B. Davis (1969a), using the absolute pollen count method, brought about a revision in our views of the boreal forest in the region, producing a sequence which went from spruce parkland in Paleo-Indian times to mixed conifer-hardwood forest in Early and Middle Archaic times. This latter forest type had a much greater potential for sustaining human life.

Dincauze and Mulholland (1977) have collected available data on Early and Middle Archaic sites in southern New England and have demonstrated that site densities were not so low as had been assumed. Funk (1977) has noted the same pattern for eastern New York.

The Dincauze and Mulholland study found a convincing correlation between percentage of oak pollen and site density during both the Early and Middle Archaic Periods, with the 20% oak isopoll as the approximate boundary between areas of scattered and those of denser settlement. They found that sites usually occurred on the most fertile lowland soils and proposed that many if not most Early and Middle Archaic sites were located on landforms no longer extant, having been covered by riverine sediments or having been located on the now-inundated Continental Shelf.

Funk (1977a) has hypothesized that Early Archaic populations in eastern New York oriented themselves primarily toward aquatic resources because of relative scarcity of terrestrial resources. He believes that Early and Middle Archaic populations stayed in New York year-round, rather than migrating several hundred miles into Pennsylvania during the cold months, as previously suggested (Ritchie and Funk 1971). These notions are entirely compatible with those of Dincauze and Mulholland.

Fig. II-36 and Table II-23 record locations and data for Early Archaic sites in the inventory compiled by this project. A total of 69 sites were recorded, of which 41 also had later occupations, chiefly in the Middle or Late Archaic Periods. This demonstrates a basic continuity of settlement pattern through the Archaic Period.

Fig. II-36 shows that Early Archaic sites are located primarily near the modern coast. The tabulation shows 14 coastal sites and six shell middens, although these sites would have been inland during Early Archaic times and the shell was deposited during later occupations. Two sites in Connecticut, Grannis Island and Ferry Road, presently are partially inundated. Since no areas which would have been coastal during the Early Archaic Period remain above sea level, the absence of coastal sites in the inventory does not imply the absence of an Early Archaic coastal adaptation.

Correlation of elevation with site distribution shows a preference for lowlands. Of 24 sites with data, 19 (79.2%) lie below 100 ft in elevation. This pattern probably indicates a preference for fertile lowland soils and the higher oak percentage supported by them during this period.

The patterns of proximity to water sources are similar to those for the Paleo-Indian Period: strong preference for small rivers and streams and limited settlement near large rivers or lakes. Tabulations for salt-water sources refer to present water sources and are inapplicable in this period.

Very little information on site size for this period is available. Ritchie and Funk (1971) note both "tiny camps" and "slightly larger" camps from New York, but no extensive sites have been reported. In southern New England, few sites have been excavated and no quantified size estimates are possible, but sites are probably small.

What may be the beginnings of the development of more rigidly defined territoriality than that found in earlier times may be evidenced by concentrations of Early Archaic sites, such as the six sites reported by Taylor (1976) for a portion of the Taunton Valley, Massachusetts. More precise suggestions regarding the significance of these site clusters cannot presently be supported by data.

In summary, the Early Archaic Period did not see a depopulation of the southern New England subarea. Instead, it saw exploitation of lowland zones with elevations predominantly below 100 ft above present sea level and with fertile soils. Settlement appears to have been linked largely to zones with significant (20% pollen) percentages of oaks. Small rivers were the preferred water source. Most sites appear to be small, but some are tightly clustered.

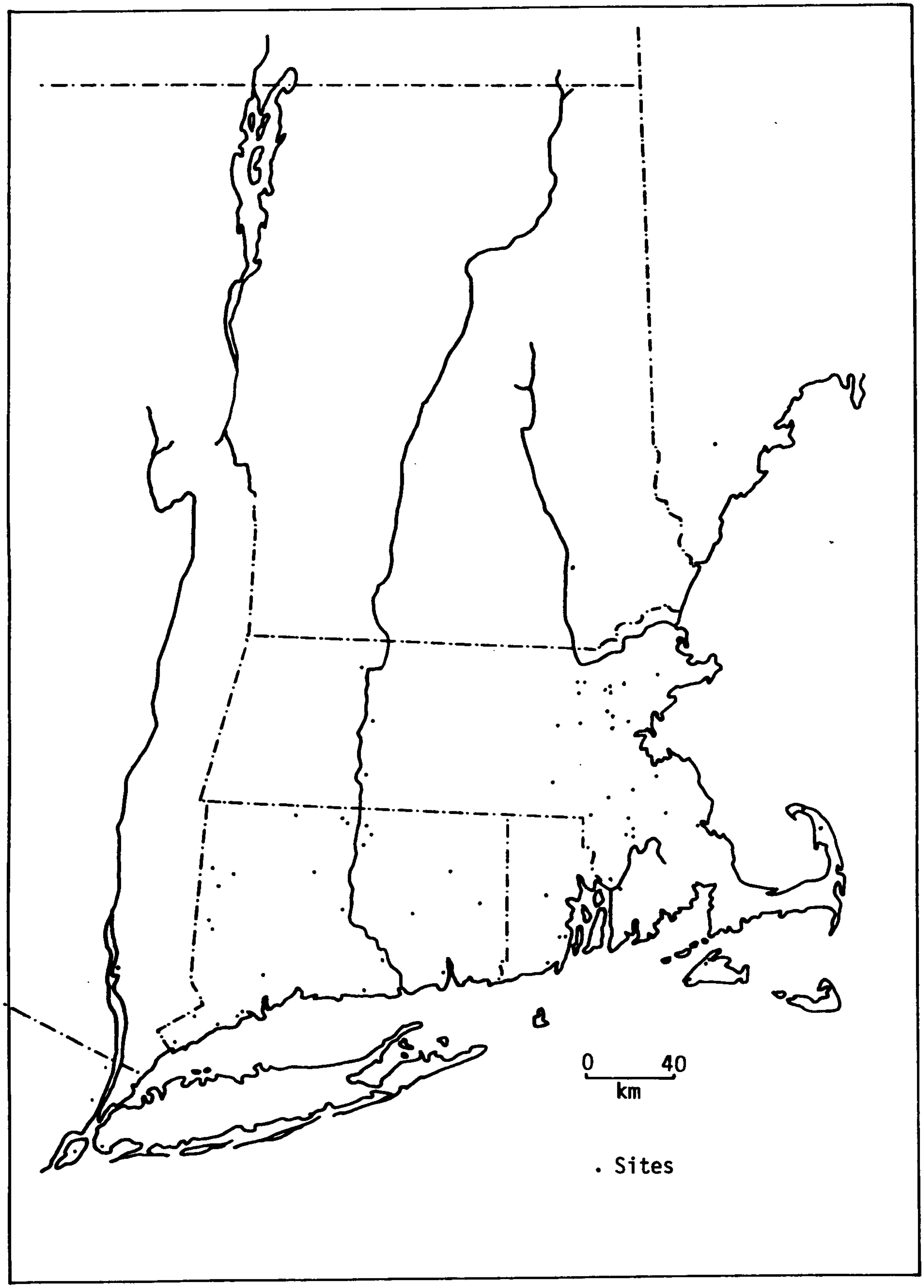


Fig. II-36: Distribution of known sites, southern New England subarea, Early Archaic Period.

TABLE II-23: Tabulation of site data, Early Archaic Period, southern New England subarea.

Site Data Tabulation Chart

PERIOD: EARLY ARCHAIC

Total sites:	52
Coastal sites:	5
Shell heaps:	0

SITES WITH MULTIPLE COMPONENTS: 41

Type of component evident:

Paleo-Indian:	4
Early Archaic:	
Middle Archaic:	36
Late Archaic:	40
Early Woodland:	23
Middle Woodland:	19
Late Woodland:	26
Unspecified Woodland:	5
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	7
Well drained steeper slope:	2
Areas subjected to flooding:	1
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	5
Sites at 3-8%:	8
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:	1	S:	1
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	1
Brook or stream:	5
Small river:	13
Major river:	11
Lake:	8
Swamp:	1
Salt marsh or estuary:	
L. I. Sound:	
Ocean:	
Bay:	3
Harbor:	1
Sites inundated:	2
Sites at confluences:	13

LANDFORM TYPE:

Low sandy shore:	1
Morains:	3
Kame terrace:	1
Ridge:	2
Outwash plain:	2
Flood plain:	1
Hill:	1
Bluff:	2

5.3.3 Middle Archaic Period

In terms of settlement, the Middle Archaic Period is basically a continuation and extension of the Early Archaic Period. Dincauze and Mulholland (1977) have found an increase in site density, with densest settlement still found within the 20% oak isopoll, which has shifted inland and toward the north. Otherwise, site locations remain much the same as earlier.

Fig. II-37 and Table II-24 present locations and data on site inventory for sites of this period. Of 131 sites analyzed, 117 (89.3%) were multicomponent, indicating continuity in settlement in these habitats.

The percentage of coastal sites (30.5%) is higher than it was in earlier periods, probably in part because the rising relative sea level was bringing about a closer congruence between the shoreline of 6000 B.P. (the end of this period) and that of today. Sites were being squeezed into smaller areas.

Still, most truly coastal environments of the Middle Archaic Period are now inundated. The lower Hudson Valley is an exception and there the fjord-like basin has resulted in the preservation of Middle Archaic oyster-shell middens (Brennan 1974). Ten of the 11 shell middens recorded in the inventory are from this region; the remaining shell midden is composed of fresh-water mollusc shells and lies inland. This estuarine exploitation during Middle Archaic times is the earliest direct evidence of human exploitation of salt-water resources in the southern New England subarea and well may be but the tip of an iceberg, the remainder of which lies submerged beneath the sea.

Middle Archaic sites occur predominantly in lowland areas. Only 14 sites (10.7%) are recorded at elevations greater than 100 ft above modern sea level.

Several other generalizations about settlement will be consistent at all later time periods, as well. Slopes of 0 to 8% were preferred (45 of 53 sites, 84.9%), as were locally high ground (27 of 38 sites, 71.1%) well-drained soils (24 of 36 sites, 66.7%). The distribution of sites near different types of water resources remains consistent with the preceding Early Archaic Period and all succeeding periods.

Functional variation becomes obvious in this period. The shell middens of the lower Hudson Valley were occupied at least largely for the purpose of shellfish exploitation and they appear to have been specialized stations to that end. On the other hand, the Neville (Dincauze 1976), WMECO (P. Thomas 1976a), and Buswell (Barber 1979a) sites apparently are anadromous-fish-exploitation stations. While fuanal remains indicating such fishing have been identified only from the Buswell site, chemical testing and site location make it possible to argue strongly that the other sites were similarly specialized. The sites are situated at falls, rapids, and a narrow channel around an island, all excellent

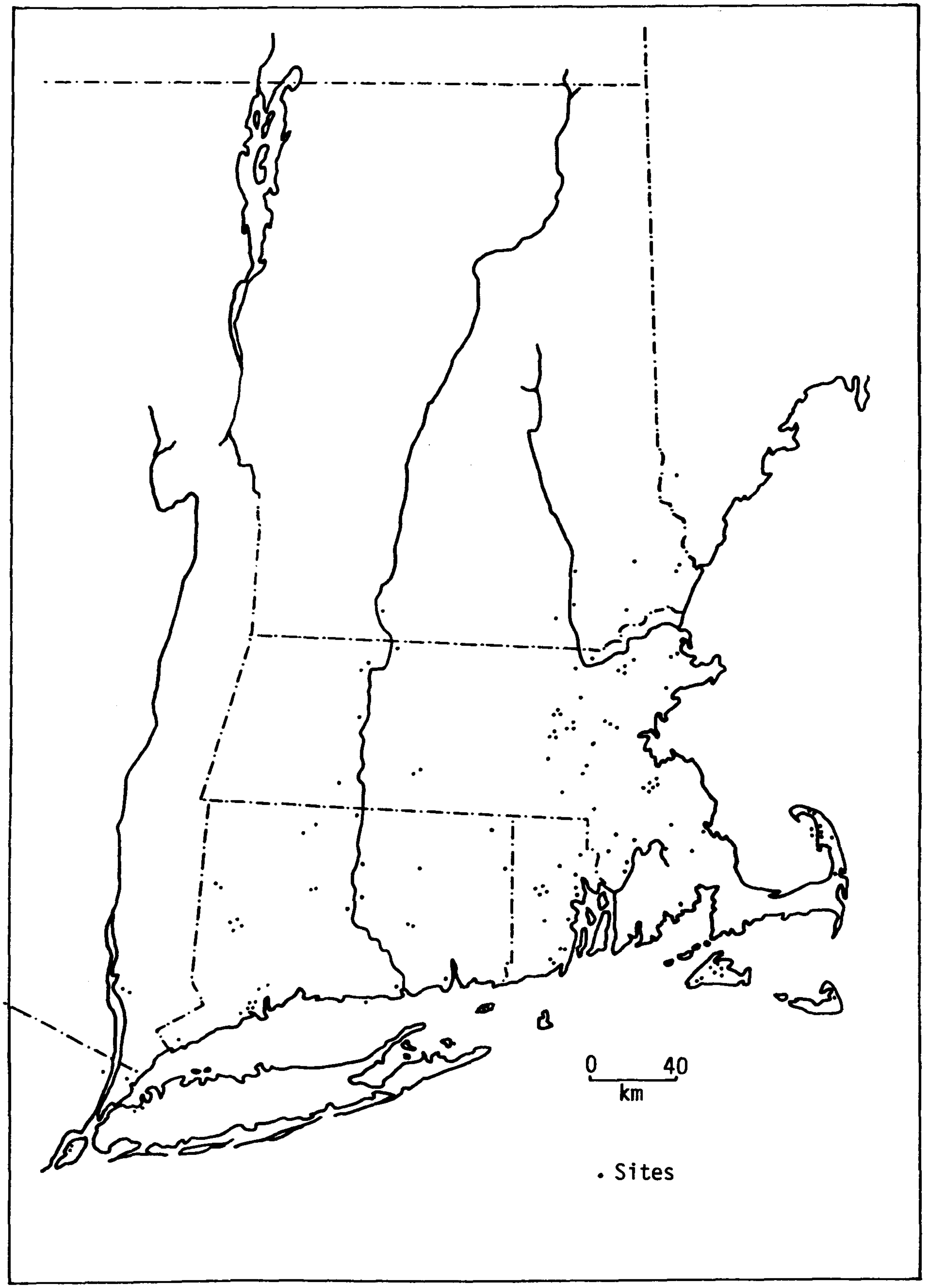


Fig. II-37: Distribution of known sites, southern New England subarea, Middle Archaic Period.

TABLE II-24: Tabulation of site data, Middle Archaic Period, southern New England subarea.

PERIOD: MIDDLE ARCHAIC

Total sites:	140
Coastal sites:	40
Shell heaps:	11

SITES WITH MULTIPLE COMPONENTS: 117

Type of component evident:

Paleo-Indian:	4
Early Archaic:	35
Middle Archaic:	
Late Archaic:	
Early Woodland:	43
Middle Woodland:	45
Late Woodland:	60
Unspecified Woodland:	24
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	24
Well drained steeper slope:	10
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	2

SLOPE:

Sites at 0-3%:	16
Sites at 3-8%:	29
Sites at 8-15%:	8
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:	2	S:	1
SW:	2	W:	2	NW:		OTHER:	ESE =2 WSW =1		

TYPE OF WATER SOURCE:

Spring:	9	L. I. Sound:	
Brook or stream:	46	Ocean:	
Small river:	46	Bay:	8
Major river:	7	Harbor:	1
Lake:	17	Sites inundated:	3
Swamp:	13	Sites at confluences:	19
Salt marsh or estuary:	9		

LANDFORM TYPE:

Falls:	2	Sand dune:	3
Low sandy shore:	2	Island:	1
Low slope:	3	Knoll:	2
Sandy knoll:	2	Esker:	1
Moraine:	4	Kame terrace:	1
Ridge:	3	Bluff:	3
Outwash plain:	3	Drumlin:	1
Terrace:	4	Till:	1

locations for the capture of large quantities of migrating fish. On the basis of site locations and the sites' available resources, Dincauze and Mulholland (1977) have argued that other sites were for winter fishing, spring and fall migratory-bird hunting, and upland hunting. Known and expected site sizes are quite variable, ranging from small upland camps to extensive shell middens.

Dincauze and Mulholland (1977) argue that the clustering of Middle Archaic sites of dissimilar sizes and apparent functions indicates the development or intensification of territoriality.

In summary, Middle Archaic Indians exploited both coastal and interior resources, utilizing various special purpose sites, including shell middens, anadromous-fishing stations, and upland camps. The documented use of the upland zone is slight, although this may be because less research has been conducted there. In this period, it is possible to see clearly several factors which will characterize the locations of Middle Archaic and later sites: well drained soil, level or nearly level ground surface (less than 8% slope), situation on locally high ground, and proximity (in descending frequency of occurrence) to small rivers or streams, lakes, swamps, large rivers, or other water sources.

5.3.4 Late Archaic Period

The Late Archaic Period in the southern New England subarea appears to have been one of population increase and expansion into or intensified exploitation of ecozones previously little used. In particular, coastal and upland zones show increased site densities during this period.

Fig. II-38 and Table II-25 summarize data on Late Archaic sites and each demonstrates the increased number of coastal sites. Of 403 sites, 112 (27.8%) are coastal, including more than 15 shell middens. In part, this increase may be because of a slackening rate of relative sea-level rise as shorelines became more like modern shorelines, resulting in fewer inundated sites than for earlier periods. It also may reflect increasing use of coastal resources. The low numbers recorded under water source types for salt water sources reflect gaps in existing records.

Dincauze (1973b) has correlated Late Archaic (and Woodland) settlement with locations of estuaries shifting upriver in response to rising relative sea levels.

The upland zone also was utilized extensively in the Late Archaic Period. In sharp contrast to low Early and Middle Archaic figures, 67 (16.6%) Late Archaic sites were located in the upland zone, including clusters such as that in central Connecticut. This percentage is notable since little research has been directed toward these upland areas.

Several site types can be inferred for the Late Archaic Period. Shell middens and estuarine fishing camps were located for exploitation of

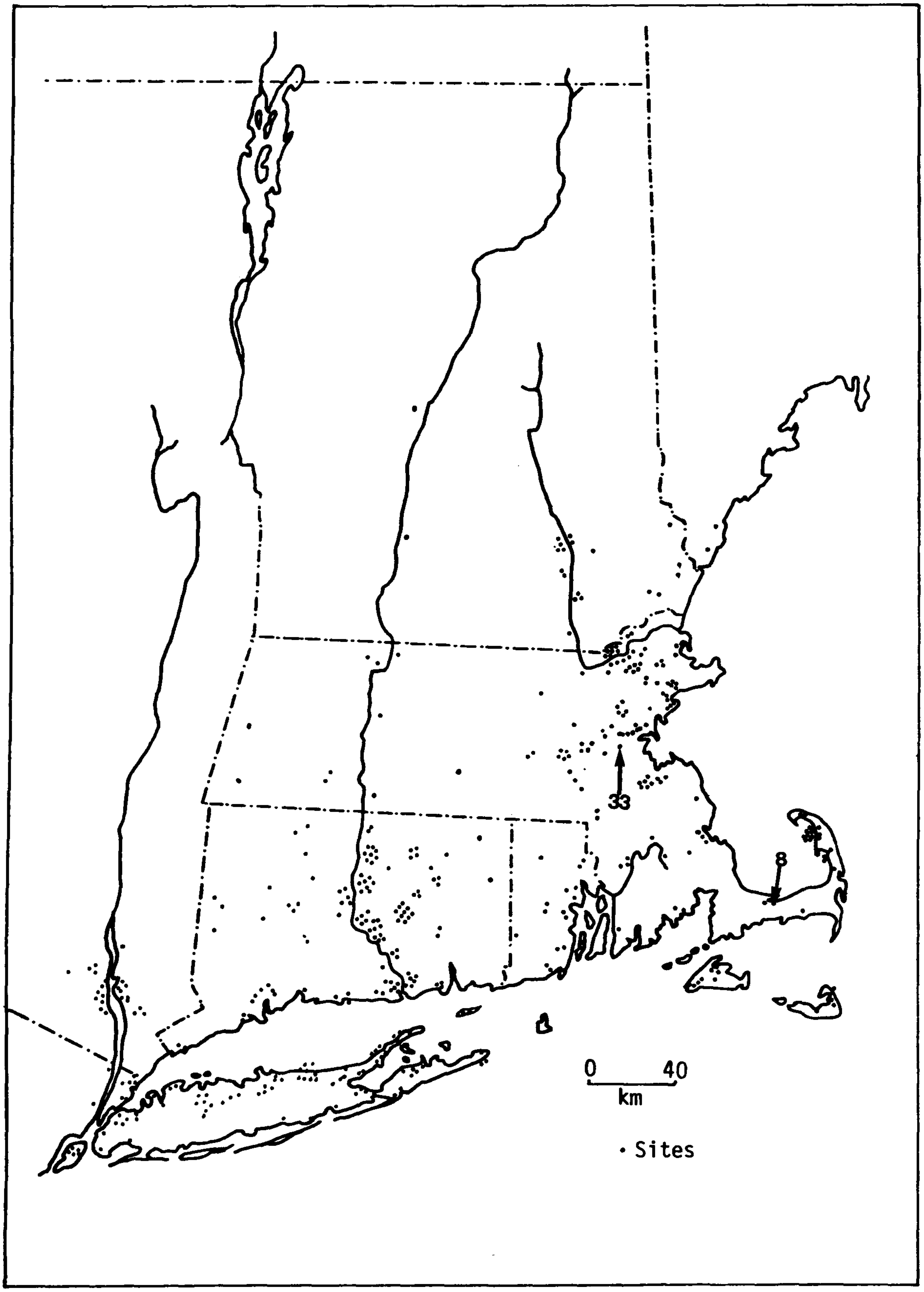


Fig. II-38: Distribution of known sites, southern New England subarea, Late Archaic Period.

TABLE II-25: Tabulation of site data, Late Archaic Period, southern New England subarea.

PERIOD: LATE ARCHAIC

Total sites:	641
Coastal sites:	111
Shell heaps:	43

SITES WITH MULTIPLE COMPONENTS: 257

Type of component evident:

Paleo-Indian:	6
Early Archaic:	37
Middle Archaic:	116
Late Archaic:	
Early Woodland:	76
Middle Woodland:	74
Late Woodland:	114
Unspecified Woodland:	6
Period Unknown:	22

SOILS CHARACTERISTICS:

Well drained level to slight slope:	108
Well drained steeper slope:	37
Areas subjected to flooding:	1
Bedrock close to surface:	2
Made land:	7

SLOPE:

Sites at 0-3%:	31
Sites at 3-8%:	106
Sites at 8-15%:	29
Sites at 15-22%:	8
Sites over 25%:	2

ASPECT:

N:	2	NE:		E:	1	SE:	3	S:	2
SW:	3	W:	5	NW:	1	OTHER:	ESE:2 WSW:2		

TYPE OF WATER SOURCE:

Spring:	18	L. I. Sound:	6
Brook or stream:	132	Ocean:	2
Small river:	130	Bay:	11
Major river:	28	Harbor:	3
Lake:	50	Sites inundated:	11
Swamp:	26	Sites at confluences:	52
Salt marsh or estuary:	24		

LANDFORM TYPE:

Saddleback ridge with sharp glacial hill: 1
Low river bank: 1
40' sandy glacila mound: 1
Water deposited ridge: 2
Tongue of land: 1
Hill- gravelly: 1
Sandy plain: 5
Sheltered lowland: 1
Gravel bank: 1
High gravel knolls: 1
Hill: 3
High ground: 1
Slight rise: 1
Knoll: 9
Plateau: 6
Beach: 1
Till: 1
Sand dune: 2
Kame terrace: 1
Island: 3
Bluff: 6
Low sandy shore: 2
Low slope: 3
Low shelf: 1
First terrace: 1
Second terrace: 4
Third river terrace: 1
Gravel knoll: 1
Sandy hill: 4
Outwash: 4
Sandy ridge: 2
Moraine: 4
Ridge: 4
Terrace: 6

salt-water resources. These fishing camps, in some cases, were located near fish weirs (Johnson 1942, 1949). Small upland camps (Dincauze 1974), small lowland camps (Barber 1976b), large lowland villages (Robbins 1968), and a variety of other site types occur in a wide variety of environments. The description of landform type in Table II-25 gives some idea of the variety of environments utilized.

The seasonality of these various site types is poorly known. Estuarine and other fishing camps for the exploitation of anadromous fish are assumed to have been used in spring when most runs occur. Dincauze (1971b, 1974) has suggested that both lowland villages with satellite camps and small upland camps were utilized in winter, but data to test this suggestion are unavailable.

Size of sites is imprecisely known. Shell middens can range from very small (most commonly) to many acres (as at Pipestave Hollow - R. Michael Gramly, personal communication). Fishing camps are usually small, as are upland camps. Rare village sites are moderately large.

Despite the diversity of cultural traditions during the Late Archaic Period in southern New England, research to date has been unable to differentiate those traditions in terms of settlement pattern (Dincauze 1974, 1975b). Recent research (DuPuis 1979) has delineated some potentially frutiful avenues of research, but has been unable to derive statistically significant correlations between tradition and site-location attributes.

In southern New England during the latter portion of the Late Archaic Period, the people of the Susquehanna tradition utilized specialized cemetery sites. These cemeteries, sometimes quite large, include cremations (of human and animal remains) and specialized, apparently ceremonial features. With the remains of the dead are found red ochre and a variety of distinctive artifacts. Dincauze (1968) has dealt with these cemeteries in terms of description, chronology, and interpretation. Cemeteries of the Susquehanna tradition occur most frequently on the coastal lowland and in major river valleys in the southern portion of this subarea.

In summary, occupants of southern New England during the Late Archaic Period increased their population significantly and expanded into previously unused or less used zones. The coastal zone was intensively occupied and the upland zone was utilized, intensively in some areas. Site types and sizes were highly variable, including moderately large villages, small camps, fish weirs, and shell middens. Estuarine settlement may have shifted with sea level changes.

5.3.5 <u>Woodland Period</u>

In southern New England, as in Maine, a large percentage of Woodland sites are undated. Consequently, 35.7% (175 of 490) of the southern New England sites must be placed in an unspecified Woodland category.

Accordingly, it seems preferable to discuss the Woodland Period as a unit with more particular treatment of its subdivisions where possible, rather than divorcing over one-third of the data from more specific discussions.

There is a fall-off of site density with the Early Woodland Period, viewed by some researchers as precipitous (Dincauze 1974; Mulholland no date). At the same time, there is a strong shift of settlement toward lower elevations and away from the uplands. Fig. II-39 and Table II-26 document this shift. Of 83 sites, 51 (61.4%) are coastal; only eight (15.7%) lie higher than 200 ft above present sea level. Braun (1974) has documented the increase in Early Woodland shell middens. In the Middle Woodland Period, settlement patterns remain similar. (See Fig. II-40 and Table II-27). Sixty-three of 89 sites (70.8%) are coastal; only 11 (12.4%) lie higher than 20 ft above modern sea level.

In the Late Woodland Period, the pattern has shifted somewhat. (See Fig. II-41 and Table II-28.) Site density has increased significantly and 143 sites are recorded. The percentage of coastal sites has dropped slightly to 61.5% (88 of 143 sites) and the upland percentage has climbed to 21.7% (31 of 143 sites) above the 20-ft elevation. Barber (1979b) has found a marked drop in coastal sites in the Merrimack Valley after about 1150 A.D., as has Bourque (1971, 1973) in Maine, suggesting that the Late Woodland coastal adaptation may have been growing less important. Contrary evidence, however, comes from the Boston Basin, where coastal sites show no decline in numbers during the Late Woodland Period (Dincauze 1974).

There are 490 Woodland sites in the inventory, summing the sites in the three subdivisions and those with insufficient data to be placed in and of the subdivisions. Of these sites, 91 (18.6%) are located above the 200-ft contour and 304 (62.0%) are coastal (Fig. II-42 and Table 29).

The generalizations outlined above regarding Woodland shell middens in Maine hold equally well in southern New England. Shell middens are found in estuaries, lagoons, or coves where the molluscs would have received some protection from storms. Elevations tend to be low, apparently in order to minimize the effort of carrying shellfish. Aspect has not been recorded systematically in site records for this subarea, but experience in coastal Massachusetts at least has revealed no consistent pattern.

Dincauze's (1973) study of estuarine settlements in the Charles Valley, Massachusetts has found a correlation between estuary head (the border between salinity intrusion and fresh water) and settlement in Woodland times. In the Merrimack Valley, Barber (1979b) found limited support for a similar pattern. The latter research has found environmental features assisting in anadromous fish capture to correlate well with Woodland settlement in the upper reaches of the estuary.

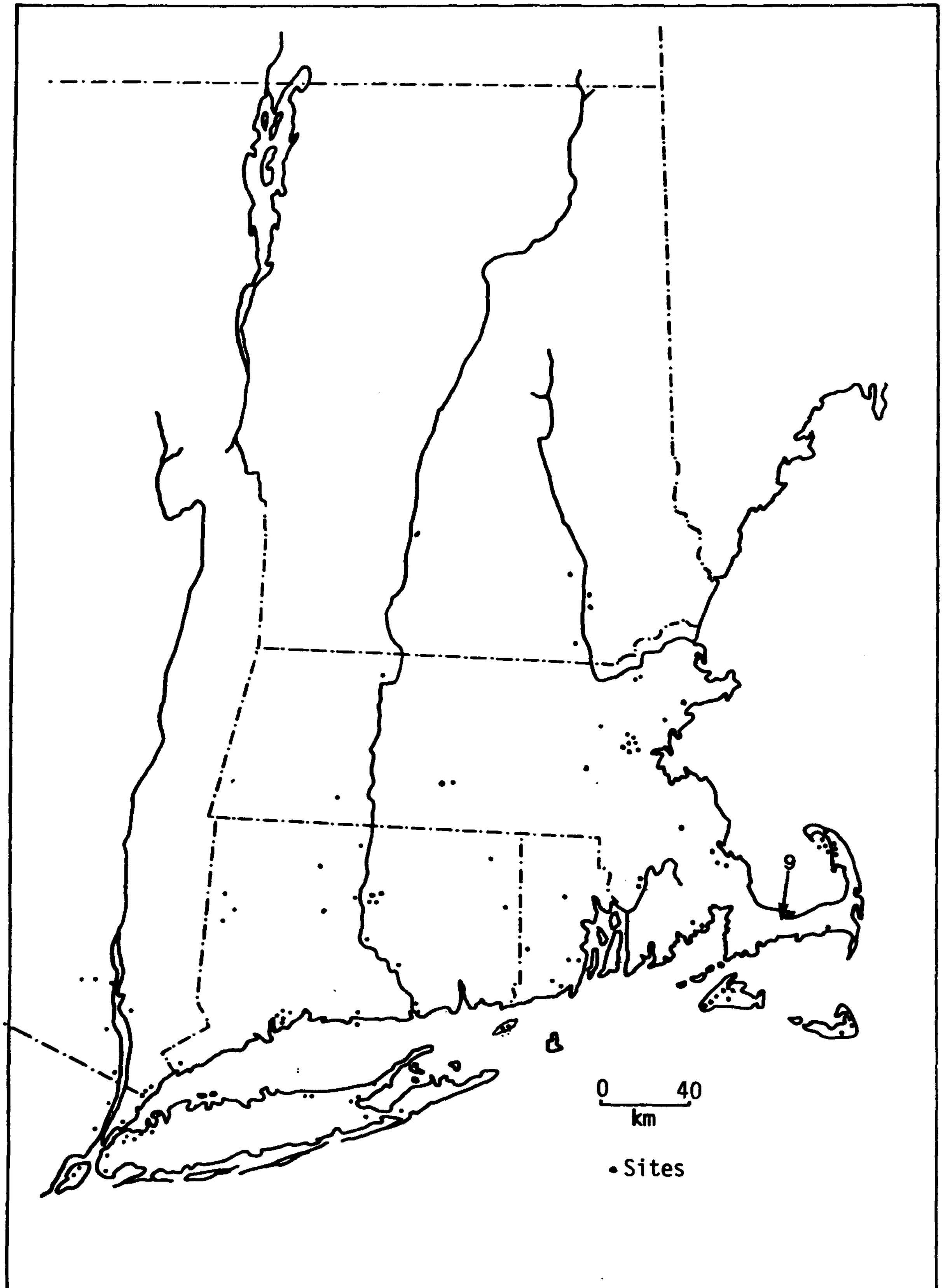


Fig. II-39: Distribution of known sites, southern New England subarea, Early Woodland Period.

TABLE II-26: Tabulation of site data, Early Woodland Period, southern New England subarea.

PERIOD: EARLY WOODLAND

Total sites:	111
Coastal sites:	14
Shell heaps:	6

SITES WITH MULTIPLE COMPONENTS: 79

Type of component evident:

Paleo-Indian:	3
Early Archaic:	26
Middle Archaic:	51
Late Archaic:	74
Early Woodland:	
Middle Woodland:	43
Late Woodland:	61
Unspecified Woodland:	4
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	6
Well drained steeper slope:	3
Areas subjected to flooding:	
Bedrock close to surface:	1
Made land:	

SLOPE:

Sites at 0-3%:	10
Sites at 3-8%:	12
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:	2	S:	1
SW:	2	W:	3	NW:	1	OTHER:			

TYPE OF WATER SOURCE:

Spring:	10	L. I. Sound:	2
Brook or stream:	28	Ocean:	1
Small river:	29	Bay:	6
Major river:	10	Harbor:	2
Lake:	10	Sites inundated:	3
Swamp:	5	Sites at confluences:	14
Salt marsh or estuary:	11		

LANDFORM TYPE:

Low sandy slope: 2	Sand dune: 2
Low slope: 1	Bluff: 3
Sandy knoll: 2	Beach: 1
Moraine: 4	First terrace: 1
Ridge: 3	Second terrace: 1
Outwash: 3	Drumlin: 1
Terrace: 5	

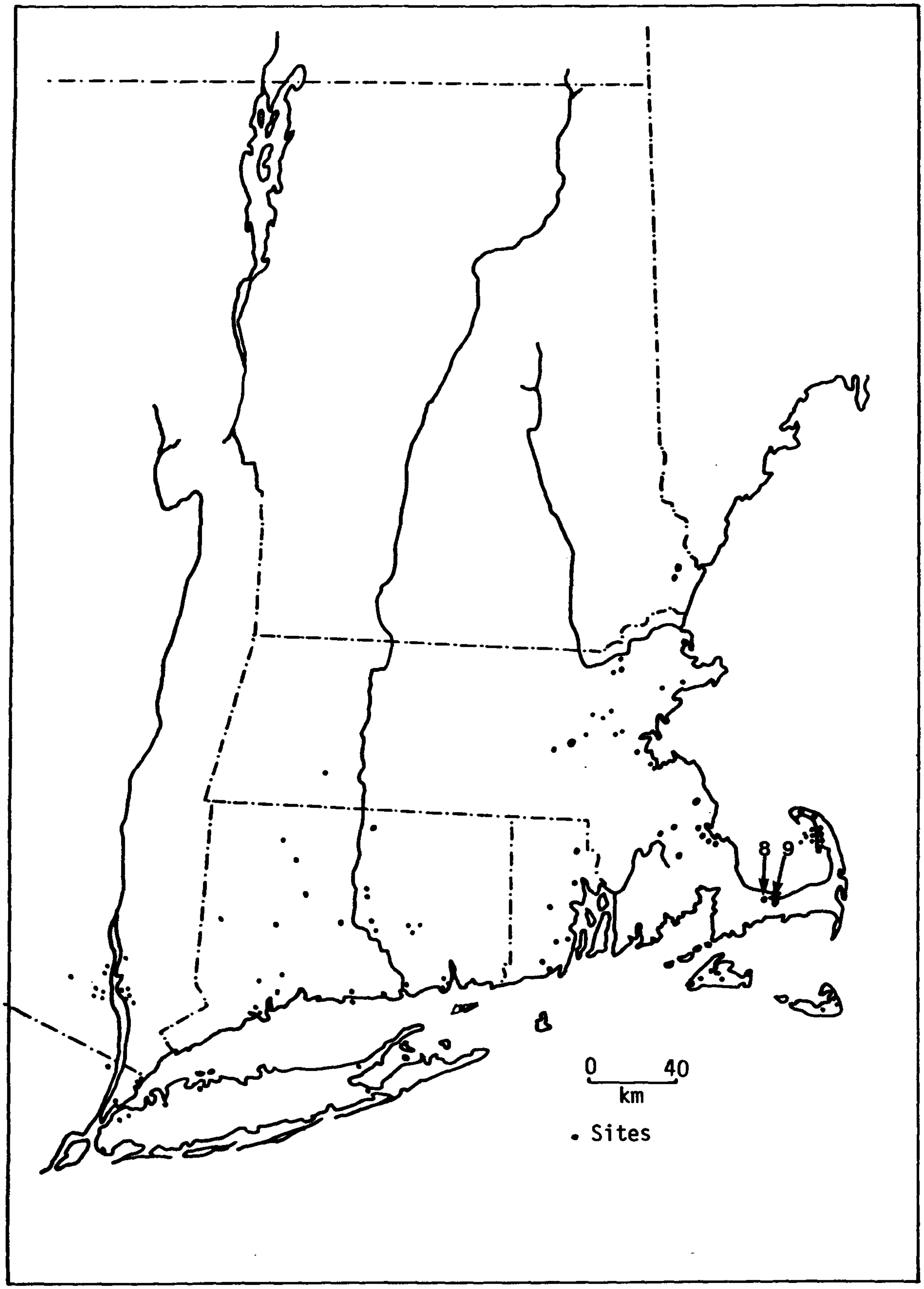


Fig. II-40: Distribution of known sites, southern New England subarea, Middle Woodland Period.

TABLE II-27: Tabulation of site data, Middle Woodland Period, southern New England subarea.

PERIOD: MIDDLE WOODLAND

Total sites:	115
Coastal sites:	16
Shell heaps:	8

SITES WITH MULTIPLE COMPONENTS: 83

Type of component evident:

Paleo-Indian:	2
Early Archaic:	18
Middle Archaic:	48
Late Archaic:	74
Early Woodland:	43
Middle Woodland:	79
Late Woodland:	72
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	7
Well drained steeper slope:	2
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	2

SLOPE:

Sites at 0-3%:	13
Sites at 3-8%:	9
Sites at 8-15%:	2
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:	~~1~~	SE:	~~2~~	S:	~~2~~
SW:	1	W:	1	NW:	1	OTHER:			

TYPE OF WATER SOURCE:

Spring:	7	L. I. Sound:	3
Brook or stream:	28	Ocean:	1
Small river:	30	Bay:	8
Major river:	3	Harbor:	2
Lake:	13	Sites inundated:	6
Swamp:	4	Sites at confluences:	14
Salt marsh or estuary:	12		

LANDFORM TYPE:

Terrace bench:	4	Knoll:	2
Large gravel hill:	1	Esker:	1
Low sandy shore:	1	Bluff:	1
Sandy knoll:	4	Till:	1
Moraine:	2	Beach:	1
Outwash:	2	Kame field:	1
Ridge:	1		
Terrace:	2		
Sand dune:	2		

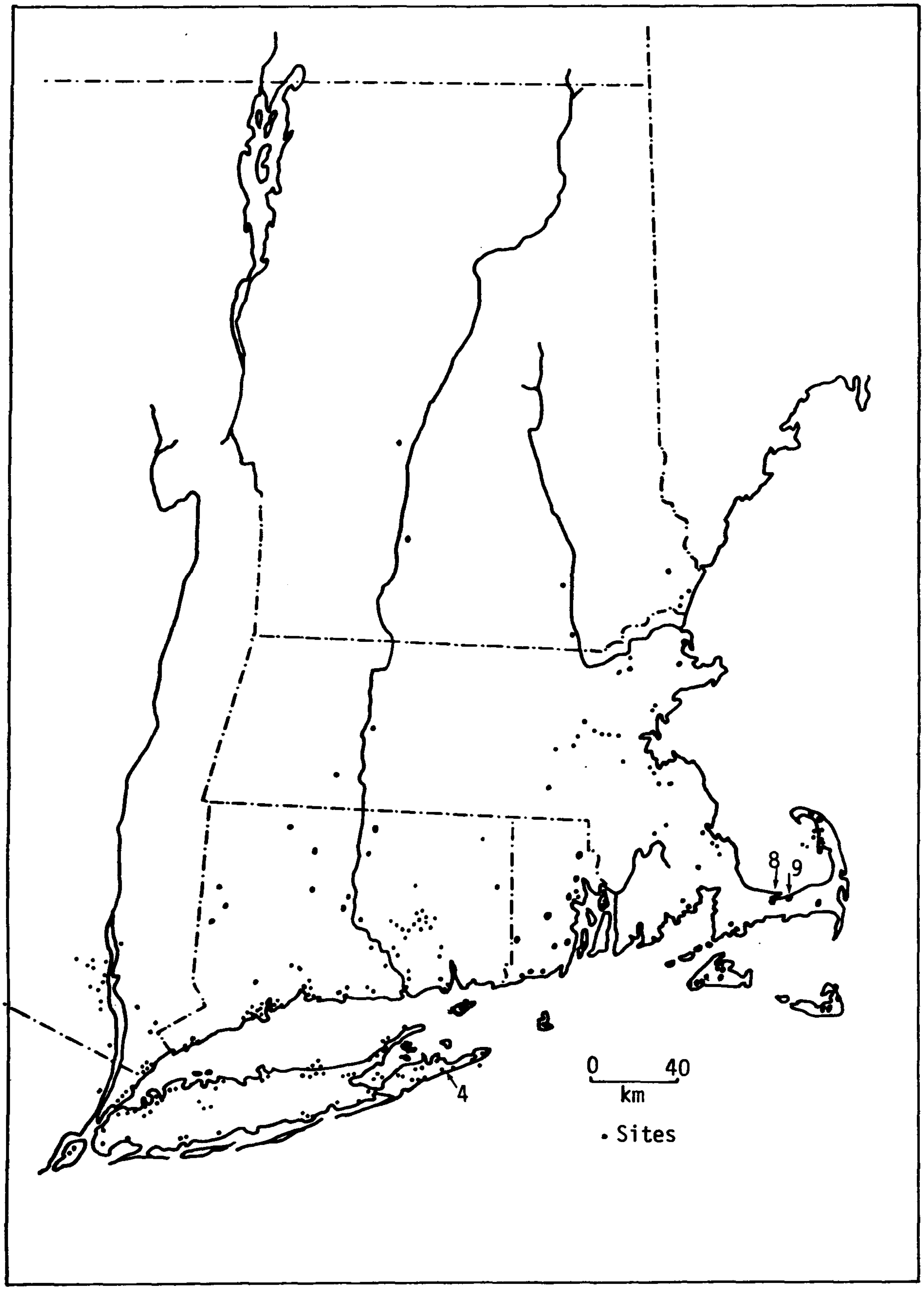


Fig. II-41: Distribution of known sites, southern New England subarea, Late Woodland Period.

TABLE II-28: Tabulation of site data, Late Woodland Period, southern New England subarea.

PERIOD: LATE WOODLAND

Total sites:	267
Coastal sites:	82
Shell heaps:	33

SITES WITH MULTIPLE COMPONENTS: 122

Type of component evident:

Paleo-Indian:	1
Early Archaic:	27
Middle Archaic:	61
Late Archaic:	116
Early Woodland:	57
Middle Woodland:	64
Late Woodland:	
Unspecified Woodland:	2
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	9
Well drained steeper slope:	5
Areas subjected to flooding:	1
Bedrock close to surface:	1
Made land:	

SLOPE:

Sites at 0-3%:	19
Sites at 3-8%:	11
Sites at 8-15%:	2
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:	1	SE:	2	S:	2
SW:	2	W:	3	NW:	1	OTHER:	ESE:1		

TYPE OF WATER SOURCE:

Spring:	12
Brook or stream:	47
Small river:	50
Major river:	8
Lake:	18
Swamp:	17
Salt marsh or estuary:	15
L. I. Sound:	6
Ocean:	1
Bay:	11
Harbor:	3
Sites inundated:	5
Sites at confluences:	23

LANDFORM TYPE:

Terrace:	8
Hill:	1
Low slope:	2
Knoll:	9
Outwash:	4
Morain:	4
Ridge:	3
Dune:	2
Bluff:	3
Till:	1
First terrace:	1
Second terrace:	1

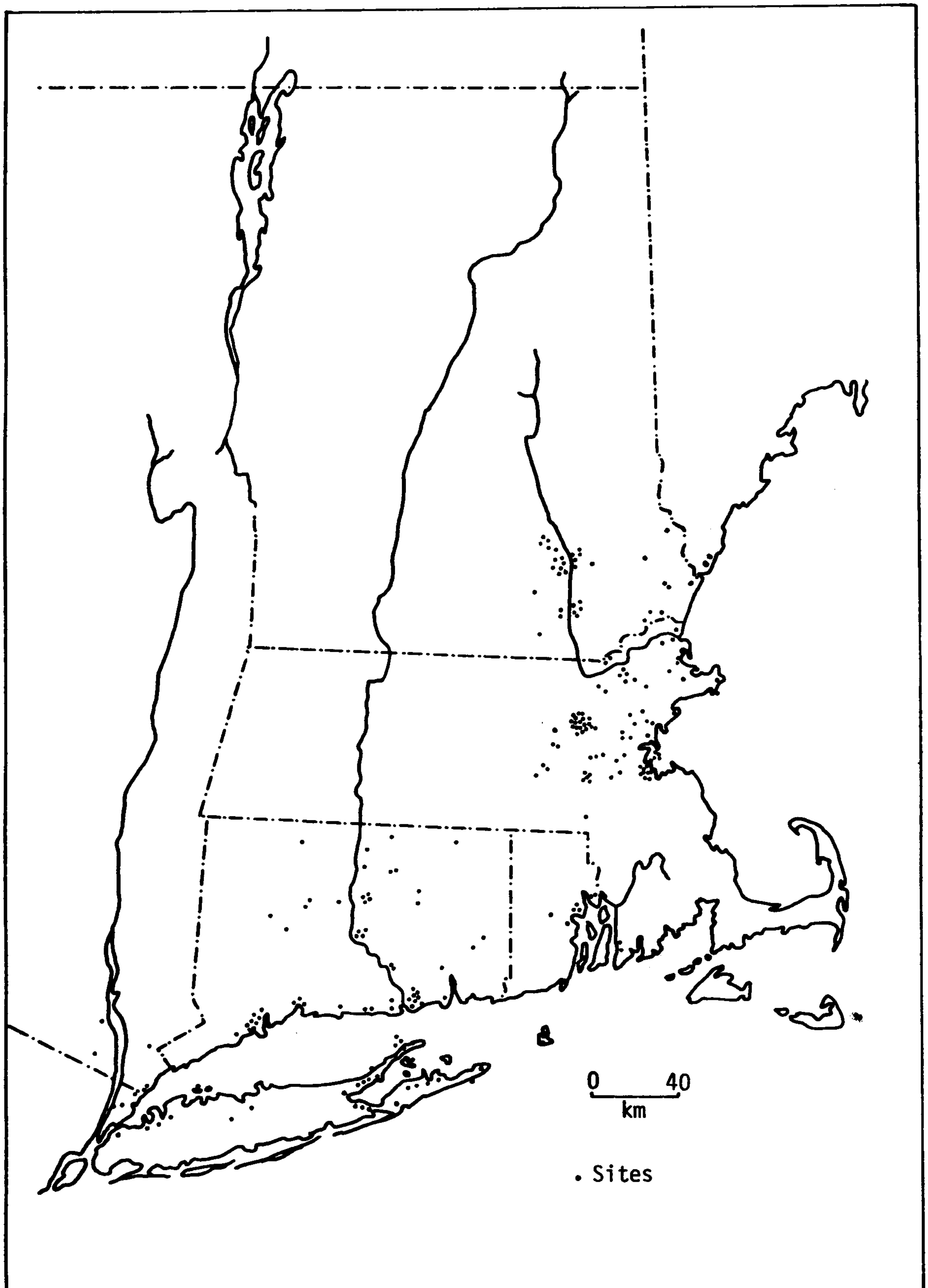


Fig. II-42: Distribution of known sites, southern New England subarea, Woodland Period in general.

TABLE II-29: Tabulation of site data, Woodland Period, in general, southern New England subarea.

PERIOD: WOODLAND

Total sites:	381
Coastal sites:	99
Shell heaps:	91

SITES WITH MULTIPLE COMPONENTS: 88

Type of component evident:

Paleo-Indian:	0
Early Archaic:	2
Middle Archaic:	24
Late Archaic:	83
Early Woodland:	3
Middle Woodland:	
Late Woodland:	2
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	61
Well drained steeper slope:	35
Areas subjected to flooding:	
Bedrock close to surface:	7
Made land:	5

SLOPE:

Sites at 0-3%:	8
Sites at 3-8%:	58
Sites at 8-15%:	25
Sites at 15-22%:	3
Sites over 25%:	1

ASPECT:

N:		NE:		E:		SE:	1	S:	4
SW:		W:		NW:		OTHER:	ESE:1 WSW:1		

TYPE OF WATER SOURCE:

Spring:	7	L. I. Sound:	2
Brook or stream:	50	Ocean:	1
Small river:	50	Bay:	
Major river:	20	Harbor:	
Lake:	14	Sites inundated:	1
Swamp:	3	Sites at confluences:	21
Salt marsh or estuary:	11		

LANDFORM TYPE:

Gravelly till: 3	Second terrace: 2
Sheltered lowland: 1	Sand hill: 3
Falls: 3	Rock shelter: 8
Gravel knolls: 1	Drumlin: 1
Blow out: 1	Sandy terrace: 1
Sandy plain: 3	Island: 1
Island: 1	Low plateau: 3
Bluff: 2	Knoll: 2
Hill: 3	Terrace: 1

Several Woodland site types are known. Shell middens, already discussed, have been found with nearby contemporary habitation sites (Barber 1979b). Salwen (1962) and Brennan (1974) have suggested this settlement pattern, essentially that of a dwelling area and separate refuse heap, but have not located confirming evidence. Other known site types include small inland camps and fishing stations. Agricultural villages and farmsteads developed in the Late Woodland Period, but were restricted to arable land, primarily in lowland valleys. Dincauze (1974) has suggested for the Charles Valley that the seasonal round in Late Woodland times included spring and fall settlement at estuary-head sites, as the major focus of settlement, with summers spent at farmsteads and winters in inland camps.

Sizes of these different site types are poorly known. Late Woodland estuary head settlements appear to have been sizable; agricultural villages were large, apparently increasing with size toward the south and west (Funk 1976). Inland camps, on the other hand, were probably small. Shell midden size is highly variable, but Table II-30 presents a summary of the sizes of seven substantially intact shell middens from a survey segment in the Merrimack Valley. As in the Maine calculations, high standard deviations and large ranges indicate high variability, with most middens falling below the mean of about 80 ft across, but a few large middens buoying up the average. The southern New England subarea is larger and more heterogeneous than Maine and these figures, taken from a single locality, should be viewed only as rough approximations of shell midden magnitude in southern New England.

In summary, the Woodland Period in the Southern New England subarea saw an increase in the number of coastal sites, the result of less frequent inundation, increased coastal exploitation, or (probably) both. Upland settlement ceased almost entirely, but may have become slightly more important in Late Woodland times. Site types include estuary-head fishing camps (small to large), shell middens (small to large, perhaps averaging 80 ft across), habitations associated with shell middens (small), and other fishing camps (usually small to moderate size). In the Late Woodland Period, farmsteads (small) and agricultural villages (large) developed, utilizing arable valley soils. Inland camps (small) became more prominent in Late Woodland times. Site density apparently dropped slightly between the Late Archaic and Woodland Periods, then increased steadily through Woodland times.

5.3.6 <u>Unknown Period</u>

Fig. II-43 and Table-31 present data and locations for sites for which no temporal assignment was possible. These sites number 812, 40.5% of the 2,006 sites inventoried. These 812 sites may draw upon the different periods in percentages comparable to those represented in the dated portion of the inventory; if so, the results presented here retain their validity. If the undated sample is skewed - for example, if a disproportionately large number of upland Early Woodland sites were undated - the results presented here might be erroneous. This reminder

TABLE II-30. Size measures of shell middens in the Merrimack Estuary, Massachusetts (calculated from data in the author's notes).

	Maximum Horizontal Dimension, Feet	Area, Square Feet	Thickness, Feet
Mean	83.4	4492.9	0.73
Standard Deviation	89.1	6562.3	0.63
Range	10 to 250	100 to 15,000	0.2 to 2.0

N=7

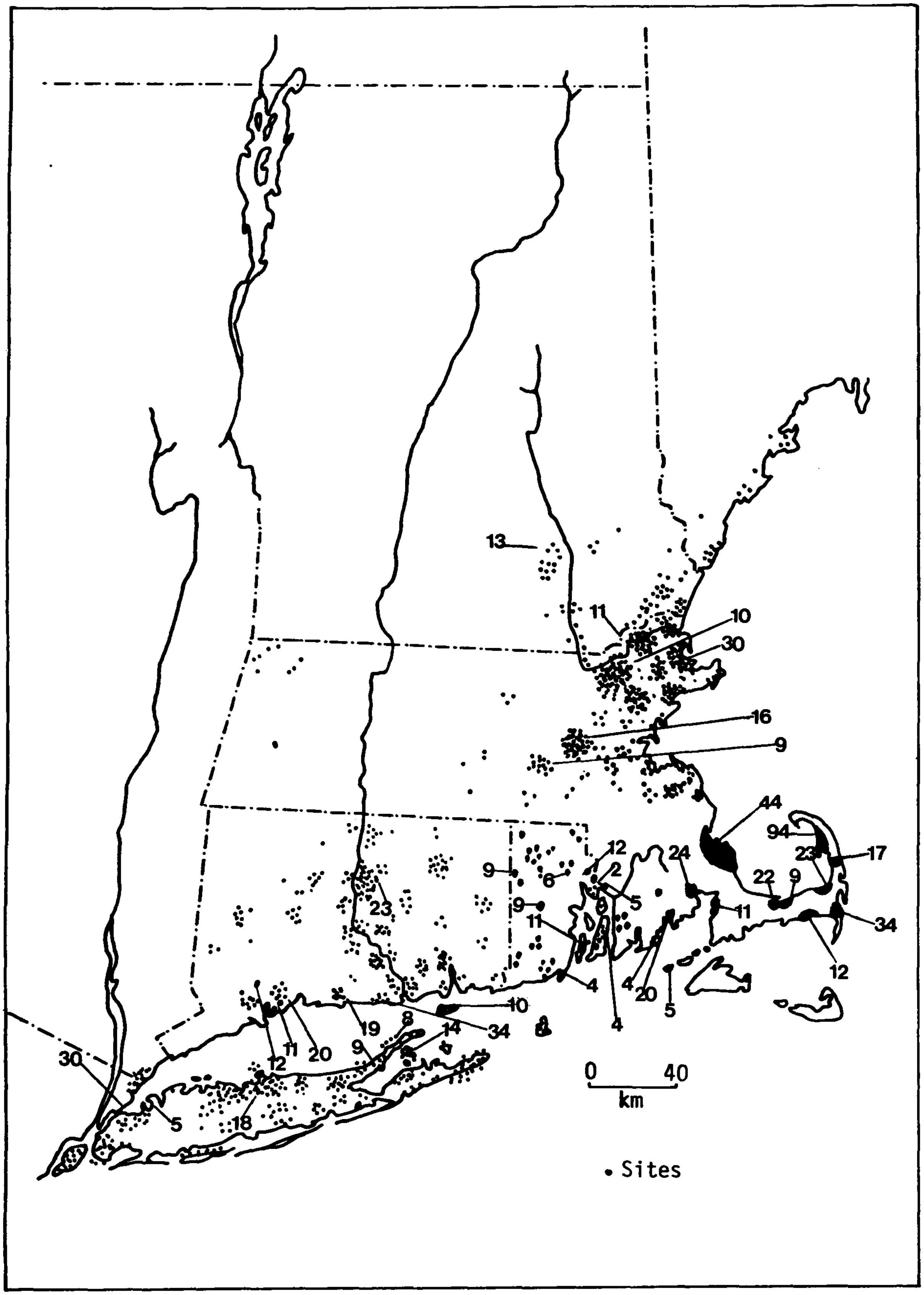


Fig. II-43: Distribution of known sites, southern New England subarea, unknown period.

TABLE II-31: Tabulation of site data, unknown period, southern New England subarea.

PERIOD: UNKNOWN

Total sites:	2043
Coastal sites:	639
Shell heaps:	466

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	309
Well drained steeper slope:	153
Areas subjected to flooding:	4
Bedrock close to surface:	21
Made land:	28

SLOPE:

Sites at 0-3%:	50
Sites at 3-8%:	281
Sites at 8-15%:	98
Sites at 15-22%:	28
Sites over 25%:	1

ASPECT:

N:	2	NE:	1	E:	1	SE:	2	S:	8
SW:	1	W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	7
Brook or stream:	160
Small river:	190
Major river:	72
Lake:	68
Swamp:	20
Salt marsh or estuary:	9
L. I. Sound:	5
Ocean:	4
Bay:	8
Harbor:	
Sites inundated:	10
Sites at confluences:	45

LANDFORM TYPE:

Island: 4
Falls: 4
Rocky ridge: 1
Long, narrow glacial ridge: 1
High glacial hill: 1
Sandy knoll: 7
Knoll: 5
Ridge: 2
Flat plain: 2
Rolling knolls: 1
High undulating field: 1
High ground: 1
Stony knoll: 1
Gravel ridge: 1
High gravel terrace: 1
Sandy plain: 4
Rock shelter: 31
Sand blow: 3
Small peninsula: 1
Esker: 1
Hogback: 1
Alluvial sand plain: 1
Small valley-like lowland: 1
Gravel knoll: 3
Rocky uplands: 1
Small drumlin: 1
High hill: 1
Low ground: 1
Doughnut-shaped rise: 1
Sandy ridge: 1
Hill: 8
Broad, flat peninsula: 1
Islands: 1
Flat grassland: 1
Kame terrace: 1
Sandy slope: 1
Small hill: 1
Fluvial terrace: 3
Point of land: 2
Bluff: 2
Swale: 1
Tombolo: 1

is presented merely as a caution, since the dated sample is the best available and there is no reason to believe it is badly biased.

5.3.7 Discussion

Certain general characteristics of settlement have recurred in the various periods and, lest they be overlooked, they will be reiterated here. First, settlement is virtually always near some source of water. The most common of these sources are small rivers and streams, followed by lakes, large rivers, marshes, and other sources. Although a single source may be nearest to a site and the only one recorded, often several types of water source are within easy walking distance and may have influenced settlement location. Second, settlement tends to occur on land which is somewhat higher than surrounding terrain, presumably to avoid miring during wet weather. Well-drained soils, also the general rule at sites, might be important for the same reason or for the vegetation they support. Finally, slopes tend to be gentle, usually not exceeding 8%.

These general characteristics are shared by all periods in southern New England prehistory. Sites located in habitats with different attributes should not be considered merely inferior versions of optimal sites, however. Throughout prehistory, there appear to have been a variety of site types associated with differing functions, seasons, or social groups and each site type no doubt required somewhat different environmental characteristics. The exceptions to the general rule are no less instructive than the cases which follow the rule, only rarer.

Throughout this section, statements regarding population or site density have been treated only briefly. Various authors (Dincauze 1974; Mulholland no date) have suggested that population fell drastically between the Late Archaic and Early Woodland Periods. These suggestions may be evaluated through the use of the inventory accumulated for this project.

Many attempts at calculating relative population have used a number of sites per period as an index, but that technique is doomed to failure if the periods are of unequal length. Given equal populations at any given date, all else being equal, the longer period should produce more sites. Fig. II-44 graphs frequency of sites per standard 1000 year period for southern New England. The following period lengths were used for the calculations:

Paleo-Indian: 2,500 years
Early Archaic: 2,000 years
Middle Archaic: 2,000
Late Archaic: 3,000 years
Early Woodland: 1,000 years
Middle Woodland: 1,000 years
Late Woodland: 500 years

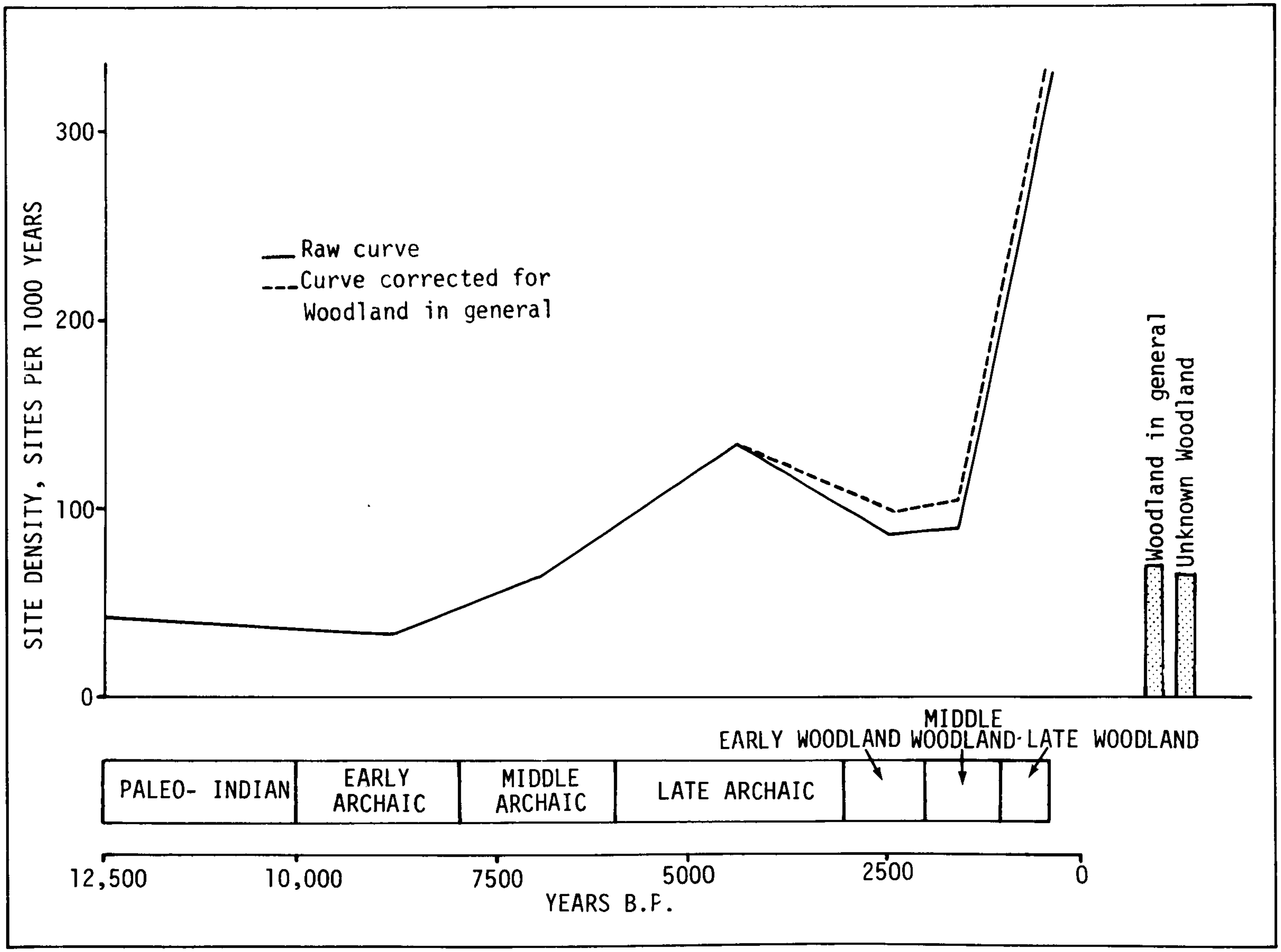


Fig. II-44: Site frequency per period, southern New England subarea.

Values were plotted at the midpoints of periods. For reference, unspecified Woodland sites and sites of unknown period, also calculated in terms of sites-per-1,000-years, are represented on the graph.

The solid line represents the site densities for specific periods; the broken line distributes unspecified Woodland sites among Early, Middle, and Late Woodland, proportionally according to the relative frequencies of sites recorded as belonging to the various periods.

Examined in this manner, a somewhat different picture is obtained. The high percentage of find spots in the Paleo-Indian frequency (71 of 101, 70.3%) greatly inflates that period's apparent site density. Since find spots have rarely been reported for other periods, it is reasonable to consider the Paleo-Indian value too high. With this consideration, site frequency can be seen to increase gradually through the Late Archaic Period, at which point it dips slightly lower for the Early and Middle Woodland Periods, then increases dramatically during Late Woodland times. Given the generally larger size of Late Woodland sites, this soaring site frequency may indicate an even more rapidly increasing population.

The dip in site frequency during Early and Middle Woodland times quite possibly indicates decreased population, but other factors should be considered. Different adaptations may produce different numbers of sites per annual cycle, dependent on the number of seasonal shifts and variety of specialized stations. The population per site may vary, as well. These and other factors may obscure details of population through time, perhaps with a slight dip in Early Woodland times, seems clear.

5.4 Mid-Atlantic States

5.4.1 Paleo-Indian Period

In the northern portion of the mid-Atlantic subarea, the traditional viewpoint has been that the sandy outer coastal plain of New Jersey and the Delmarva Peninsula was little used during the Paleo-Indian Period. Surveys of fluted point finds by Mason (1959) and H. Kraft (1977) have found concentrations in interior portions near the Delaware River, but few remains on the outer coastal plain. Mounier (1978) has discussed the environmental potential of the outer coastal plain and argued that it was unlikely to have supported substantial aboriginal populations, either in Paleo-Indian times or later.

Mason, Kraft, and Mounier all recognized that archaeological survey and excavation have been far less intensive on the outer coastal plain than they have further inland, and that this sample bias may have produced misleading results. Cresson and Bonfiglio (1978) have conducted a program of survey and excavation in New Jersey's coastal plain in order to gather additional data from this zone. Their results indicate that sample bias, indeed, has made this zone appear disproportionately unpopulated in the Paleo-Indian Period.

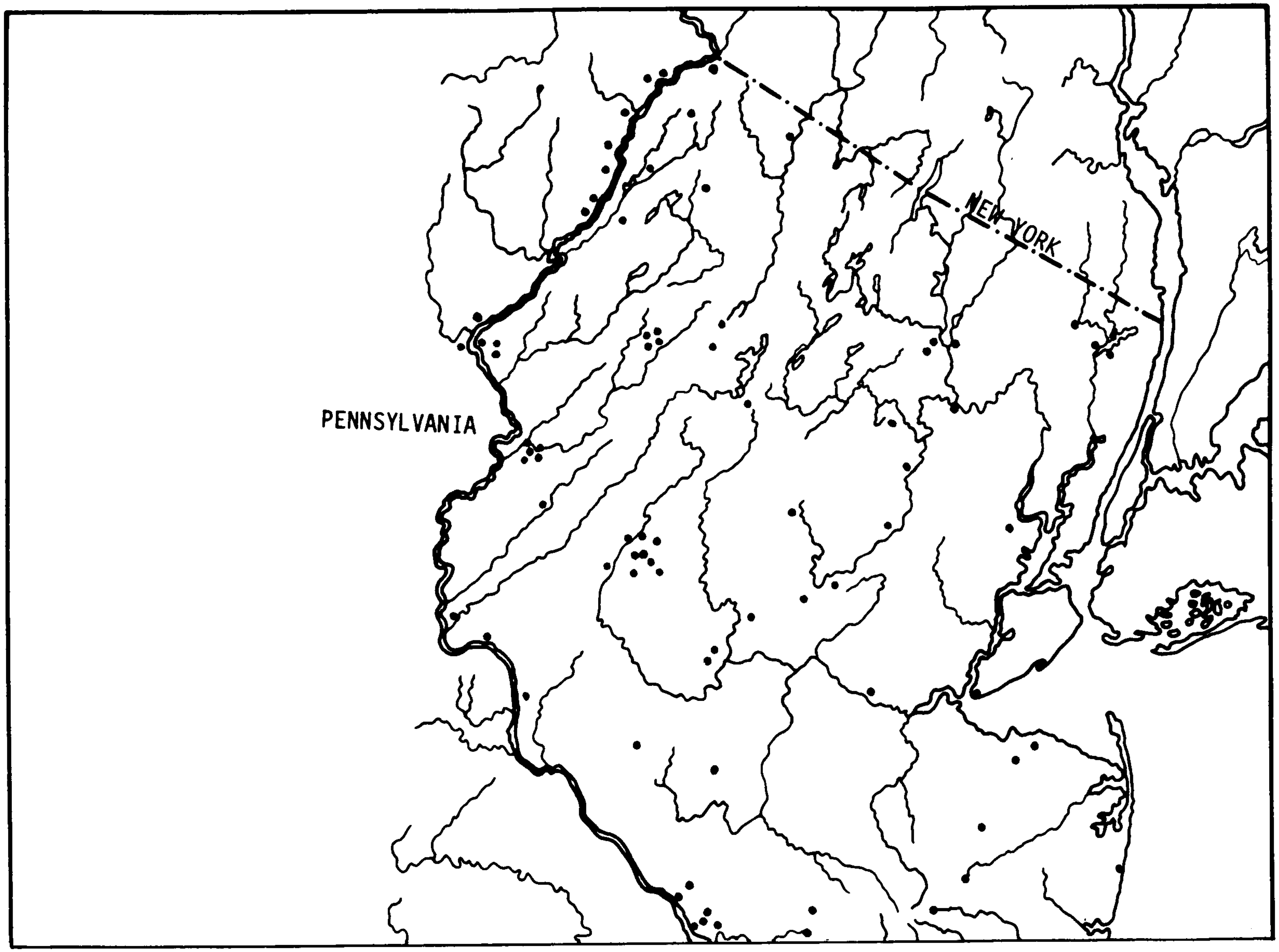
Cresson and Bonfiglio have focused their research on "pingos." By definition, a "pingo" is a circular or oval depression ranging from ten to 100 meters in diameter, roughly two to three meters in depth, which results from the interaction of ground water and extreme cold. In ice-free areas of the permafrost zone, the freezing of groundwater or the injection of freezing sediments and water from the artesian system through hydrostatic pressure forces the ground upward. With subsequent thawing, these blister-like domes of soil collapsed, leaving the depression, usually with water-retaining capability and permanent biotic communities. This definition and description of "pingos" is presently the subject of controversy, so the word will be used only within quotation marks to describe these shallow depressions on the coastal plain.

To date Cresson and Bonfiglio have examined 95 "pingos," 90 of which have produced Paleo-Indian and/or Early Archaic remains. The sites do not appear, however, to be very large or to represent intensive occupation. While a more definite conclusion must await further investigation, including excavation, it seems most likely that the "pingo" sites indicate exploitation of the outer coastal plain in an extensive, but non-intensive way. While sites appear to be numerous, they may represent only stopovers during sorties into this zone. More substantial sites tend to be further inland.

Eisenberg (1978) has examined Paleo-Indian sites in the Hudson and Delaware drainages in an attempt to determine their functions. His study provides models of settlement which may be applicable to the mid-Atlantic subarea, at least its northern portion.

By examining the stone tools found in various sites, Eisenberg concluded that a multitude of functions were being performed at these sites and, by implication, that a variety of resources were being exploited. The environments for the sites, as determined by paleoenvironmental reconstruction, supported this conclusion.

Three types of sites were described by Eisenberg. Lowland waterside camps frequently were located in or near areas which would have been coniferous swamp. In addition, many of these sites could have served as fishing camps, since they were found along large rivers. A second site type is the upland bluff camp and a third is the ridge-top camp. The latter two types were in upland areas, where deciduous trees were dominant. The recurrence of similar site types, coupled with the fact that local stone tool assemblages, suggests that the site occupants followed a regular seasonal round which took them to sites lying within a restricted area.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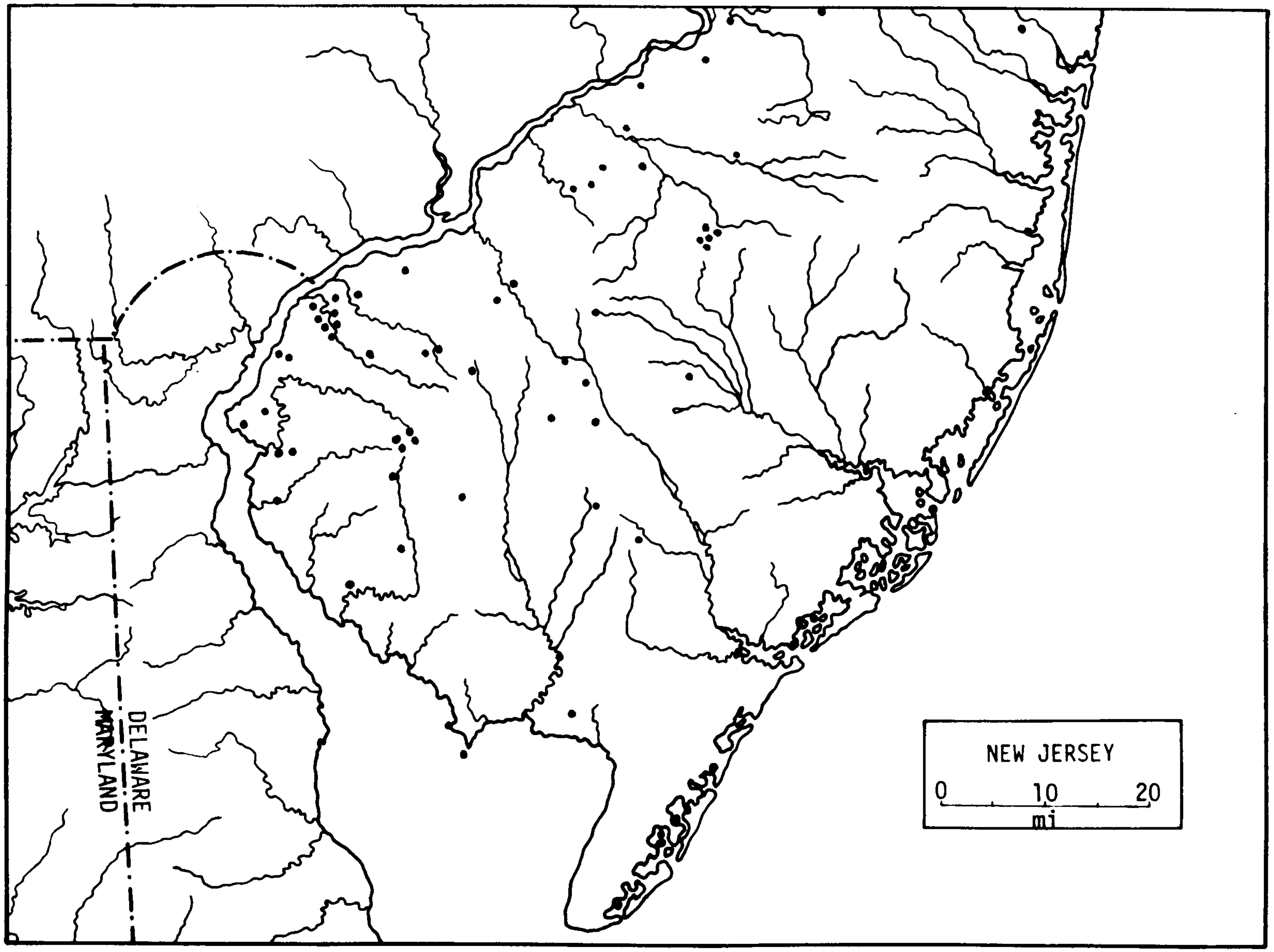


Fig. II-45a: Distribution of known sites, mid-Atlantic subarea, Paleo-Indian Period (includes facing page).

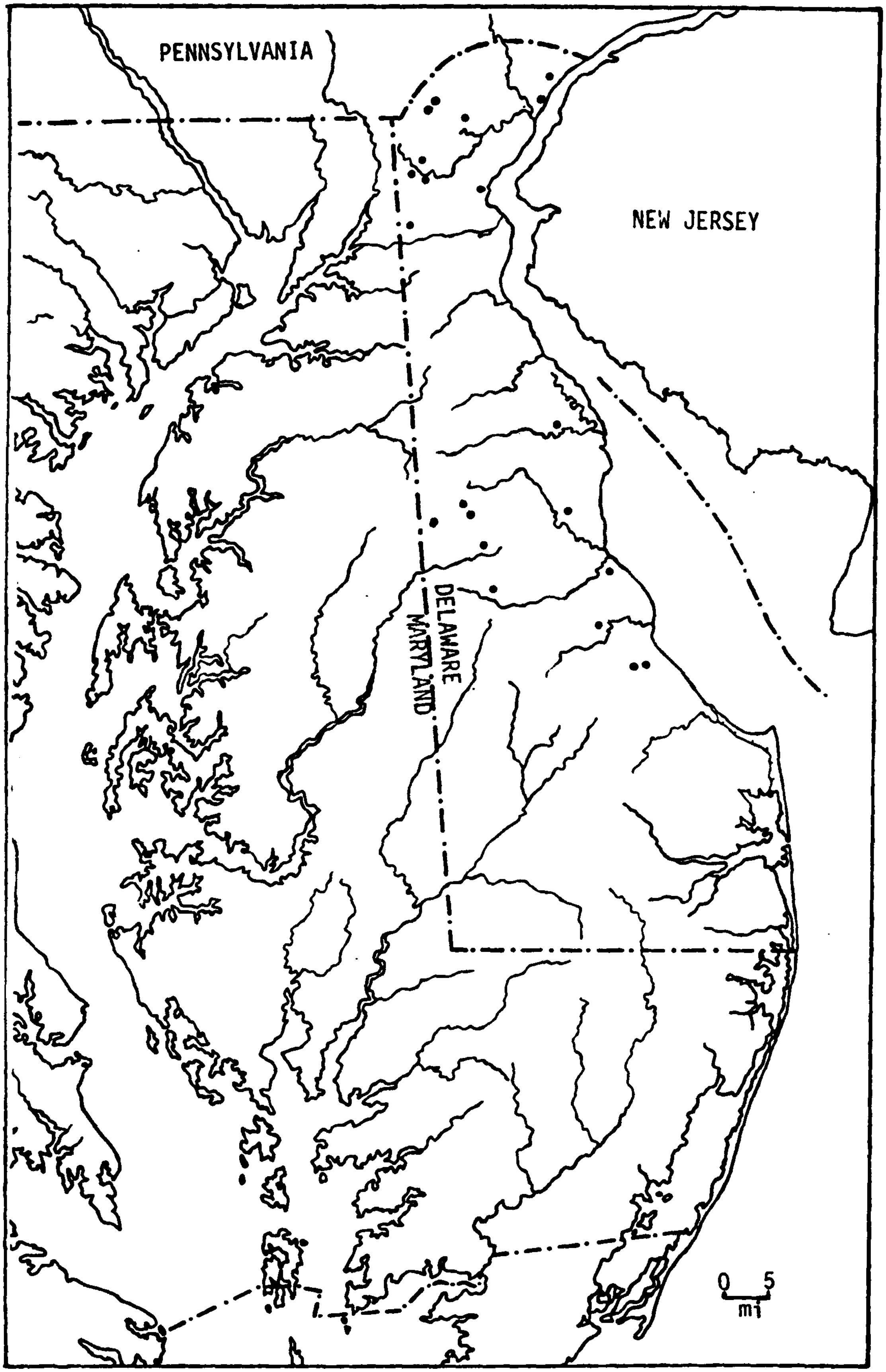


Fig. II-45b: Distribution of known sites, mid-Atlantic subarea, Paleo-Indian Period.

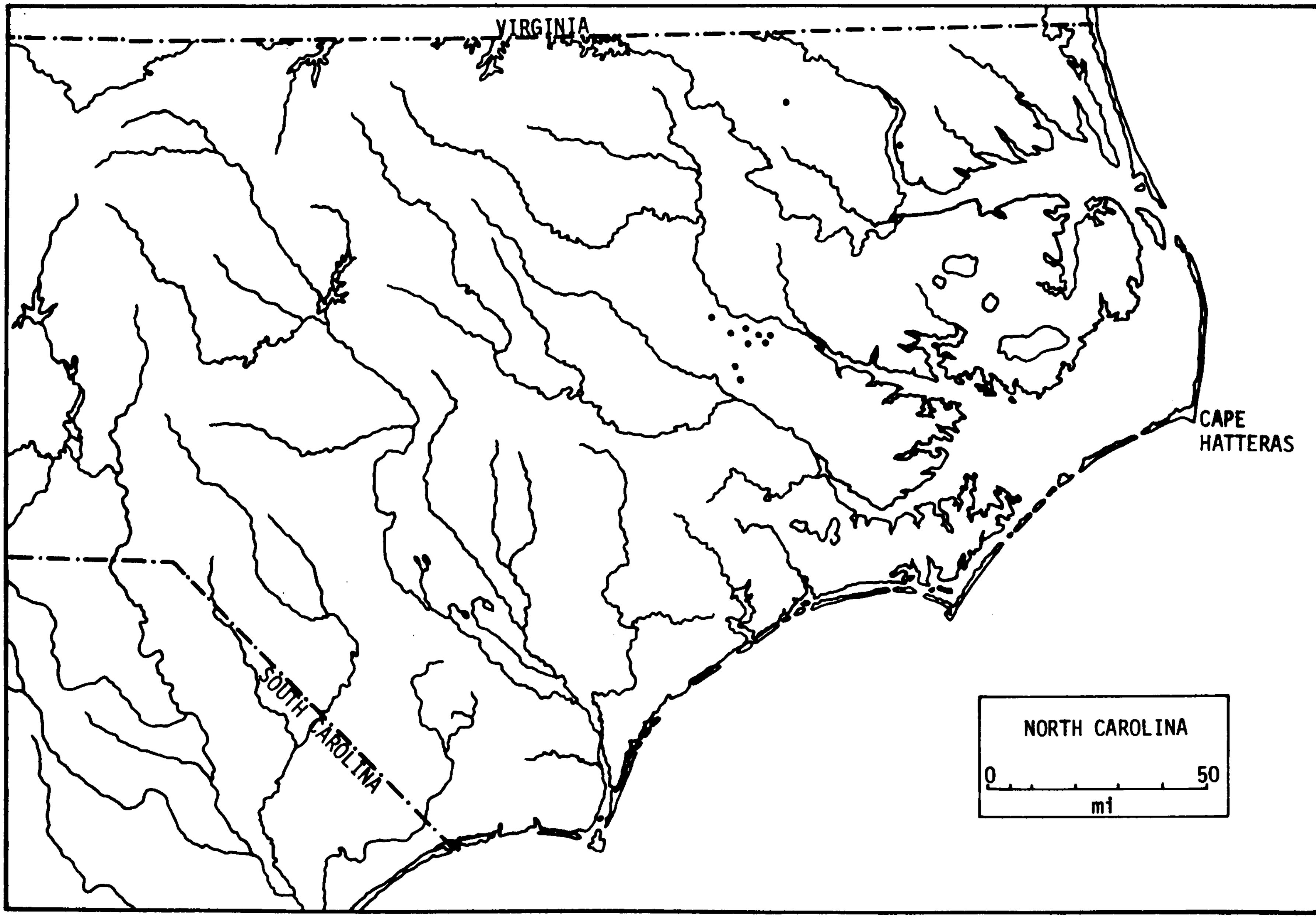


Fig. II-45c: Distribution of known sites, mid-Atlantic subarea, Paleo-Indian Period.

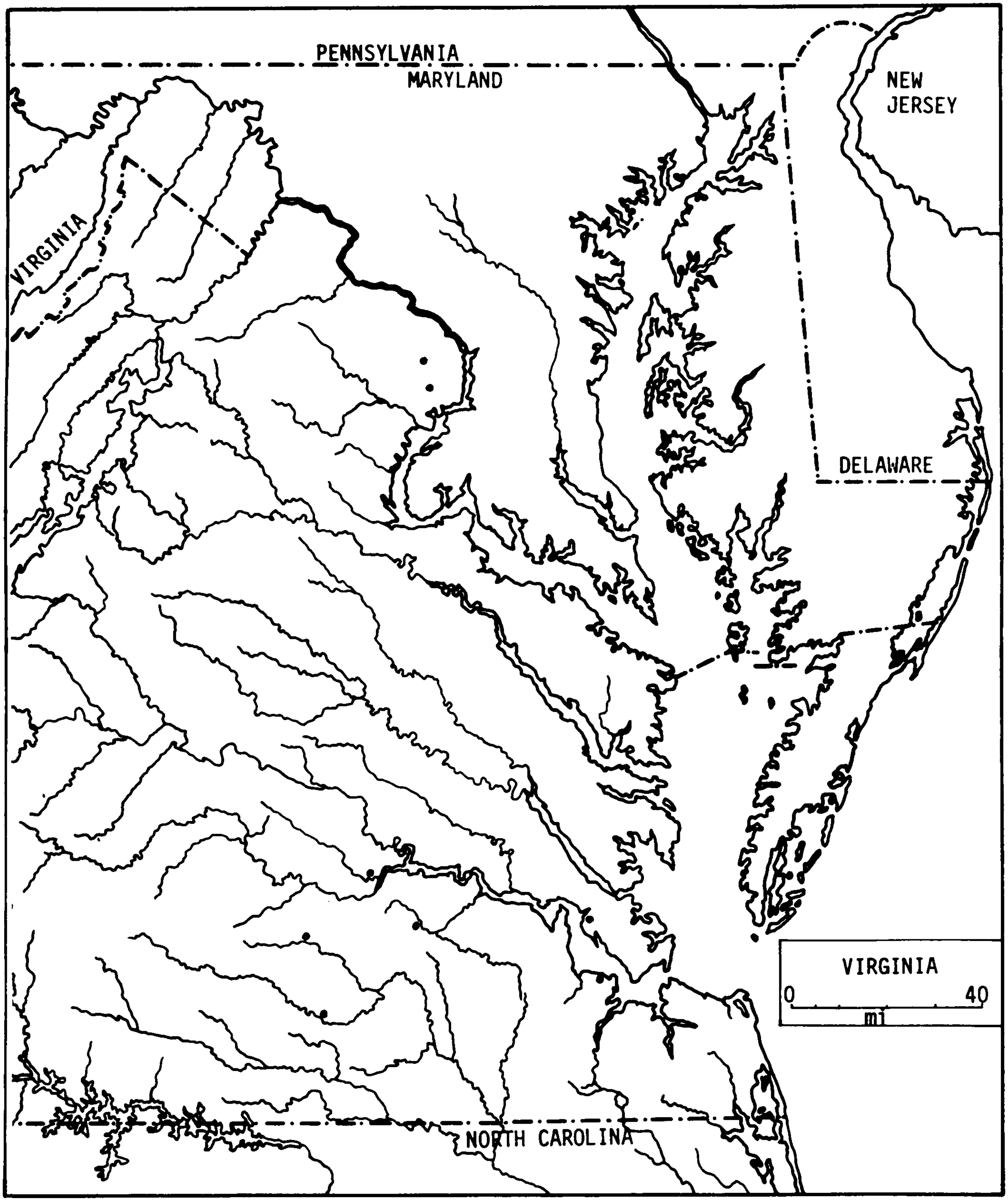


Fig. II-45d: Distribution of known sites, Mid-Atlantic subarea, Paleo-Indian Period.

TABLE II-32: Tabulation of site data, Paleo-Indian Period, mid-Atlantic subarea.

PERIOD: PALEO-INDIAN

Total sites:	135
Coastal sites:	38
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	6
Sites at 3-8%:	6
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	36	Ocean:	
Small river:	14	Bay:	
Major river:	13	Harbor:	
Lake:	1	Sites inundated:	
Swamp:	4	Sites at confluences:	3
Salt marsh or estuary:	26		

LANDFORM TYPE:

Further south and inland, in the mountains of Virginia, Gardner (1974, 1977) has developed another model of settlement for the Paleo-Indian Period. Unlike Eisenberg, who uses biological resources as the important factor in site location, Gardner uses lithic resources as the prime factor.

Based on analysis of a series of Paleo-Indian sites of the Flint Run complex, he describes five site types. Three of these, the largest and most permanent, are located so as to take advantage of outcrops of jasper, an easily worked and presumably desirable material for flaking stone tools. A <u>quarry</u>, is a limited-purpose camp, occupied exclusively for the purpose of extracting stone from the ground. <u>Quarry reduction sites</u> are located nearby and serve as the location for preliminary flaking to remove excess stone and reduce the weight to be carried. <u>Quarry-related base camps</u> are located on flood plains near quarries and are multi-purpose settlements. According to Gardner, they are located in such a ways as to maximize sunlight exposure, minimize wind exposure, and maximize availability of local food resources.

The remaining two site types described by Gardner are <u>periodically revisted hunting sites</u> and <u>sporadically visited hunting sites</u>. Sites of both types are small, but the former show greater intensity of reuse, while the latter appear transitory. The former are known from flood plain margins, the latter from mountainous uplands.

Gardner's model appears well supported for the upland zone for which it was developed. Its applicability to lowland areas, including the study area, is dubious, however, since resources, topography, and other environmental factors are (and were) so different. R. Thomas (1976a) has noted some correspondence between Paleo-Indian settlement and jasper outcrops, but the diversity of lowland sites appears to be greater than can be classified by Gardner's model. While it has been noted and examined, it has not been integrated into the models prepared in the course of this study.

Fig. II-45 plots the distribution of known Paleo-Indian sites for the mid-Atlantic area about which data were compiled for this study. Table II-32 summarizes environmental variables for those 135 sites and find spots. (Unfortunately, existing site records did not permit researchers to make a distinction between sites and find spots, so these figures represent combined totals.) Few inferences can be drawn from these data, but settlement along rivers and streams, including major rivers, was typical. The high total for estuarine sites reflects the modern estuary placement, but none of these sites were in estuarine zones during their periods of occupation.

5.4.2 <u>Early Archaic Period</u>

For northern portions of the mid-Atlantic subarea, as for southern New England, Kinsey (1972) has attempted to apply the "boreal forest hypothesis." As discussed earlier, this hypothesis suggests that Early and Middle Archaic peoples abandoned northern woodland areas of North America because the predominant boreal forest there could not provide adequate food supplies. As Section 4 of this volume has shown, the environmental reconstruction supporting this hypothesis appears to be faulty; rather than an abandonment of this subarea, gradual population increase appears to fit the data best. (See 5.4.7 Discussion below for further development of this idea.)

The small number of sites from the Early Archaic Period has limited interpretation of the period and few settlement models have been devised for this subarea. Turner (1978), Cavallo (1978), and Gardner (1977) all see an essential similarity of settlement patterns from the Paleo-Indian and Early Archaic Periods, noting similarity of site locations and high frequency of two-component sites with these two periods represented. (It should be recalled that Gardner's data base for his conclusions is drawn primarily from highland information and its applicability to the different terrain and resources of the lowlands is disputable.)

Coe (1964) has constructed a hypothesis that fishing camps will be established at locations with characteristics favoring the exploitation of anadromous fish. His test of the hypothesis supported its correctness for Archaic groups in the piedmont and there is little reason to doubt its correctness elsewhere. It is probable, therefore, that Early Archaic fishing camps were located near falls, rills, and rapids.

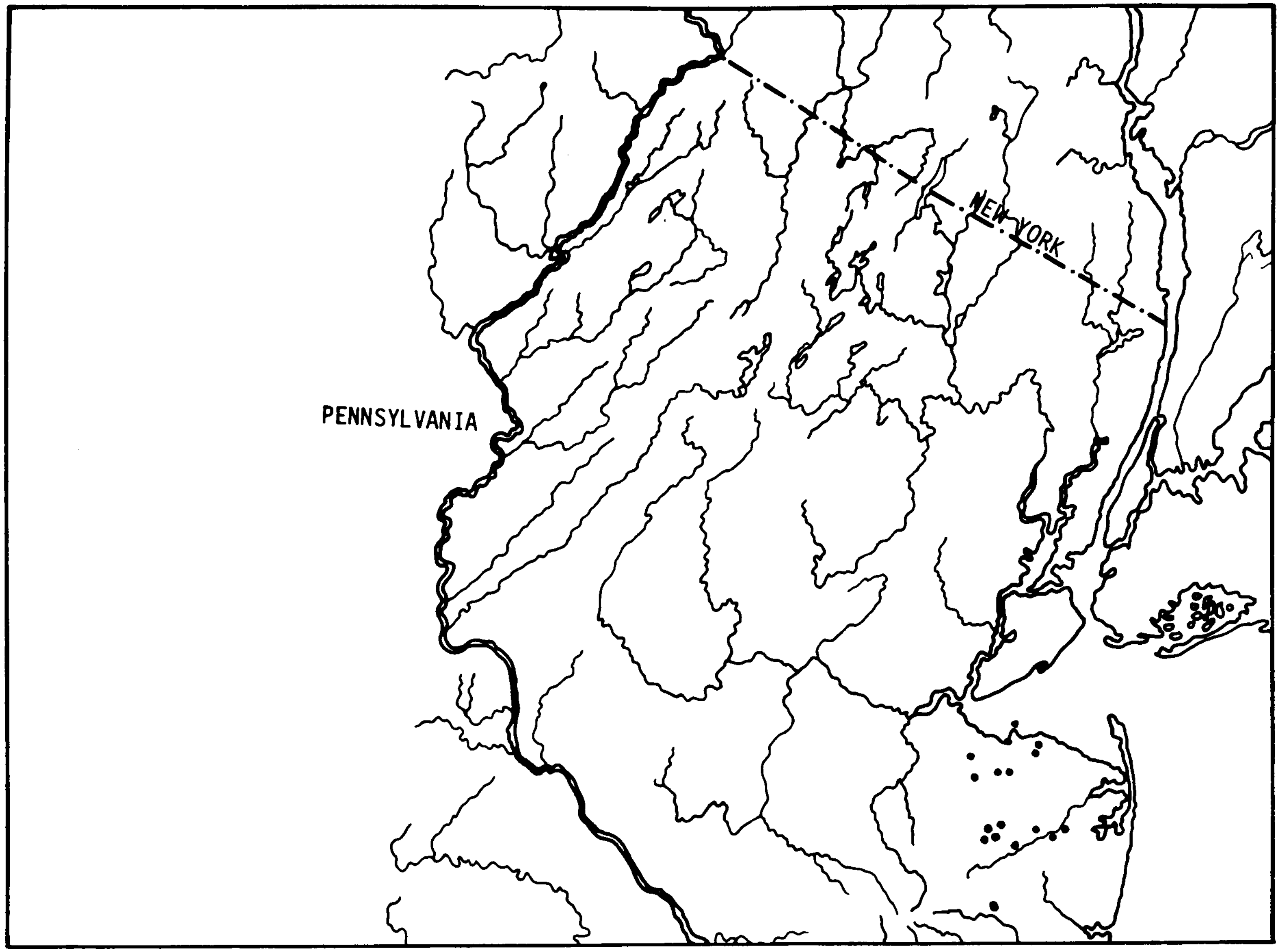
Fig. II-46 shows the distribution of known Early Archaic sites over space and Table II-33 gives frequencies for various locational attributes. Other than a basic similarity to their Paleo-Indian counterparts (shared less strongly by the maps and tables describing later site distributions), few conclusions are obvious.

5.4.3 Middle Archaic Period

The Middle Archaic Period in the mid-Atlantic subarea, like the Early Archaic Period, is known from a relatively few sites and has not been the subject of intensive locational studies. The exception is Gardner's (1978) research, based on an idealized transect crossing several zones, ranging from coastal plain to mountains. His analysis is preliminary, but it appears that a significant shift in settlement patterns took place between Early and Middle Archaic times.

As Gardner interprets this shift, Middle Archaic populations sought to situate their settlements in locations which would maximize the mix of available food resources. Ecotones, edges of zones, and areas which were environmental mosaics became the foci of settlement.

Fig. II-47 and Table II-34 give data on the locations of known Middle Archaic sites in this subarea. Using these data, it is difficult to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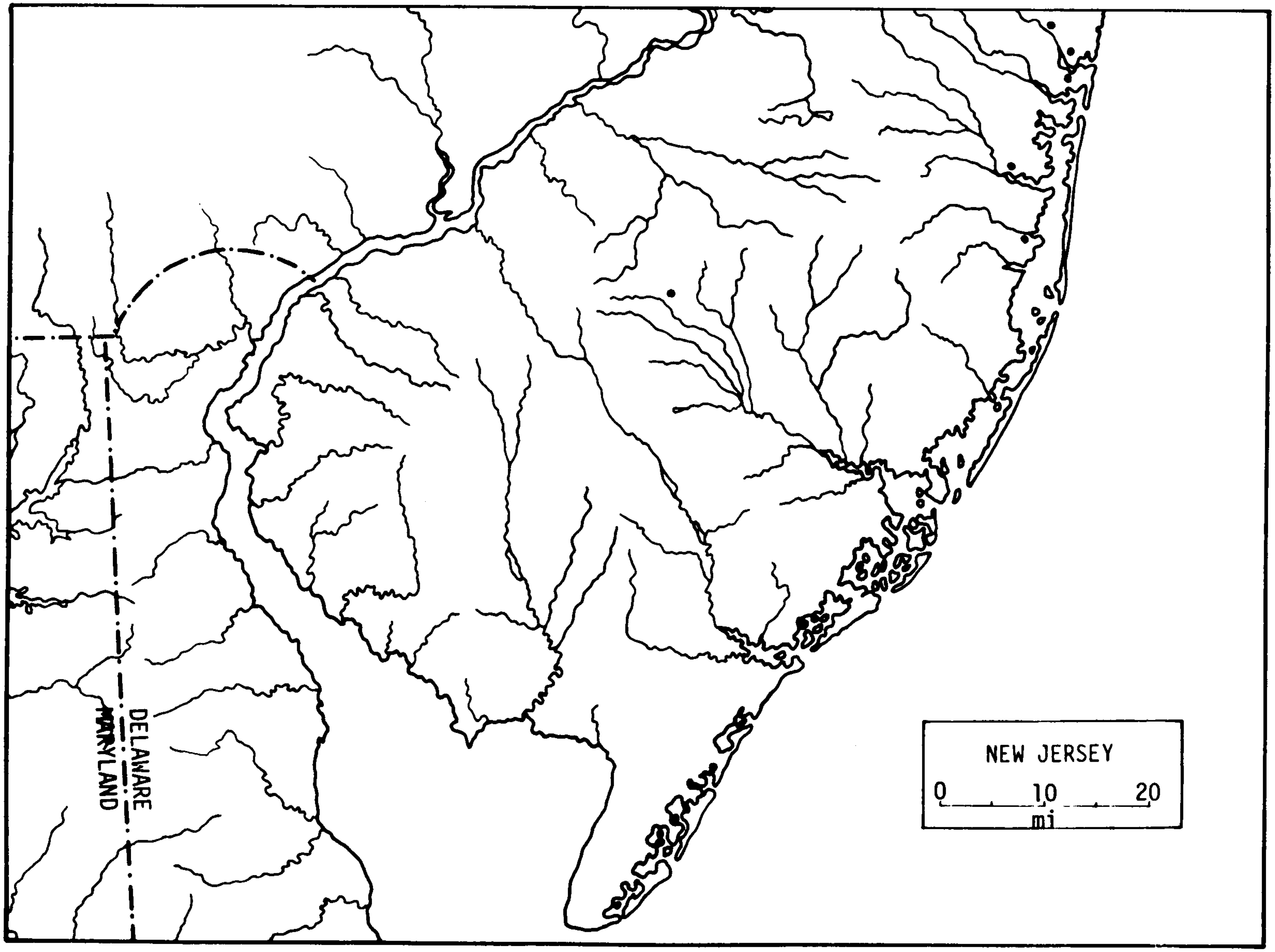


Fig. II-46a: Distribution of sites, mid-Atlantic subarea, Early Archaic Period. (Includes facing page.)

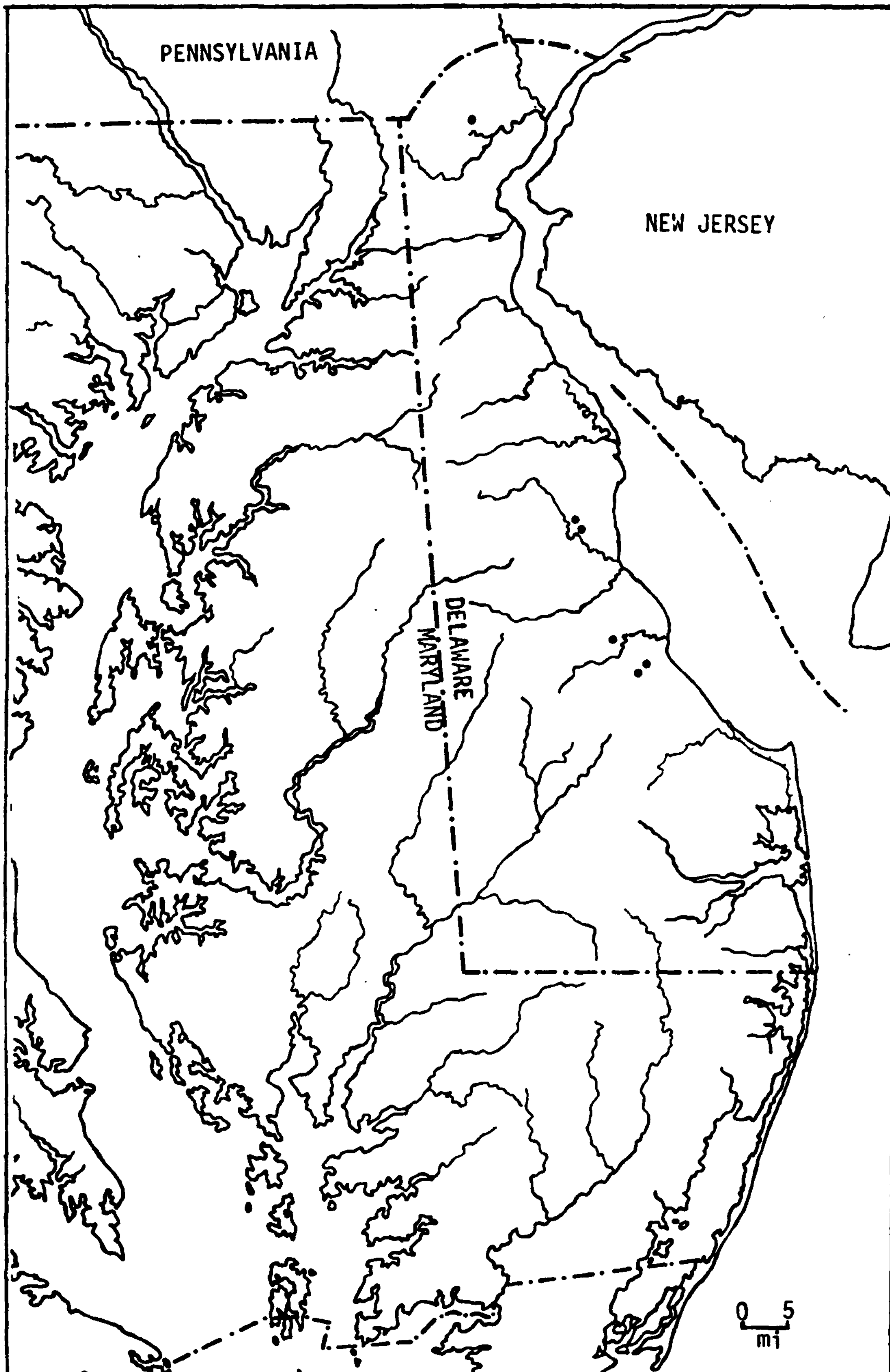


Fig. II-46b: Distribution of sites, mid-Atlantic subarea, Early Archaic Period.

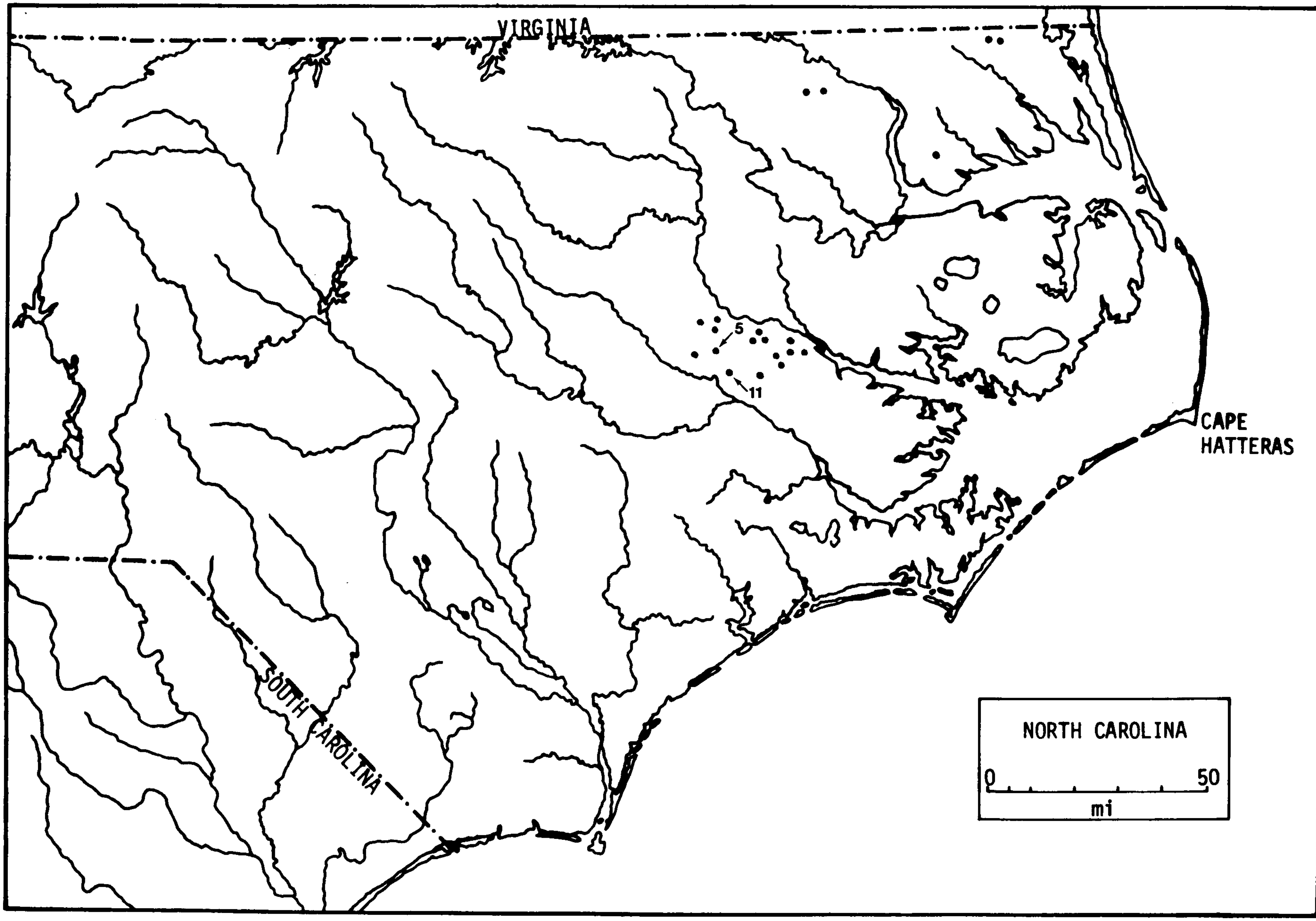


Fig. II-46c: Distribution of sites, mid-Atlantic subarea, Early Archaic Period.

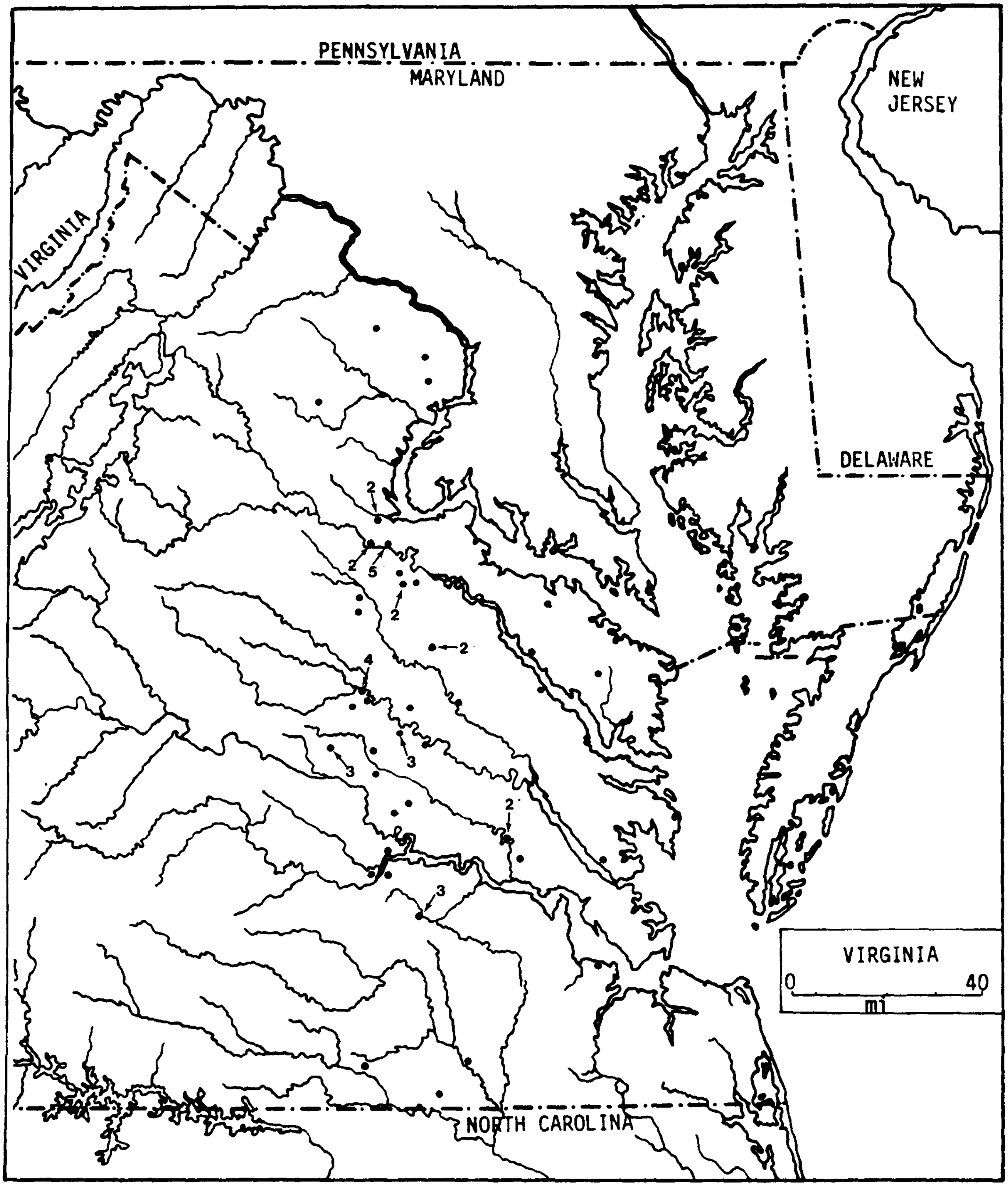


Fig. II-46d: Distribution of sites, mid-Atlantic subarea, Early Archaic Period.

TABLE II-33: Tabulation of site data, Early Archaic Period, mid-Atlantic subarea.

PERIOD: EARLY ARCHAIC

Total sites:	134
Coastal sites:	15
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	2
Sites at 3-8%:	3
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

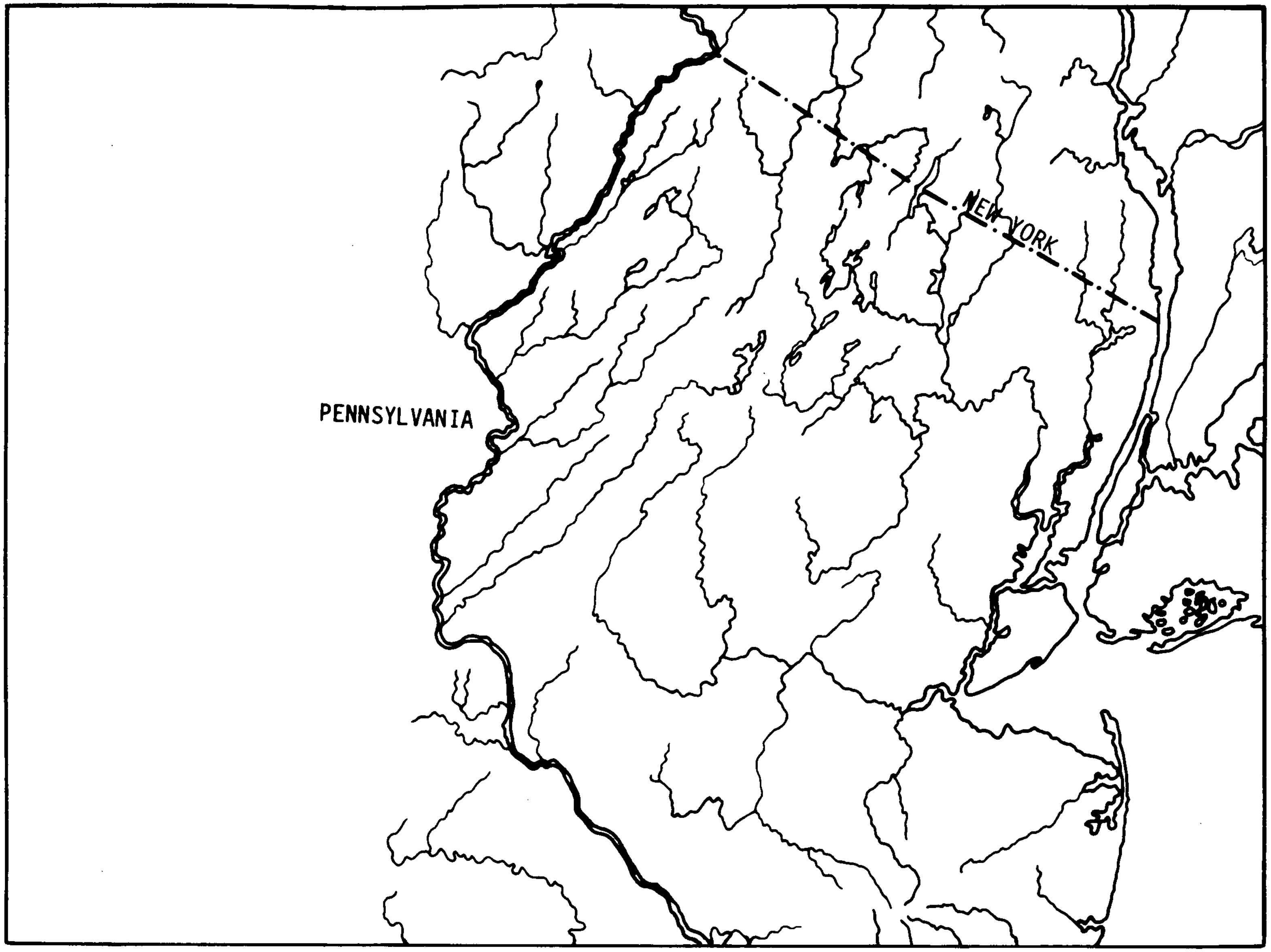
N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	
Brook or stream:	60
Small river:	24
Major river:	10
Lake:	3
Swamp:	13
Salt marsh or estuary:	1

L. I. Sound:	
Ocean:	
Bay:	
Harbor:	
Sites inundated:	
Sites at confluences:	9

LANDFORM TYPE: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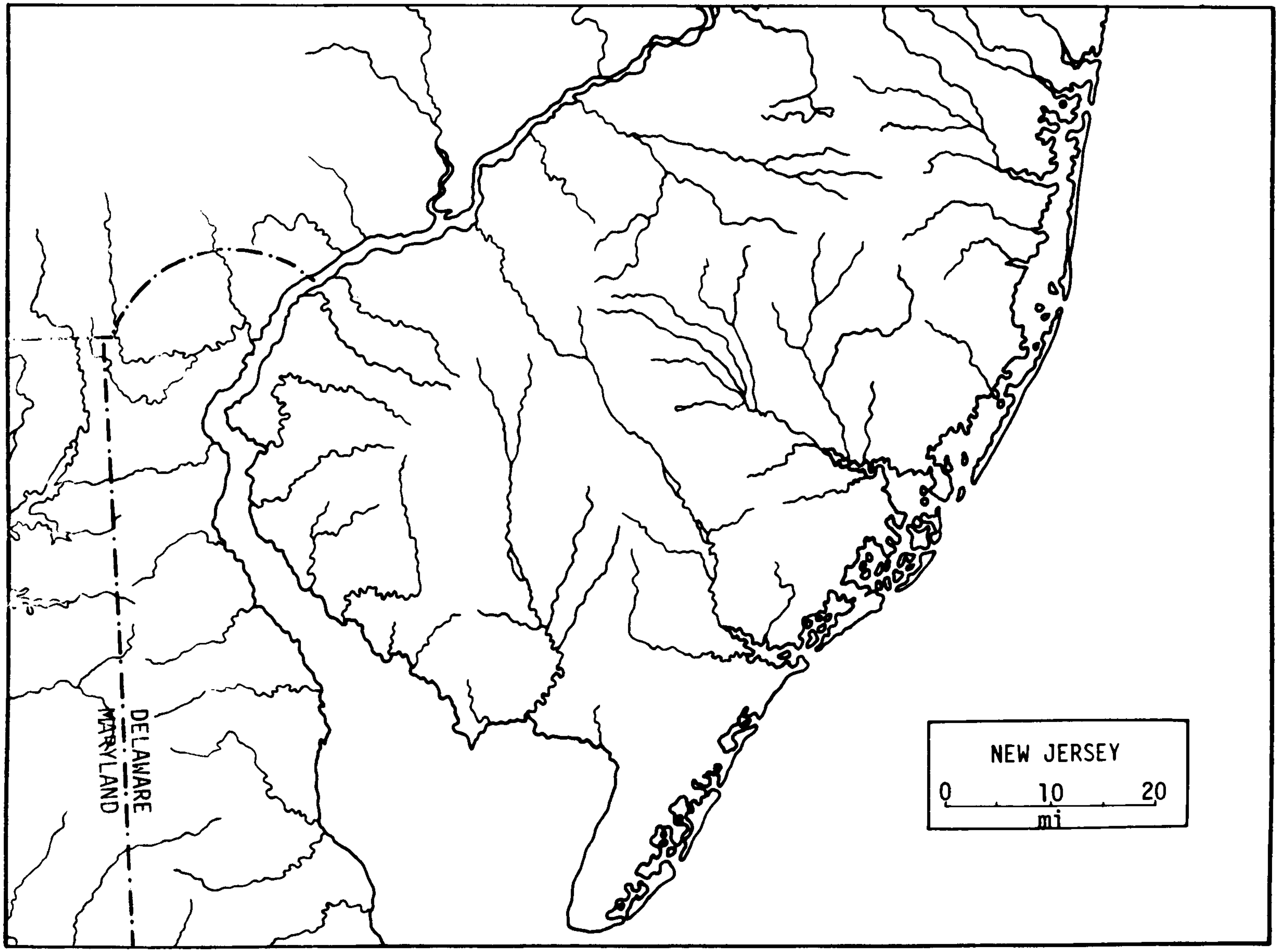


Fig. II-47a: Distribution of sites, mid-Atlantic subarea, Middle Archaic Period. (Includes facing page.)

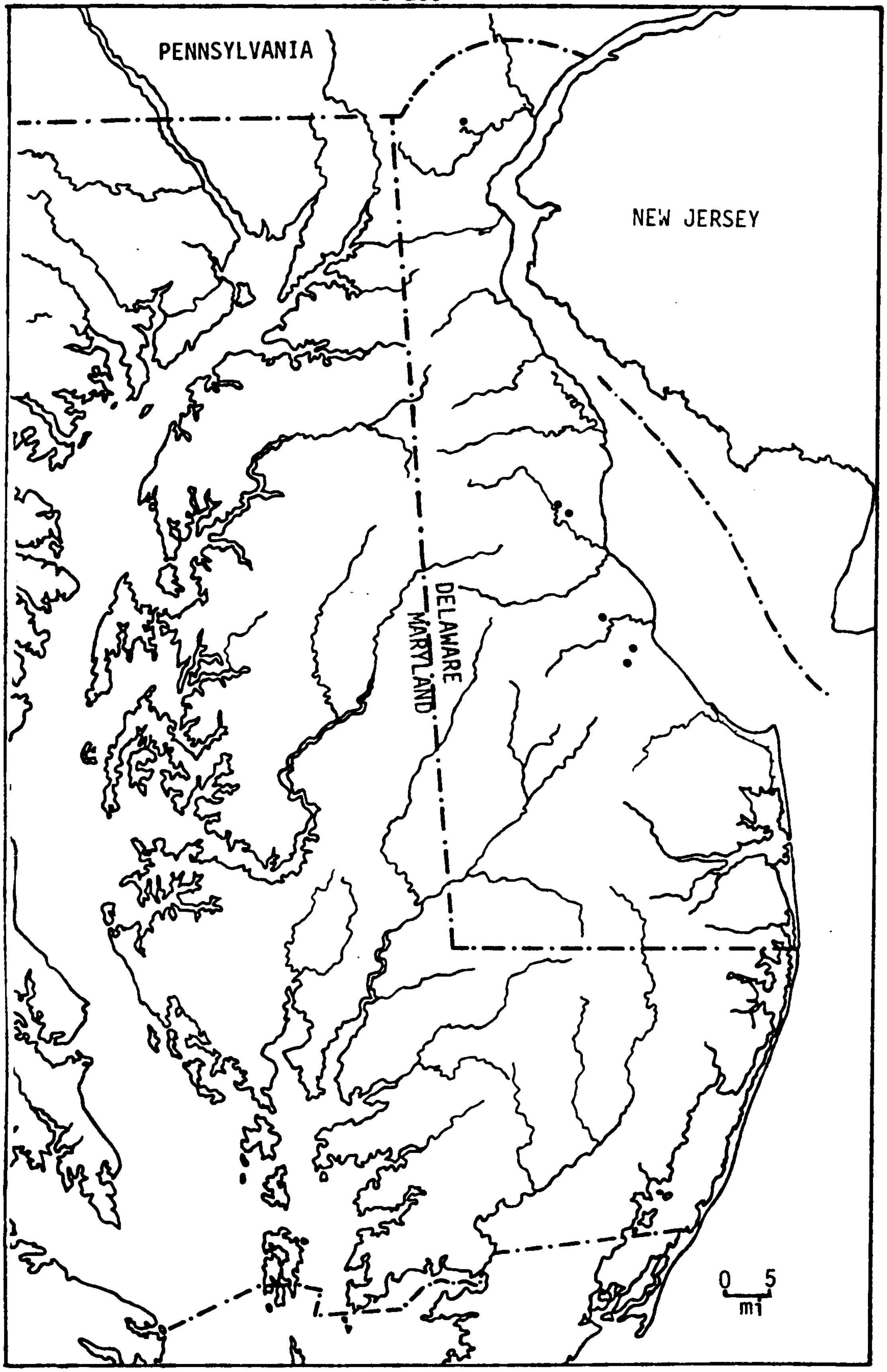


Fig. II-47b: Distribution of known sites, mid-Atlantic subarea, Middle Archaic Period.

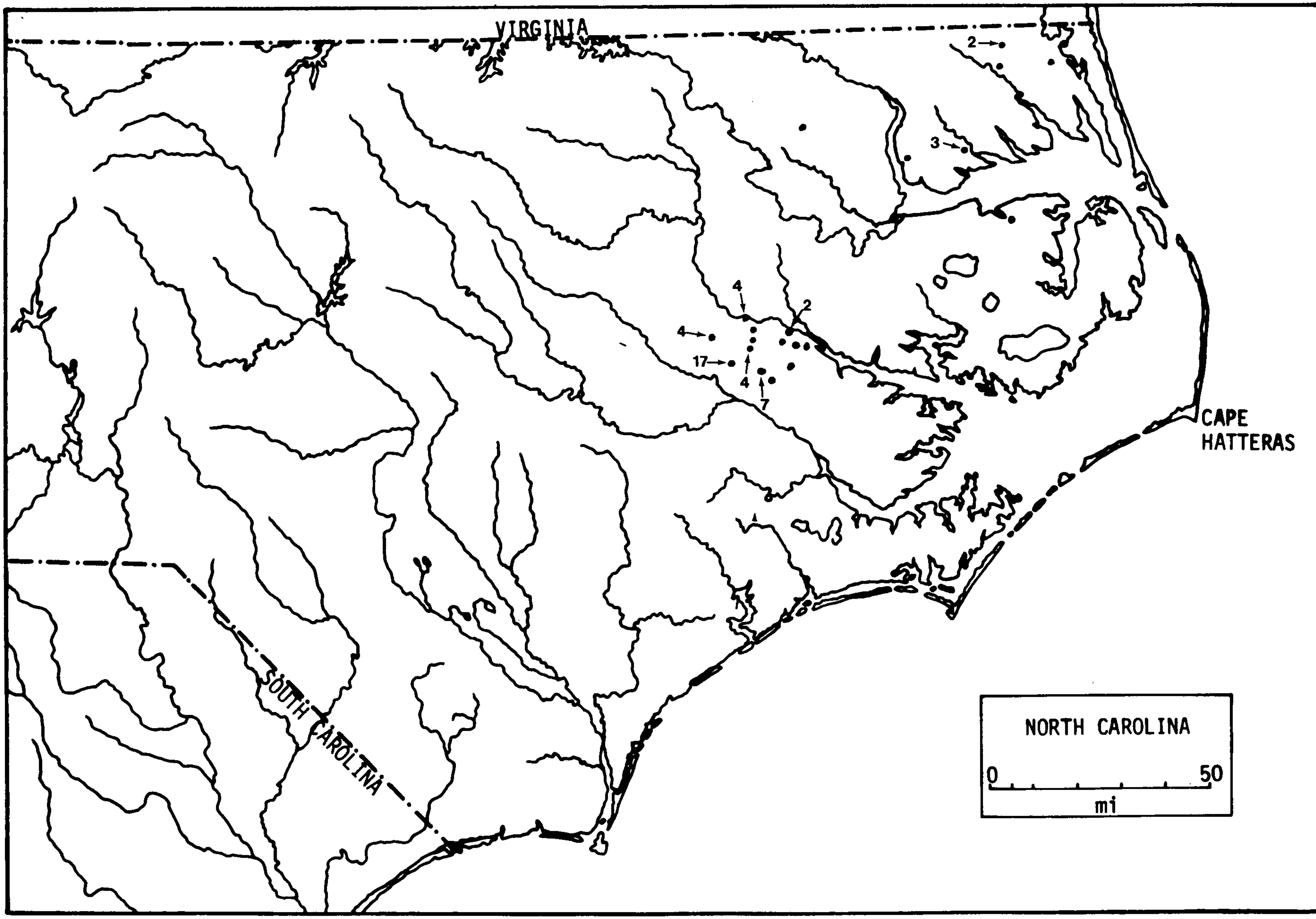


Fig. II-47c: Distribution of sites, mid-Atlantic subarea, Middle Archaic Period.

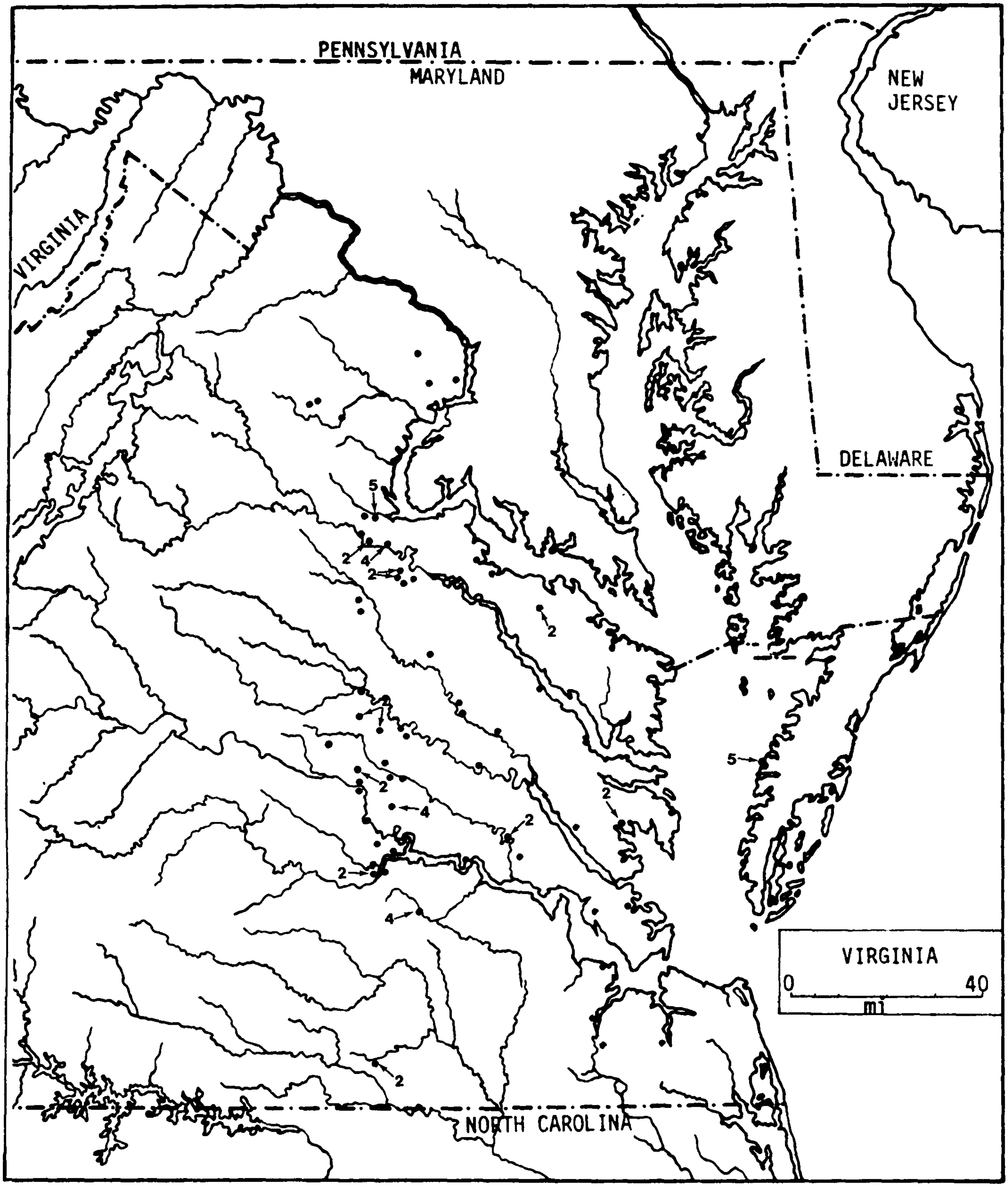


Fig. II-47d: Distribution of sites, mid-Atlantic subarea, Middle Archaic Period.

TABLE II-34: Tabulation of site data, Middle Archaic Period, mid-Atlantic subarea.

PERIOD: MIDDLE ARCHAIC

Total sites:	173
Coastal sites:	3
Shell heaps:	

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	3
Sites at 3-8%:	2
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	94	Ocean:	
Small river:	20	Bay:	
Major river:	12	Harbor:	
Lake:	1	Sites inundated:	
Swamp:	29	Sites at confluences:	10
Salt marsh or estuary:			

LANDFORM TYPE:

confirm or refute this pattern, unless the increase in the brookside settlements (from 44.8% in the Early Archaic Period to 54.4% in the Middle Archaic Period) represents a shift toward greater use of zones where valleys are narrower and a wider variety of resources cluster.

Other studies contribute information on other site types and frequencies. Coe (1964) has demonstrated the existence of fishing camps near falls and other environmental features facilitating fishing. Turner (1978) has documented, for Virginia at least, a number of Middle Archaic sites in the present-day coastal and transitional zones that is considerably smaller than the number found further inland. These unpopulous zones, in Middle Archaic times, would have been the inner coastal plain, while the populous zone would have been an upland area; the contemporary coastal zone has since been inundated and these relationships therefore have no bearing on Middle Archaic coastal settlement.

5.4.4 Late Archaic Period

With the coming of the Late Archaic Period, the diversity of site types and locations known in the archaeological record increases (Cavallo 1978). Part of this increase can probably be attributed to use of a wider variety of resources, but another part is an artifact of less inundation of former land surfaces than in earlier periods. (See below.)

As in previous periods, fishing camps were located at falls, rills, and rapids (Coe 1964). Turnbaugh (1975) and Custer (1978) have both argued for the importance of fishing camps in the Susquehanna tradition, attempting to correlate climatic change, anadromous fish distribution, and distribution of sites of this tradition. Custer, in particular, suggests that the Susquehanna tradition was oriented more strongly toward fish exploitation than earlier or later traditions. It should be remembered that both Turnbaugh's and Custer's arguments are speculative and that the postulated correlations are not compelling.

The Late Archaic Period in the mid-Atlantic subarea is the first period where lower estuarine and full coastal zones of that time have remained above the level of the transgressing sea and sites from these zones are known. Probably not coincidentally, the Late Archaic Period is also the first period where shell middens are represented. As Table II-35 shows, 41 shell middens (out of 684 sites) are recorded for this subarea and Period. This number is somewhat misleading, since only Virginia has identified the date of significant numbers of its shell middens. In Virginia, of 514 Late Archaic coastal plain sites, 39 are shell middens. (Fifty-four shell middens from that state are of uknown period and some of these also may be Late Archaic.) Study of these shell middens has been limited and locational attributes isolated are few, but they are found along protected shores of both estuaries and full coasts.

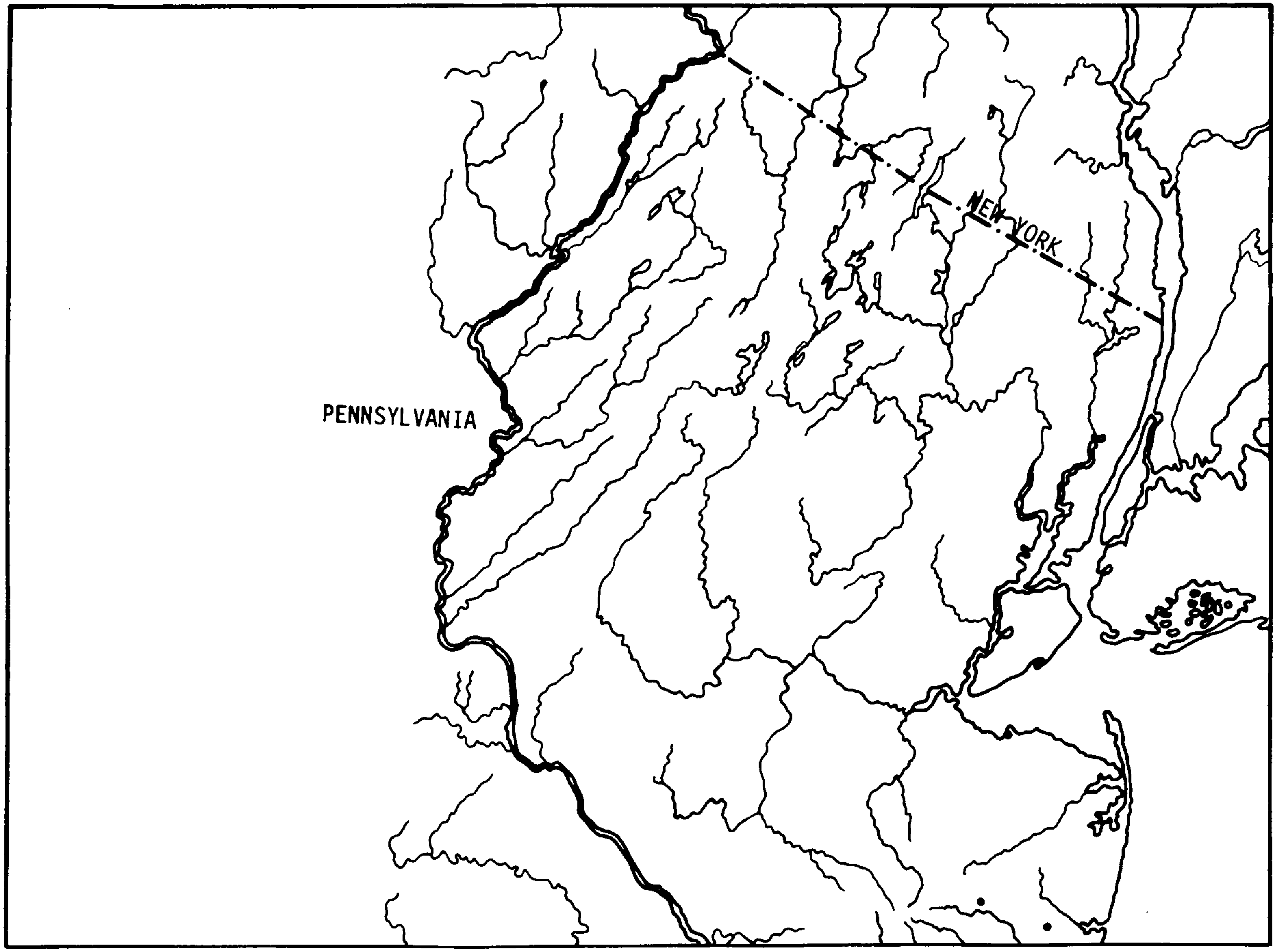


Fig. II-48a: Distribution of sites, mid-Atlantic subarea, Late Archaic Period. (continued on following page).

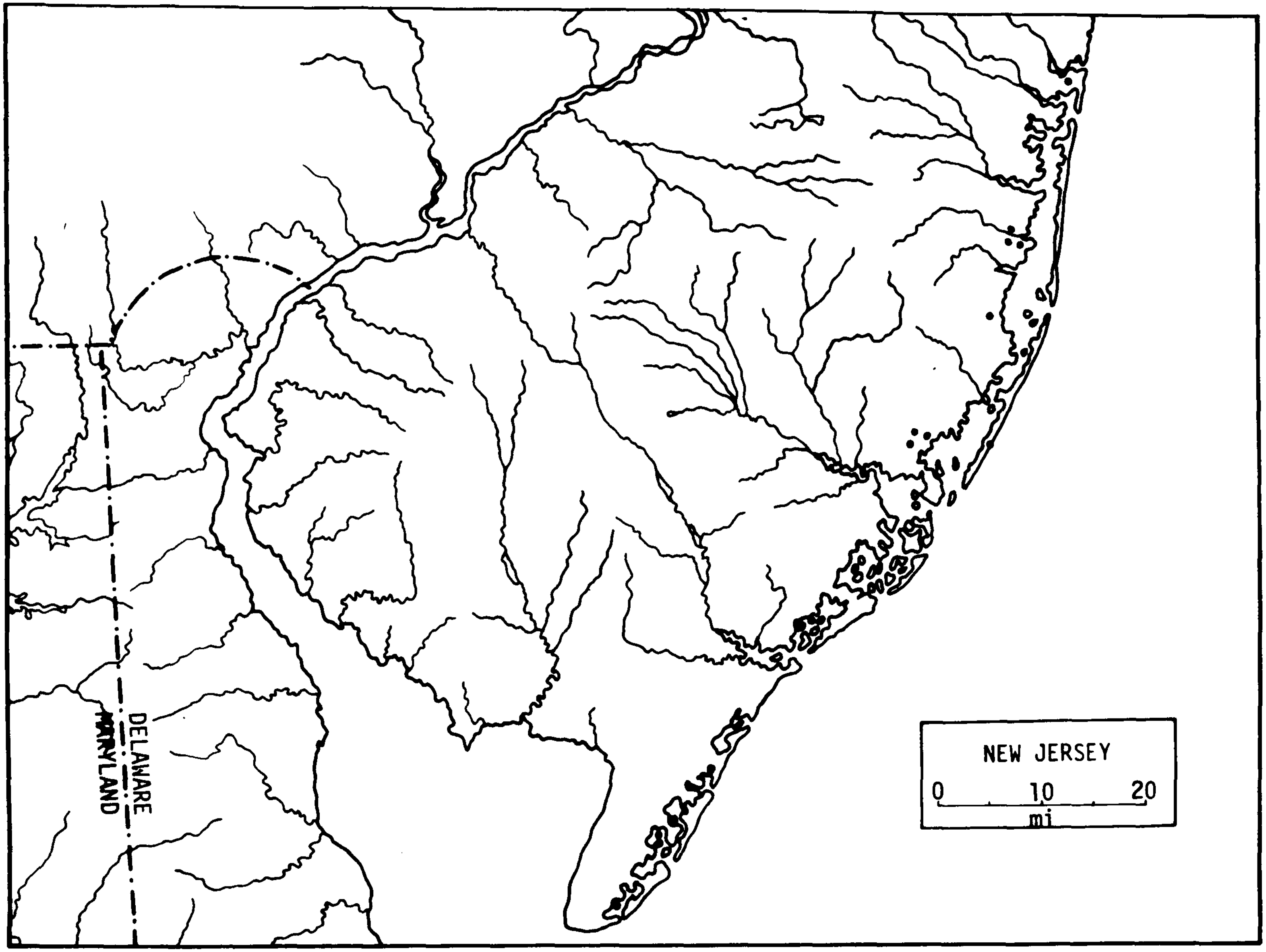


Fig. II-48a: Distribution of sites, mid-Atlantic subarea, Late Archaic Period.

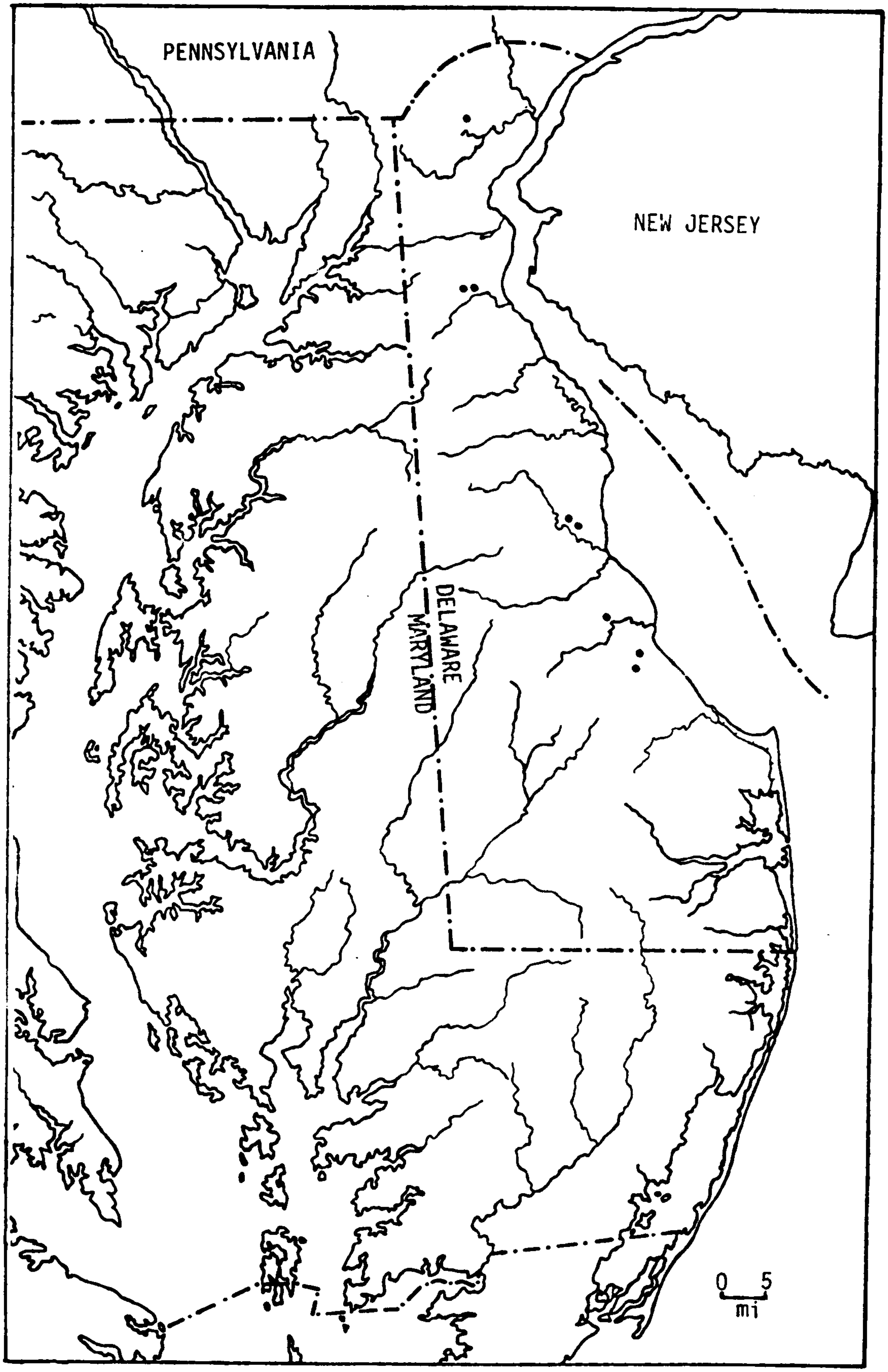


Fig. II-48b: Distribution of sites, mid-Atlantic subarea, Late Archaic Period.

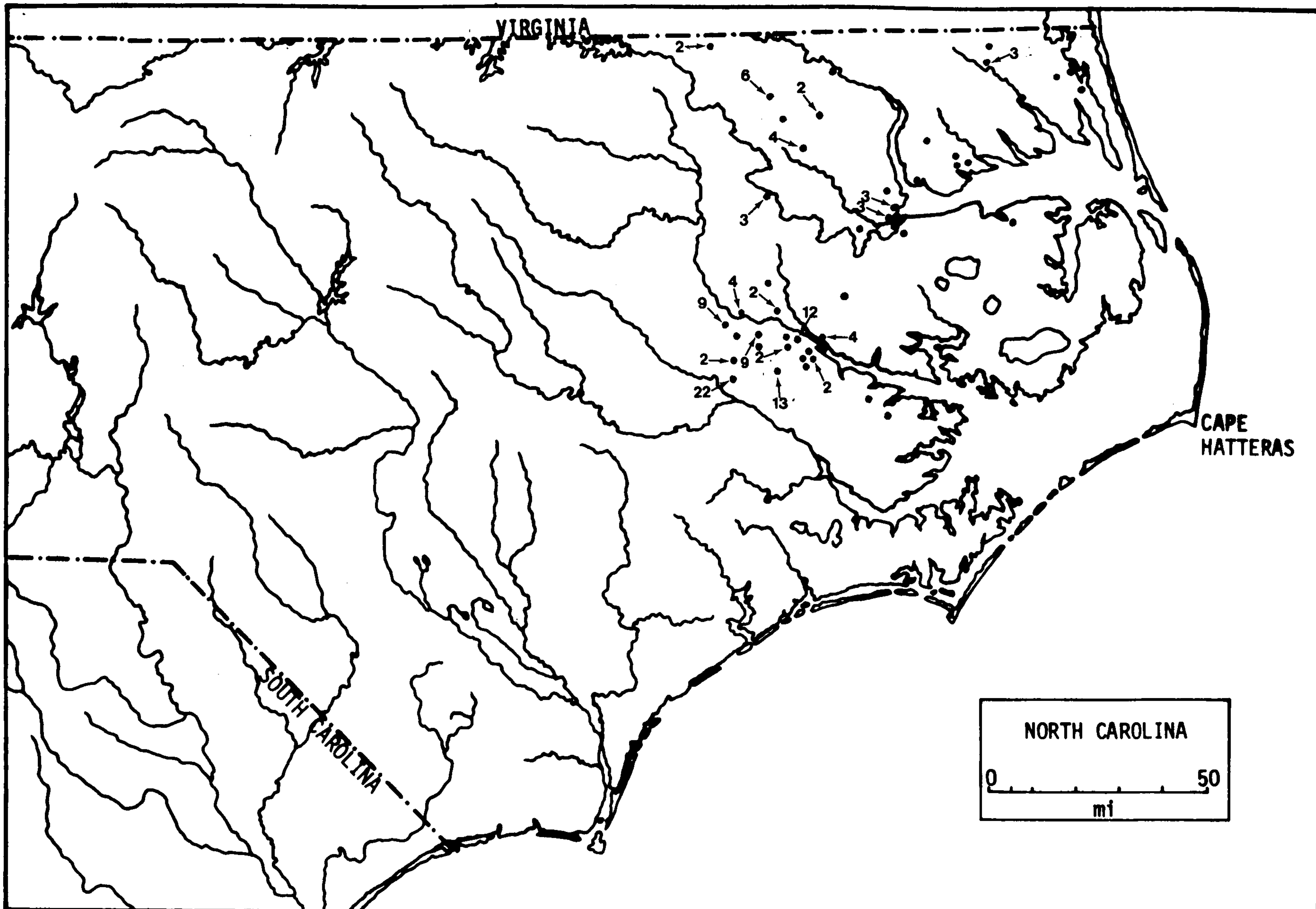


Fig. II-48c: Distribution of sites, mid-Atlantic subarea, Late Archaic Period.

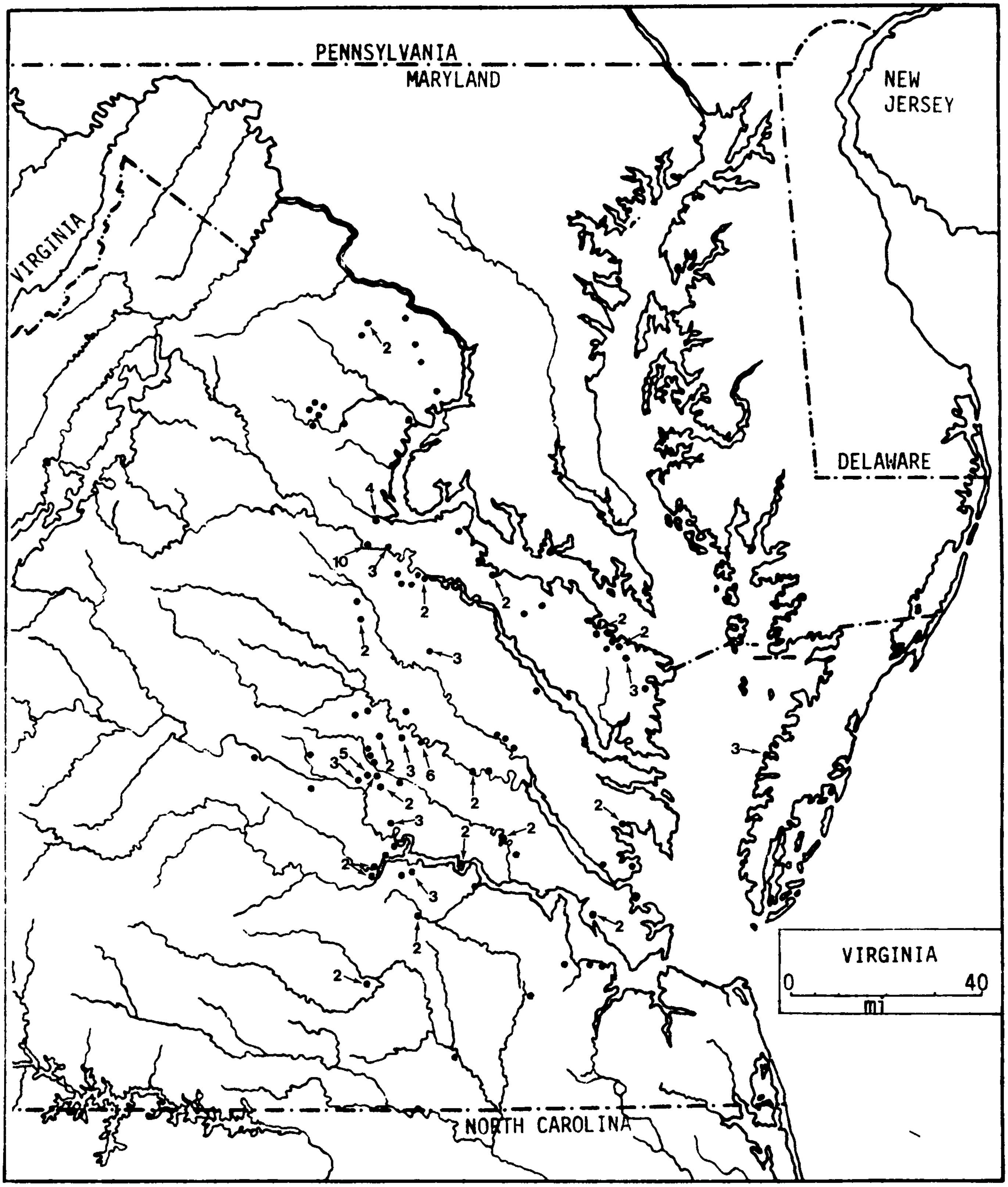


Fig. II-48d: Distribution of sites, mid-Atlantic subarea, Late Archaic Period.

TABLE II-35: Tabulation of site data, Late Archaic Period, mid-Atlantic subarea.

PERIOD: LATE ARCHAIC

Total sites:	684
Coastal sites:	10
Shell heaps:	41

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	8
Sites at 3-8%:	2
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	358	Ocean:	
Small river:	112	Bay:	
Major river:	75	Harbor:	
Lake:	5	Sites inundated:	
Swamp:	42	Sites at confluences:	41
Salt marsh or estuary:	3		

LANDFORM TYPE:

The greatest portion of settlement variety is subsumed into the category of camps, where settlement locations and presumed functions are highly varied. In his idealized transect, Gardner (1978) has documented this fact and has noted that greatest size variation is on the coastal plain. There, camps vary from very small to very large, sometimes covering several acres; in the piedmont, camps are nearly always small. Turner (1978) has seen a somewhat greater frequency for sites of this period on the inner portion of the coastal plain than on the outer portion.

Fig. II-48 shows the distribution of Late Archaic sites in the mid-Atlantic subarea. Table II-35 tabulates the locational data on these sites. The diversity of nearest water type shown in this table probably reflects the diversity of environmental placement of settlements which has been noted above. Fig. II-49 shows the distribution of sites of the Archaic Period for which there is no more specific dating information.

5.4.5 <u>Woodland Period</u>
Of the 1,333 sites recorded for the Woodland Period, over two-thirds (904 sites) cannot be assigned to a more limited span within this Period. This fact, coupled with the general absence of settlement models for the Early or Middle Woodland Periods, has necessitated the treatment of the Woodland Period as a whole. In cases where more limited spans can be discussed, notably the Late Woodland Period, the settlement patterns of that period have been treated separately.

In New Jersey, Mounier (1978) has noted that Woodland settlement on the outer coastal plain was of low density, with small camps in a wide variety of environmental circumstances; the exception to this generalization to a number of somewhat larger camps near the head of tide of medium-sized rivers. These larger camps might be fishing camps. In Virginia, Turner (1978) has seen an increasing intensity in use of the coastal zone through the Woodland Period, but with the more interior zones always being more intensively used.

Wright (1973) has characterized coastal camps in the Chesapeake Bay region as small, less than 100 ft in greatest dimension. These camps occur in widely varying environments, but almost always near permanent water sources. Other coastal site types noted by Wright are black earth middens (deposits of organic-rich refuse, with oyster lenses in some cases) and shell middens (deposits of organic-rich refuse, with large quantities of shell). In general, black earth middens are smaller than shell middens, which may be well over 100 ft in diameter. Data indicate that both types of middens occur throughout estuarine and coastal zones, but specific locational attributes (other than proximity of shellfish beds for shell middens) have not been discovered (Autrey and Loftfield 1976; Wright 1973).

Dealing with the Late Woodland Period only, Wright (1973) found that shell middens tended to be more numerous than in earlier periods, but that individual shell middens tended to be smaller. The inventory

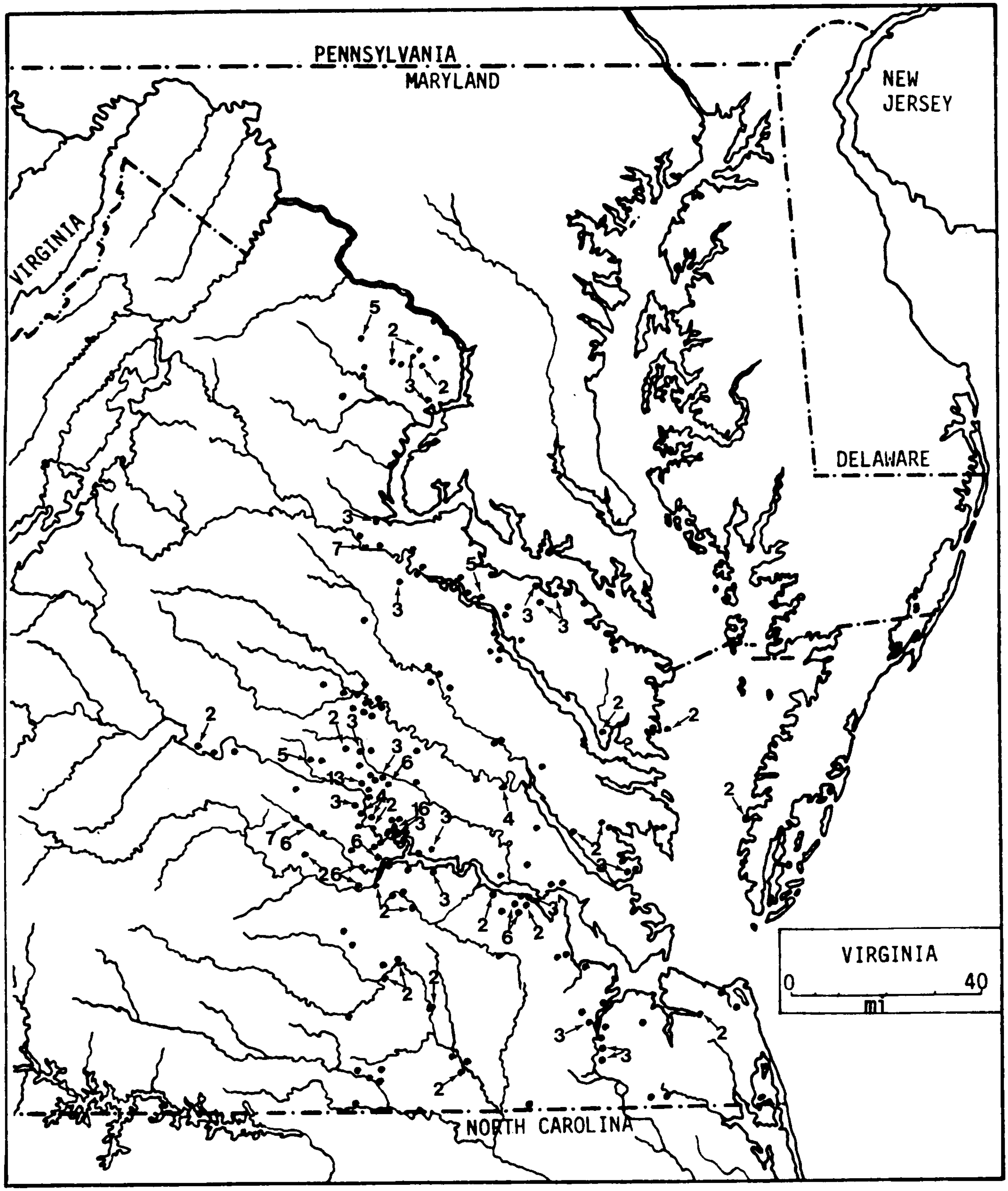


Fig. II-49: Distribution of sites, mid-Atlantic subarea, Archaic Period in general (there is no information available dating them more specifically).

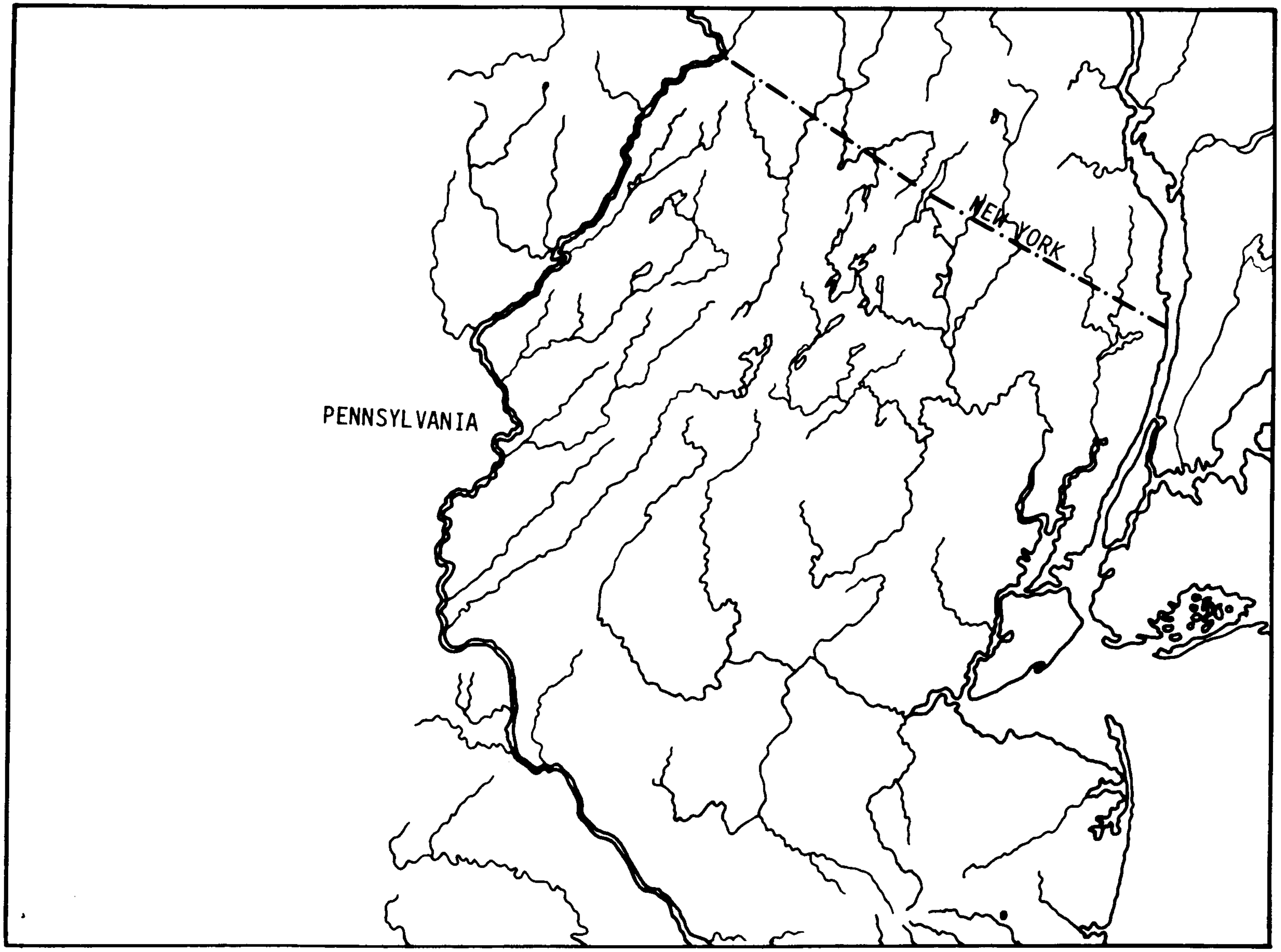


Fig. II-50a: Distribution of sites, mid-Atlantic subarea, Early Woodland Period (continued on following page).

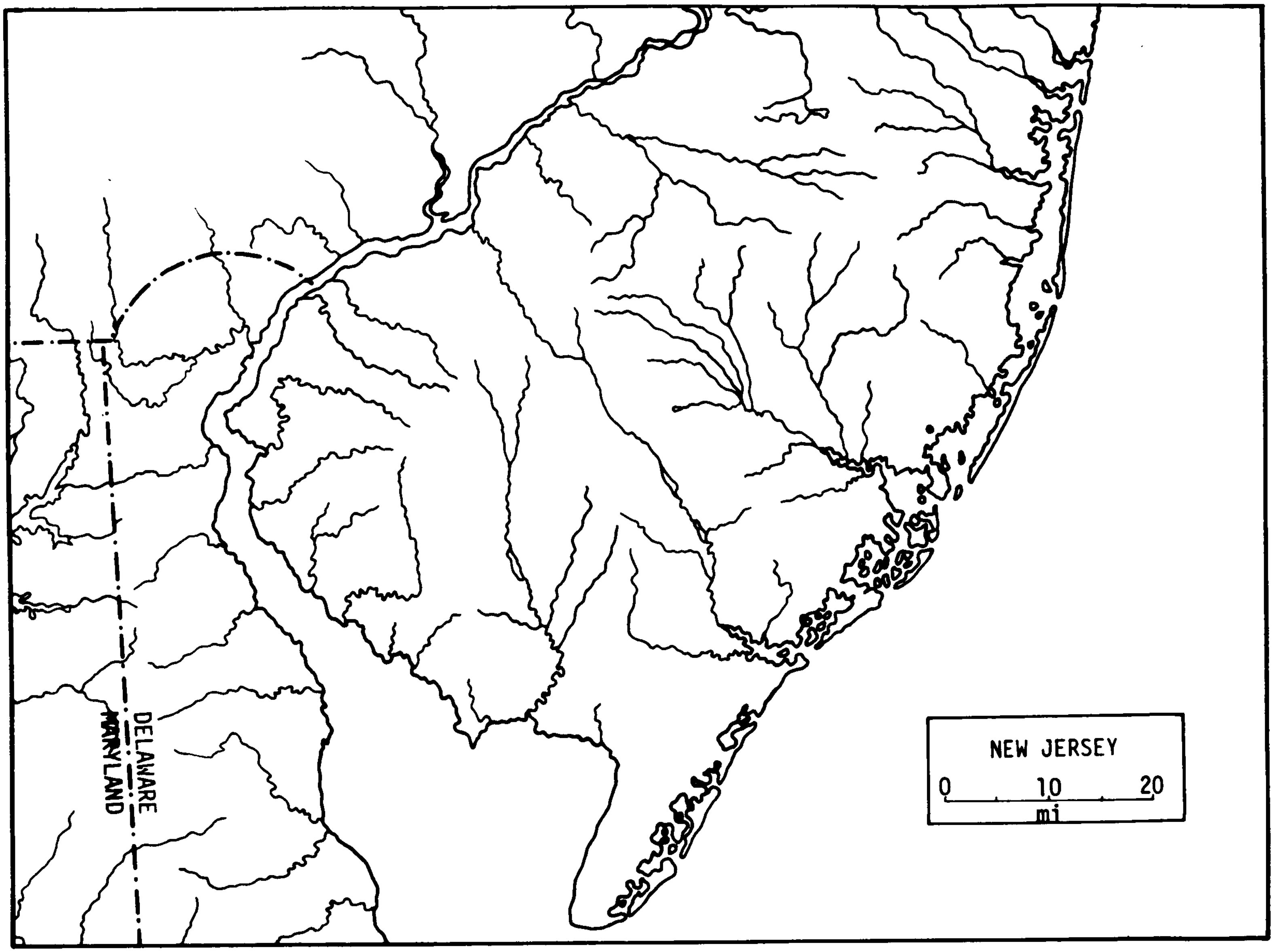


Fig. II-50a: Distribution of sites, mid-Atlantic subarea, Early Woodland Period

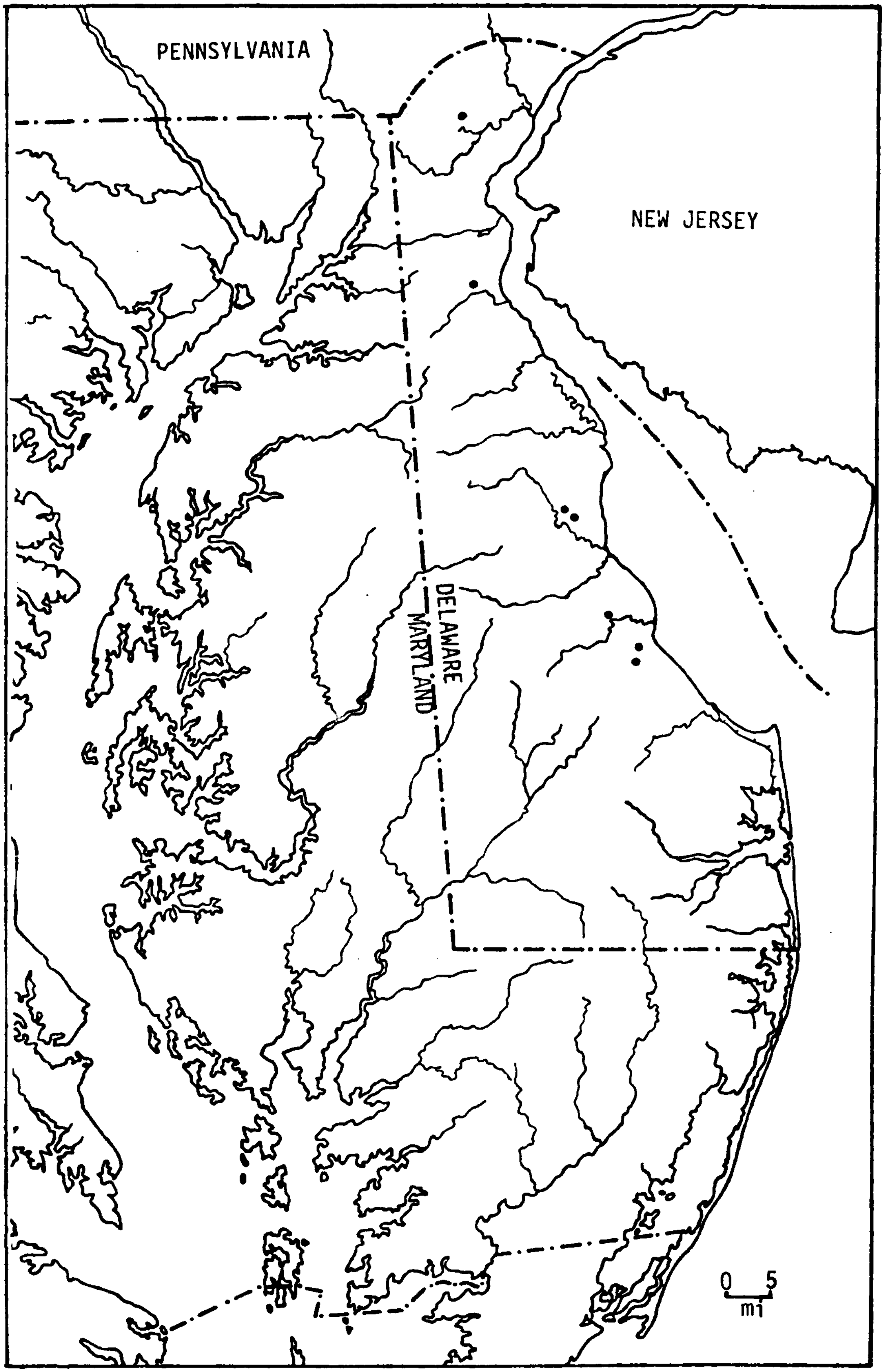


Fig. II-50b: Distribution of sites, mid-Atlantic subarea, Early Woodland Period.

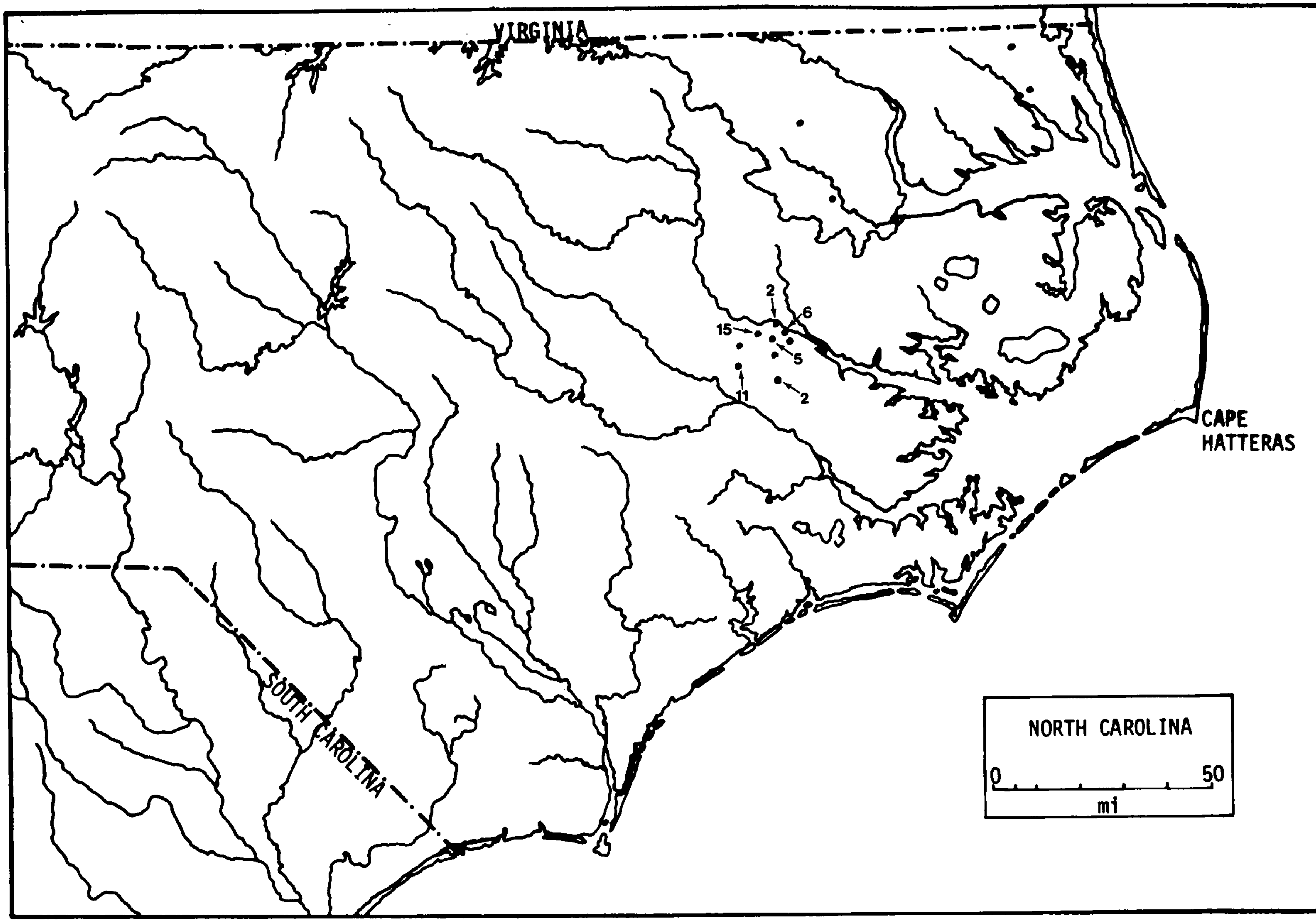


Fig. II-50c: Distribution of sites, mid-Atlantic subarea, Early Woodland Period.

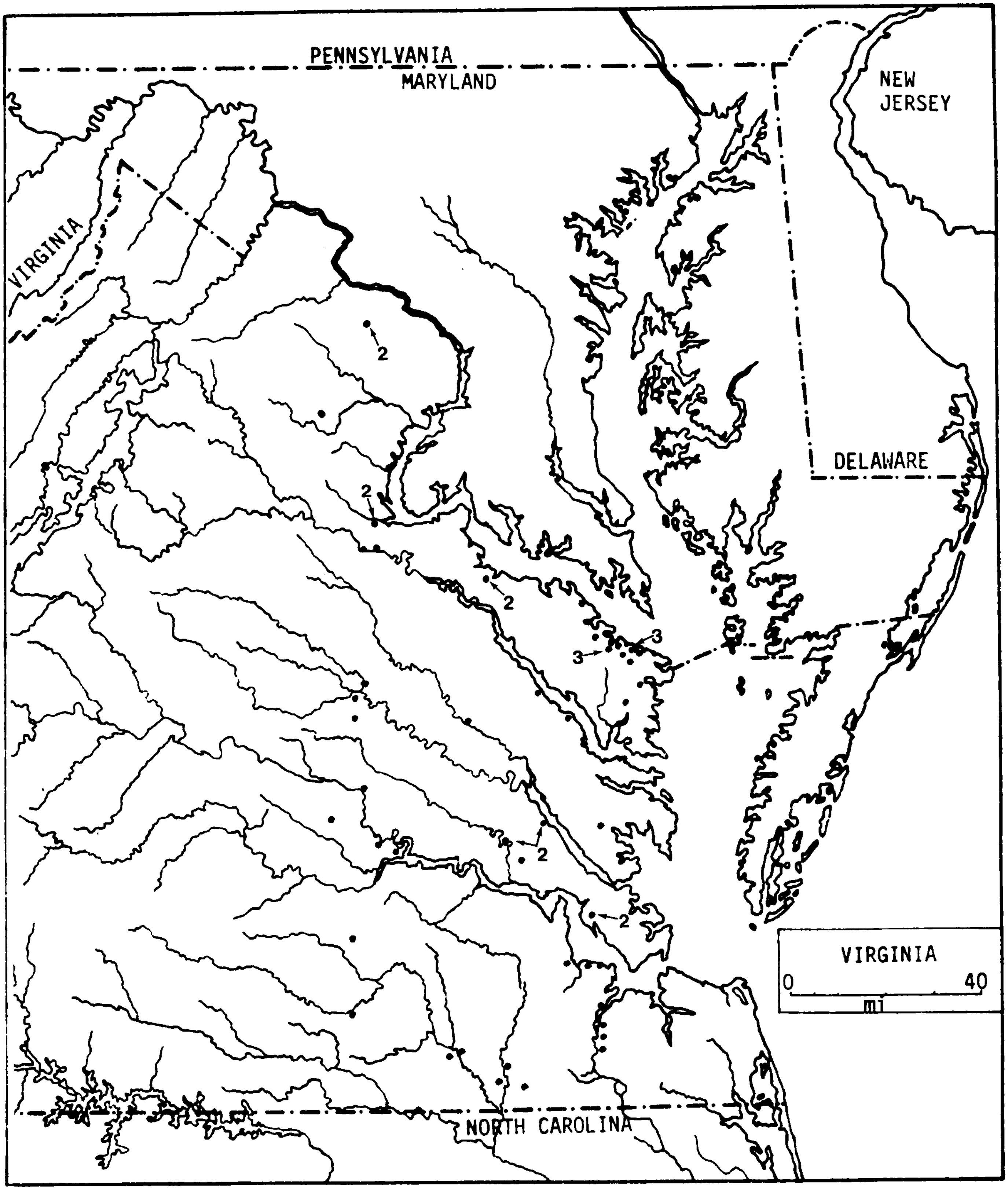
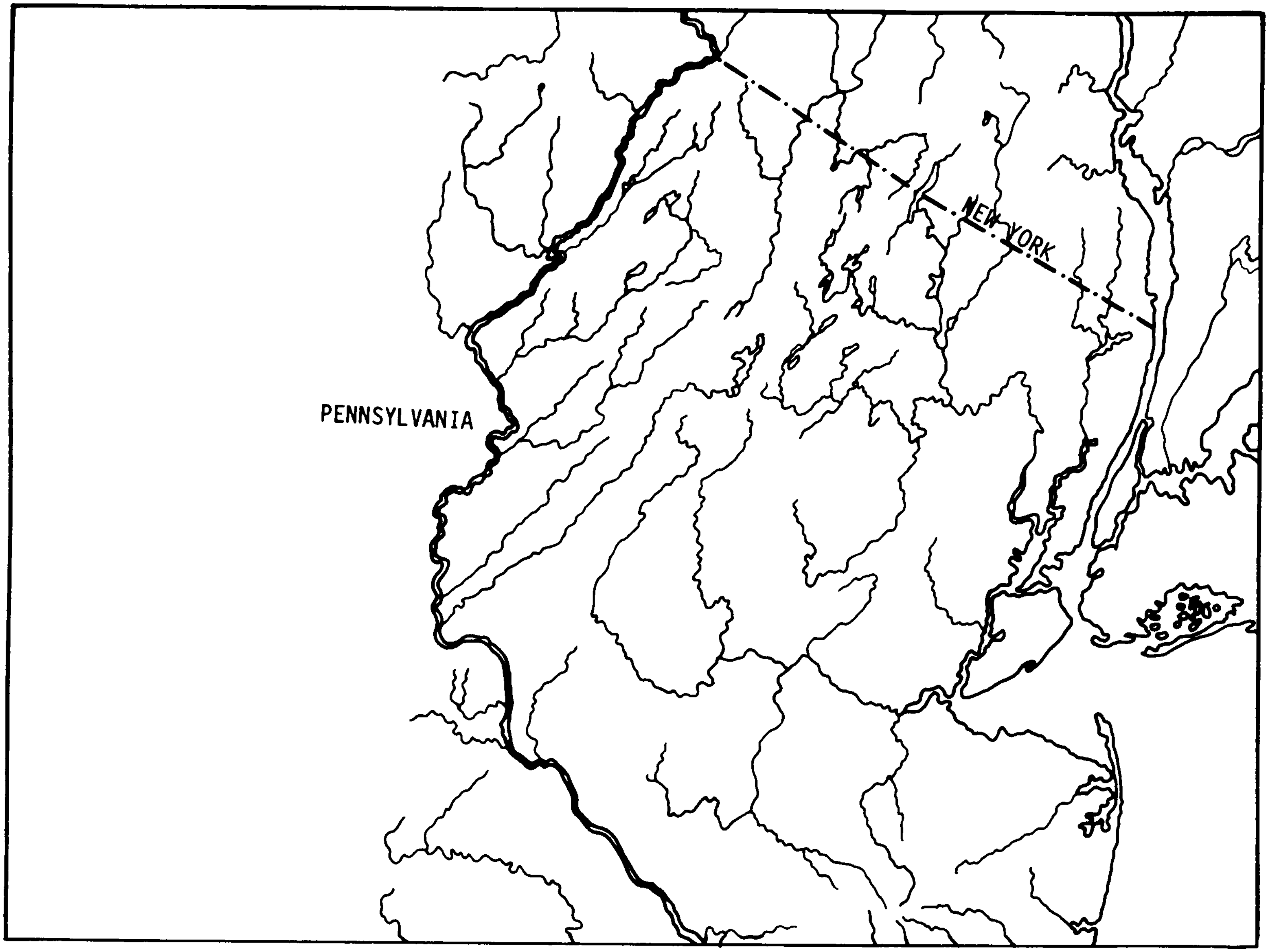


Fig. II-50d: Distribution of sites, mid-Atlantic subarea, Early Woodland Period.


NEW YORK
PENNSYLVANIA

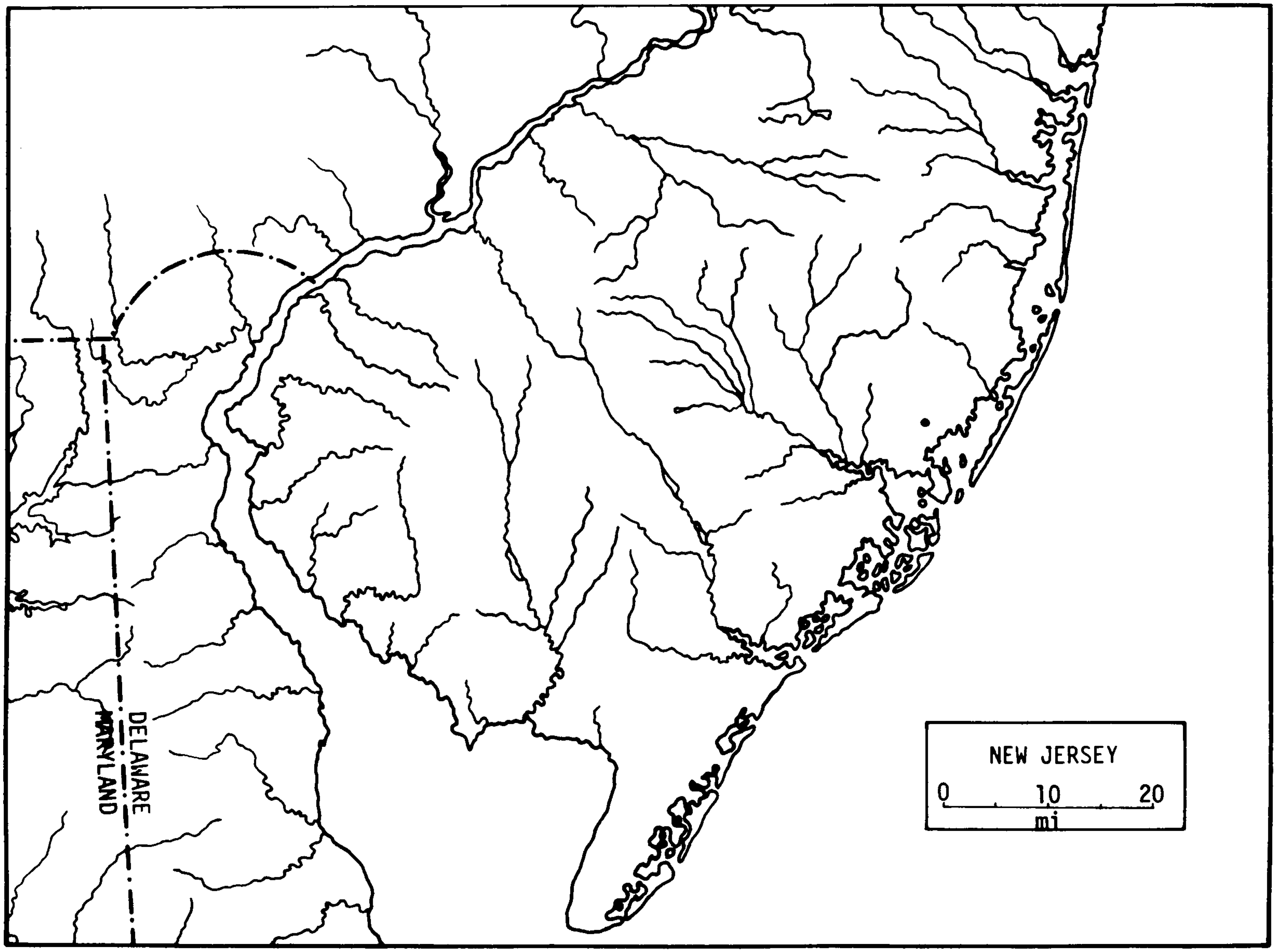


Fig. II-51a: Distribution of sites, mid-Atlantic subarea, Middle Woodland Period.

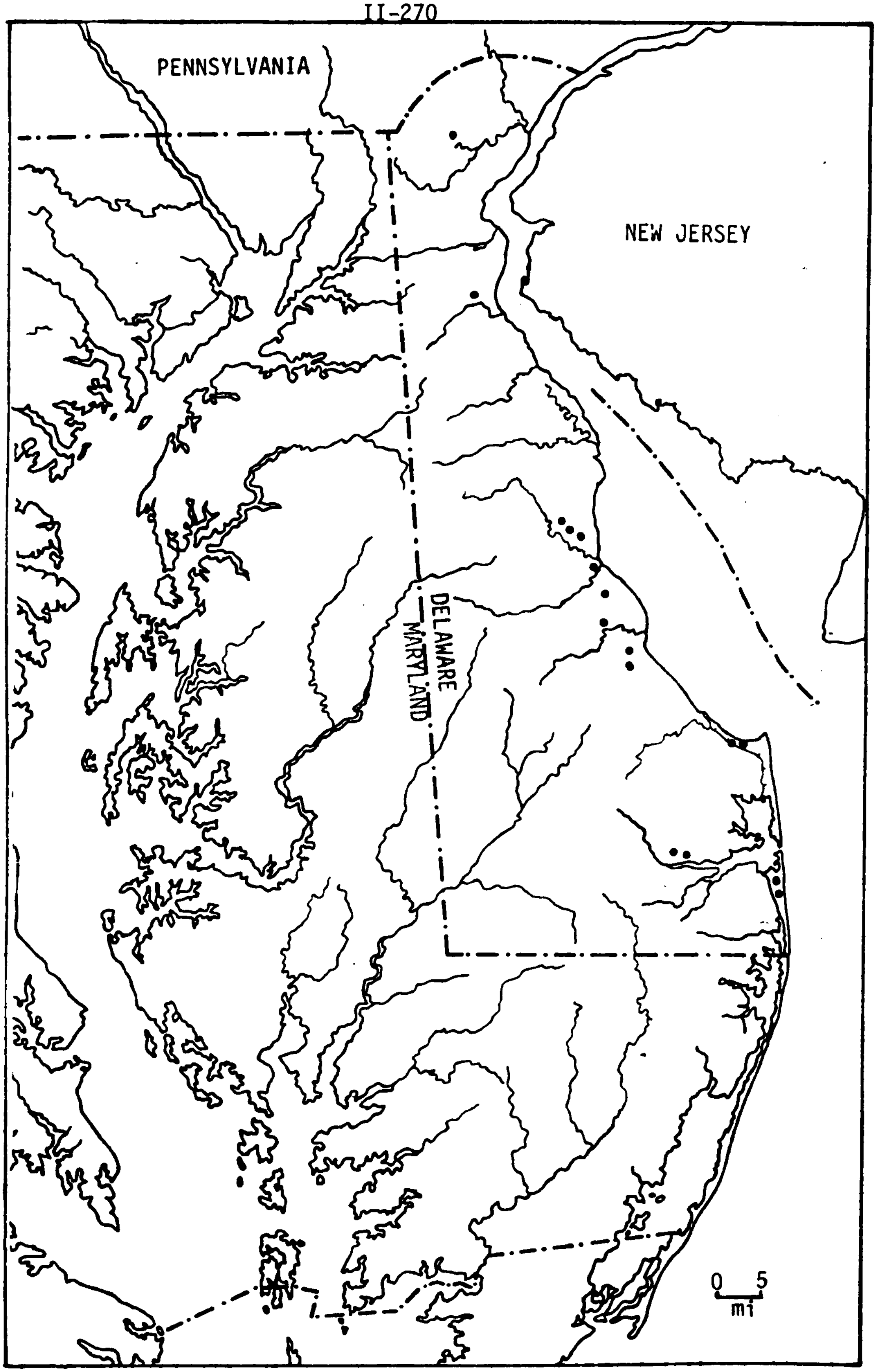


Fig. II-51b: Distribution of sites, mid-Atlantic subarea, Middle Woodland Period.

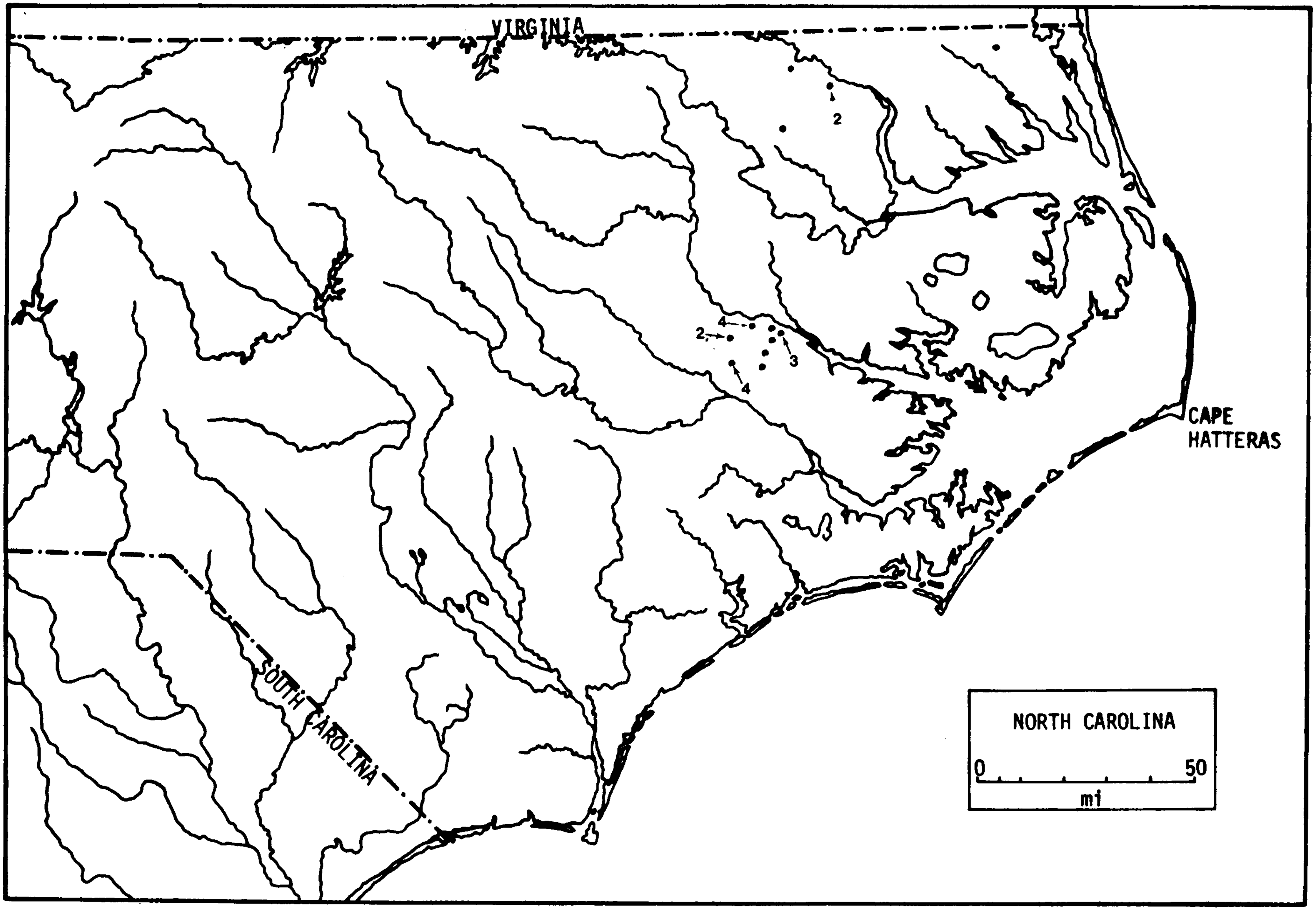


Fig. II-51c: Distribution of sites, mid-Atlantic subarea, Middle Woodland Period.

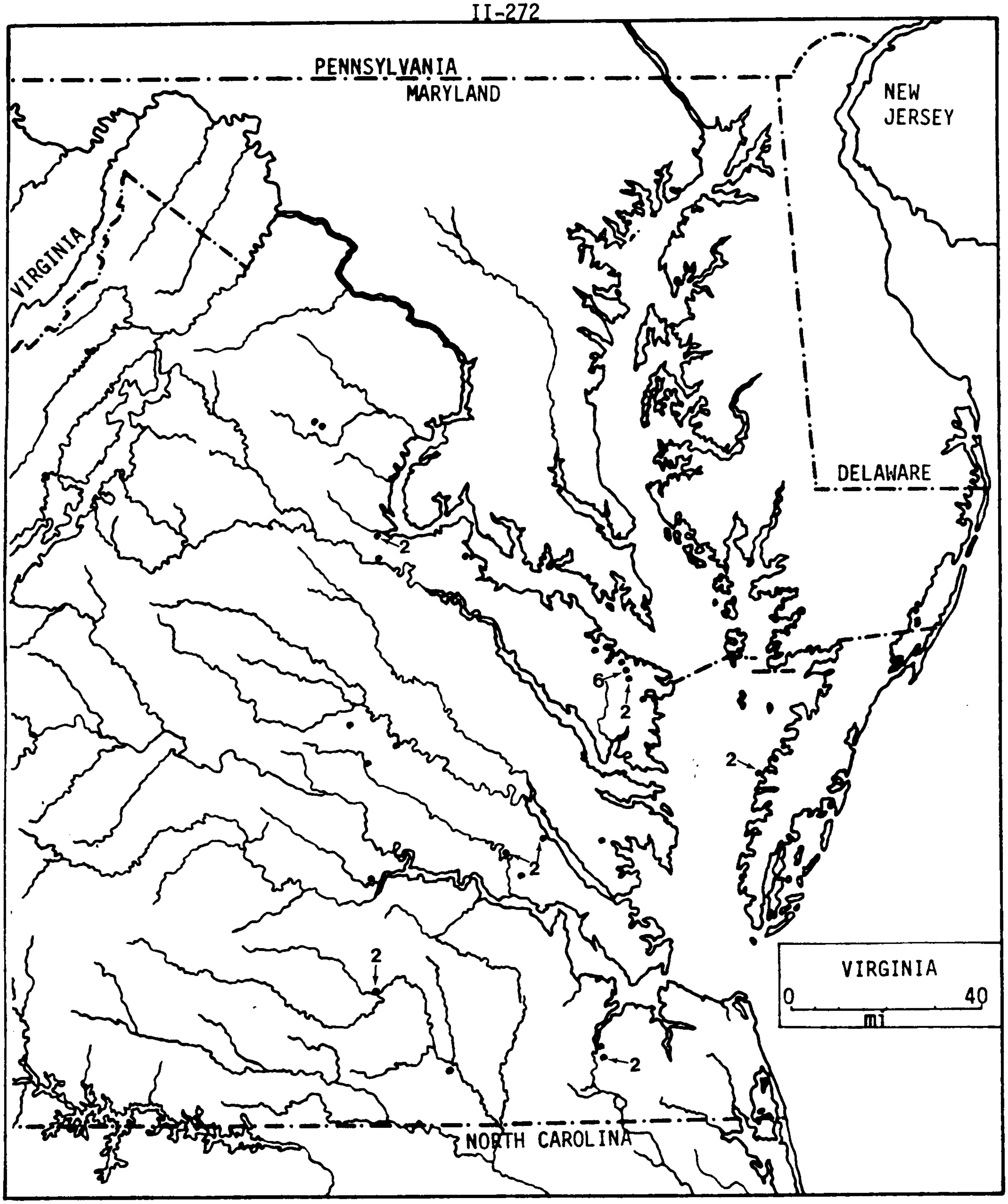


Fig. II-51d: Distribution of sites, mid-Atlantic subarea, Middle Woodland Period.

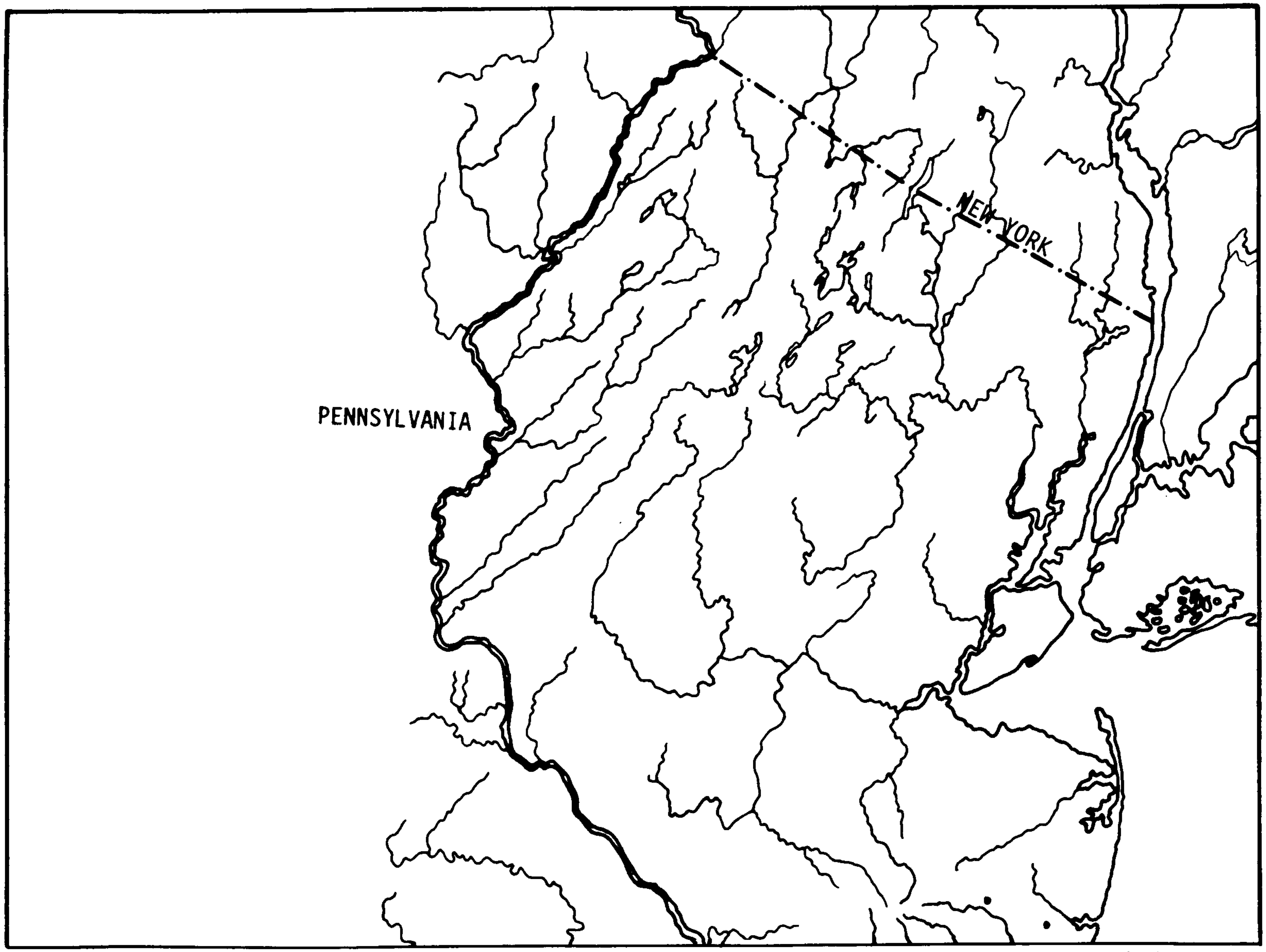


Fig. II-52a: Distribution of sites, mid-Atlantic subarea, Late Woodland Period
(continued on following page).

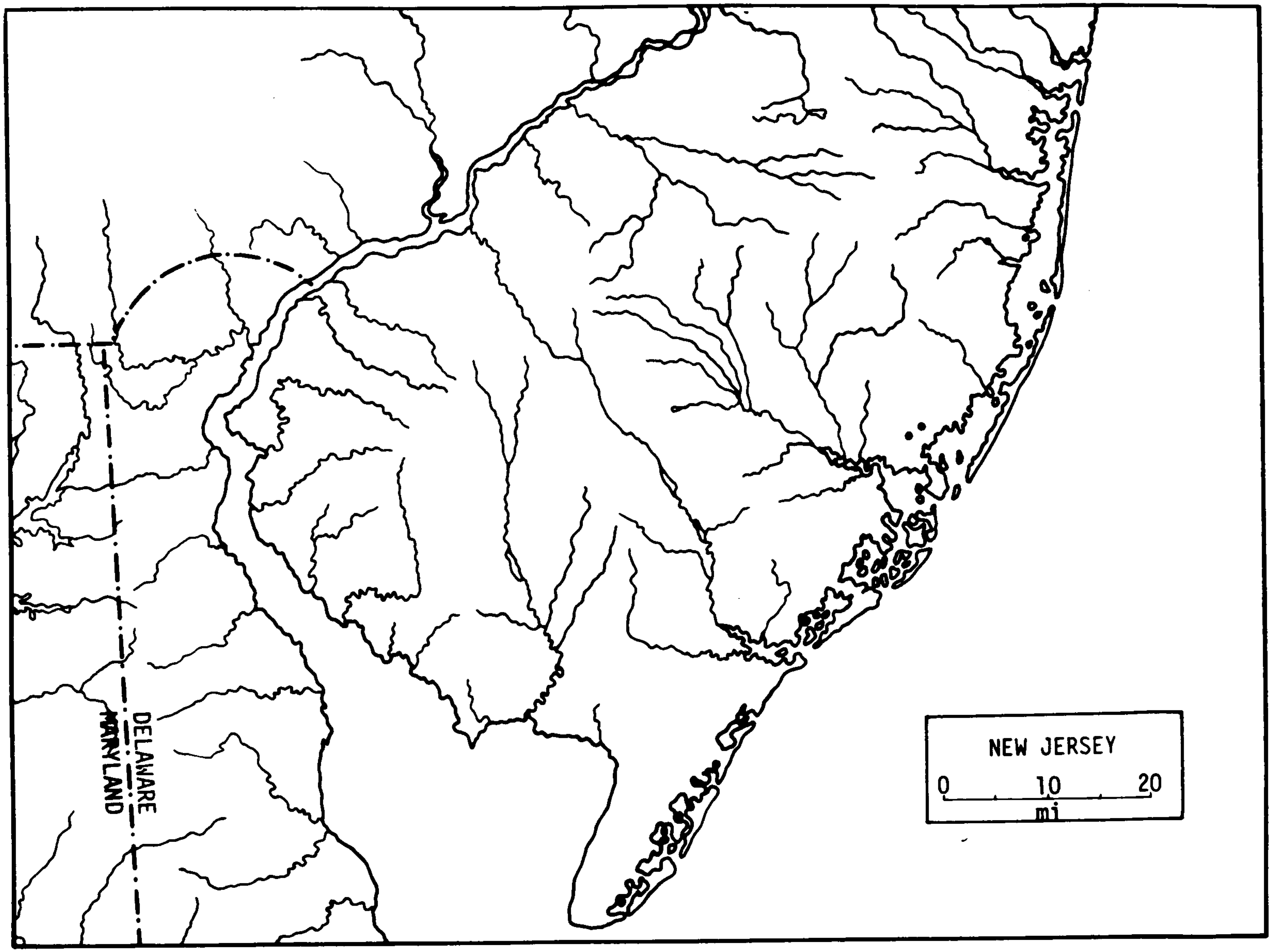


Fig. II-52a: Distribution of sites, mid-Atlantic subarea, Late Woodland Period

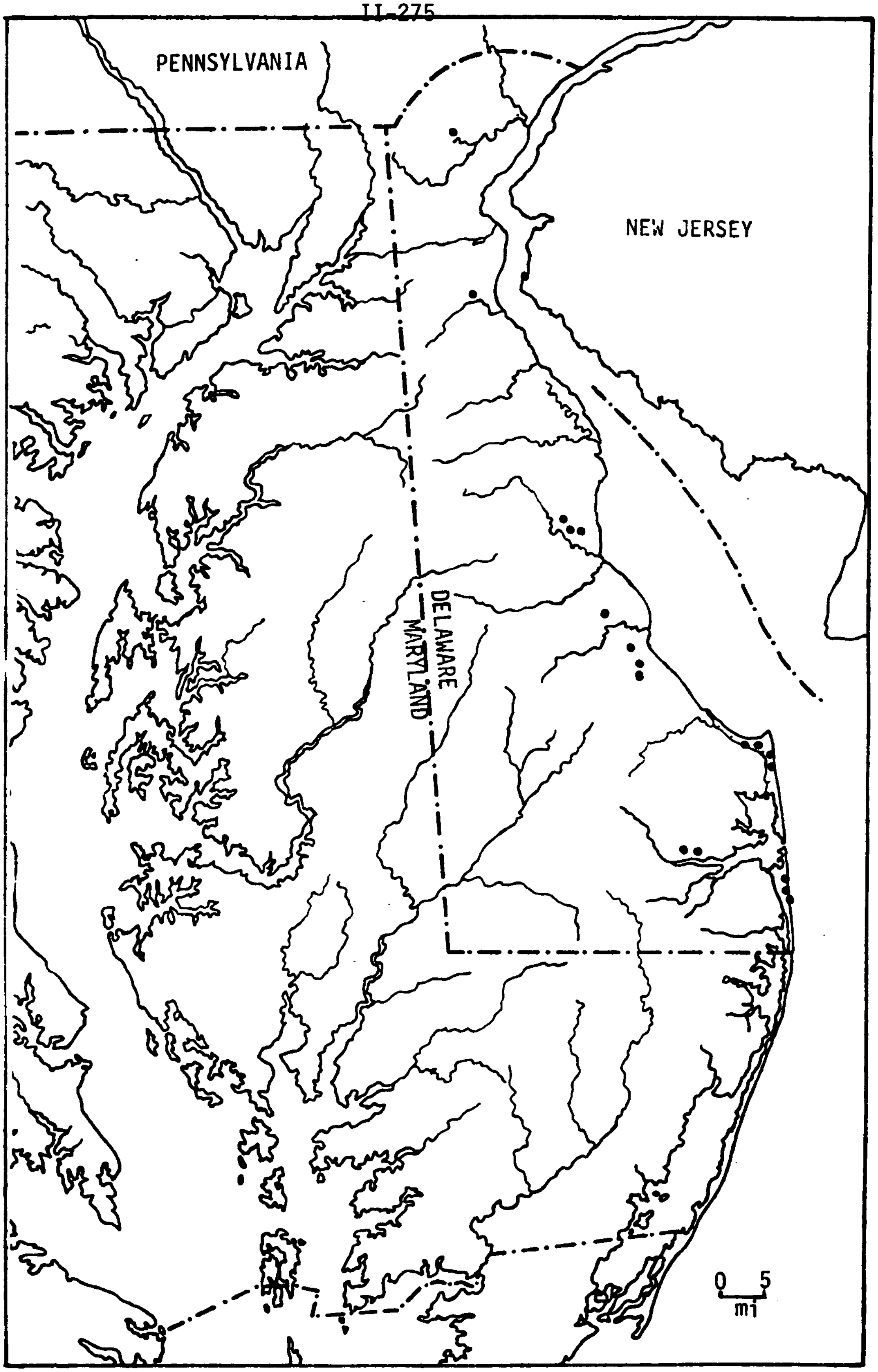


Fig. II-52b: Distribution of sites, mid-Atlantic subarea, Late Woodland Period.

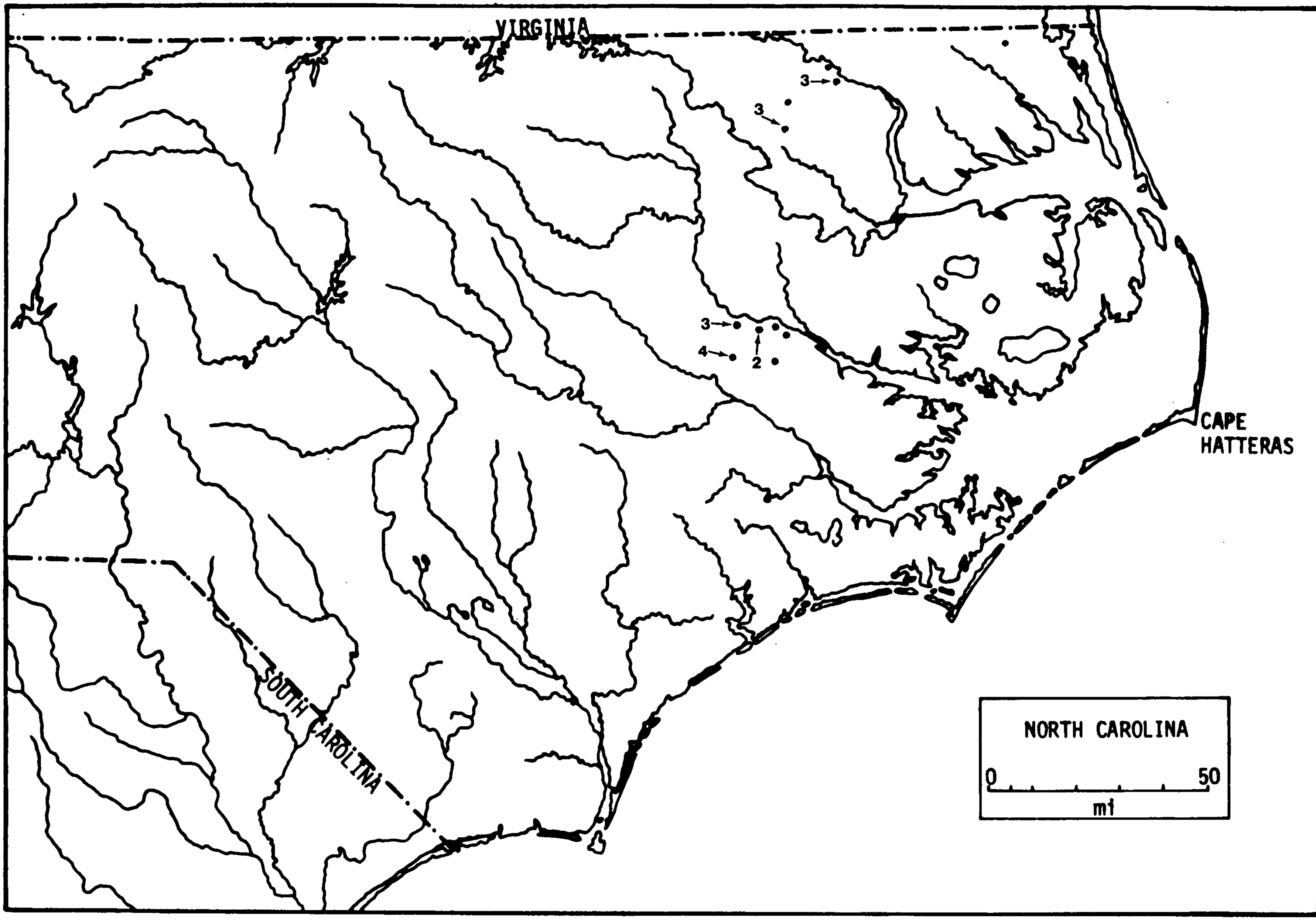


Fig. II-52c: Distribution of sites, mid-Atlantic subarea, Late Woodland Period.

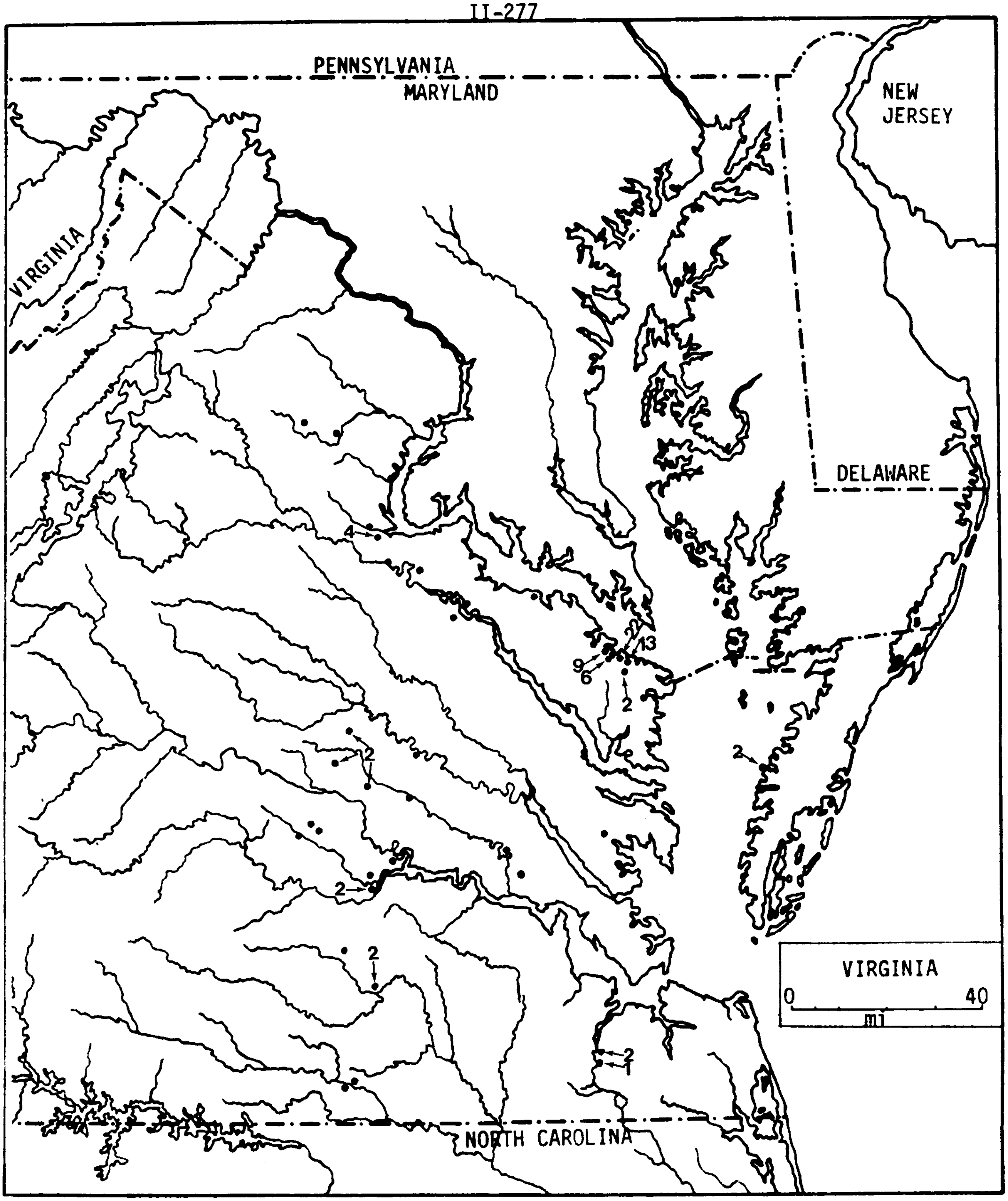


Fig. II-52d: Distribution of sites, mid-Atlantic subarea, Late Woodland Period.

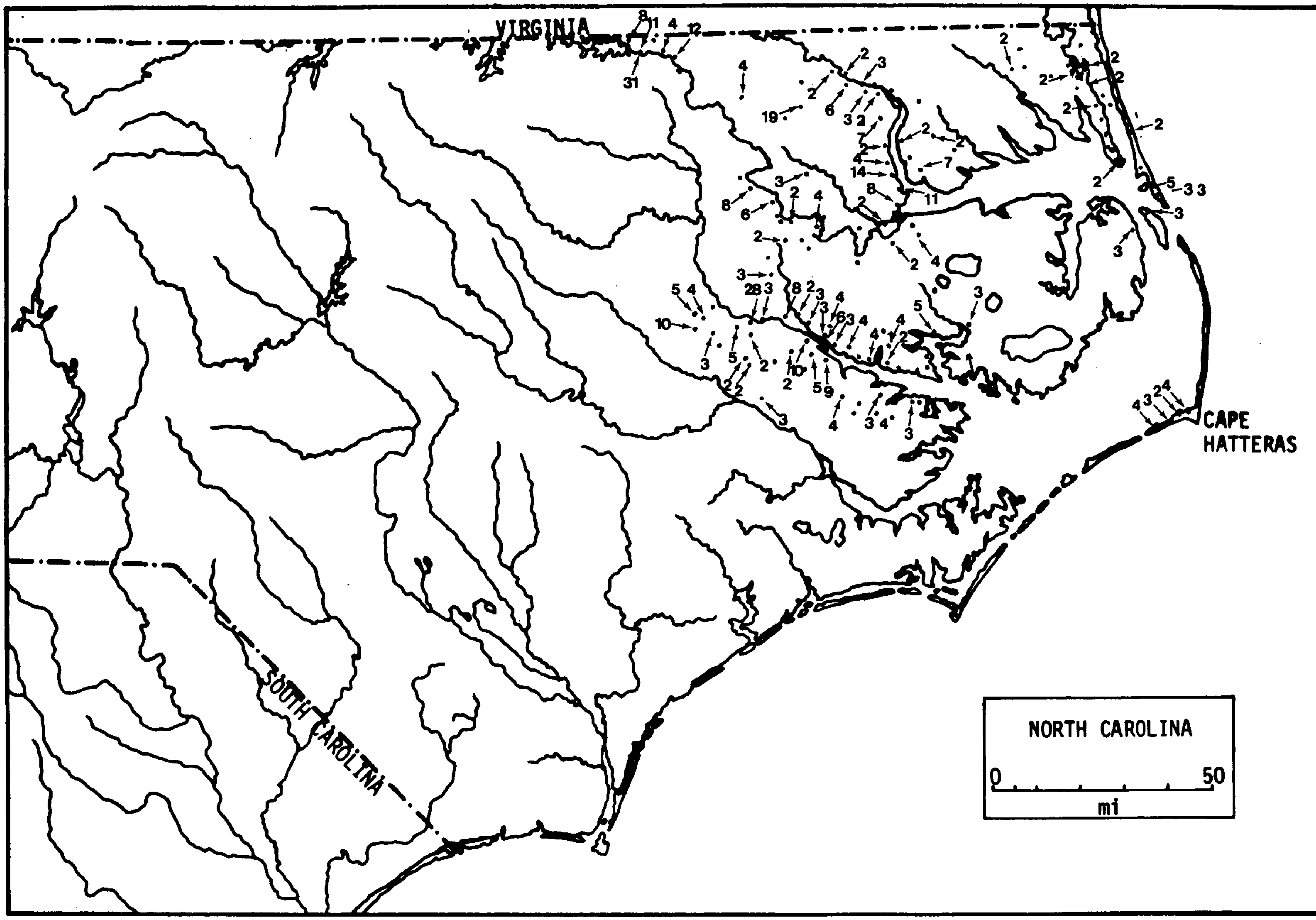


Fig. II-53a: Distribution of sites, mid-Atlantic subarea, Woodland in general.

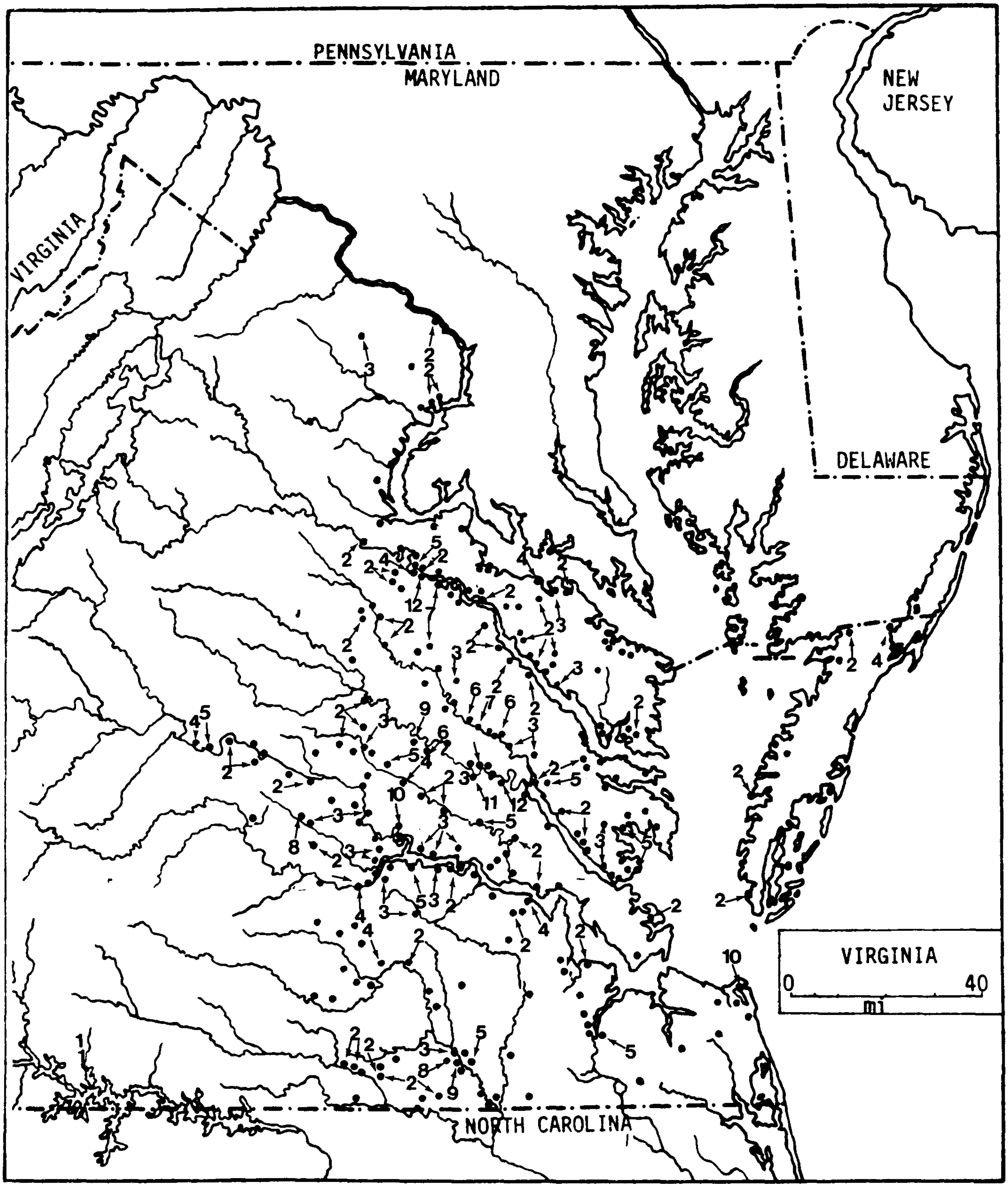


Fig. II-53b: Distribution of sites, mid-Atlantic subarea, Woodland in general.

TABLE II-36: Tabulation of site data, Early Woodland Period, mid-Atlantic subarea.

PERIOD: EARLY WOODLAND

Total sites:	122
Coastal sites:	1
Shell heaps:	15

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	6
Sites at 3-8%:	2
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	44	Ocean:	
Small river:	17	Bay:	
Major river:	8	Harbor:	
Lake:	3	Sites inundated:	
Swamp:	8	Sites at confluences:	6
Salt marsh or estuary:	1		

LANDFORM TYPE:

TABLE II-37: Tabulation of site data, Middle Woodland Period, mid-Atlantic subarea.

PERIOD: MIDDLE WOODLAND

Total sites:	94
Coastal sites:	8
Shell heaps:	21

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	3
Sites at 3-8%:	3
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	45	Ocean:	
Small river:	22	Bay:	
Major river:	3	Harbor:	
Lake:	3	Sites inundated:	
Swamp:	8	Sites at confluences:	3
Salt marsh or estuary:	2		

LANDFORM TYPE:

TABLE II-38: Tabulation of site data, Late Woodland Period, mid-Atlantic subarea.

PERIOD: LATE WOODLAND

Total sites:	213
Coastal sites:	15
Shell heaps:	43

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	4
Sites at 3-8%:	3
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	90	Ocean:	
Small river:	48	Bay:	
Major river:	8	Harbor:	
Lake:	10	Sites inundated:	
Swamp:	4	Sites at confluences:	12
Salt marsh or estuary:	5		

LANDFORM TYPE:

TABLE II-39: Tabulation of site data, Woodland Period in general, mid-Atlantic subarea.

PERIOD: WOODLAND, IN GENERAL

Total sites:	904
Coastal sites:	48
Shell heaps:	87

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	
Sites at 3-8%:	
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:	
Brook or stream:	428
Small river:	202
Major river:	108
Lake:	14
Swamp:	45
Salt marsh or estuary:	1

L. I. Sound:	
Ocean:	
Bay:	
Harbor:	
Sites inundated:	
Sites at confluences:	31

LANDFORM TYPE:

results support the suggestion that they become more numerous in the subarea as a whole, but data are not available to test whether size diminished in this period throughout the mid-Atlantic subarea (see Tables II-36 through -38).

R. A. Thomas and others (1975) have presented a series of settlement-subsistence models for the prehistoric coastal plain of Delaware. These models are inferential and have been derived from reconstructions of resource endowment and assumptions about human behavior and are largely untested. The Hughes-Wallis and Indian Landing sites, both approximately contemporaneous Late Woodland sites, have been examined and the authors believe that they form part of a settlement system consisting of summer and early fall seasonal camps along the coast and estuary (shell middens and perhaps black earth middens and camps), spring camps along the estuary and river valleys in well-drained woodlands (fishing camps), and mid-fall to late winter semi-permanent base camps further inland (villages?, camps?). The existence of such base camps at the same period as the Hughes-Wallis and Indian Landing sites has not yet been documented, so this site type has not been added to Table II-32.

With the development of agriculture in the Late Woodland Period, there were concommitant settlement-pattern changes. Large villages developed throughout the study area (Cavallo 1978; Hranicky 1974; Ritchie 1949; R. A. Thomas 1976a), probably in response to a combination of increased population and the need to store seasonal agricultural surplus. In Virginia (Turner 1978) and probably elsewhere, these villages tend to occur on fertile agricultural soils.

Figs. II-50 through -53 and Tables II-36 through -39 present data on locations of known Woodland sites in the mid-Atlantic subarea.

5.4.6 Unknown Period

Table II-40 and Fig. II-54 present data on the location and locational attributes of sites of unknown period in the mid-Atlantic subarea. The 1,323 sites in this category only 34.9% of the sites for which records were compiled in the mid-Atlantic subarea. This percentage is the lowest found in the three subareas and in this respect, the mid-Atlantic data base is the best documented.

The environmental attributes summarized in Table II-40 have relative values similar to those for specific periods, with a significant set of exceptions. The numbers of coastal sites and sites near salt-marshes and estuaries are inordinately high, considerably higher than for any specific period. The dated sample appears to underrepresent these sites, perhaps severely.

5.4.7 Discussion

Several series of characteristics believed to typify archaeological sites of all prehistoric periods have been suggested for the mid-Alantic

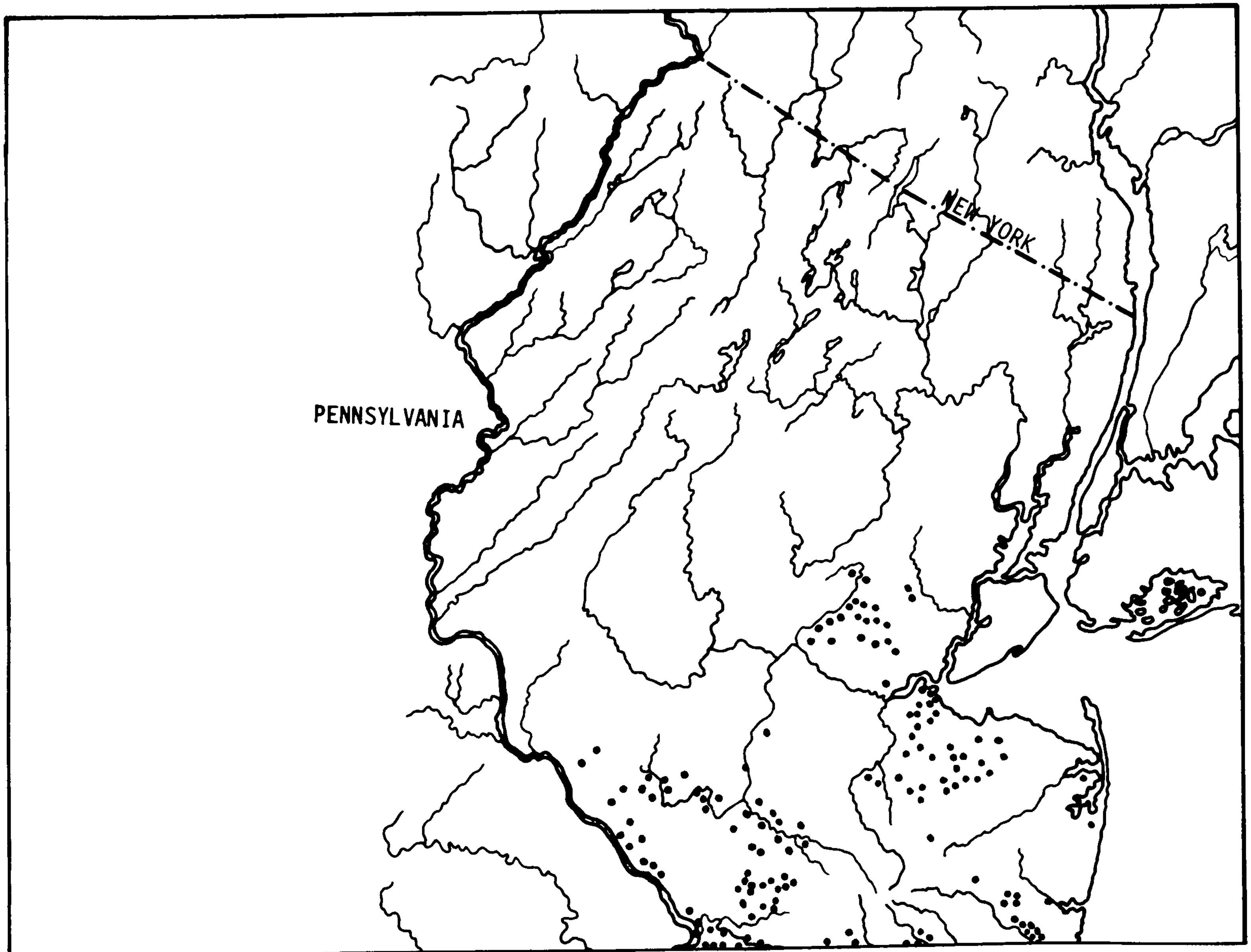


Fig. II-54a: Site distribution, mid-Atlantic subarea, unknown period (continued on following page).

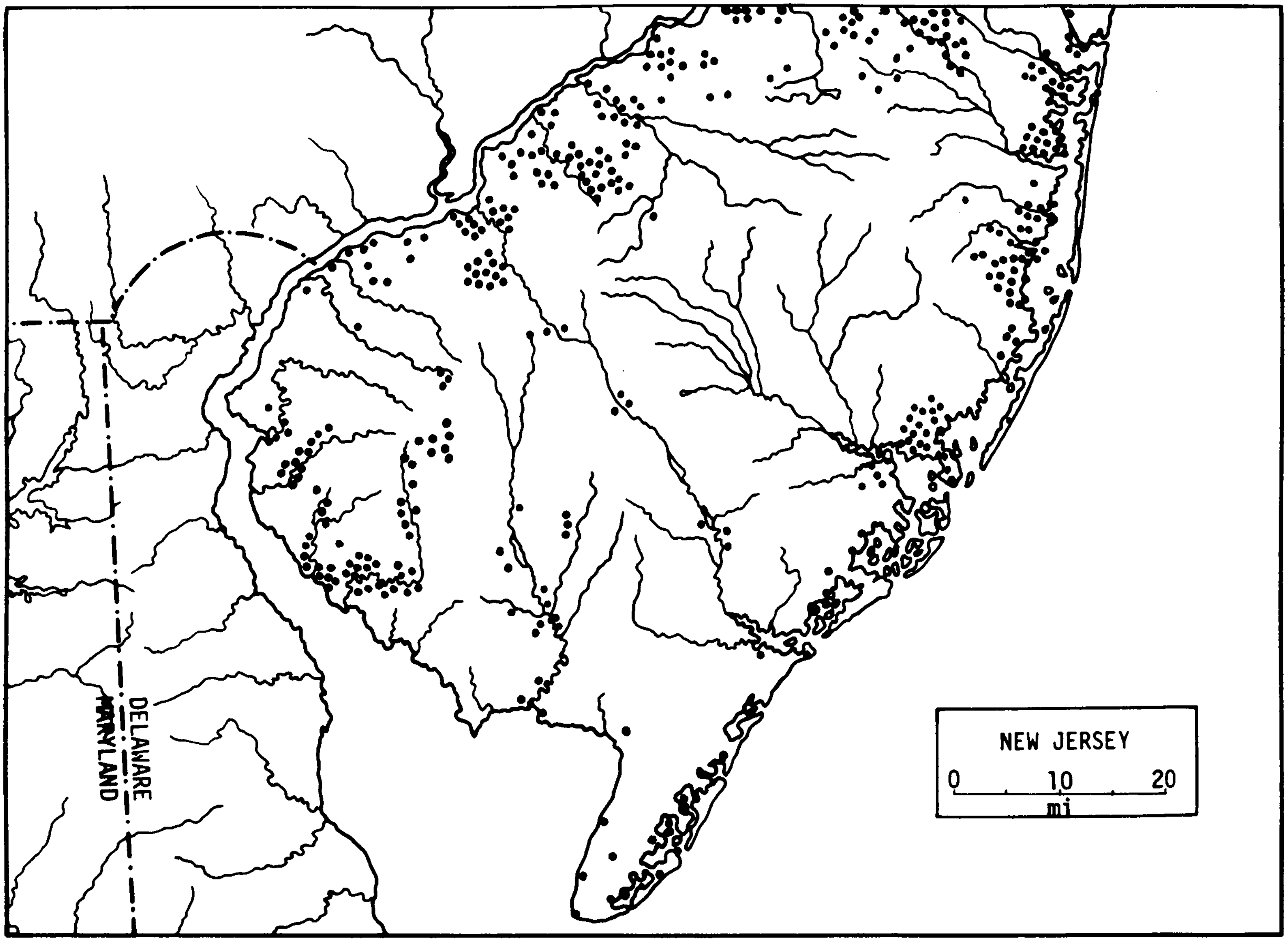


Fig. II-54a: Site distribution, mid-Atlantic subarea, Unknown period.

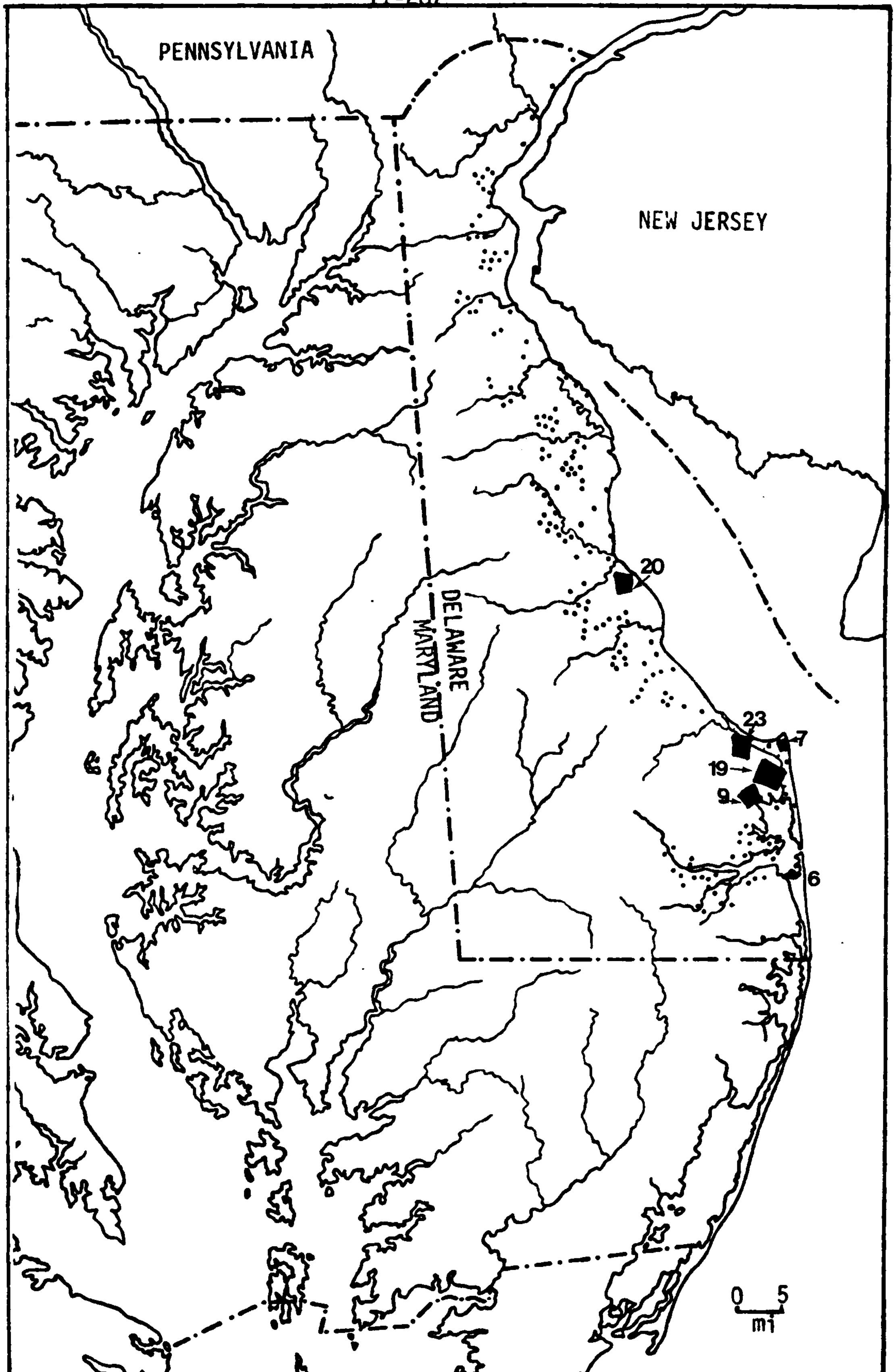


Fig. II-54b: Site distribution, mid-Atlantic subarea, unknown period.

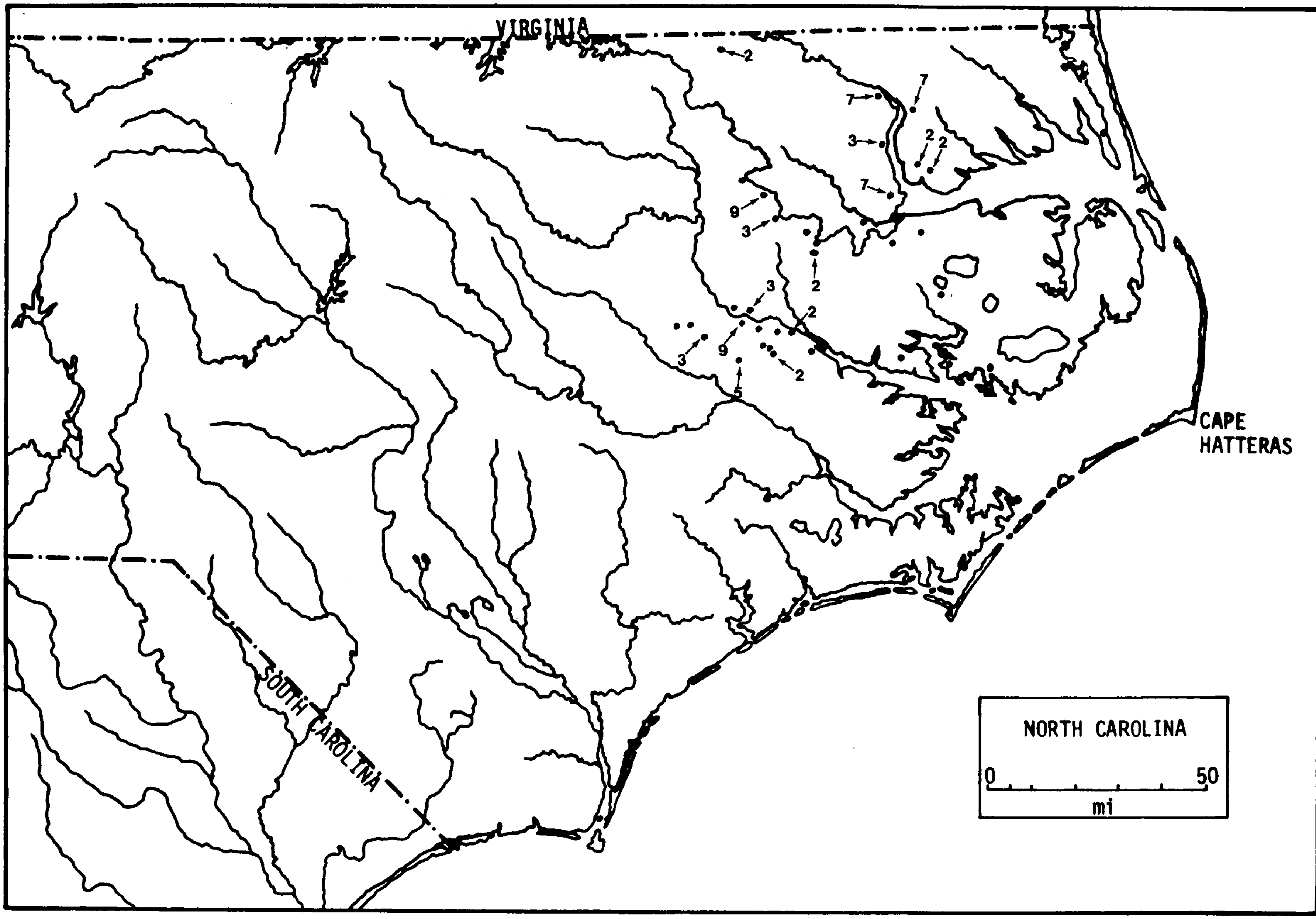


Fig. II-54c: Site distribution, mid-Atlantic subarea, unknown period.

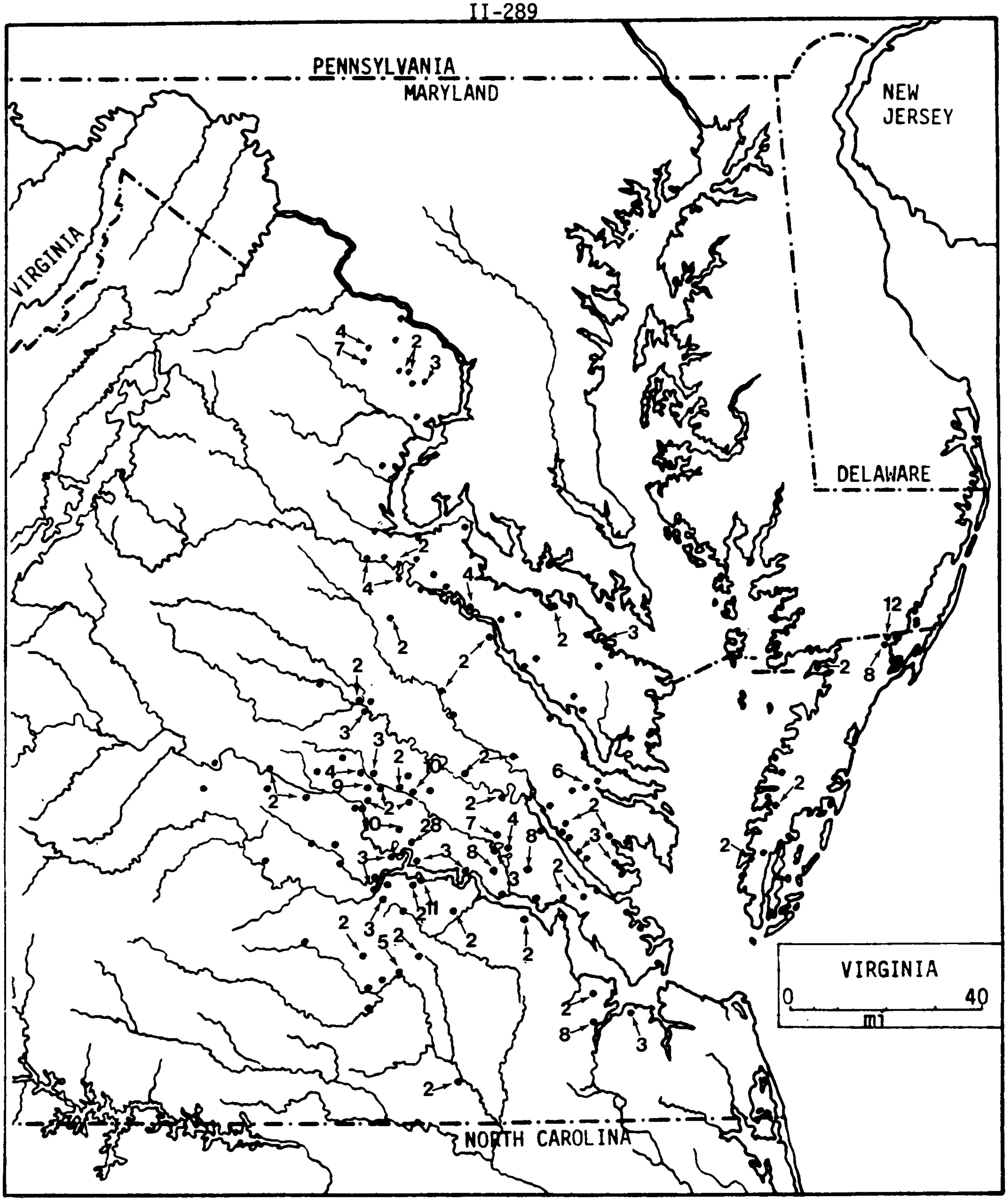


Fig. II-54d: Site distribution, mid-Atlantic subarea, unknown period.

TABLE II-40: Tabulation of site data, period unknown, mid-Atlantic subarea.

PERIOD: UNKNOWN

Total sites:	1,323
Coastal sites:	306
Shell heaps:	83

SITES WITH MULTIPLE COMPONENTS:

Type of component evident:

Paleo-Indian:	
Early Archaic:	
Middle Archaic:	
Late Archaic:	
Early Woodland:	
Middle Woodland:	
Late Woodland:	
Unspecified Woodland:	
Period Unknown:	

SOILS CHARACTERISTICS:

Well drained level to slight slope:	
Well drained steeper slope:	
Areas subjected to flooding:	
Bedrock close to surface:	
Made land:	

SLOPE:

Sites at 0-3%:	7
Sites at 3-8%:	1
Sites at 8-15%:	
Sites at 15-22%:	
Sites over 25%:	

ASPECT:

N:		NE:		E:		SE:		S:	
SW:		W:		NW:		OTHER:			

TYPE OF WATER SOURCE:

Spring:		L. I. Sound:	
Brook or stream:	301	Ocean:	
Small river:	226	Bay:	
Major river:	88	Harbor:	
Lake:	26	Sites inundated:	
Swamp:	21	Sites at confluences:	28
Salt marsh or estuary:	185		

LANDFORM TYPE:

subarea, chiefly in connection with cultural resource management studies (see for example, C. Lee 1976; Schneider and Frantz 1977). Such sets of characteristics usually are impressionistic, that is, they are selected intuitively and tested by no rigorous, quantitative methods. Nonetheless, they appear to be moderately reliable in the limited tests to which they have been subjected (see for example, Cavallo 1978).

Cavallo (1978) has presented a set of 15 characteristics typifying mid-Atlantic site location. This set is the most complicated set available, but it remains largely untested. Its characteristics are:

1. Slope at site: 2-5%.

2. Slope in contiguous areas: same as site or greater.

3. Aspect (orientation): southward, especially southeastward.

4. Distance from water source: usually 500 ft or less.

5. Distance from running water: less than 500 ft, usually less than 100 ft.

6. Stream order: usually near two or more second- or third-order streams.

7. Confluences: often on confluences.

8. Low-order streams on floodplain: often near these features.

9. Swamps and bogs: usually near these features.

10. Other water resources: often within 5,000 ft, often within 3,000 ft of multiple marshes or ponds or springs.

11. Lithic sources: often near outcrops or cobble source areas for workable stone.

12. Habitat overlap: maximized, as inferred from soils.

13. Geological formation overlaps: maximized. (This variable can determine soil differences, which in turn can influence biological resources.

14. Drainage: well drained soils.

15. Distribution of periglacial features: proximity to "pingos."

These characteristics have not been tested adequately in terms of their utility as site location predictors, so they have not been incorporated into Table II-41. In some cases, the characteristics suggested as predictive variables have not been borne out by the results of the site inventory compiled here. For example, of 3,782 sites, only 144 (3.8%) were recorded as being on confluences. In this case, the predictor variable may have little usefulness or the site records may not always include the necessary information.

In the discussion of southern New England settlement patterns earlier in this section, a site frequency curve was prepared. Fig. II-55 is a comparable curve prepared for the mid-Atlantic subarea. As before, the vertical unit is number of sites per 1,000 years. The solid line is the curve as drawn between mid-points of periods; the broken line is the curve resulting when the general Woodland sites are distributed to the specific Woodland periods proportionally according to ratio of dated sites in each period. The quantities represented by Woodland in general and unknown period categories are graphed to the right.

The resulting curve describes a gradually growing population (or at least site frequency) with a dip downward in the Middle Woodland Period. This dip is probably an artifact of the data, although present data do not allow the confirmation or refutation of this view. Middle Woodland pottery in this subarea is more variable and difficult to identify than that from any other period and that fact could create an underrepresentation in site records. Coupled with the lack of any obvious reason for such a dip, this factor could falsely creat the impression of a drop in population.

In order to investigate population changes on one portion of the mid-Atlantic subarea, Virginia's coastal plain, Turner (1978) performed systematic archaeological surveys of several countries in Virginia, then calcualted site frequencies per period.

Fig. II-56 is taken from Turner (1978: Fig. 2). The solid line is the curve presented by Turner, representing sites per period found in the survey; the broken lines represent extrapolations. The dotted line represents Turner's data, converted into sites per 1,000 years for this study.

As Fig. II-56 shows, Turner's curve shows a constantly increasing rate of population growth throughout the period. The version of the curve which standardizes for Period length makes the increase in rate appear quite marked at the Early Woodland Period. In neither version is there any dip or deviation from a regular curve of increasing steepness.

A word of caution is in order regarding Figs. II-44, II-55, and II-56. While all of these curves represent changes of site frequency, their vertical scales are different and comparison of shape of the curves must be done with care. The scale for the mid-Atlantic curve is three times

TABLE II-41 SUMMARY, LOCATIONAL ATTRIBUTES OF PREHISTORIC SITES, INDUCTIVE MODELS.

Subarea	Period	Site Type	Expected Site Density	Expected Size	Locational Attributes
Maine	Paleo-Indian	habitation	low	small	wide variety; especially lakesides
	Early Archaic	habitation	low	small	wide variety
	Middle Archaic	habitation	increasing, low	small?	coastal
		fishing camp	increasing, low	small	inland; stream or river shores; near falls, rills, rapids, and narrows
	Late Archaic	shell midden	medium	small–large	coastal; near shellfish beds; near sizable waterways with access to open sea
		black earth midden	low?	medium to large	coastal
		other coastal habitations	--	--	coastal

TABLE II-41 SUMMARY, LOCATIONAL ATTRIBUTES OF PREHISTORIC SITES, INDUCTIVE MODELS. (CONT.)

Subarea	Period	Site Type	Expected Site Density	Expected Size	Locational Attributes
		fishing camp	medium to high	small to medium	inland; stream or river shores; near falls, rills, rapids, and narrows
	Woodland	shell midden	high	small to large, mean 20 ft diameter	coastal; near shellfish beds; elevation usually below 5 ft above present sea level; protected shores and estuaries; southwest or south-facing slopes
		black earth midden	medium?	medium to large	coastal
		fishing camp	high	small to medium	inland; stream or river shores; near falls, rills, rapids, and narrows
Southern New England	Paleo-Indian	habitation	low	small to large	wide variety; near small rivers and streams especially; usually below 400 ft above present sea level; often on landforms higher than surrounding terrain

TABLE II-41 SUMMARY, LOCATIONAL ATTRIBUTES OF PREHISTORIC SITES, INDUCTIVE MODELS. (CONT.)

Subarea	Period	Site Type	Expected Site Density	Expected Size	Locational Attributes
	Early Archaic	habitation	low	usually small, sometimes clustered	lowlands, usually below 100 ft above present sea level; zones with 20% or greater oak pollen; near small rivers and streams
	Middle Archaic	shell midden I	low	small to medium	coastal; estuary shores
		shell midden II	very low	medium	inland; near freshwater bivalve habitats
		fishing camp	low to medium	small to medium	inland; stream or river shores; near falls, rills, rapids, and narrows; well drained soil/locally high ground/less than 8% slope; usually below 100 ft above present sea level; zones with 20% or greater oak pollen
		upland camp	low	small	inland; above 200 ft above present sea level; zones with 20% or greater oak pollen; well drained soil/locally high ground/less than 8% slope/stream or small river shores

TABLE II-41 SUMMARY, LOCATIONAL ATTRIBUTES OF PREHISTORIC SITES, INDUCTIVE MODELS. (CONT.)

Subarea	Period	Site Type	Expected Site Density	Expected Size	Locational Attributes
		fishing camp	high	small to large	estuaries and inland; stream or river shores; often at estuary heads or near falls, rills, rapids, and narrows; well drained soil/ locally high ground/less than 8% slope
		rock shelter	low	small	inland; protected areas near rock outcrops or cliffs
	Late Woodland in particular	upland camp	low to medium	small	inland; above 200 ft above present sea level; well drained soil/locally high ground/less than 8% slope/stream or small river shore
		estuary head fishing camps	medium to high	large	at estuary heads; well drained soil/locally high ground/less than 8% slope
		coastal habitation	high	small	coastal; associated with and near shell middens (attributes given above)
		villages	high	large	inland; lowlands; arable and fertile soil; usually on floodplains; well drained soil/ less than 8% slope
		farmsteads	high	low	inland; lowlands; arable and fertile soil; often on floodplains; well drained soil/less than 8% slope

TABLE II-41 SUMMARY, LOCATIONAL ATTRIBUTES OF PREHISTORIC SITES, INDUCTIVE MODELS. (CONT.)

Subarea	Period	Site Type	Expected Site Density	Expected Size	Locational Attributes
	Late Archaic	shell midden	medium	small to medium	coastal; near shellfish beds; protected shores and estuaries; well drained soil/locally high ground/less than 8% slope
		camp	high	small to medium	coastal and inland; all elevations; well drained soil/locally high ground/less than 8% slope/stream or small river shores
		fishing camp	medium to high	small	estuaries or inland; stream or river shores; near falls, rills, rapids, and narrows; well drained soil (locally high ground)/less than 8% slope; all elevations; sometimes at estuary heads
		fish weir	low to medium	small	estuarine or inland; in streams or rivers near fishing camps (attributes given above)
		village			inland; lowlands, usually below 100 ft above present sea level; well drained soil/locally high ground/less than 8% slope; lake shores
	Woodland	shell midden	high	small to large, mean 80 ft diameter	coastal; near shellfish beds; protected shores and estuaries; well drained soil/locally high ground/less than 8% slope
		camp	high	small to medium	coastal and inland; predominantly lowland below 200 ft above present sea level; well drained soil/locally high ground/less than 8% slope/stream or small river shores

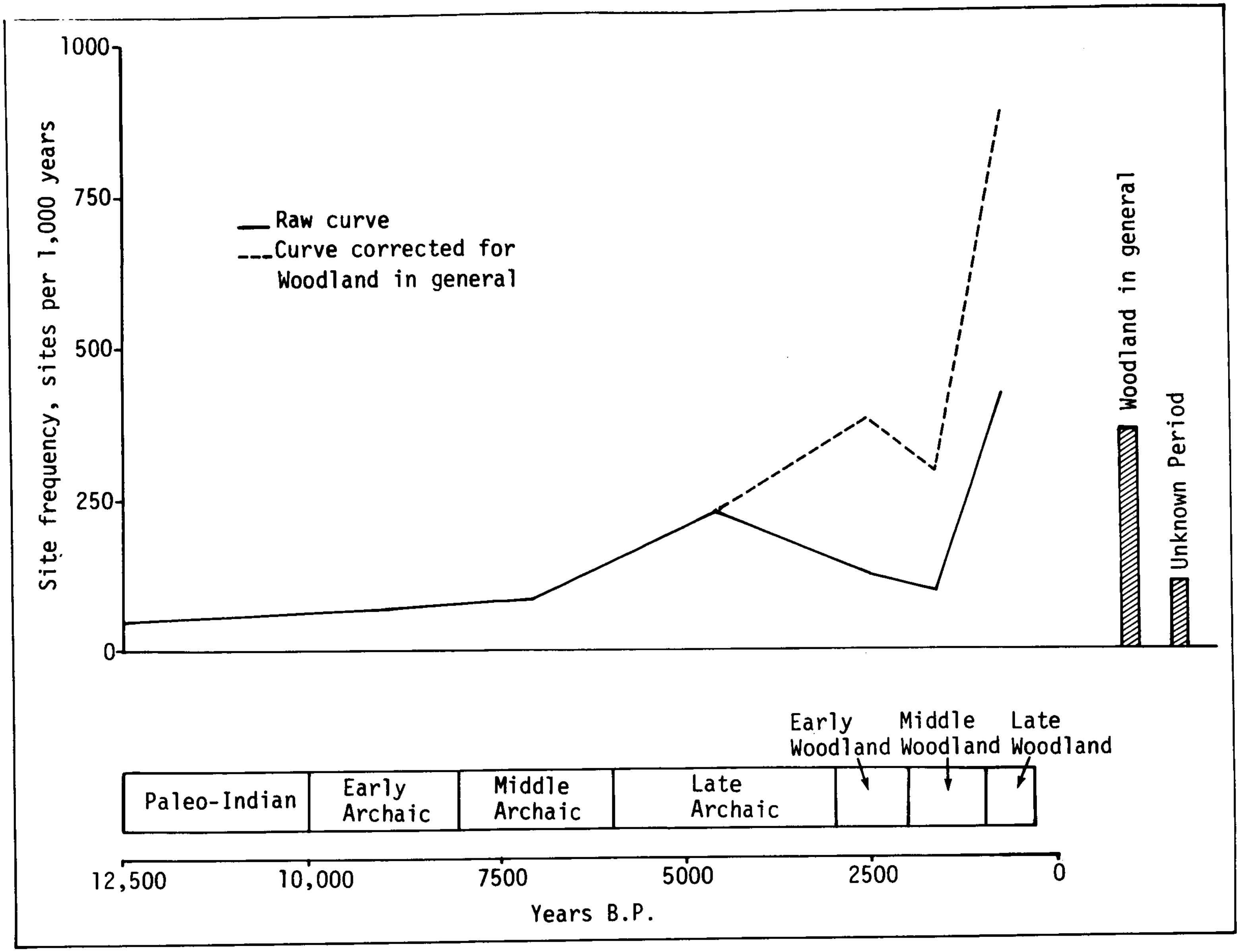


Fig. II-55: Site frequency per period, mid-Atlantic subarea.

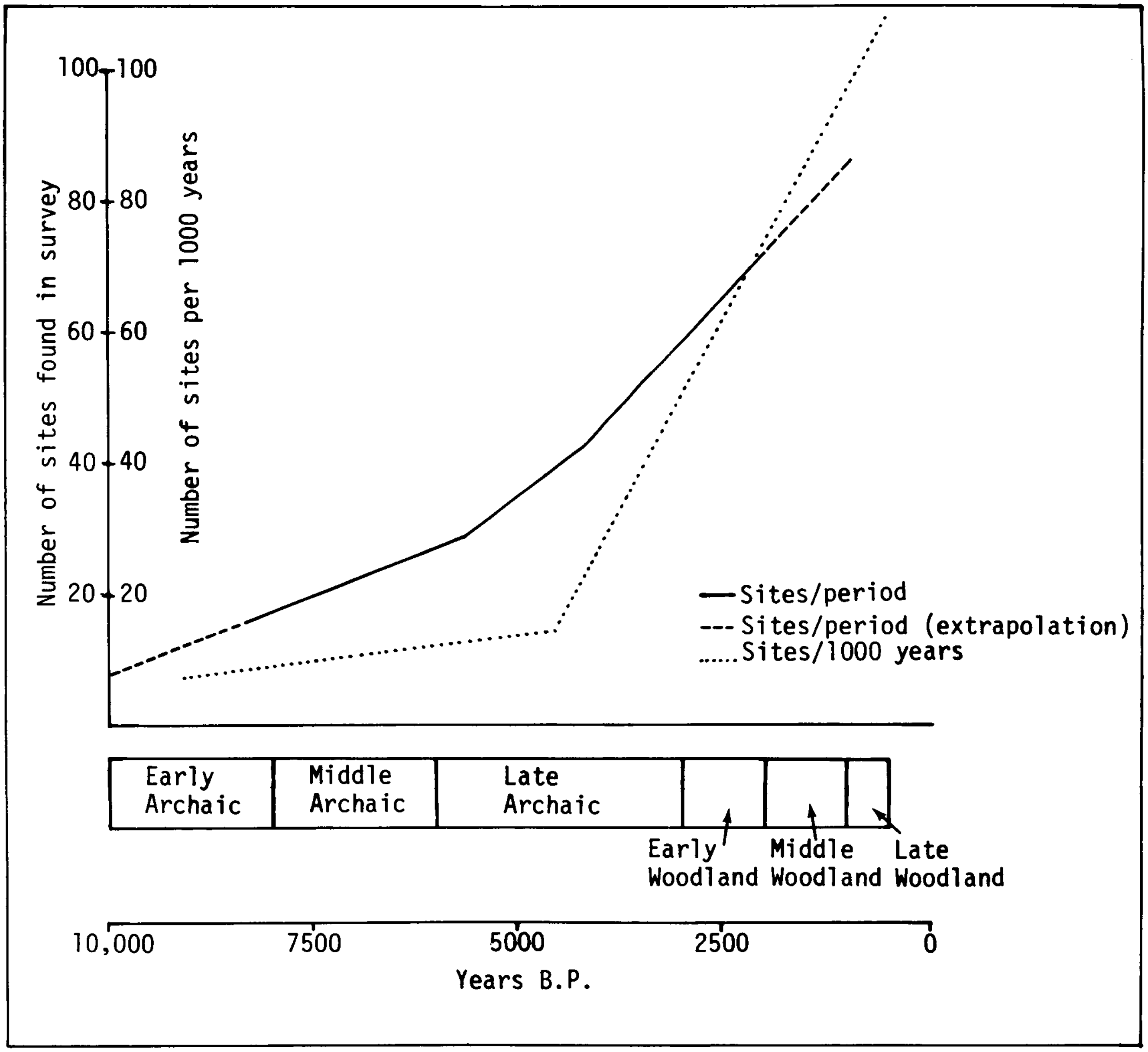


Fig. II-56: Projected site frequency for the Virginia Coastal Plain, 10,000 B.P. to A.D. 1600 (after Turner 1978). 7500 as compressed as is that for the southern New England curve; consequently, although the curves visually appear to have about the same slopes, the mid-Atlantic curve is actually considerably steeper. This inconvenience is regrettable, but the use of the same vertical scale on both figures would result in compressing the southern New England curve so much that its form would be obscured. Since neither intensity of site survey nor land area of subareas has been held constant, the significance of these differences in steepness cannot be ascertained.

5.5 Paleo-Indian Period: General Considerations

The paucity of data on the Paleo-Indian Period has inclined archaeologists toward broad interpretations, often based on data from areas distant from the focus of their research. This approach has certain limitations, but it also has certain advantages. This section draws on data felt to be relevant and criticizes what are believed to be misapplications of data from areas outside the study area.

The Paleo-Indian adaptation to the hunting of herbivorous magafauna in western North America has been commented upon earlier. The expectation of archaeologists has prompted a search for similar exploitative patterns among eastern Paleo-Indians. Mastodon and caribou have been the prime candidates as species which were important prey for Paleo-Indians. By extension, settlement often has been assumed to have been migratory, specialized, and tied to herds of these creatures. As a result, several authors (Ritchie 1953, 1957; Witthoft 1952) have emphasized Paleo-Indian sites in upland zones, suggesting that they may have served as overlooks to locate herds.

Section 3 pointed out that evidence for specialization in megafauna hunting by Paleo-Indians is very sparse and that other prey are indicated with at least as great frequency. In this section, analysis of site data has shown that relatively small percentages of Paleo-Indian sites occur in the uplands, percentages comparable to those for later periods. These conclusions are identical to those drawn by Eisenberg (1978) in his study of Paleo-Indian settlement in the Hudson and Delaware Valleys, based on distribution of sites and range of tasks inferred from artifacts.

From the Continental shelf and adjacent coasts, there is no evidence of Paleo-Indian utilization of the coast. This is not surprising, since the entirety fo the Atlantic coastline of Paleo-Indian times now lives underwater and has received little archaeological investigation. During the Paleo-Indian Period, however, the Champlain Valley (Vermont and New York) and adjacent areas were an arm of the ocean known as the Champlain Sea. A complicated set of interrelated factors later resulted in uplift of the region, turning the Champlain Sea to a fresh-water lake

(Lake Champlain). The former shorelines of the saline Champlain Sea presently lie well above water level and afford the only dry-land situation in eastern North America where Paleo-Indian coastal adaptations might be evidenced.

Stephen Loring (1978) has compiled information on Paleo-Indian sites on the eastern side of the Champlain Valley. (For reference, these sites have been added to Fig. II-35). These sites cluster on former shorelines of the Champlain Sea, usually near a river or stream. Since none of these sites have been dated, it cannot be stated with confidence that they were located in estuarine zones, but they certainly indicate coastal exploitation. No faunal remains are known from any of these sites.

Loring's Champlain Valley study indicates that Paleo-Indians on the Continental Shelf probably exploited the coastal zone. Although the ecology of the Champlain Sea presumably was different than that of the Atlantic coast and there is no reason to assume identical patterns of subsistence and settlement in the two areas, it is clear that coastal adaptation (in the Champlain Valley, at least) took place early in the continuum of human occupation. This conclusion runs counter to Osborn's (1977) hypothesis that coastal adaptation develops in response to population pressure and occurs only late in a region's occupational history. While definite data are not available for the Continental Shelf, it seems most likely that the coastal zone would have been exploited during Paleo-Indian times.

5.6 Summary

This section has provided a series of models of settlement during different periods and for different areas. The models are "loose," that is, they do not explain events and phenomena systematically, but present generalizations which have been derived from the analysis of known site locations. These generalizations have little explanatory value in many cases, but their practical value lies in their demonstrated good fit with known settlement patterns.

Strictly speaking, these models apply to the areas from which data were drawn - presently dry-land areas - not to the inundated portion of the Continental Shelf. The extrapolation of these models to the inundated Shelf and the conditions of applicability will be discussed in Sections 7 and 8.

Table II-41 presents a summary of the predictions for prehistoric settlement derived from the inductive models. Although the table is lengthy, it treats only the major or well-defined site types. Within any given subarea and period, other sites types no doubt exist, but either occur only rarely or have not been recognized in research to date.

It should be noted that quarry and workshop sites have not been included in the discussion of site locations. This is not because quarry and workshop sites are not expected on the Continental Shelf. Indeed, the researches of Fanale (1974) and R. Michael Gramly (personal communication) in the mid-Atlantic and New England states respectively indicate that the exploitation of raw material suitable for stone tools may have been a factor in placement of various site types, including quarries, workshops, and habitations. The omission of this factor from discussion reflects an inability to predict accurately and reliably (either on land or, especially, underwater) where usable lithic material will outcrop.

6.0 DEDUCTIVE MODELS OF SETTLEMENT PATTERNS

6.1 Theory and Approach

6.1.1 Optimal foraging models

Optimal foraging models are ideal patterns of food-collection behavior, derived from assumptions about the goals of foragers and the means by which those goals can best be achieved. In particular, it is assumed that groups try to maximize the quantity of food collected; although it usually is not possible to minimize effort expended at the same time, efforts are made to reduce effort as much as possible while still seeking maximum yield.

Based on the theory behind optional foraging models, it is possible to derived models of subsistence and population distribution. Such models have been elaborated and tested for animals, and recently have been applied with success to human groups. Using the reconstruction of the environments and resources of the Continental Shelf (Section 4), optimal foraging models will be applied in order to produce models of human settlement there. The predictions made by these models will be synthesized in Section 7 with the predictions derived from the inductive models (Section 5).

Effort expended in food collection will be measured by time. Search time is the time required to locate a resource and is greatest for mobile and unpredictable species; capture time is the amount of time spent in gathering, killing, or otherwise extracting a resource from the environment once it has been located; processing time is the amount of time spent in converting the foodstuff, once captured or collected, into its edible form.

DeBenedictus and others (1978) have argued that natural selection in animals operates on total amount of energy intake (food) rather than the efficiency with which that food is gathered. Efficiency becomes important, however, if foraging time is limited by nature (DeBenedictus and others 1978). Orians and Pearson (no date) argue that it is adaptive for foragers to maximize net rate of energy intake, if there are competing uses of time which will aid in survival or if there are risks involved in foraging. Since these latter conditions clearly apply to human foragers, caloric return rates (the ratio of calories foraged to time expended in their collection) will be used to measure the relative attractiveness of various resources and environments to human exploiters. In some cases, caloric return rates cannot be calculated and other measures or estimates will be used.

In the broadest terms, environments are either uniform (similar resource endowment throughout) or patchy (a mosaic of patches of different resource distributions and densities). Patchiness can be measured by the size of the patches and the variability between patches. Section 4 has demonstrated that there has been considerable patchiness in environments in all portions of the Continental Shelf between the Bay of Fundy and Cape Hatteras, at least from 18,000 B.P. onward.

The strategies used by foragers to exploit these two types of environment are expected to be very different. The less variability between patches, the more predictable the spatial environment (MacArthur 1972).

These three factors - input of effort, output of food, and characteristics of the environment - interrelate and it is possible to calculate qualitatively the effectiveness of different strategies. Out of these calculations, one can derive general patterns of exploitation which would be optimal under certain conditions.

A simple example illustrates the method. A hypothetical environment has extensive wooded areas separated by grasslands. In the wooded areas, a large herbivore browses on a specific plant, which is found in some but not all of the wooded areas. Throughout the wooded and grassy areas are a number of smaller species which are considerably more common than the large herbivore.

Translated into the jargon of optimal foraging models, the environment has two patch types (woodland and grassland) and, since the composition of the woodlands is variable, it has low predictability. The search time for the large herbivore would be high, but the search time for small game would be low. Given estimates of the search times and the animals' size, caloric return rates could be calculated, comparing the relative viabilities of specializing in large herbivore capture and exploiting small game in a generalized strategy.

The contrived example was simplified for the purposes of demonstrations In more complicated situations, it becomes more difficult to predict intuitively which of several strategies will be more efficient. Under those circumstances, optimal foraging models become most useful.

The types of predictions made by optimal foraging models are of several sorts. First, they make spatial predictions, such as those concerning which patches will be exploited. Second, they make dietary predictions about which resources will be taken and in what proportions. Third, the optimal group size for exploiting an environment can be predicted. Small dispersed groups reduce search time, while large, aggregated groups reduce capture time. Fourth, predictions regarding seasonal exploitation of a patch can be made by examining the changing resource availabilities.

The types of predictions made by optimal foraging models are of several sorts. First, they make spatial predictions, such as which patches will be exploited and for what resources. The contrived example fell into this category. Second, the optimal group size for exploiting an environment can be predicted. Small, dispersed groups reduce search time, while large, aggregated groups reduce capture time. Third, predictions regarding seasonal exploitation of a patch can be made by examining the changing resource availabilities in different patches through the year. The number and variety of generalizations about foraging behavior which have been derived is great.

6.1.2 The relation to settlement patterns

The three basic elements of settlement patterns of hunter-gatherers are characteristics of settlement locations (physical, biological, and social), seasonality of usage, and group size. All three of these elements can be predicted by optimal foraging models.

The scale of prediction must be broad, since human beings often locate a settlement at some distance from an exploited zone and travel daily. The area which is exploited from that settlement (the site catchment area) may include a number of resources and patches. The actual site location may be a compromise between locations which would each increase efficienty for a single resource, allowing slightly less efficient exploitation of both resources (Perlman 1978).

When viewed from the narrow perspective, optimal foraging models can predict foraging area locations, not settlement location. Considering the coarseness and broad scale of environmental information from the Continental Shelf, however, the problem evaporates. These models cannot predict on which side of a stream a site will be located, but they can predict the density and type (function, size) of sites in the uplands of a given area and period. It is the latter use to which they will be applied in this report.

Optimal foraging models and any settlement models derived from them are primarily explanatory models and their primary purpose, obviously, is to explain. Hypotheses can be generated out of them and the testing of these hypotheses will produce results which either support or refute the assumptions of the models and the explanations which they suggest. In this project, however, the primary goal is prediction of settlement location, not explanation of the causes of settlement distribution. Accordingly, these models are provisionally adopted as accurate approximations of reality (based on their previous support from tests), and are used to produce predictions. These predictions are, strictly speaking, testable hypotheses; in cases where both hypotheses (deductive models) and empiric data (inductive models) are available, the general goodness of fit supports the assumptions underlying the deductive models (see Section 7).

The predictions produced in this section are especially valuable in cases where the inductive models of Section 5 clearly do not apply. For example, to argue that no Paleo-Indians ate shellfish because no Paleo-Indian shell middens have been found ignores the inundation of Paleo-Indian coastal zones and would be an egregious misapplication of generalizations about known archaeological sites. In such cases where there are no contemporary analogues represented in the known site record, deductive models must be the sole means of predicting site distribution.

A caution given in Section 2 is worth repeating here: the predictions derived from optimal foraging models are predictions about how rational, informed foragers, interested only in food, would exploit given environments. Deviations are to be expected in behvaior of actual human groups, although the magnitude is believed not to be great. Those deviations point the way to refinements of the models so as to include more factors and to consider their interrelations more carefully.

6.1.3 Operationalization

Using the resources deemed most important in Section 4, assessments will be made of expectable yields in terms of quantities of food per unit time, ignoring the energy costs of foraging. These yields will come from historic and experimental studies and, whenever possible, will include data on a variety of environments in which the resource may occur.

Yields are not necessarily proportional to resource density. The distribution of the resource affects search time and the nature of the resource affects capture and processing time; these factors in turn affect yields to human foragers.

Resources will be classified according to two dichotomies. First, resources will be divided into primary and secondary, based on caloric return rates. Primary resources, with very high rates, are expected to have been exploited intensively, while secondary resources, although potentially important, presumably would have been exploited less intensively.

Second, resources can be classified as determinate or indeterminate. Determinate resources are those which are likely to be exploited at settlements located in terms of the distribution of that resource. Certain resources, shellfish for example, have localized distributions; in addition, the high percentage of waste weight (shell) encourages the location of sites near the shellfish beds. Indeterminate resources, on the other hand, are more evenly distributed over the landscape and can be exploited more or less well from any number of locations. (Gravity models discuss this phenomenon in a quantitative manner, but the data available allow only qualitative assessments. See Hamilton 1967).

Using these and other attributes of resources in conjunction with information on the past distribution of resources in the project area, predictions will be made about the patterns of settlement in terms of site types, sizes, seasonality, and frequency. Site sizes and frequencies, in most cases, can be discussed in ordinal terms only, relative to one another, since absolute quantitative estimates cannot be made from the models and data available.

6.2 Resource Yields

6.2.1 Nuts

Nuts are a concentrated foodstuff with high fat and moderate protein and carbohydrate values. Calories per 100 grams range from 221 (*Quercus alba*) to 696 (*Carya ovata*) for species discussed (Asch and others 1972).

In temperate hardwood forests such as those in which significant nut resources have existed, nut trees are more or less regularly distributed through the forests. Table II-42 summarizes data on yields of nuts from upland and flood-plain environments in Illinois. These data come from government surveys performed prior to the introduction of intensive agriculture and are the only such data available. It is expected that yields in Illinois were larger than would have been on the Continental Shelf, since soils in the latter area were less mature and less fertile. Nonetheless, these figures illustrate the large yields possible and show that yields may be expected to be higher in the uplands than on flood plains.

Nuts are available seasonally. White-tailed deer and squirrels consume vast quantities of nuts, especially acorns (Goodrum and other 1971), and their consumption requires that they be collected shortly after they drop (Christisen and Korschgen 1955; Cypert and Webster 1948; Gysel 1971). Animal consumption of nuts has been estimated at 90 to 100% of the annual crop (Koristan in Christisen and Korschgen 1955).

Variability of the drop season is documented by Cypert and Webster (1948), Millikan (1969), and Downs and McQuilkins (1944), ranging typically from early September to late November. Towle (1978) has compiled a series of factors which cause variability in the nut crop from year to year, including insect infestation, failure to mature, stunting by frost, and others. She concludes that in an average of 21 of 50 years, a stand will have good crops; 21 years will be fair; four years will be near failures, and four years will be failures. (Judgments were made subjectively by various authors.)

Table II-43 summarizes return rates for nuts based on Perlman's (1979) experiments. These figures do not include processing time, one minute

Table II-42. Upland oak-hickory forest in Illinois (A); and floodplain forest (swamp-dry) in Illinois (B) (after Zawacki and Hausfater 1969).

(A)

PLANT NAME	MIN. YIELDS/ SQUARE MILE bushels	MAX. YIELDS/ SQUARE MILE bushels	NO. OF TREES/ SQUARE MILE	% OF TOTAL	YIELD PER TREE bushels
bur oak (32 lbs) (*Q. macrocarpa*)	25	277	300	.1	1/4 - 1 1/2
red oak (60 lbs) (*Q. rubra*)	121	1,212	2,700	.9	1/4 - 1 1/2
white oak (*Q. alba*) (70 lbs)	2,030	30,455	88,200	29.1	1/4 - 1 1/2
black oak (*Q. velutina*) (45 lbs)	6,389	54,500	78,800	26.0	1/4 - 1 1/2
hickory (*Carya* spp.) (33 lbs)	29,546	59,091	60,300	19.9	1 1/2 - 2

Total nut production/square mile estimate: 38,111-145,535 bu/yr.

(B)

bur oak (*Q. macrocarpa*)	245	2,207	2,900	1.3	1/4 - 1 1/2
red oak (*Q. rubra*)	79	396	1,600	.7	1/4 - 1 1/2
white oak (*Q. alba*)	220	3,310	8,800	3.9	1/4 - 1 1/2
black oak (*Q. velutina*)	2,471	22,240	31,200	13.8	1/4 - 1 1/4
pecan (*C. illinoensis*)	3,395	9,054	2,900	1.3	---
hickory (*Carya* spp.)	2,207	5,886	2,900	1.3	---

Total nut production/square mile estimate: 5,222-34,039 bu/yr.

Table II-43. Minimum and maximum return rates and caloric values for nuts and deer (Perlman 1976; 1979).

Minimum and Maximum Returns for Nuts and Deer

	MINIMUM	MAXIMUM
Pecan	3.5 lbs/hr	13.5 lbs/hr
Large Acorns	10 lbs/hr	30 lbs/hr
Small Acorns	.4 lbs/hr	3.5 lbs/hr
Deer	10 lbs/hr	20 lbs/hr
Caloric Values		
	MINIMUM	MAXIMUM
Pecan	10,820/hr	41,735/hr
Large Acorns	10,800/hr	32,400/hr
Small Acorns	432/hr	3,780/hr
Deer	5,100/hr	10,200/hr

of which can process 1.5 pecans, 1.9 large acorns, or 3.5 small acorns (Perlman 1979). If acorns are leached to remove tannic acid, a common and - for some species - necessary process, processing time increases. Data are unavailable for chestnuts, a large nut, or for beech nuts, which are very small. All else being equal, the greater search and processing time required to exploit resources in small units makes their exploitation inefficient (Schoener 1971); accordingly, beech nuts were probably never utilized extensively by human beings. Their presence, however, might attract a portion of animal exploitation, leaving greater densities of larger nuts for human use, unless animal populations increased proportionately.

Caloric return rates on nuts are very high and the size of the nut crop, judging from the Illinois data, can be great. The high percentage of the nut crop consumed by animals and the considerable variability in the crop's size, quality, and period of availability has led Towle (1978) to suggest, however, that nuts were not an important resource to hunter-gatherers in the project area. Root (1978) has presented an alternative case, arguing that the nearness of patches to one another would allow the switching of exploitation to a nearby patch if the nut crop was poor in a given area. She also has pointed out that human beings could effectively compete with animals in nut gathering and that animal consumption need not make the resource unattractive. Root's argument appears sound and is accepted here.

Optimal foraging models predict that specialist exploitation of a resource will take place if the resource has high yields, high caloric return rates, and low variability (MacArthur and Pianka 1966). Nuts have high yields and return rates and are classified as primary. Accepting Root's interpretation, variability is low. Accordingly, specialized use is expected.

The distribution of nuts is broad: patches are many and widespread, though more productive in uplands. Nuts, therefore, are considered an indeterminate resource.

6.2.2 Mammoth and mastodon

As extinct animals, mammoth and mastodon can be discussed only through analogy. Herbivore flesh is a good source of fat and protein and has high caloric values.

An analogy to modern elephants, also grazers, mammoths probably had variable group size, ranging from herds of 20 or so to large congregations, ranging up to 2,000 in modern elephants (Buechner and others 1963; Laws 1974). The tundra-like environment of the Continental Shelf could not support such large seasonal congregations. Mammoths probably ranged widely, as is the rule for grazers. Mastodon, as browsers, probably had far smaller groups than mammoths and were less migratory.

No data on density, variability, foraging time, or caloric return rates are available or can be extrapolated reliably to these species. A few inferences, however, can be made, based on environmental characteristics.

Slobodkin and Sanders (1968) have characterized the early post-glacial environment which supported mammoth and mastodon as low in species diversity, due to recent stresses of glaciation. Productivity and thus animal densities probably also were low. Further, mammoths in particular would be unpredictable in terms of densities, since their necessary food - tundra grass and sedge - could be destroyed easily by trampling, icing, or fire (Fitzhugh 1972). The short food chain, based on an unstable plant base, can be expected to produce frequent plummets of the mammoth population. Further, average search time for migratory mammoths would be great.

Probably low caloric return rates and unpredictability for mammoths make them an unlikely candidate for specialized exploitation. Mastodon has a slightly better likelihood, but the most efficient strategy for exploiting an environment with low density and diversity would be with small groups of generalist foragers (MacArthur and Pianka 1966).

Mammoth and mastodon, therefore, are considered secondary, indeterminate resources. It is not expected that their utilization was a major part of human exploitation on the Continental Shelf. Any exploitation probably would be by small groups, dispersed to reduce search time.

6.2.3 Caribou

As described in Section 4, caribou vary from small groups in summer and winter and large migrating herds in late spring and early winter. Grazers, caribou move a great deal and their paths are unpredictable over short periods (Bliss 1975). Based on modern caribou, densities per km vary between 1.7 and 4.6 individuals.

The same arguments advanced for mammoth apply to caribou, and caribou are classified as a secondary, indeterminate resource.

6.2.4 Moose

Moose are solitary or found in small groups, averaging around two per group (Jochim 1976). They are browsers and, as might be expected, their seasonal and short-term movements are much fewer and shorter than those of caribou. Density of moose is lower (less than two individuals per square kilometer), but body weight is greater and resource density is comparable.

Moose have fixed home ranges, varying between one and two miles across (Houston 1974). The relative stability of forest conditions leads to the rarity of population carshes. These two factors make moose a predictable resource, with a high return rate (Jochim 1976). The overall low density of the resource, however, makes it unlikely that economies specialized in moose; it is classed as a secondary, indeterminate resource. Hunting of moose would be expected by a single hunter or small group, since low densities suggest that a single capture would sufficiently lessen the likelihood of another capture in that patch, and thus make hunting by a larger group inefficient.

6.2.5 White-tailed deer

Deer are browsers and have small home ranges, varying between 400 and 1200 acres (Servinghaus and Cheatum 1956). In dense forest, density is about eight per square kilometer and group size is small except when sheltering together in winter. In more open areas, density doubles or triples and group size usually increases to more than six.

The density of deer is higher than that for any other ungulate discussed. Further, predictability is high: home range is small, seasonal movements are regular, and they are not subject to massive population fluctuations. Accordingly, search and capture times are low, leading to high return rates. Perlman (1976) calculated upland return rates to be 4.5 kg of flesh per hour or 5,100 calories per hour; lowland values would be about twice these figures.

Deer are predicted to have been exploited intensively during periods and in environments they were where common and deer are considered a primary resource. Their extensive distribution, however, makes it unlikely that settlement was located specifically for deer exploitation and deer are considered an indeterminate resource.

6.2.6 Seals and walrus

Seals inhabit different zones and congregate in different sized groups in different seasons. Most seal species aggregate in groups ranging from six to more than 1,000 individuals on fast ice during late winter and spring; favored feeding areas sometimes see large aggregations in late summer and early fall (Mansfield 1967). During winter, seals stay in the water under fast ice.

Fast ice is more common on irregular coasts, and seal population densities vary accordingly: in areas of favorable fast ice, 35 seals per square mile is expectable; along straight coasts, ten seals per square mile is typical (McLaren 1961).

Perlman (1976) has calculated capture and caloric-return rates for seals. The capture rate varies with different periods: non-basking is 0.03 per hour, pre-peak basking is 0.06 per hour, and peak basking is 0.15 per hour. Assuming an average capture weight of 156 pounds, average capture weight per hour is 42.19 pounds. Caloric return rates vary seasonally: during spring aggregations, 3,710 calories per forager per hour and, at other periods, 760 calories per forager per hour.

The high return rates make seals a primary resource during spring, when the resource is highly predictable. At that time, specialized exploitation of seals would be expectable and the resource is determinate. At other times of the year, seals would be a secondary, indeterminate resource.

Walrus are generally larger than seals, averaging about 500 pounds per individual. In late summer, large groups are found, in other periods, small groups.

Freeman (1967) has characterized walrus hunting as a high-cost activity with a low probability of success. Capture rates are 0.167 per hunter per day (spring), 0.216 per hunter per day (summer), and 0.222 per hunter per day (autumn). (Modern hunters do not hunt walrus in winter.)

Walrus constitute a secondary resource, possibly determinate at certain seasons. The very low expectable return makes it unlikely that walrus were extensively exploited.

6.2.7 Anadromous fish

The different species of anadromous fish have different nutritional values, but, in general, protein is high and fat is moderate. Calories per 100 grams of flesh range from around 120 to 250.

The size of a fish run varies with the species, river, and year, but under normal circumstances is large. In cases where several species spawn at similar times, the effects of a disaster in one species are damped by the presence of other species, which can be exploited more heavily (Schalk 1977).

Anadromous fish are highly seasonal and the biomass of fish passing a given location is several orders of magnitude greater than food resources at that locality could support. This tremendous density, coupled with highly predictable arrival dates make the search time low and caloric return great. Perlman (1976) has calculated return rates for sturgeon, striped bass, and alewife at five kilograms per hour, a figure which probably is too low for sturgeon; that figure translates to between 450 and 475 calories per hour for various species.

These characteristics make anadromous fish a primary, determinate resource, abundant and capable of attracting settlement specially for their exploitation. Since much fish-capture technology is uncomplicated, such a fishing station could be used by a small human group. Alternatively, the great caloric return and high biomass could support a large group. Settlement might be for a short season, exploiting one or a few runs, or for a long season if the timing of runs permitted it.

6.2.8 Other fish

Non-migratory fish are distributed relatively evenly through their habitat and their density is far lower than that of anadromous fish during spawning. Accordingly, search and capture time is greater and caloric return rates are much lower. No calculations are available, but Winterhalder (1977) indicates that caloric return rates would vary widely depending on technology employed. Seasonal and other variations in resource distribution would be small and the resource would be highly predictable.

Non-migratory fish are expected to have been an important resource on the Continental Shelf, a dependable and more or less localized foodstuff. It is unclear, however, whether non-migratory fish would be a primary or secondary resource. It could constitute a determinate resource.

6.2.9 Marine molluscs

Marine molluscs are high in protein, but low in fat. Species vary between 60 and 80 calories per 100 grams of flesh.

Molluscs with potential for exploitation occur in dense beds which may be raked, picked, or dug, depending on the species. Density and total biomass are great. With the exception of scallops, molluscs are immobile; annual fluctuations are usually small, although storms can increase sediment load, destroying oyster beds. Search time is low, but capture time can be lengthy. Perlman (1976) has calculated a return rate of 350 calories per hour average for marine shellfish, a figure depressed by low caloric value. Meehan (1977), on the other hand, has found that the Anabara of Australia can collect 2,000 calories'-worth of molluscs in two hours, trebling Perlman's rate. This disparity may be an artifact of more fertile Australian mollusc beds, but it may be that Perlman's figure is too conservative.

Marine molluscs are predictable, have high biomass and density, and have return rates variously calculated between fair and good. Assuming good return rates, specialized shellfish sites could be expected; such sites have been found archaeologically (Barber 1979b; Brennan 1974; Salwen 1962; Snow 1974). Occupants of other sites have proven to have had greater dietary inputs from resources other than shellfish (J. Cross 1979); Perlman 1976).

A special factor, in addition to those discussed above, argues that shellfish had a special influence over the location of sites. Over half of a mollusc's wieght is usually shell which must be discarded. To minimize effort, the processing station should be near the shellfish bed, minimizing transportation of extra weight. In effect, the shell midden would be an analogue of an industrial processing site near a natural resource deposit, a pattern long recognized by geographers (Hamilton 1967). For this reason, marine molluscs are considered a determinate resource. The moderately low return rates make them a secondary resource.

6.3 Predictions

6.3.1 Specialist and generalist strategies

In seasonal environments with strong annual fluctuations in conditions and resource availability, specialist strategies relying on a single or narrow range of resources for the entire year are rare. From 18,000 B.P. onward, the Continental Shelf north of Cape Hatteras has been highly seasonal, so such strategies are not expected.

Seasonally, however, it may be advantageous for human populations to concentrate on a single species or a narrow range of resources if conditions are met. Those conditions include high resource density and biomass of standing crop (existing organisms), good return rates, and high predictability (Horn 1968). As argued above, the primary resources listed above (marine molluscs and anadromous fish) satisfy these criteria. It is predicted that anadromous-fish-exploitation sites and shell middens occur in areas which had dense aggregations of these resources. No other site types are expected to reflect such seasonal specialization.

6.3.2 Resource mix in generalist strategies

The mechanical prediction of the percentages of various resources in diet can be detailed only where data on density, return rates, and distribution are known well. Since many of those data are now known for the Continental Shelf, predictions will be limited to qualitative and ordinal scales.

In forests with large percentages of nut trees, deer and nuts stand out as two major resources. Since deer meat and skins are best in autumn and since nuts drop then, their exploitation could occur simultaneously during that season. During that season and especially other seasons, less major resources are predicted to have provided much toward subsistence. Various locations in these forests would also have been favorable for the capture of anadromous fish in season.

Protected coastal zones, including lagoons and estuaries, would have had both anadromous-fish and marine-mollusc resources which would have made major contributions to diet. In addition, since coastal zones are only narrow strips of the interface between salt water and land, terrestrial resources would have been available within a short distance. The total available resource mix in coastal zones, therefore, would have been greater than it was inland.

6.3.3 Seasonality

The marginal value theorem (Charnov 1976) states that a patch will be abandoned for exploitation when the capture rate of its resources falls below that of surrounding patches. Nuts and anadromous fish are highly seasonal resources which appear abruptly and disappear or are exhausted rapidly. Since other resources are being depleted at the same time these seasonal resources are being used, the capture rate in the patch falls below surrounding capture rates once the season of availability has passed. It is predicted that sites for exploitation of anadromous fish and nuts will be occupied only during the seasons of availability for those resources. Other resources scheduling predictions require unavailable data on resource mixes, with the possible exception of ungulates. Many ungulates (probably mammoth, certainly caribou and deer) have seasonal aggregation into herds for migration (mammoth and caribou) or winter protection (deer). These seasonal aggregations might warrant specialized seasonal exploitation, discussed below. In such case, seasonal exploitation sites would be expected.

6.3.4 Site size

Site size appears to be correlated closely with site population (Naroll 1962; among others), with the possible exception of shell middens (Barber 1979b). In foraging terms, population of a settlement is a function of the dispersal or concentration of foraging activities conducted from it. Dispersed foraging is best served by small, widely spaced settlements; concentrated foraging is most efficient from a few larger sites.

In general, the optimal strategy for predictable, mobile, and evenly distributed resrouces is forager dispersal; for unpredictable, immobile and clumped resources, aggregation at a central location is optimal (Hamilton and Watt 1970; Horn 1968; Thompson and others 1974). Information exchange will be increasingly important if resources are increasingly unpredictable but clumped, since a change encounter could search out far more food than could be used by a small foraging group. On the other hand, the lower the density and greater the dispersal of resources, the greater the travel costs to come together and exchange information. In terms of the environments of the Continental Shelf, three categories can be constructed.

First, extreme dispersal is predicted for tundra-like and parkland environments. The major resources there were evenly distributed within (and perhaps through) patches and highly mobile. While distribution and density were unpredictable, information exchange probably would have been prohibitively costly, since resources were unaggregated at most times and the low density and wide dispersal would have required tremendous travel times. Sites in these environments are predicted to have been small.

Second, coastal zones and favorable locations for anadromous fish capture are predicted to have caused the concentration of foraging. The resources exploited are immobile and highly clumped, with high density and biomass. The resources also are predictable; consequently, aggregation for information exchange would not be necessary for the exploitation of those resources. For other purposes, including exchange of information on other resources and non-subsistence topics, mate exchange, and other group activities, aggregation of population would be desirable.

Ungulate populations often aggregate seasonally. The migratory herds of mammoth or caribou are dense, mobile, and unpredictable resources. Without data, it is impossible to calculate whether it would be more efficient to incorporate an aggregation of small foraging groups for information exchange into the strategy. In any case, the wide range and unpredictability of ungulate migratory herds would make their exploitation a high risk strategy which would be likely to produce disastrously low returns occasionally; a single such low return at a critical period could spell demographic catastrophe for a human foraging group. (See Fitzhugh 1972 for examples among caribou exploiters.) The average return might be marginally greater than that secured by dispersed, small foraging groups with little information exchange, but the range of returns would be unacceptable. It is predicted that migratory ungulates were exploited by small groups, living in small settlements.

Deer aggregations in sheltered spots during winter are a different matter. They are predictable, relatively immobile, and clustered. Exploitation by a large foraging group would be possible, but disturbance tends to break up the deer aggregations, which are unstable and relatively short-lived in any case (Godin 1977). Density would drop immediately upon exploitation and the marginal value theorem would predict that human exploitation cease. Settlement under such cases would be impractical, so the winter deer aggregations may be viewed as fluctuations in resource density.

Third, some environments lie between the extremes of conditions making either extreme dispersal or extreme congregation efficient. Mixed conifer-deciduous and deciduous forest fall into this category. Depending on the resource mix and the technology employed, various predictions would be possible.

6.3.5 Site frequency

Site size is a function of strategies used to exploit an environment; site frequency is a function of the relative attractiveness of various environments for exploitation. The attractiveness of an environment is determined by its resource density, return rates, predictability, and other factors, including factors unrelated to subsistence. Since these factors and their interrelationships cannot be reconstructed reliably for the Continental Shelf, an approximation of expected site frequency will be based on measures of resource endowment.

Table II-44 summarizes the resource density values assigned various paleoenvironments in Section 4. The assignment of values was impressionistic and these values cannot be used for meaningful comparisons between resources. Within a single resource, however, they form an ordinal scale of abundance.

From Table II-44, it can be seen that protected coasts have greater resources than open coasts, mature estuaries more than early estuaries. Given that mammoth and mastodon were succeeded by caribou and moose

TABLE II-44. Resource density values for various paleoenvironments of the Continental Shelf. (P= present, 0= absent, 1= low, 2= medium, 3= high.)

Resources

Environments	Nuts	Mammoth and mastodon	Caribou and moose	White-tailed deer	Anadromous fish	Other fish	Marine molluscs	Seals and walrus
open coast	0	0	0	0	0	1	0	2-0*
protected coast	0	0	0	0	0	1	3	3-0*
early estuary	0	0	0	0	3	1-2	1-2	0
mature estuary	0	0	0	0	3	1-2	3	0
valley (tundra, parkland, early forest)	0	P	1-2	0	3	1-2	0	0
valley (20% or more oak)	2	0	0	3	3	1-2	0	0
upland (tundra, parkland, early forest)	0	P	1-2	0	1	1	0	0
upland (20% or more oak)	3	0	0	2	1	1	0	0

*decreasing over time, decreasing southward and that overlap, if it occurred, was minor and short-lived, oak forests had more abundant resources than tundras, parklands, and early (non-oak) forests; valleys had more abundant resources than uplands. Estuaries had more resources than full coasts.

A more precise measure of an environment's resource potential is net primary productivity, the rate at which plant material is produced. This measure, however, does not account for differences in length of food chain between plant and human resource; the longer a food chain, the more energy is lost. Table II-45 shows productivity of a series of environments. Using these values, open coasts can be seen to be very unproductive. Arctic tundra and temperate grasslands yield extreme values, between which postglacial tundra-like environments probably fall. Parkland and early forest are probably comparable to boreal forest in productivity and temperate hardwood forests are far more productive. Estuaries and lagoons (protected coasts) are the most productive of all environments. Barber (1979b) has used ecological reasoning to argue that estuaries will be very intensively exploited by human foragers.

These lines of reasoning have placed the various Continental Shelf environments discussed in the following order of increasing expected site frequency: open coast, upland (tundra, parkland, early forest), valley (tundra, parkland, early forest), upland (20% or more oak), valley (20% or more oak), early estuary, protected coast, and mature estuary.

More precise measures of site frequency or population cannot be calculated reliably. To give a hint at the possible population of the Continental Shelf, however, estimates based on historic population densities of hunter-gatherers in similar environments can be calculated.

As an estimate of Paleo-Indian populations exploiting tundra or parkland, Root (1978) has taken a typical historical documented density of caribou hunters (0.1 per sq mi) and multiplied by the size of the Atlantic Continental Shelf at that period (322,275 sq mi). The resulting population estimate is 32,227. Wobst (1976) estimates that the minimum size for a viable, reproducing human population is 475, with an average group size of 25. Assuming only one site per year per group - unlikely in an environment favoring mobility - and assuming no change through time, there would be one site every 190 sq mi.

Performing similar calculations for 7000 B.P., Root uses a population density of five persons per square mile, based on California hunter-gatherers. She estimates a population of 322,223. If sites were used year-round and never shifted, then one site can be expected every five square miles.

TABLE II-45. Net primary productivities of selected environments (compiled in Perlman 1978, Barber 1979b).

Environment	Primary Productivity, calories/m^2/year
Open coast/beach	about 500
Arctic tundra	630
Temperate grassland	2,500
Boreal forest	3,000
Temperate hardwood forest	8,000
Estuary and lagoon	20,000

These figures are crude estimates and are intended to indicate the scale of probable aboriginal occupation of the Continental Shelf. They are not intended as precise predictions.

6.3.6 Optimal foraging models: summary of predictions for northern Continental Shelf

Table II-46 presents predictions for settlement on the Continental Shelf between the Bay of Fundy and Cape Hatteras, as derived from application of optimum foraging models. The table is divided by subarea, period, and paleoenvironment. Predictions are site size, site frequency, and site type (for shell middens and anadromous fish exploitation sites only). This table is merely an explicit summary of the predictions made in the preceding pages.

The basic procedure for deriving predictions was to examine paleoenvironmental factors, chiefly processes leading to increased protection of the coast, estuary maturity, and northward colonization of oaks. The paleoenvironment (full coastal, estuarine, inland valley, or upland) then was classified into one of the eight finer-grained environmental types given in Table II-44. On the basis of reconstruction of resources for those environmental types, optimal foraging models were applied in order to derive the predictions listed.

Site size and frequency are predicted in ordinal terms. Extreme values (very small, very high) are solidly based on deductive models, but intermediate values tend to be slightly less reliable. Intermediate values were assigned primarily to environments predicted to be exploited in terms of a broad resource mix; the specific composition of that mix could produce different patterns of site size. Site frequency and size are predicted to increase slightly as inland environments become more attractive, since their catchment areas would include both coastal and inland areas, making it possible to exploit both. Shell middens are assumed to have range as large as "medium" from earliest times, even if the exploiting group was small, since the rapid accumulation of shell can cover a large area in a short period.

Within a subarea, the ordinal measures have a basic consistency. Between subareas, however, the scale changes, so that a "high" site frequency in Maine might be only "medium" in North Carolina. In general, site frequency is predicted to become markedly higher between Maine and southern New England, then gradually greater in a southward gradient.

TABLE II-46. Summary of settlement predictions for the project area, deductive models.

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
Maine	18,000-12,000	under glacier or sea	none	none		
	12,000-9000	full coastal	small	low		
		estuarine	small	low		
		inland valley	very small	low		X
		upland	very small	low		
	9000-6000	full coastal	small-medium	medium-low	X	
		estuarine	small	medium	X	X
		inland valley	small	low		X
		upland	small	low		
	6000-3000	full coastal	small-large	medium-high	X	

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
	6000-3000	full coastal	small-large	medium-high	X	
		estuarine	small-medium	medium	X	X
		inland valley	small-medium	medium		X
		upland	small	low		
	3000-present	full coastal	small-large	high	X	
		estuarine	small-medium	medium	X	X
		inland valley	small-medium	medium		X
		upland	small	low		
Southern New England	18,000-15,000	full coastal	small	low		
		estuarine	small	low		X

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
		inland valley	small	low		X
		upland	very small	low		
	15,000-12,000	full coastal	small	low		
		estuarine	small	low		X
		inland valley	small	low		X
		upland	very small	very low		
	12,000-9000	full coastal	small-medium	medium	X	
		estuarine	small-medium	medium	X	X
		inland valley	small	low		X
		upland	small	very low		
	9000-6000	full coastal	small-medium	medium	X	

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
		estuarine	medium	medium	X	X
		inland valley	small-medium	medium		X
		upland	small	low		
	6000-3000	full coastal	small-large	high	X	
		estuarine	small-large	high	X	X
		inland valley	small-large	medium-high		X
		upland	medium	medium		
	3000-present	full coastal	small-large	high	X	
		estuarine	small-large	high	X	X
		inland valley	small-large	medium-high		X

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
		upland	medium	medium		
Mid-Atlantic	18,000-15,000	full coastal	small	very low		
		estuarine	small	low		X
		inland valley	small	low		X
		upland	very small	low		
	15,000-12,000	full coastal	small	very low		
		estuarine	small	low		X
		inland valley	small	low		X
		upland	very small	very low		
	12,000-9000	full coastal	small-medium	medium	X	

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
		estuarine	small-medium	medium	X	X
		inland valley	small	low		X
		upland	small	very low		
	9000-6000	full coastal	small-medium	medium	X	
		estuarine	small-medium	medium	X	X
		inland valley	small-medium	medium-high		X
		upland	small	low-medium		
	6000-3000	full coastal	small-large	high	X	
		estuarine	small-large	high	X	X

TABLE II-46. Summary of settlement predictions for the project area, deductive models. (cont.)

Subarea	Time Span, B.P.	Paleoenvironment	Predicted Site Size	Predicted Site Density	Includes Shell Middens	Includes Anadromous-Fish Camps
		inland valley	small-medium	medium-high		X
		upland	small-medium	medium		
	3000-present	full coastal	small-large	high	X	
		estuarine	small-large	high	X	X
		inland valley	small-medium	medium-high		X
		upland	small-medium	medium		

7.0 DISCUSSION AND CONCLUSIONS

7.1 Introduction

Both the inductive and the deductive models suffer from weaknesses, gaps, and limitations. This section discusses some of those shortcomings, first those specific to this study or application, then those which logically must plague certain types of models. Finally, a synthesis of the two sets of models is offered as the best available predictive model for the northern portion of the Continental Shelf of the eastern United States.

7.2 Weaknesses of Models

7.2.1 Inductive model

The sample of archaeological sites from what is now dry land is biased in a variety of ways. Research has been concentrated in some areas at the expense of others; some periods have been studied intensively, while others have been virtually ignored; in some areas, natural processes or modern development have destroyed sites, leaving no traces.

More subtle biases also affect the archaeological record. Academic disagreements over classification of artifacts can lead to different interpretations. For example, before Funk's (1965) definition of Beekman Triangle points, characteristic of the Late Archaic Period, many of these points would have been assigned to the Levanna type, characteristic of the Late Woodland Period. Sites whose data were recorded before this definition would probably be called Late Woodland, while those recorded after would be called Late Archaic, even though the material cultures might be identical.

In addition to the high probability of sample biases, certain categories of potentially useful data were rarely recorded. Soils data, for example, are a critical environment variable, since soils not only affect the engineering quality of a location and its suitability for housing or other activities, but also have strong effects on local vegetation, which in turn affects animal life. Unfortunately, soils data were recorded too infrequently to allow their use in general models of settlement.

Typically paleoenvironmental data were also not included in site reports. Accordingly, it is difficult to evaluate an early site on a present lakeshore. Without extensive study of a kind which has been completed only in a few cases, one cannot determine whether the lake was present at the time of site occupation, where it was located, how large it was, and so forth.

Finally, there are certain large-scale gaps. Knowledge of Maine prehistory, overall, is weak relative to areas further south. The earliest and latest periods are especially weak. In Maine and elsewhere, archaeological research has rarely been directed toward the uncommon areas where early coastal zones have maintained themselves above sea level as a result of local land movement or other processes. (Brennan 1974 and Loring 1978 are exceptions.) Information from these areas could shed tremendous light on settlement on the inundated portion of the Continental Shelf.

Despite these criticisms, the inductive model probably is basically sound. Most of the criticisms refer to gaps in information, probably resulting in failure to include certain site types, rather than confusion of patterns. Relative frequencies may be somewhat distorted, but it is hoped that the large sample of sites will provide the closest available approximation to an unbiased sample.

7.2.2 Deductive models

The deductive approach, using optimal foraging models, was plagued by two sets of problems: lack or unreliability of paleoenvironmental data pertinent to the Continental Shelf, and a general inability to quantify either data or predictions.

The Continental Shelf is a large area, and relatively little paleoenvironmental reconstruction has been done for it. For example, the only pollen samples analyzed from the Shelf (Balsam and Heuser 1976) appear to have been secondarily deposited, washed downstream from presently exposed areas. Without data from the Shelf itself, it is impossible to resolve questions of coastal-to-inland climate gradients.

Very few quantitative estimates have been produced in the deductive models, chiefly for two reasons. First, data on paleoenvironments of the Shelf are rarely quantifiable, and conclusions can be no more quantified than the premises upon which they are built. Second, the scale of the project is great in terms of both space and time. The mere collection of paleoenvironmental data of sufficient detail to permit more quantified predictions of resource mix and concomitant settlement pattern - if such data had been collected and were available - would be a monumental task. Without that detailed information, however, predictions must be primarily qualitative or ordinal.

The use of discrete subareas and time periods has obscured the general continuity of culture and adaptation. Northern New Jersey has more environmental similarity to coastal New York than to coastal New Hampshire, yet the use of subareas has obscured this fact.

The use of periods has had somewhat more serious effects. Vegetation, landforms, sea level, and climate have changed at different rates and the system of periods used here, 3,000-year intervals, has forced certain processes into Procrustean beds. Yet, the alternative approaches, very short periods, would have led to a false impression of accuracy of dating and would have unnecessarily encumbered an already detailed study.

7.3 Synthesis of Inductive and Deductive Models

7.3.1 Necessity

The logical limitations of inductive and deductive models have been discussed earlier and will be treated briefly here.

Inductive models are based on the archaeological record. The factors isolated to use in inductive models may not be the factors which will produce the most reliable model, but the goodness of fit between data and model is assured. In this study, the inductive models were produced from data pertaining to dry-land sites and will be applied to a different data set: inundated portions of the Continental Shelf. Since the environmental variables assumed to be of primary importance in determining settlement patterns are somewhat different in the two areas, it is unlikely that the dry land model will be entirely appropriate to the inundated shelf.

The deductive models, on the other hand, were derived from knowledge and assumptions about foraging behavior and the paleoenvironmental reconstruction. They were not based on the archaeological record, but predict how efficient and knowledgeable human foragers would settle on the land. They represent simplified first approximations of human behavior, not the complexities of real human behavior.

In cases where the paleoenvironment of the Continental Shelf is analogous to contemporary paleoenvironments on presently dry land, both the deductive and the inductive models should produce reasonable predictions of settlement location. In cases where contemporary paleoenvironments were not present on what is today dry land, however, the inductive model should not apply and only the deductive model should be used.

The types of predictions derived from the inductive and deductive models are different, in large part because of differences in scale. While the deductive model makes predictions about the intensity and form of settlement in a given paleoenvironment, the inductive model incorporates in many cases predictions of the location of sites within a paleoenvironment. That is, the deductive model might predict intensive use of an estuarine zone; the inductive model might predict that sites would be found on certain soil types or on certain topographic features. Many of the fine-grained prediction variables in the inductive models cannot be reconstructed for the Continental Shelf and are of little practical use for this study. By combining the preditions of the two models, a richer, more detailed, and, it is to be hoped, more accurate prediction of prehistoric settlement can be derived.

7.3.2 Approach

In determining the final model, the first necessary decision was whether both models or only the deductive model would be applicable to a given paleoenvironment, period, and subarea. This decision amounted to determining whether the paleoenvironment had analogous paleoenvironments in areas presently above sea level and, consequently, whether the inductive model incorporates data from similar areas. The question of whether an environment was unique or had contemporary analogues on what is now dry land is not clear cut. Indeed, all environments are unique and no two spots have identical environments.

Implicit in the type concept, used to classify environments throughout this report, is the assumption that environments with characteristics that are similar to a given degree can be treated as a unit. Because of the coarseness of paleoenvironmental reconstructions of the Continental Shelf, the environmental types are broad and must remain so. Absence of environmental detail makes it difficult to assess the degree of similarity between environments, but estimates can be made on the basis of the same criteria used in defining the four paleoenvironmental types used throughout.

For example, non-coastal areas away from major waterways would be classified as "uplands" on the inundated Continental Shelf; on dry land, similar areas would also be classified as "uplands," even though there might be considerable difference in the environments of the two areas. On the other hand, a coastal site adjacent to the ocean would be "full coastal," while no presently dry land areas might have been adjacent to the ocean at the same period; in this case, there would be no present-day dry land analogue. This method of analogue identification is somewhat crude and allows for considerable variation within certain environmental types, but it is believed to be the best estimate possible with the available data.

Table II-47 lists the subareas, periods, and paleoenvironments which this method has determined to have no contemporary analogues on present-day dry land. For these times and places, the inductive model will be inapplicable. For all others, the predictions of both models are applicable. (See below for a discussion of possible incongruities in the predictions of the two models.)

TABLE II-47. Environments on the inundated Continental Shelf with no analogues on what is now dry land.

Subarea	Period, B.P.	Coastal Environments
Maine	18,000 to 8000	full coastal
	18,000 to 10,000	estuarine
Southern New England	18,000 to 4000	full coastal
	18,000 to 8000	estuarine
Mid-Atlantic	18,000 to 4000	full coastal
	18,000 to 6000	estuarine

7.3.3 Site types

The site types used for the final model of settlement in the study area are based in part on those used in the inductive model, in part on those used in the deductive model. In the inductive model, site types were drawn from those found in existing literature and it was noted that they had not been developed systematically, but that their definitions were more or less generally agreed upon. The nature of the deductive model is such that the number of site types derived was very limited, since exploitation of a zone was being discussed. Site types included "habitation" (for most zones) and special-purpose sites, such as fishing camps.

The site types used in the final model of settlement are defined and described below. Prefixes and suffixes modifying a basic site type are named for locational, functional, or arbitrary factors, but are necessary to differentiate sites of the same basic type whose site size, frequency, and locational attributes may differ.

Camp: a habitation site, usually presumed to be more or less temporary; sometimes there is a connotation of special-purpose use.
- fishing camp: used for fishing
- seal-hunting camp: used for seal hunting
- other camp I: along coast
- other camp II: in piedmont or upland

Rock shelter: a habitation site, located in a cave or rock overhang providing shelter; usually small, with the connotation of impermanence.

Farmstead: a habitation site, small, associated with agricultural fields; associated with but separate from larger sites.

Village: a habitation site, of considerable size; permanent or semi-permanent.

Habitation: a residual category, embracing sites which human beings occupied but whose exact nature is unknown or does not fit other types.
- other habitation: in addition to habitation sites of documental or inferred type.

Black earth midden: a deposit of organic refuse with little or no shell included; may be a habitation or a work area, where restricted functions were performed by people from a separate habitation.

Shell midden: a deposit of organic refuse with considerable quantities of shell included; may be a habitation or a work area, where restricted functions were performed by people from a separate habitation.

Fish weir: a non-habitation site, consisting of a system of stakes, mats, nets, and/or other materials, placed in a river to capture fish.

7.3.4 Site size and frequency

As with both the deductive and inductive models, measures of site size and frequency are ordinal, except in a few cases where empiric data are known. In the absence of more data on the Continental Shelf, more refined estimates would have a low probability of accuracy.

7.3.5 Scale

As discussed briefly earlier, the scale of prediction for the inductive model is much finer than that for the deductive model. In other words, the inductive model deals more with details of settlement patterns, while the deductive model treats broader patterns.

Scale also becomes important in the translation of the final settlement model into spatial terms on maps. Since only large rivers and their valleys have been mapped for the Continental Shelf, "inland valley" and "estuarine" environments can be located only in the cases of large rivers, although smaller rivers also would have had estuaries and inland valleys. This inability to reconstruct the Continental Shelf environment in greater detail causes an unavoidable limit to the accuracy of the model.

7.3.6 Results: The final predictive model of settlement on the Continental Shelf, Bay of Fundy to Cape Hatteras

Table II-48 summarizes the predictions for the final model of settlement in the project area. Figure II-57, Table II-49, and Charts II-1 through II-4 show the predicted distribution of site types at different periods.

As the maps show, density of site distribution increases with proximity to present shorelines. This pattern is understandable, since site frequency per 1,000 years was steadily increasing over time (see Section 5) and areas further form present shore, by and large, were inundated earlier. The areas closer to shore have several millennia of occupation; the areas further away only had a few millennia of occupation. The nearshore areas received not only the denser late occupation, but also occupation from all previous periods.

This numerical measure of archaeological sensitivity must be considered in light of another factor, however. The further from shore, the more unique the paleoenvironments. With no intact, above-water Paleo-Indian-

TABLE II-48 Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras.

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
Maine	18,000-12,000	under glacier or sea		none				
	12,000-9000	full coastal	seal-hunting camp	low	small			
		estuarine	fishing camp	low	small		X	near falls, rills, rapids, and narrows
		inland valley	fishing camp	low	small		X	near falls, rills, rapids, and narrows
		upland	habitation	low	small			wide variety; especially lakesides
	9000-6000	full coastal	seal-hunting camp, shell midden	low-medium	small-medium	X		
		estuarine	fishing camp, shell midden	medium	small	X	X	

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		inland valley	fishing camp	low, increasing	small		X	stream or river shores; near falls, rills, rapids, and narrows
		upland	habitation	low, increasing	small			
	6000 3000	full coastal	shell midden	medium	small-large	X		near shellfish beds; near sizable waterways with access to open sea
		full coastal	black earth midden	low?	medium-large			
		full coastal	other habitations	--	--			
		estuarine	shell midden	medium	small-large	X		near shellfish beds; near sizable waterways with access to open sea
		estuarine	fishing camp	medium	small-medium		X	near falls, rills, rapids, and narrows

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		inland valley	fishing camp	medium	small-medium		X	near falls, rills, rapids, and narrows
		inland valley	other habitations	--	--			
		upland	habitation	low	small			
	3000 present	full coastal	shell midden	high	small-large, mean 20 ft diameter	X		near shellfish beds; elevation usually less than 5 ft above present sea level; protected shores; southwest or south-facing slopes
		full coastal	black earth midden	medium?	medium-large			
		estuarine	shell midden	high	small-large, mean 20 ft diameter	X		near shellfish beds; elevation usually less than 5 ft above present sea level; southwest or south-facing slope

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		estuarine	fishing camp	high	small-medium		X	near falls, rills, rapids, and narrows
		inland valley	fishing camp	high	small-medium		X	near falls, rills, rapids, and narrows
		inland valley	other habitations	--	--			
		upland	habitations	low	small			
Southern New England	18,000-12,000	full coastal	seal-hunting camp	low	small			
		estuarine	fishing camp, other habitations	low	small		X	
		inland valley	fishing camp, other stations	low	small		X	

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		upland	habita-tion	low	very small			
	12,000-9000	full coastal	seal-hunting camp	low	small			
		estuarine	shell midden, fishing camp	low	small	X	X	
		inland valley	fishing camp, other habita-tions	low	small-large		X	
		upland	habita-tion	very low	small		X?	wide variety; near small rivers and streams especially; usually below 400 ft above present sea level, often on landforms high-er than surrounding terrain
	9000 6000	full coastal	shell midden	medium	small-medium	X		

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		estuarine	shell midden, fishing camp	medium	small-medium	X	X	
		inland valley	fishing camp, other habitations	low-medium	small-medium		X	near falls, rills, rapids, and narrows; well-drained soil/locally high ground/less than 8% slope; usually below 100 ft above present sea level; zones with 20% or greater oak pollen
		upland	camp	low	small			above 200 ft above present sea level; zones with 20% or greater oak pollen; well-drained soil/locally high ground/less than 8% slope/stream or small river shores
	6000 3000	full coastal	shell midden	high	small-large	X		near shellfish beds; protected shores; well-drained soil/locally high ground/less than 8% slope
		estuarine	shell midden	high	small-large	X	X	near shellfish beds; well-drained soil/locally high ground/less than 8% slope

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		estuarine	fishing camp	medium-high	small		X	near falls, rills, rapids, and narrows; well-drained soil/locally high ground/less than 8% slope; sometimes at estuary heads
		inland valley	fishing camp, other habitations	medium-high	small			near falls, rills, rapids, and narrows; well-drained soil/locally high ground/less than 8% slope; all elevations
		upland	habitation	medium	small			well-drained soil/locally high ground/less than 8% slope
		coastal or inland	camp	high	small-medium			all elevations; well-drained soil/locally high ground/less than 8% slope/stream or small river shores
		stream or river	fish weir	low-medium	small		X	near fishing camps (see above)

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		inland valley or upland	village	low-medium	large			lowlands; usually below 100 ft above present sea level; well-drained soil/locally high ground/less than 8% slope; lake shores
	3000 present	full coastal	shell midden	high	small-large, mean 80 ft diameter	X		near shellfish beds; protected shores; well-drained soil/locally high ground/less than 8% slope
		estuarine	shell midden	high	small-large, mean 80 ft diameter	X		near shellfish beds; protected shores; well-drained soil/locally high ground/less than 8% slope
		estuarine	fishing camp	high	small-large		X	often at estuary heads or near falls, rills, rapids, and narrows; well-drained soil/locally high ground/less than 8% slope
		inland valley	fishing camp	high	small-large		X	stream or river shores; often near falls, rills, rapids, and narrows; well-drained soil/locally high ground/less than 8% slope

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		coastal or inland	camp	high	small-medium			predominantly lowland, below 200 ft above modern sea level; well-drained soil/locally high ground/less than 8% slope/stream or small river shores
		inland	rock-shelter	low	small			protected area near rock out-crops or cliffs
		upland	camp	low-medium	small			above 200 ft above present sea level; well-drained soil/locally high ground/less than 8% slope/stream or small river shores
	900-1500 A.D., in particular	estuarine	fishing camp	medium-high	large		X	estuary heads; well-drained soil/locally high ground/less than 8% slope
		full coastal or estuarine	habita-tion	high	small			associated with and near shell middens (see above)

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		inland valley	village	high	large			lowlands; arable and fertile soil; usually on floodplains; well-drained soil/less than 8% slope
		inland valley	farm-stead	high	small			lowlands; arable and fertile soil; usually on floodplains; well-drained soil/less than 8% slope
Mid-Atlantic	18,000-15,000	full coastal	camp	very low	small			
		estuarine	fishing camp	low	small		X	
		inland valley	fishing camp	low	small		X	
		upland	camp	low	very small			
	15,000-12,000	full coastal	camp	very low	small			

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
		estuarine	fishing camp	low	small		X	
			shell midden	low	small	X		
		inland valley	fishing camp	low	small		X	
		upland	camp	very low	very small			
	12,000-9000	full coastal	shell midden	medium	small-medium	X		
		estuarine	fishing camp	medium	small-medium		X	
			shell midden	medium	small-medium	X		
		inland valley	fishing camp	medium	small-medium		X	along small to medium sized rivers; areas of contemporary coniferous swamps

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
			other camp I	medium	very small to small			sandy coastal plain; near "pingos"
		upland	other camp II	low	small-large			upland bluffs; ridge tops; near permanent water
	9000 6000	full coastal	shell midden	medium	small-medium	X		
		estuarine	fishing camp	medium	small-medium		X	
			shell midden	medium	small-medium	X		
		inland valley	fishing camp	medium	small-medium		X	along small to medium sized rivers; areas of contemporary coniferous swamps
			other camp I	medium	very small to small			sandy coastal plain; near "pingos"
		upland	other camp II	low-medium	small-large			upland bluffs; ridge tops; near permanent water

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
	6000 3000	full coastal	shell midden	medium-high	small-large	X		along protected coasts
		estuarine	fishing camp	high	small-large		X	along small to medium sized rivers; at falls, rills, rapids
			shell midden	high	small-large	X		near shellfish beds
		inland valley	other camp I	medium-high	small-medium		X	in piedmont; near permanent water, wide variety of habitats
			other camp II	medium-high	small-very large			on coastal plain; near permanent water; wide variety of habitats
		upland	other camp II	medium	small-medium			on coastal plain; near permanent water; wide variety of habitats
	3000 present	full coastal	shell midden	very high	small-large	X		along lagoons; on barrier islands; protected shores; near shellfish beds

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
			black earth midden	high	small-medium			along lagoons; headlands and protected embayments
		estuarine	shell midden	very high	small-large	X		along estuaries; near shell-fish beds
			fishing camp	medium	small-medium		X	along estuaries of small to large rivers; at falls, rapids, rills
			black earth midden	high	small-medium			along estuaries; headlands and protected embayments
		inland valley	fishing camp	medium	small-medium		X	along small to large rivers; at falls, rapids, rills
			other camp I	medium	small, less than 100 ft diameter			in piedmont; near permanent water; wide variety of habitats

TABLE II-48. Summary of predictions, final model of settlement, continental shelf from the Bay of Fundy to Cape Hatteras. (cont.)

Subarea	Period, B.P.	Paleo-environment	Site Type	Predicted Site Frequency	Predicted Site Size	Includes Shell Middens	Includes Anadromous Fishing Sites	Locational Attributes
			other camp II	medium-high	small, less than 100 ft diameter (sometimes larger near estuary head)			on coastal plain; near permanent water; wide variety of habitats (low density in New Jersey)
		upland	other camp I	medium	small, less than 100 ft diameter			in piedmont; near permanent water; wide variety of habitats
	900-1500 A.D.	full coastal	shell midden	very high	small-medium	X		along lagoons; on barrier islands; protected shores; near shellfish beds
		estuarine	shell midden	very high	small-medium	X		along estuaries; near shellfish beds
		inland valley	village	high	large			on arable soils, especially river valleys; usually near coast

Period coastlines available for study, the importance of a coastal Paleo-Indian site on the inundated Continental Shelf cannot be overestimated.

7.3.7 Assessment

The goodness of fit between the predictions of the deductive model and the empiric patterns represented by the inductive model constitute a test of the hypotheses generated out of optimal foraging theory. While it is not the purpose of this volume to examine the validity and utility of optimal foraging theory, it is important to assess how well the deductive model, which had considerable input into the final settlement model, is supported by data.

Of the predictions relating to the 35 paleoenvironments (in the various subareas and periods) which have approximate analogues in the dryland record, only two instances arose in which the predictions of the two models were incompatible. First, the deductive model predicts more upland settlement in southern New England during Woodland times than is represented in the site records. Mulholland (no date) has argued that minor climatic change around 3000 B.P. caused an increase in forest diversity and unpredictability, making upland exploitation a higher-risk strategy. When these factors were coupled with a drop in site frequency and perhaps population, there may have been retraction from upland zones. Second, shell-midden densities for Middle and Late Archaic times in the entire project area are lower in the archaeological record than was predicted by deductive models, probably as a result of inundation of much of the coastal zone for those periods. The small fraction of these zones which is above present sea level probably creates a false impression of scarcity for these sites, so site frequency estimates will be taken from the deductive model. In the other cases, site size and frequency estimates were the same or at least overlapping.

The degree of agreement between the deductive and inductive settlement models is high for situations where they can be compared. The conclusion is that optimal foraging models approximate hunter-gatherer foraging patterns well and can be used to provide a good first approximation of settlement patterns in the study area. This conclusion, in turn supports their use in predicting settlement patterns for periods and areas where inductive models are inapplicable.

This settlement model is offered as the most sophisticated model which can be supported by the data. It can be improved through the implementation of further studies and the collection of new data, as discussed in Volume IV, and its accuracy should be tested by studies on the Continental Shelf. Given the present state of knowledge, this model is believed to present a moderately sophisticated and reliable prediction of prehistoric settlement on the norther Atlatnic Continental Shelf of the United States.

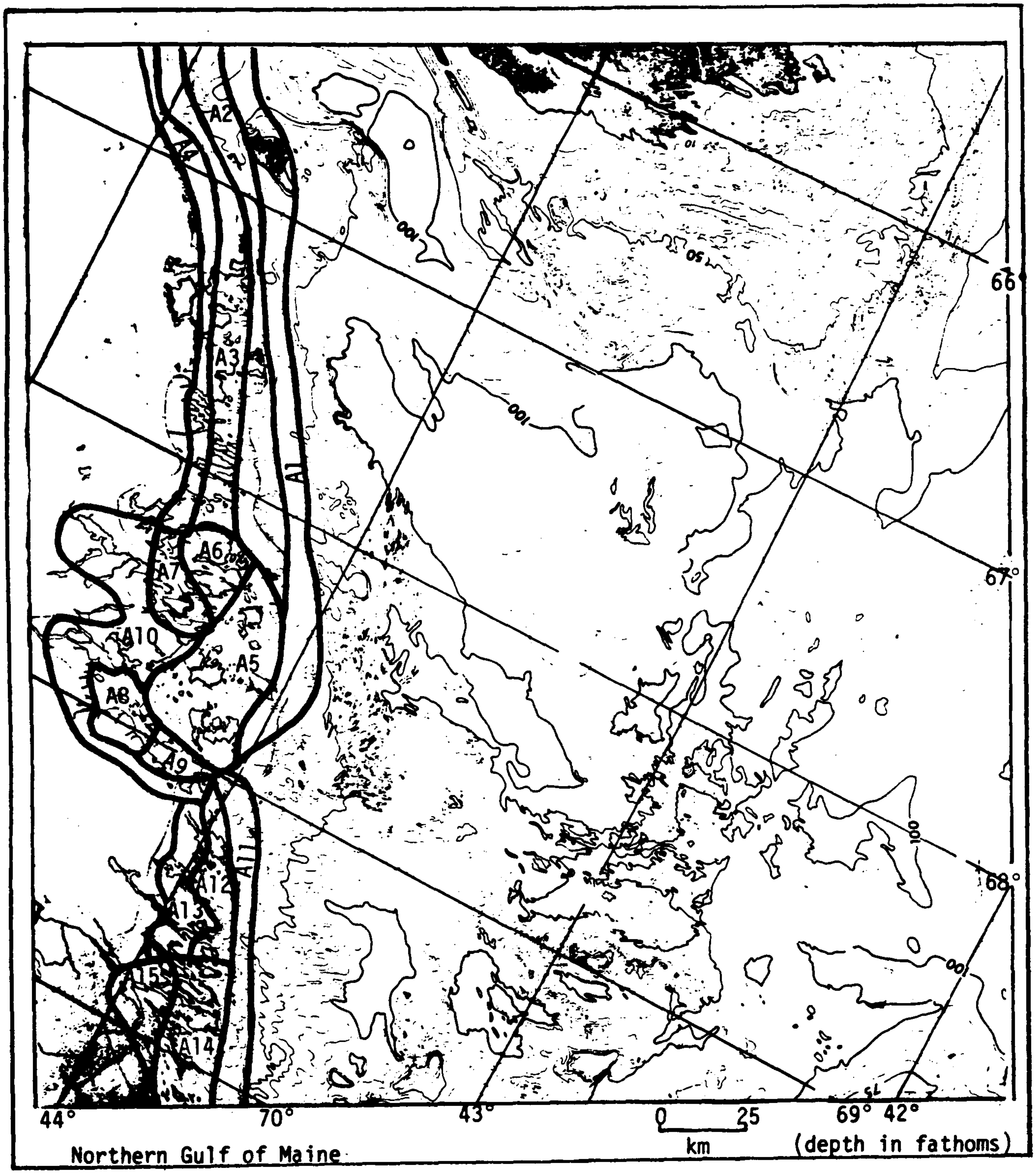


Fig. II-57a: Archaeology Zones.

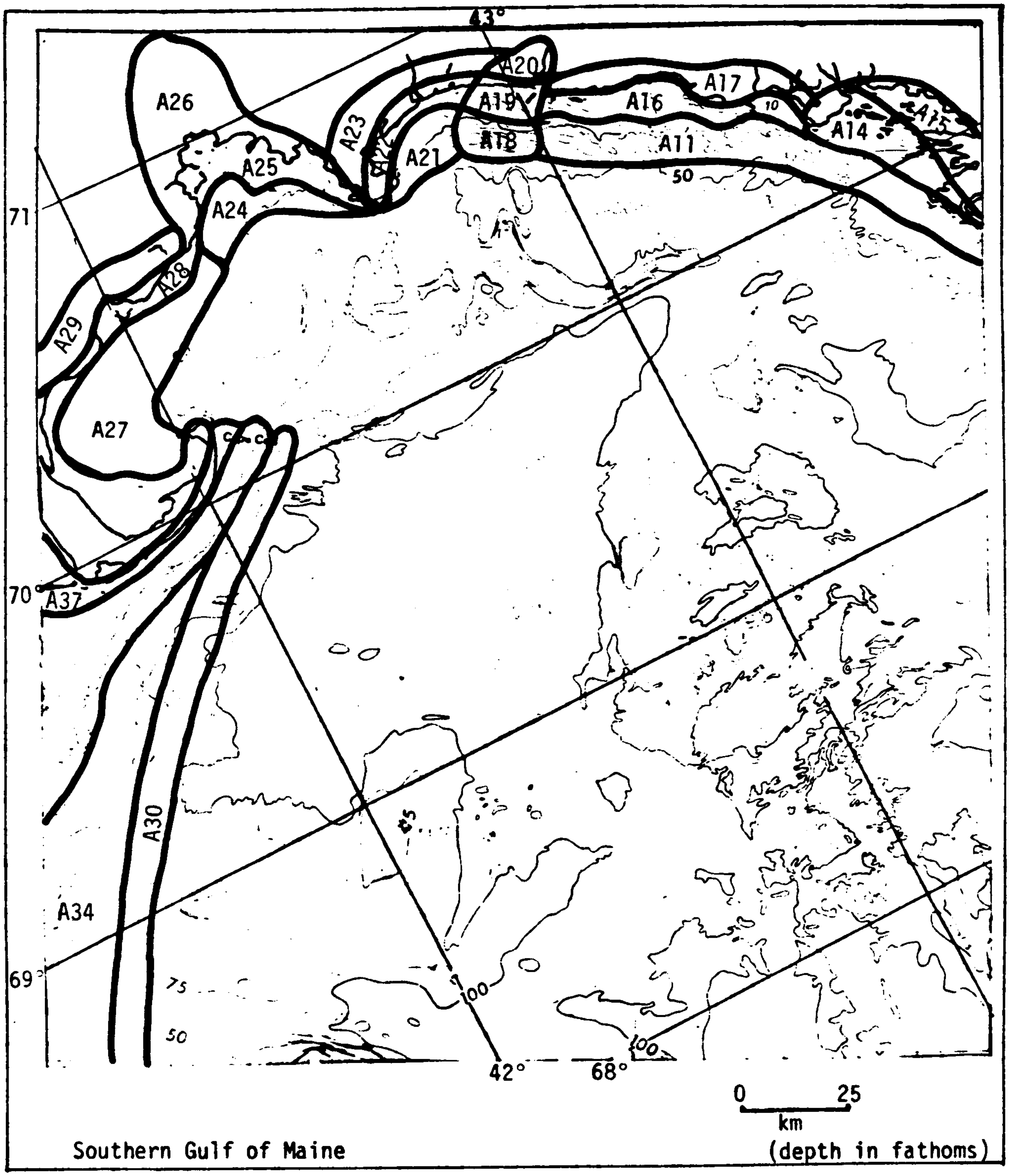


Fig. II-57b: Archaeology Zones.

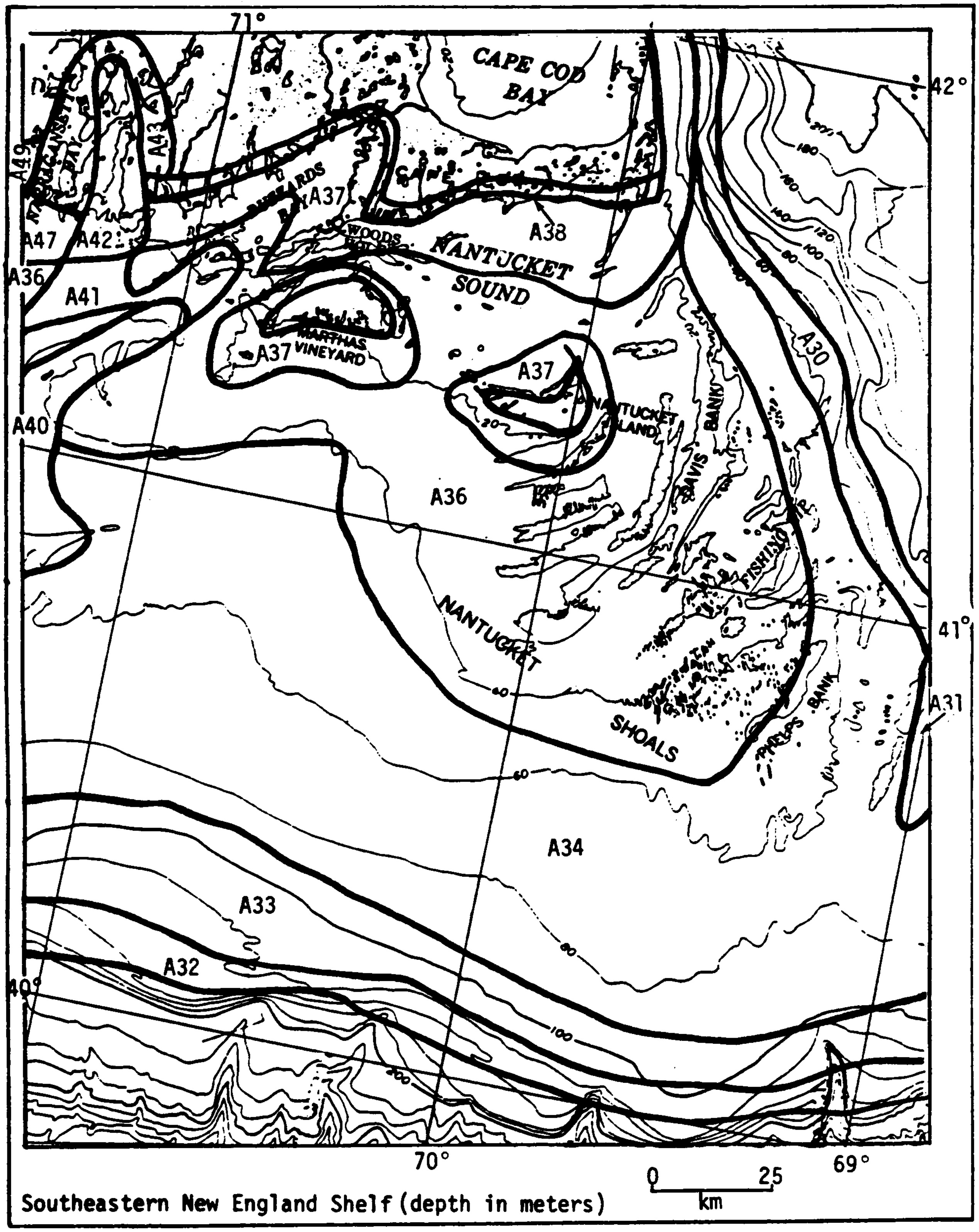


Fig. II-57c: Archaeology Zones.

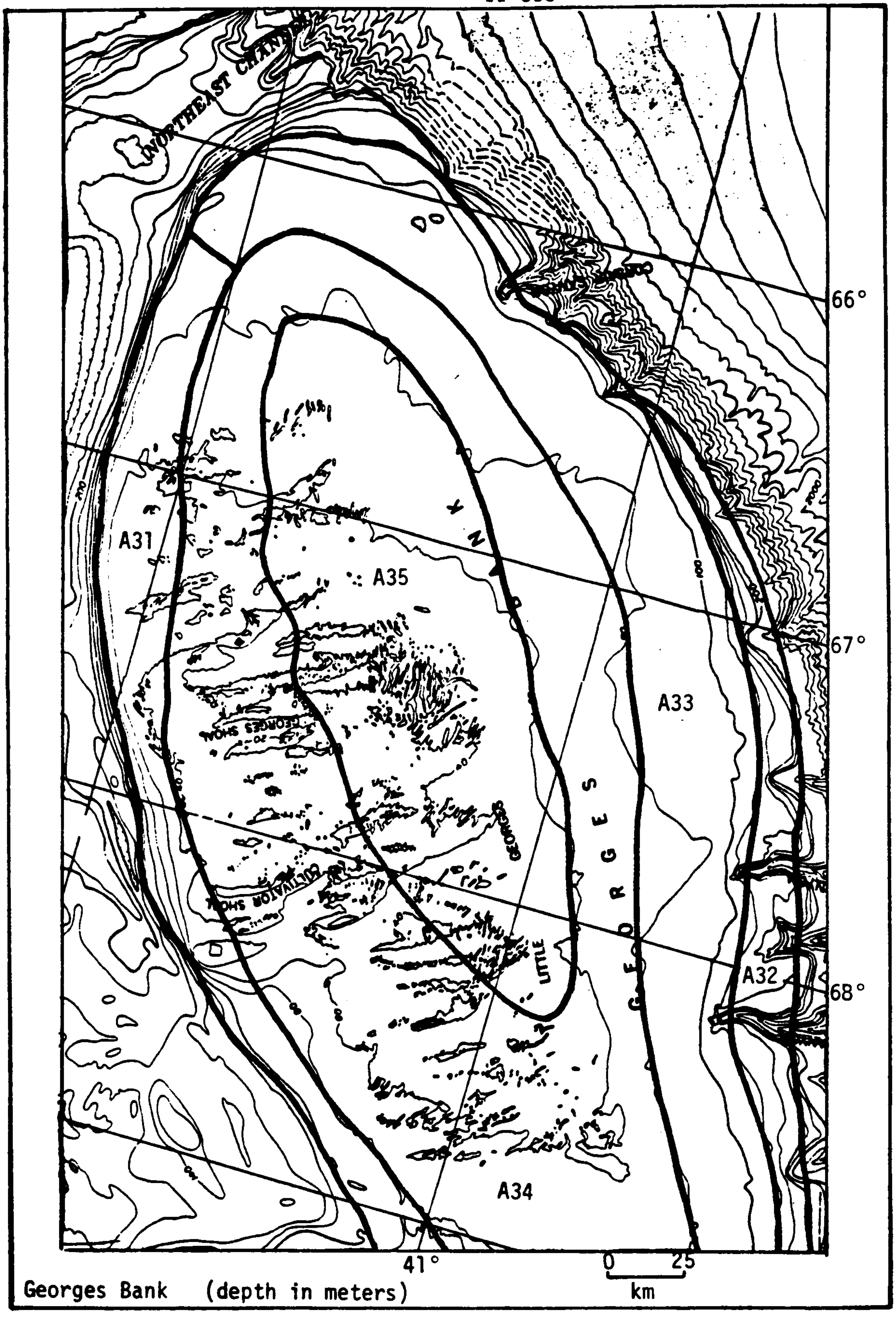


Fig. II-57d: Archaeology Zones.

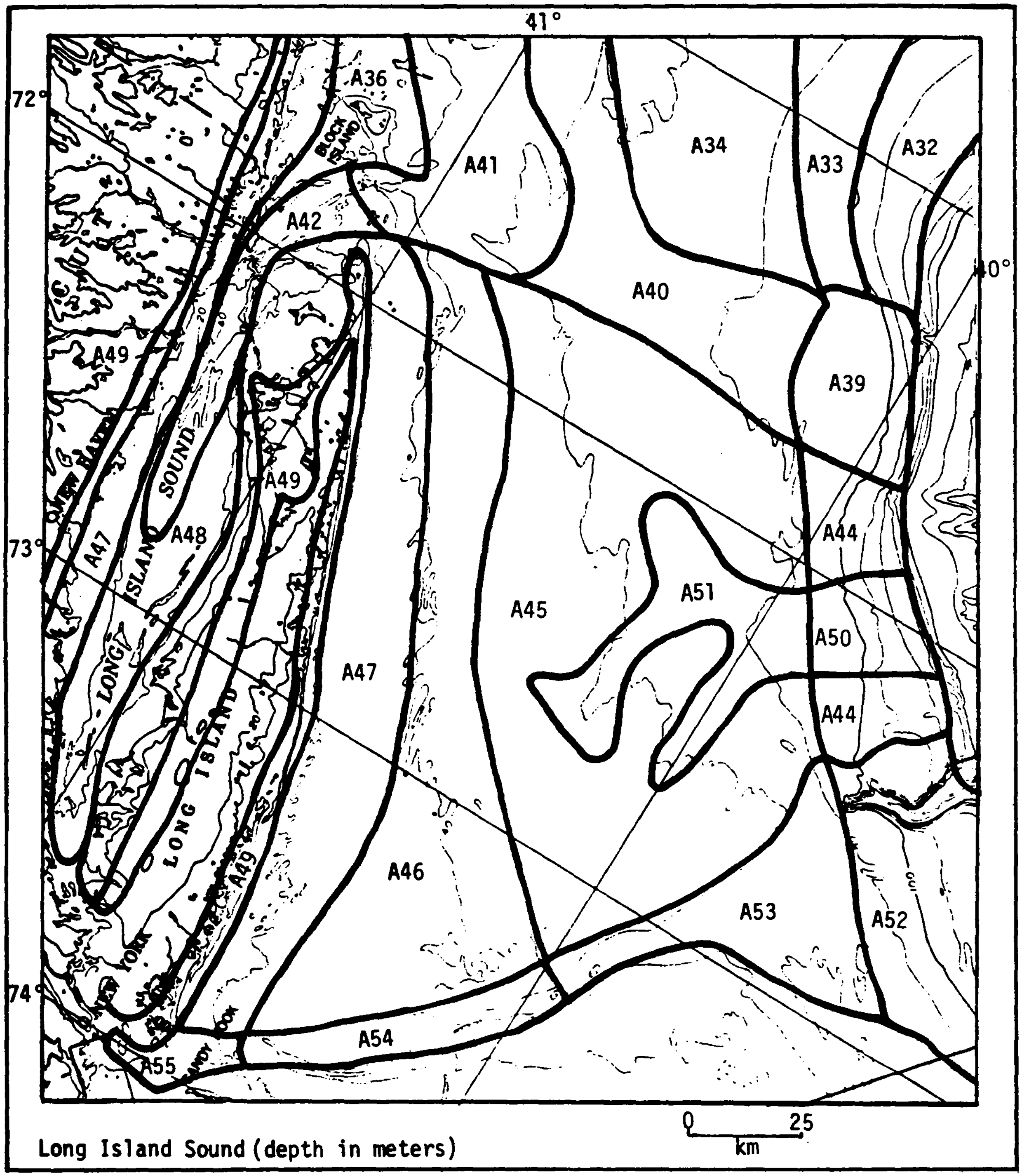


Fig. II-57e: Archaeology Zones.

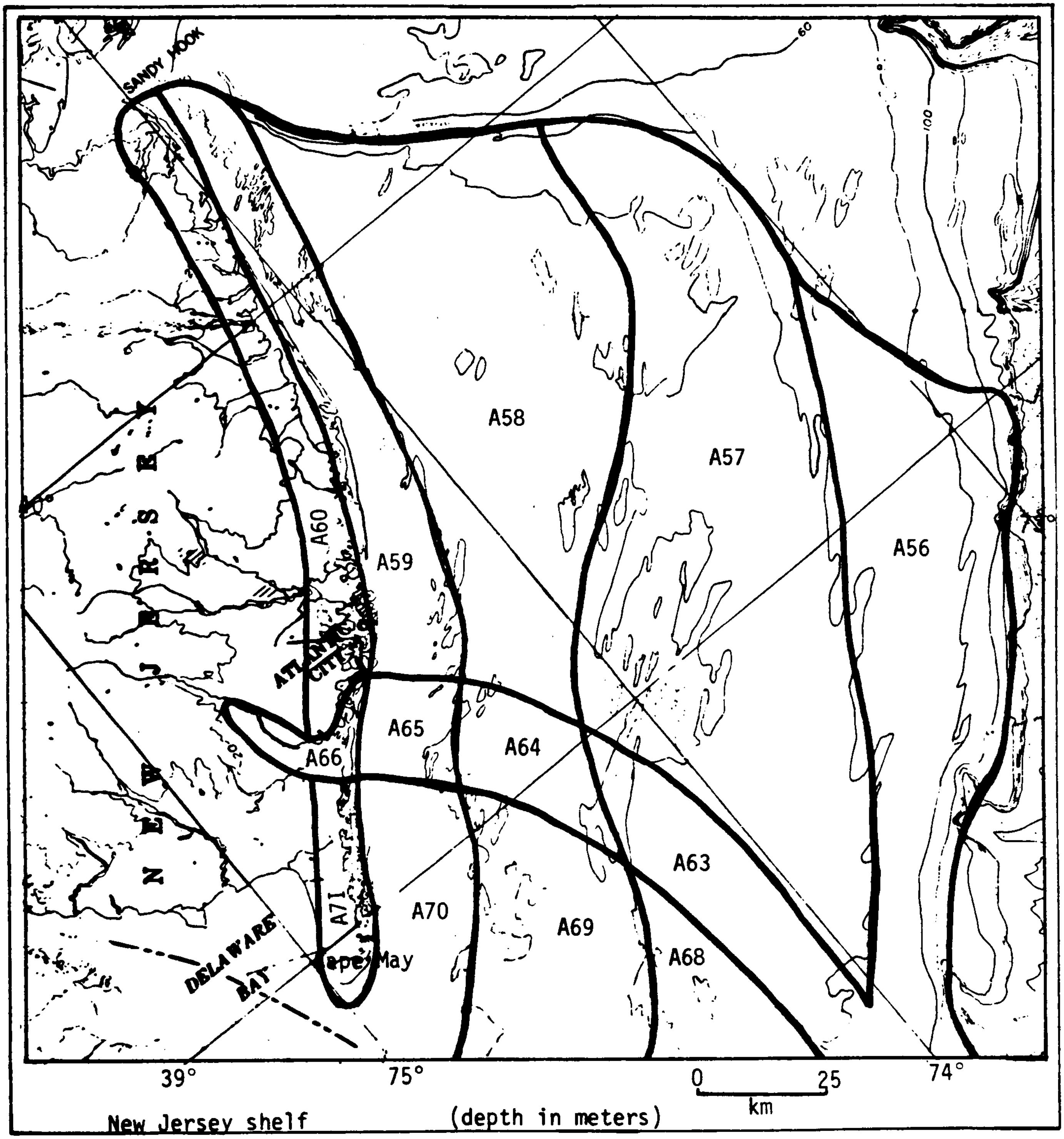


Fig. II-57f: Archaeology Zones.

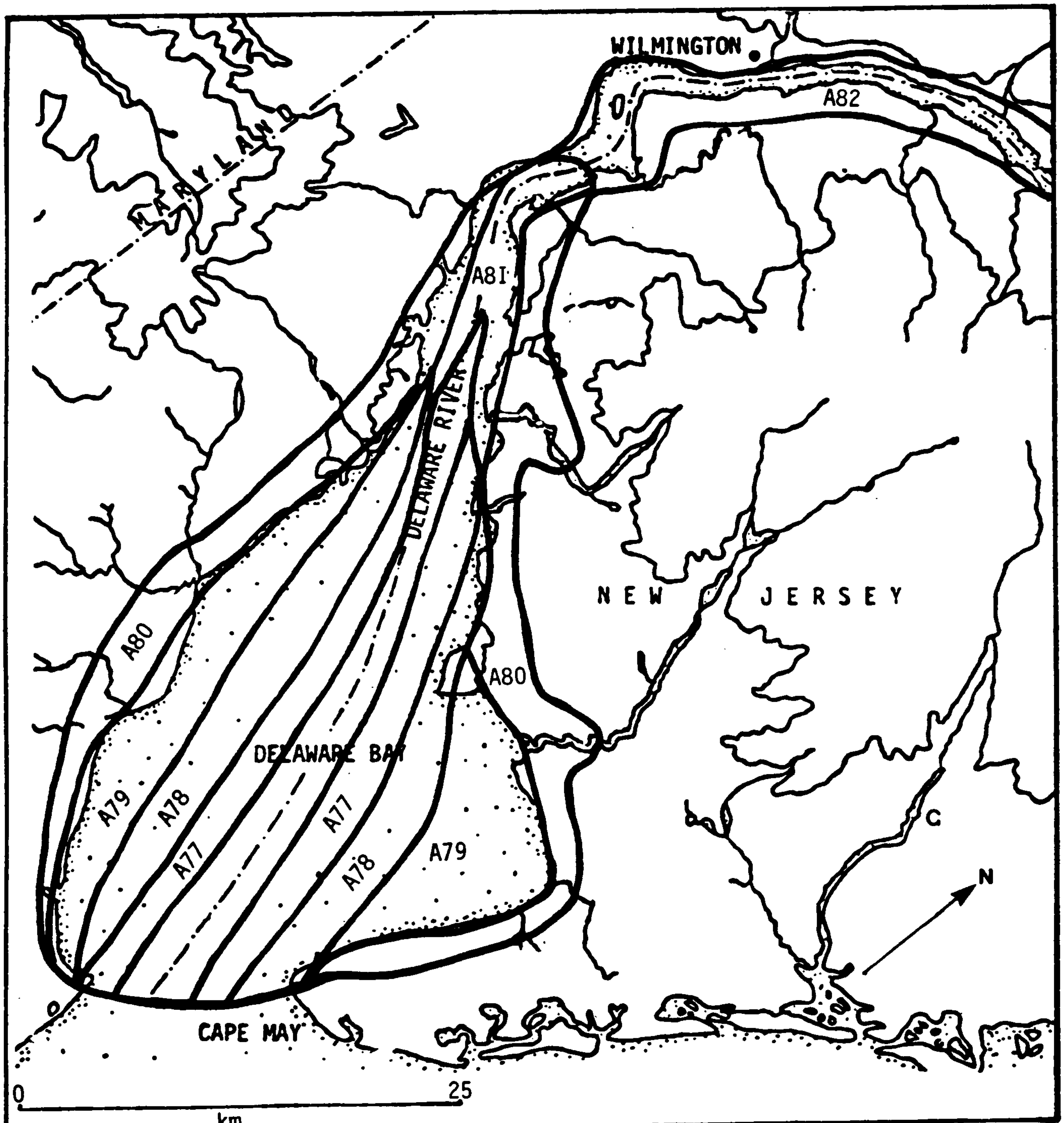


Fig. II-57g: Archaeology Zones.

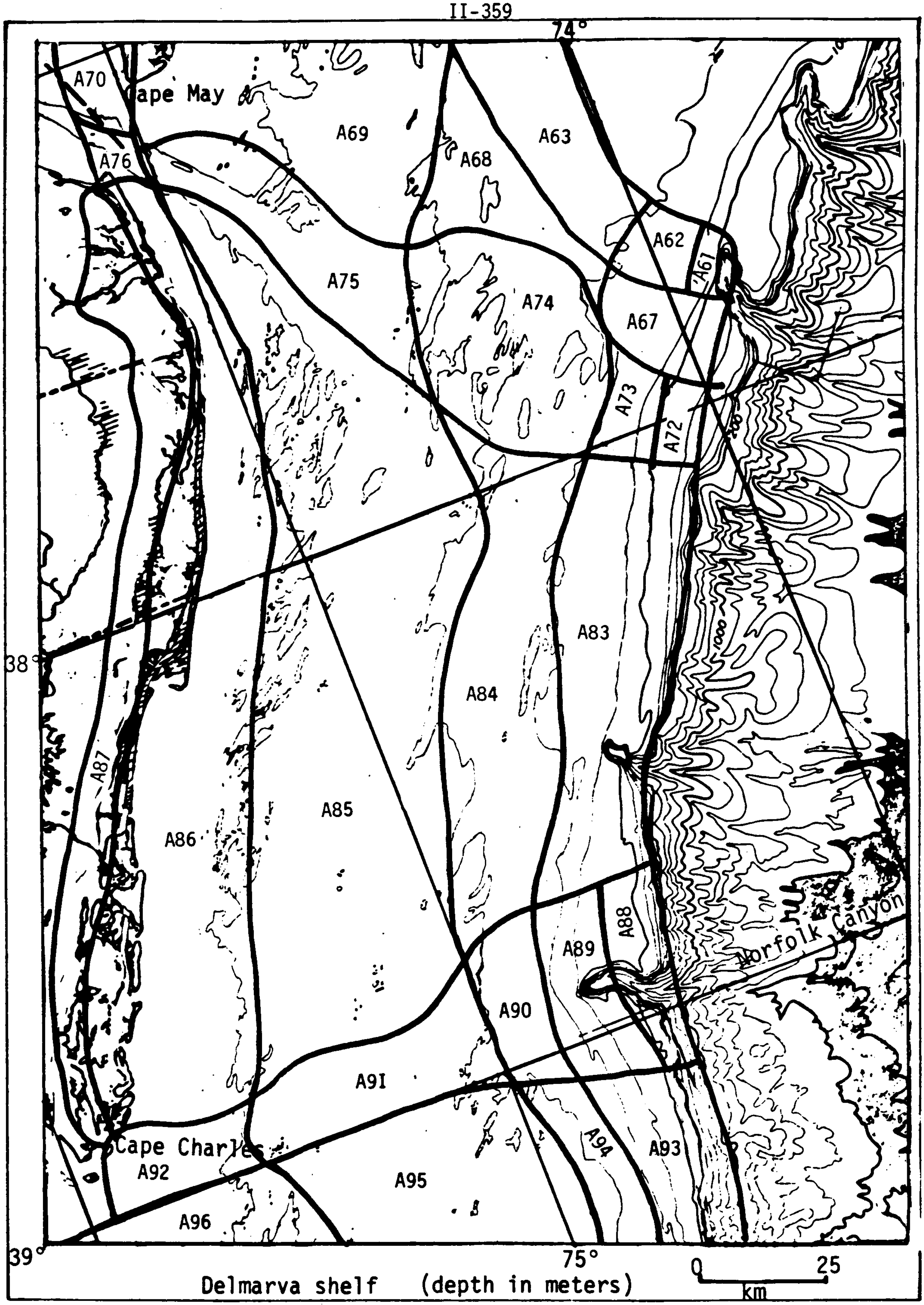


Fig. II-57h: Archaeology Zones.

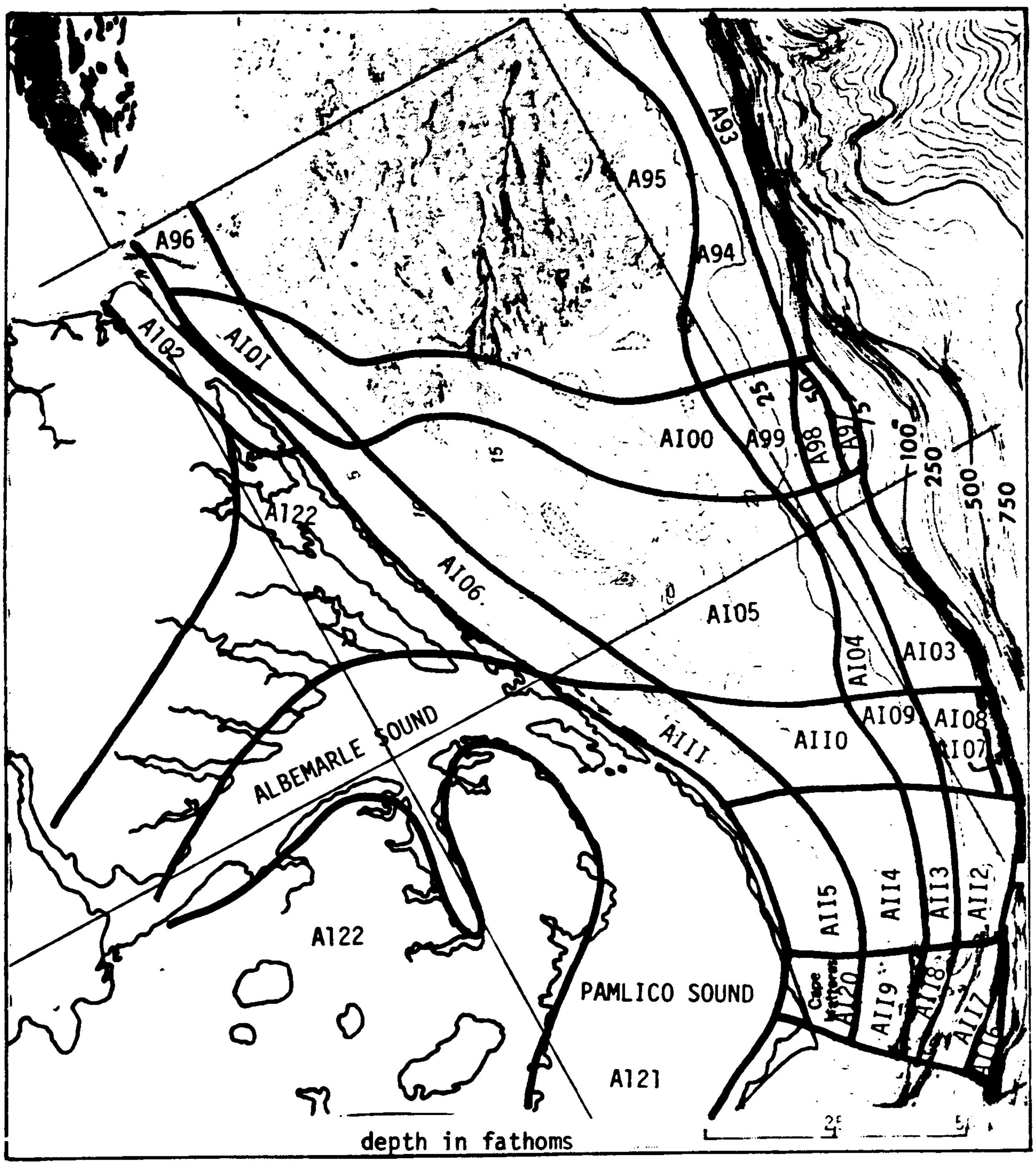


Fig. II-57i: Archaeology Zones.

Table II-49. Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A1: 12,000 coastline from St. Croix to Vinal Haven Island.	12,000-9000	Seal hunting camp	Low	Small
A2: 9000 coastline from St. Croix to Mt. Desert Island.	12,000-9000	Habitation	Low	Small
	9000-6000	Seal hunting camp/ shell midden	Low-medium	Small-medium
A3: 6000 coastline from St. Croix to Mt. Desert Island.	12,000-9000	Habitation	?	?
	9000-6000	Habitation	Low	Small
	6000-3000	Shell midden	Medium	Small-large
		Black earth midden	Low?	Medium-large
A4: Modern coastline St. Croix to Mt. Desert Island.	12,000-9000	Habitation	Low	Small
	9000-6000	Habitation	Low/increasing	Small
	6000-3000	Habitation	?	?
	3000-present	Shell midden	High	Small-large
		Black earth midden	Medium	Medium-large
A5: 12,000 shoreline to 6000 shoreline from Mt. Desert to Vinal Haven Island.	12,000-9000	Estuarine fishing camp	Low	Small
	9000-6000	Fishing camp/ shell midden	Medium	Small
A6: 6000 shoreline to inland of present day shoreline around Mt. Desert Island.	12,000-9000	Estuarine fishing camp	Low	Small
	9000-6000	Fishing camp/ shell midden	Medium	Small
	6000-3000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-large
	3000-present	Shell midden	High	Small-large
		Black earth midden	Medium?	Medium-large
A7: Modern coast from Mt. Desert Island to Brooklin.	Same as A6	Same as A6	Same as A6	Same as A6
A8: 6000 coastline to Belfast in Penobscot Bay.	12,000-9000	Same as A6	Same as A6	Same as A6
	9000-6000	Same as A6	Same as A6	Same as A6
	6000-3000	Shell midden	Medium	Small-large
A9: 6000 coastline from Vinal Haven to Camden in Penobscot Bay.	12,000-9000	Same as A6	Same as A6	Same as A6
	9000-6000	Same as A6	Same as A6	Same as A6
	6000-3000	Shell midden	Medium	Small-large
		Black earth midden	Low?	Medium-large
		Other habitations	?	?
	3000-present	Shell midden	High	Small-large

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A10: 6000 coastline to head of Penobscot Bay and Graham Lake.	12,000-9000	Fishing camp	Low	Small
	9000-6000	Fishing camp	Medium	Small
	6000-3000	Same as A9	Same as A9	Same as A9
	3000-present	Same as A9	Same as A9	Same as A9
A11: 9000 coastline to 6000 coastline from Rockland to Portsmouth, NH	12,000-9000	?	?	?
	9000-6000	Seal hunting camp/ shell midden	Low-medium	Small-medium
A12: 6000 coastline to modern coastline from Rockland to Casco Bay.	12,000-9000	Habitation	Low	Small
	9000-6000	Habitation	Low/increasing	Small
	6000-3000	Shell midden	Medium	Small-large
		Black earth midden	Low?	Medium-large
		Other habitations	?	?
A13: Modern coastline from Rockland to Casco Bay.	12,000-9000	Same as A12	Same as A12	Same as A12
	9000-6000	Same as A12	Same as A12	Same as A12
	6000-3000	Habitation	?	?
	3000-present	Shell midden	High	Small-large
A14: 6000 coastline to modern coastline.	12,000-9000	Fishing camp	Low	Small
	9000-6000	Fishing camp/ shell midden	Medium	Small
	6000-3000	Shell midden	Medium	Small-large
		Fishing camp	Medium	Small-medium
A15: Modern coast to heads of Casco Bay.	12,000-9000	Habitation	Low	Small
	9000-6000	Fishing camp	Medium	Small
	6000-3000	Fishing camp	Medium	Small-medium
	3000-present	Fishing camp	High	Small-medium
A16: 6000 coastline to modern coastline from Casco Bay to Portsmouth, NH.	9000-6000	Habitation	Low/increasing	Small
	6000-3000	Shell midden	Medium	Small-large
		Habitation	?	?
A17: Modern coastline from Casco Bay to Portsmouth, NH.	9000-6000	Same as A16	Same as A16	Same as A16
	6000-3000	Habitation	?	?
	3000-present	Shell midden	High	Small-large
		Habitation	?	?
A18: 9000 coastline to 6000 coastline off Portsmouth, NH.	12,000-9000	Fishing camp	Low	Small
	9000-6000	Shell midden/ fishing camp	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A19: 6000 coastline to modern coastline off Portsmouth, NH.	12,000-9000	Fishing camp	Low	Small-large
	9000-6000	Shell midden/ fishing camp	Medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Fishing camp	Medium-high	Small
A20: Modern coastline around Portsmouth, NH.	12,000-9000	Same as A19	Same as A19	Same as A19
	9000-6000	Fishing camps	Low-medium	Small-medium
	6000-3000	Fishing camps	Medium-high	Small
	3000-present	Shell midden	High	Small-large
A21: 9000 coastline to 6000 coastline from Portsmouth, NH to Cape Anne.	12,000-9000	Habitation	Very low	Small
	9000-6000	Shell midden	Medium	Small-medium
		Camp	Low	Small
A22: 6000 coastline to modern coastline from Portsmouth, NH to Cape Anne.	12,000-9000	Habitation	Very low	Small
	9000-6000	Camp	Low	Small
	6000-3000	Shell midden	High	Small-large
A23: Modern coastline from Portsmouth, NH to Cape Anne.	12,000-9000	Habitation	Very low	Small
	9000-6000	Camp	Low	Small
	6000-3000	Habitation	Medium	Small
	3000-present	Shell midden	High	Small-large
		Camp	High	Small-medium
		Habitation	High	Small
A24: 9000 shoreline to 6000 shoreline off Boston.	12,000-9000	Fishing camp/ habitation	Low	Small-large
	9000-6000	Fishing camp/ shell midden	Medium	Small-medium
A25: 6000 shoreline to modern shoreline off Boston.	12,000-9000	Fishing camp/ habitation	Low	Small-large
	9000-6000	Fishing camp/ shell midden	Medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Fishing camp	Medium-high	Small
A26: Modern shoreline around Boston.	12,000-9000	Fishing camp/ habitation	Low	Small-large
	9000-6000	Fishing camp/ habitation	Low-medium	Small-medium
	6000-3000	Fishing camp	Medium-high	Small
	3000-present	Shell midden	High	Small-large
		Fishing camp	High	Small-large
		Habitation	High	Small

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A27: 9000 shoreline to 6000 shoreline from Boston to Provincetown.	12,000-9000	Fishing camp/ habitation	Low	Small-large
	9000-6000	Shell midden	Medium	Small-medium
		Camp	Low	Small
A28: 6000 shoreline to modern coastline from Boston to Provincetown.	12,000-9000	Fishing camp/ habitation	Low	Small-large
		Habitation	Very low	Small
	9000-6000	Camp	Low	Small
	6000-3000	Shell midden	High	Small-large
		Habitation	Medium	Small
		Village	Low-medium	Large
A29: Along modern coast from Boston to Provincetown.	12,000-9000	Fishing camp/ habitation	Low	Small-large
		Habitation	Very low	Small
	9000-6000	Camp	Low	Small
	6000-3000	Habitation	Medium	Small
		Village	Low-medium	Large
	3000-present	Shell midden	High	Small-large
		Camp	High	Small-medium
		Habitation	High	Small
A30: 18,000 coastline to 12,000 coastline from Cape Cod to Great South Channel.	18,000-12,000	Seal hunting camp	Low	Small
A31: 15,000 coastline to 12,000 coastline from Great South Channel to tip of Georges Bank.	18,000-12,000	Habitation	Low	Very small
A32: 18,000 coastline to 15,000 coastline from approximately 66° 30'/41° on Georges Bank to Block Canyon.	18,000-15,000	Seal hunting camp	Low	Small
		Habitation	Low	Small
		Fishing camps	Low	Small
A33: 15,000 coastline to 12,000 coastline from tip of Georges Banks to Block Canyon.	18,000-15,000	Habitation	Low	Small
		Fishing camp	Low	Small
	15,000-12,000	Seal hunting camp	Low	Small
		Habitation	Low	Very small
A34: 12,000 coastline to 9000 coastline from Cape Cod to Block Canyon including Georges Banks.	18,000-15,000	Habitation	Low	Very small
	15,000-12,000	Habitation	Low	Very small
		Fishing camp	Low	Small
	12,000-9000	Seal hunting camp	Low	Small
		Habitation	Very low	Small

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A35: Inside 9000 coastline on Georges Banks.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-?	Shell midden	Medium	Small-medium
		Habitation	Low-medium	Small-medium
A36: 9000 coastline to 6000 coastline from Cape Cod to Block Canyon including Nantucket shoals and around Block Island.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Shell midden	Medium	Small-medium
		Habitation	Low-medium	Small-medium
A37: 6000 coastline to modern shoreline from Cape Cod to Narragansett Bay including Martha's Vineyard and Nantucket Island.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Habitation	Low-medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Habitation	Medium	Small
		Camp	High	Small-medium
A38: Along modern coastline from Chatham, MA to Narragansett Bay.	18,000-12,000	Same as A37	Same as A37	Same as A37
	12,000-9000	Same as A37	Same as A37	Same as A37
	9000-6000	Same as A37	Same as A37	Same as A37
	6000-3000	Shell midden	High	Small-large
		Habitation	Medium	Small
		Camp	High	Small-medium
		Village	Low-medium	Large
	3000-present	Shell midden	High	Small-large
		Habitation	High	Small
		Camp	High	Small
A39: 18,000 coastline to 12,000 coastline in Block Valley.	18,000-12,000	Fishing camp/ habitation	Low	Small
A40: 12,000 coastline to 9000 coastline in Block Valley.	18,000-12,000	Fishing camp/ habitation	Low	Small
	12,000-9000	Shell midden/ fishing camp	Low	Small
A41: 9000 coastline to 6000 coastline in Block Valley.	18,000-12,000	Fishing camp/ habitation	Low	Small
	12,000-9000	Fishing camp/ habitation	Low	Small-large
	9000-6000	Shell midden/ fishing camp	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A42: 6000 coastline in Block Valley to end of Block Valley in Long Island sound and up Narragansett Bay.	18,000-12,000	Same as A41	Same as A41	Same as A41
	12,000-9000	Same as A41	Same as A41	Same as A41
	9000-6000	Fishing camp/ habitation	Low-medium	Small-medium
	6000-inundation (LIS)-3000 in (NB)	Shell midden	High	Small-large
		Fishing camp	Medium-high	Small
		Fish weir	Low-medium	Small
A43: Modern coastline around Narragansett Bay.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Fishing camp/ habitation	Low-medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Fishing camp	Medium-high	Small
		Habitation	Medium	Small
		Village	Low-medium	Large
		Camp	High	Small-medium
	3000-present	Shell midden	High	Small-large
		Fishing camp	High	Small-large
		Habitation	High	Small
A44: 18,000 coastline to 12,000 coastline from Block Canyon to Hudson Canyon except A50.	18,000-12,000	Seal hunting camp	Low	Small
		Habitation	Low	Very small
A45: 1,200 coastline to 9000 coastline from Block Canyon to Hudson Canyon except A51.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Seal hunting camp	Low	Small
		Habitation	Very low	Small
A46: 9000 coastline to 6000 coastline from Block Canyon to Hudson Canyon.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Shell midden	Medium	Small-medium
		Camp	Low	Small
A47: 6000 coastline to modern coastline seaward of Long Island, from boundry of A48 to present shoreline, along Long Island and to Narragansett Bay.	18,000-12,000	Same as A46	Same as A46	Same as A46
	12,000-9000	Same as A46	Same as A46	Same as A46
	9000-6000	Camp	Low	Small
		Habitation	Low-medium	Small-medium
		Shell midden/ fishing camp	Medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Habitation	Medium	Small
		Camp	High	Small-medium
		Fishing camp	Medium-high	Small
		Village	Low-medium	Large

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A48: Long Island Sound inside 6000 coastline outside Block Canyon and inundated prior to 3000.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Fishing camp/ habitation	Low-medium	Small-medium
		Camp	Low	Small
	6000-inundation	Fishing camp	Medium-high	Small
A49: Modern coastline of Long Island and coast from Narragansett Bay to New York City.	18,000-12,000	Habitation	Low	Very small
	12,000-9000	Habitation	Very low	Small
	9000-6000	Camp	Low	Small
	6000-3000	Fishing camp	Medium-high	Small
		Habitation	Medium	Small
		Camp	High	Small-medium
		Village	Low-medium	Large
	3000-present	Shell midden	High	Small-large
		Habitation	High	Small
		Fishing camp	High	Small-large
		Camp	High	Small-medium
A50: 18,000 coastline to 12,000 coastline Long Island Valley.	18,000-12,000	Fishing camp/ habitation	Low	Small
A51: 12,000 coastline until inundation of Long Island Valley.	18,000-12,000	Fishing camp/ other stations	Low	Small
	12,000-inundation	Shell midden/ fishing camp	Low	Small
A52: 18,000 coastline to 12,000 coastline Hudson Canyon.	18,000-12,000	Fishing camp/ habitation	Low	Small
A53: 12,000 coastline to 9000 coastline in Hudson Canyon.	18,000-12,000	Fishing camp/ other station	Low	Small
	12,000-9000	Shell midden/ fishing camp	Low	Small
A54: 9000 coastline to 6000 coastline in Hudson Canyon.	18,000-12,000	Fishing camp/ other stations	Low	Small
	12,000-9000	Fishing camp/ other habitation	Low	Small-large
	9000-6000	Shell midden/ fishing camp	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A55: 6000 coastline to modern caostline in Hudson Canyon.	18,000-12,000	Fishing camp/ other stations	Low	Small
	12,000-9000	Fishing camp/ other habitation	Low	Small-large
	9000-6000	Fishing camp/ other habitation	Low-medium	Small-medium
	6000-3000	Shell midden	High	Small-large
		Fishing camp	Medium-high	Small
		Fish weir	Low-medium	Small
A56: 18,000 coastline to 12,000 coastline from Hudson Canyon to Great Egg Valley.	18,000-12,000	Coastal camp	Very low	Small
		Upland camp	Low	Very small
A57: 12,000 coastline to 9000 coastline from Hudson Canyon to Great Egg Valley.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Shell midden	Medium	Small-medium
		Upland other camp II	Low	Small-large
A58: 9000 coastline to 6000 coastline from Hudson Canyon to Great Egg Valley.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Upland other camp II	Low	Small-large
	9000-6000	Shell midden	Medium	Small-medium
		Upland other camp II	Low-medium	Small-large
A59: 6000 coastline to modern coastline from Hudson Canyon to Great Egg Valley.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Upland other camp II	Low	Small-large
	9000-6000	Upland other camp II	Low-medium	Small-large
	6000-3000	Shell midden	Medium-high	Small-large
		Upland other camp II	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

escription	Period B.P.	Site Type	Frequency	Size
60: Modern coastline rom Hudson Canyon to reat Egg Valley.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Upland other camp II	Low	Small-large
	9000-6000	Upland other camp II	Low-medium	Small-large
	6000-3000	Upland other camp II	Medium	Small-medium
	3000-present	Shell midden	Very high	Small-large
		Black earth midden	High	Small-medium
		Village	High	Large
		Inland valley camp I	Medium	Small
61: 18,000 coastline to 5,000 coastline in reat Egg Valley.	18,000-15,000	Fishing camp	Low	Small
62: 15,000 coastline to 2,000 coastline in reat Egg Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
		Shell midden	Low	Small
63: 12,000 coastline to 000 coastline in reat Egg Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
64: 9000 coastline to 000 coastline in reat Egg Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Inland valley other camp I	Medium	Small
		Upland other camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
65: 6000 coastline to odern coastline in reat Egg Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Inland valley other camp I	Medium	Small
		Upland other camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Inland valley other camp I	Medium	Small
		Upland other camp II	Low-medium	Small-large
	6000-3000	Fishing camp	High	Small-large
		Shell midden	High	Small-large

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A66: Modern coastline around Great Egg Harbor.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Inland valley other camp I	Medium	Small
		Upland other camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Inland valley other camp I	Medium	Small
		Upland other camp II	Low-medium	Small-large
	6000-3000	Fishing camp	High	Small-large
		Inland valley other camp I	Medium-high	
		Inland valley other camp II	Medium-high	Small-very large
	3000-present	Shell midden	Very high	Small-large
		Black earth midden	High	Small-medium
		Fishing camp	Medium	Small-medium
		Inland valley camp II	Medium-high	Small
		Inland valley camp I	Medium	Small
		Village	High	Large
A67: 18,000 coastline to 12,000 coastline from Great Egg Valley to Delaware Valley.	Same as A56	Same as A56	Same as A56	Same as A56
A68: 12,000 coastline to 9000 coastline from Great Egg Valley to Delaware Valley.	Same as A57	Same as A57	Same as A57	Same as A57
A69: 9000 coastline to 6000 coastline from Great Egg Valley to Delaware Valley.	Same as A58	Same as A58	Same as A58	Same as A58
A70: 6000 coastline to modern coastline from Great Egg Valley to Delaware Valley.	Same as A59	Same as A59	Same as A59	Same as A59
A71: Modern coastline from Great Egg Harbor to Cape May.	Same as A60	Same as A60	Same as A60	Same as A60

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A72: 18,000 coastline to 15,000 coastline in Delaware Valley.	Same as A61	Same as A61	Same as A61	Same as A61
A73: 15,000 coastline to 12,000 coastline in Delaware Valley.	Same as A62	Same as A62	Same as A62	Same as A62
A74: 12,000 coastline to 9000 coastline in Delaware Valley.	Same as A63	Same as A63	Same as A63	Same as A63
A75: 9000 coastline to 6000 coastline in Delaware Valley.	Same as A64	Same as A64	Same as A64	Same as A64
A76: 6000 coastline to mouth of Delaware Bay.	Same as A65	Same as A65	Same as A65	Same as A65
A77: 18,000 river bank to 9000 river bank of Delaware River from Cohansey River to present bay mouth.	18,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
A78: 9000 river bank to 6000 river bank of Delaware River from Cohansey River to present bay mouth.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Inland valley camp I	Medium	Small
		Upland camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
A79: 6000 river bank to 3000 river bank of Delaware River from approximately Cohansey River to present bay mouth.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Inland valley camp I	Medium	Small
		Upland camp II	Low	Small-large
	9000-6000	Inland valley camp I	Medium	Very small-small
		Upland camp II	Medium	Small-large
	6000-3000	Fishing camp	High	Small-large
		Shell midden	High	Small-large
		Inland valley camp II	High	Small-very large
		Upland camp II	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A80: Modern coastline of Delaware Bay.	18,000-12,000	Upland camp	Low	Very Small
	12,000-9000	Inland valley camp I	Medium	Small
		Upland camp II	Low	Small-large
	9000-6000	Inland valley camp I	Medium	Very small-small
		Upland camp II	Medium	Small-large
	6000-3000	Inland valley camp II	High	Small-very large
		Upland camp II	Medium	Small-medium
	3000-present	Shell midden	Very high	Small-large
		Black earth midden	High	Small-medium
		Fishing camp	Medium	Small-medium
		Inland valley camp II	High	Small
		Village	High	Large
A81: Upper reaches of Delaware Bay to modern coastline from Cohansey River to Delaware City.	18,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
	9000-6000	Fishing camp	Medium	Small-medium
	6000-3000	Fishing camp	High	Small-large
		Shell midden	High	Small-large
A82: Delaware River from Delaware City to Philadelphia.	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
	9000-6000	Fishing camp	Medium	Small-medium
	6000-3000	Fishing camp	High	Small-large
	3000-present	Fishing camp	Medium	Small-medium
		Inland valley camp II	High	Small
		Village	High	Large
A83: 18,000 coastline to 12,000 coastline from Delaware Valley to Susquehanna Valley.	Same as A56	Same as A56	Same as A56	Same as A56
A84: 12,000 coastline to 9000 coastline from Delaware Valley to Susquehanna Valley.	Same as A57	Same as A57	Same as A57	Same as A57
A85: 9000 coastline to 6000 coastline from Delaware Valley to Susquehanna Valley.	Same as A58	Same as A58	Same as A58	Same as A58

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A86: 6000 coastline to modern coastline from Delaware Valley to Susquehanna Valley.	Same as A59	Same as A59	Same as A59	Same as A59
A87: Modern coastline from Cape Henlopen to Cape Charles.	Same as A60	Same as A60	Same as A60	Same as A60
A88: 18,000 coastline to 15,000 coastline in Susquehanna Valley.	Same as A61	Same as A61	Same as A61	Same as A61
A89: 15,000 coastline to 12,000 coastline in Susquehanna Valley.	Same as A62	Same as A62	Same as A62	Same as A62
A90: 12,000 coastline to 9000 coastline in Susquehanna Valley.	Same as A63	Same as A63	Same as A63	Same as A63
A91: 9000 coastline to 6000 coastline in Susquehanna Valley.	Same as A64	Same as A64	Same as A64	Same as A64
A92: 6000 coastline to present mouth of Chesapeake Bay.	Same as A65	Same as A65	Same as A65	Same as A65
A93: 18,000 coastline to 12,000 coastline from Susquehanna Valley to James Valley.	Same as A56	Same as A56	Same as A56	Same as A56
A94: 12,000 coastline to 9000 coastline from Susquehanna Valley to James Valley.	Same as A57	Same as A57	Same as A57	Same as A57
A95: 9000 coastline to 6000 coastline from Susquehanna Valley to James Valley.	Same as A58	Same as A58	Same as A58	Same as A58

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A96: 6000 coastline to modern coastline from Susquehanna Valley to James Valley.	Same as A59	Same as A59	Same as A59	Same as A59
A97: 18,000 coastline to 15,000 coastline in James Valley.	Same as A61	Same as A61	Same as A61	Same as A61
A98: 15,000 coastline to 12,000 coastline in James Valley.	18,000-15,000	Fishing camps	Low	Small
	15,000-12,000	Fishing camps	Low	Small
		Shell midden	Low	Small
A99: 12,000 coastline to 9000 coastline in James Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
		Shell midden	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
A100: 9000 coastline to 6000 coastline in James Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
		Inland valley camp I	Medium	Very small-small
		Upland camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
		Inland valley camp I	Medium	Small-medium
		Upland camp II	Medium	Small-large
A101: 6000 coastline to modern coastline in James Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Inland valley camp I	Medium	Very small-small
		Upland camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Inland valley camp I	Medium	Small-medium
		Upland camp II	Medium	Small-large
	6000-3000	Fishing camp	High	Small-large
		Shell midden	High	Small-large

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A102: Modern coastline from Chesapeake Bay to Currituck Sound.	Same as A60	Same as A60	Same as A60	Same as A60
A103: 18,000 coastline to 12,000 coastline from James Valley to Albemarle.	Same as A56	Same as A56	Same as A56	Same as A56
A104: 12,000 coastline to 9000 coastline from James Valley to Albemarle.	Same as A57	Same as A57	Same as A57	Same as A57
A105: 9000 coastline to 6000 coastline from James Valley to Albemarle.	Same as A58	Same as A58	Same as A58	Same as A58
A106: 6000 coastline to modern coastline from James Valley to Albemarle.	Same as A59	Same as A59	Same as A59	Same as A59
A107: 18,000 coastline to 15,000 coastline in Albemarle Valley.	Same as A61	Same as A61	Same as A61	Same as A61
A108: 15,000 coastline to 12,000 coastline in Albemarle Valley.	Same as A98	Same as A98	Same as A98	Same as A98
A109: 12,000 coastline to 9000 coastline in Albemarle Valley.	Same as A99	Same as A99	Same as A99	Same as A99
A110: 9000 coastline to 6000 coastline in Albemarle Valley.	Same as A100	Same as A100	Same as A100	Same as A100
A111: 6000 coastline to modern coastline in Albemarle Valley.	Same as A101	Same as A101	Same as A101	Same as A101

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A112: 18,000 coastline to 12,000 coastline from Albemarle Valley to Diamond Valley.	Same as A56	Same as A56	Same as A56	Same as A56
A113: 12,000 coastline to 9000 coastline from Albemarle Valley to Diamond Valley.	Same as A57	Same as A57	Same as A57	Same as A57
A114: 9000 coastline to 6000 coastline from Albemarle Valley to Diamond Valley.	Same as A58	Same as A58	Same as A58	Same as A58
A115: 6000 coastline to modern coastline from Albemarle Valley to Diamond Valley.	Same as A59	Same as A59	Same as A59	Same as A59
A116: 18,000 coastline to 15,000 coastline in Diamond Valley.	Same as A61	Same as A61	Same as A61	Same as A61
A117: 15,000 coastline to 12,000 coastline in Diamond Valley.	Same as A98	Same as A98	Same as A98	Same as A98
A118: 12,000 coastline to 9000 coastline in Diamond Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
		Shell midden	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
A119: 9000 coastline to 6000 coastline in Diamond Valley.	18,000-15,000	Fishing camp	Low	Small
	15,000-12,000	Fishing camp	Low	Small
		Shell midden	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
	9000-6000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium

Table II-49 (continued). Detailed description of archaeology zones.

Description	Period B.P.	Site Type	Frequency	Size
A120: 6000 coastline to modern coastline in Diamond Valley.	18,000-15,000	Fishing camp	Low	
	15,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
	9000-6000	Fishing camp	Medium	Small-medium
		Shell midden	Medium	Small-medium
	6000-3000	Fishing camp	High	Small-large
		Shell midden	High	Small-large
A121: In present day Pamlico and Albemarle Sounds and Barrier Beaches the more recent sites tending toward modern shorelines.	18,000-12,000	Fishing camp	Low	Small
	12,000-9000	Fishing camp	Medium	Small-medium
		Inland valley camp I	Medium	Small-medium
		Upland camp II	Low	Small-large
	9000-6000	Fishing camp	Medium	Small-medium
		Inland valley camp I	Medium	Very small-small
		Upland camp II	Medium	Small-large
	6000-3000	Fishing camp	High	Small-large
		Inland valley camp I	High	Small-medium
		Inland valley camp II	High	Small-very large
		Shell midden	High	Small-large
	3000-present	Fishing camp	Medium	
		Shell midden	Very high	Small-large
		Inland valley camp II	High	Small
		Village	High	Large
		Black earth midden	High	Small-medium
A122: Wetland zones inside North Carolina Barrier Beaches and bordering Pamlico and Albemarle Sounds.	18,000-12,000	Upland camp	Low	Very small
	12,000-9000	Upland camp II	Low	Small-large
	9000-6000	Upland camp II	Medium	Small-medium
	6000-3000	Upland camp II	Medium	Small-medium
		Inland valley camp II	High	Small-very large
	3000-present	Inland valley camp II	High	Small
		Village	High	Large

APPENDIX II -1

SOURCES OF SITE RECORDS ACQUIRED DURING THIS STUDY

Massachusetts Historical Commission, Boston.

Maine State Museum, Augusta.

Ross Moffett, Massachusetts Archaeological Society.

Narragansett Archaeological Society, Rhode Island.

North Carolina Office of Historic Preservation, Raleigh.

Nassau County Museum, New York.

Ocean County Historical Society, Toms River, N.J.

Peter Thomas, University of Vermont, Burlington.

Queens College, New York, Courtesy of Dr. Lynn Ceci and Robert Paynter.

Rhode Island Office of Historic Preservation, Courtesy of Jeff Moran.

Suffolk County Archaeological Association, New York.

Staten Island Museum, New York.

Thomas Ulrich, University of Massachusetts/Amherst.

American Museum of Natural History, N.Y.

Historic Preservation Office, Albany (Bruce Fullem).

Public Archaeology Lab, Brown University, Providence.

Charles Bolian, University of New Hampshire, Durham.

Connecticut College, New London, Ct.

Dr. Dena Dincauze, University of Massachusetts/Amherst.

Dr. Douglas Jordan, University of Connecticut, Storrs, Ct.

Heye Foundation, New York.

Haffenreffer Museum, Brown University, Providence.

John Cavallo, Monmouth College, Asbury Park, N.J.

Massachusetts Archaeological Society, Attleboro.

Mary Lou Curran, University of Massachusetts/Amherst.

GLOSSARY

ABSOLUTE DATING. Chronological placement of cultural or natural materials in terms of years; radiocarbon dating (q.v.) is the best known absolute dating method (compare with relative dating).

ABSOLUTE POLLEN COUNT. A method of pollen analysis where numbers of pollen grains per surface area per year are calculated for each species; yields inferences of species density (c.f. percentage pollen count.

ADADROMOUS FISH. Fish which live in salt water but seasonally spawn in fresh water; their migrations ("runs") are predictable and have often been exploited by human beings.

ARCHAIC. A period of prehistory, characterized by the absence of either Pleistocene megafauna (q.v.) or ceramics; about 10,000 to 3000 B.P.; divided into Early (10,000 to 8000 B.P.), Middle (8000 to 6000 B.P.), and Late (6000 to 3000 B.P. Periods.

ASPECT. The direction toward which a site on a slope faces; an outmoded culture historic category.

ASSEMBLAGE. The corpus of cultural materials at a site; a class of the total assemblage at a site (for example, faunal assemblage or point assemblage).

B.P. Abbreviation for "before present;" technically, years before 1950 A.D.; usually used for radiocarbon dates (q.v.).

BARRIER ISLAND. A sand island, parallel to and near the mainland; the lagoon (q.v.) it encloses has high biological productivity (q.v.).

BIFURCATE-BASED POINT. A stone tool, that can be hafted (sic) as a projectile point, with a notch dividing the base into two lobes; a distinctive artifact of the Early Archaic Period.

BIOMASS. Mass of living matter per unit area.

BIOTIC COMMUNITIES. Certain recurrent combinations of plants and animals.

BLACK-EARTH MIDDEN. A type of site, characterized by black organic soil, absence of shell, and coastal location.

BOREAL FOREST. A dense coniferous forest, presently confined to high latitudes; once thought to have characterized northeastern North America between about 10,000 and 5000 B.P.

BROWSER. A herbivore which subsists chiefly on tree leaves and twigs; usually with smaller range and body size than grazers (q.v.).

CABRIE. Unit of energy in terms of food or activity; strictly speaking, a kilocalorie or "big calorie."

CALORIC RETURN RATE. The ratio of calories in a food foraged relative to the calories expended in its location, capture, and processing.

CAPTURE TIME. The amount of time required to extract a resource (for example, to kill a bear, dig a clam, pick a berry).

CARRYING CAPACITY. The theoretical limit of population which an area can support with food; differing human technologies can alter an area's carrying capacity.

CASTELLATION. A type of pottery rim, characterized by angularity and outflaring; usually distinctive to the Late Woodland Period, but known from earlier (Bourque 1971).

CERAMIC. Made of fired clay.

CLIMATIC OPTIMUM. Period of highest temperatures since deglaciation, around 5000 B.P.

COMPLEX. A coherent series of cultural traits, functionally interrelated, but not forming a whole culture; examples: a burial complex, a fish-processing complex, a ceramic complex.

COMPONENT. A unitary occupation at a site, of limited duration; a site may have a single component or several.

CONTINENTAL SLOPE. The zone of rapid elevation change at the outer edge of the Continental Shelf (CS).

CORD MARKING. The production of patterns on ceramic pottery by the paddling of the surface (when wet) with a cord wrapped paddle.

CROSS-CULTURAL. A type of study using information from many cultures/societies and treating it statistically to derive generalizations.

CROSS-DATING. The dating of cultural materials by their similarity to styles securely dated at other sites.

CULTURE. The non-biological means of adapting to one's environment; beliefs, values, norms, and behavior of a social group; an archaeological unit with consistent material culture (q.v.), distributed over a limited region and with limited time depth.

CULTURE HISTORY. The classification of archaeological units and the relation of those units to one another; the progression and change of those units in a region over time.

CULTURE SEQUENCE. The sequence of culture units in a region over time.

DEDUCTIVE MODEL. A model (q.v.) reasoned from known or assumed generalizations.

DELTA. A shoreline feature consisting of unconsolidated sediments in or at the mouth of a major river; includes distributary streams and sometimes lakes or marshes.

DETERMINATE RESOURCE. A resource whose clustering promotes settlement near research patches (c.f. indeterminate resource).

DIFFUSION. The spread through space of ideas, styles, objects, or peoples.

DIRECT HISTORICAL METHOD. The attribution of local historic tribal affiliation to archaeological culture units using rigorous criteria for correspondence and the extension of those units back into prehistory.

EDAPHIC. Relating to soils or the characteristics of soils.

ENVIRONMENT. All physical, biological, and social conditions surrounding and affecting a social group.

ESTUARY (ESTUARINE). The zone of mixing of salt and fresh waters in a semi-enclosed body of water such as a lower portion of a river.

ESTUARY HEAD. The upriver boundary between salt and fresh water in an estuary (q.v.).

ETHNOGRAPHY. The description of contemporary cultural groups.

ETHNOHISTORY. The study of ethnography (q.v.) using written records as data.

EUSTATIC SEA LEVEL. World-wide sea level, not relative to local land elevation (c.f. relative sea level).

EXOSKELETON. External protective structure for an animal, made of calcium carbonate or silica; a "shell."

FAST ICE. Frozen sea, adjacent and attached to a land mass.

FIND SPOT. A location where a distinctive artifact has been found, but where the presence of other cultural remains has not been established (compare site).

FLUTED POINT. A stone tool, that can be hafted as a projectile point, with a flake or series of flakes (on one or both faces) running from the base toward the tip; a distinctive artifact of the Paleo-Indian Period.

FORAMINIFERA. One type of plankton (q.v.) with distinctive exoskeletons (q.v.) and fine environmental tolerances.

FOSSIL. The remains of a plant or animal, altered from its original form by mineralization or other processes (c.f. sub-fossil).

FULL COASTAL. Environments adjacent to the ocean, including lagoons (q.v.).

GEOMORPHOLOGY. The study of landforms, their origins, and implications for geological history.

GRAVITY MODEL. A geographical model which postulates that settlement is attracted to other settlements or to resource clusters.

GRAZER. A herbivore which subsists chiefly on grass and sedge; usually wide-ranging and large (q.v. browser).

HIGH WAVE-ENERGY BEACH. A beach where normal wave action strikes with strong force; high-wave-energy beaches have little biological productivity and erode rapidly.

HORTICULTURE. Non-intensive plant cultivation, with gardens rather than plowed fields.

INDETERMINATE RESOURCE. A resource which is distributed more or less evenly and which does not promote clustered settlement (c.f. determinate resource).

INDUCTIVE MODEL. A model (q.v.) built up from empiric generalization.

ISOPOLL. A line charting areas with equal percentages or amounts of pollen; analogous to a contour line on a topographic map.

LAGOON. A protected body of salt water, lying between the mainland and a spit (q.v.) or barrier island (q.v.); lagoons often have high biological productivity (q.v.).

LINEAR INTERPOLATION. The insertion of a value between two known values on the assumption that change between the known values is gradual and regular.

MAINLAND BEACH. A beach on a continental shore, without the protection of a spit (q.v.) or barrier island (q.v.); characterized by low biological productivity (q.v.).

MARGINAL VALUE THEOREM. A rule stating that foragers leave a patch when the energy/time yield drops below the average of the environment (Charnov 1976).

MARITIME. Referring to resources of the open sea.

MATERIAL CULTURE. The artifactual remains of a society or archaeological culture.

MATURITY. A concept referring to a hypothetical final or stable state in development; for examples, mature soils have regular sequences of soil horizons from humus to subsoil, stream systems develop from trellis systems (q.v.) to mature dendritic systems, salt marshes develop into extensive and deep environments.

MEGAFAUNA. Big game, usually associated with Pleistocene (q.v.) times.

MICROPALEONTOLOGICAL METHOD. One method of foraminifera (q.v.) analysis, correlating species found in a sample with their known environmental tolerances to infer paleoenvironment (c.f. oxygen isotope method).

MIDDEN. A deposit of organic-rich soil, formed by the accumulation of organic matter, usually accumulated on a ground surface, rather than in a pit; shell middens have shell and other refuse; black-earth middens contain little or no shell.

MIDWEST(TERN) TAXONOMIC SYSTEM. A system of culture historic classification, developed in the 1930's; designed to be descriptive but not to integrate time differences.

MODEL. A simplified picture of reality, constructed from factors important to the situation being modeled.

MOLLUSCAN PROVINCE. Latitidinal zone of the ocean with specific temperature characteristics and associated mollusc species.

MULTI-COMPONENT SITE. A site which has been occupied more than once, usually with a hiatus between occupations.

NON-ARBOREAL POLLEN (NAP). Pollen produced by plants other than trees, such as herbs, grasses, and sedges.

OPTIMAL FORAGING MODEL. A class of deductive models which predict foraging, subsistence, and settlement patterns on the basis of the distribution of food resources and their caloric return rates.

OXYGEN ISOTOPE METHOD. One method of plankton (q.v.) analysis, calculating ratios of different oxygen isotopes to determine the temperature at which the exoskeletons (q.v.) were formed (c.f. micropaleontological method).

PALEOCLIMATE. The climate of an area at a given period in the past.

PALEOENVIRONMENT. The ancient environment (q.v.)

PALEO-INDIAN. A period of prehistory, characterized by Pleistocene megafauna (q.v.), late glacial and early postglacial times, about 15,000 to 10,000 B.P.

PALEONTOLOGY. The study of ancient plants and animals.

PARKLAND. Environmental zone intermediate between grassland and forest, with scattered stands of trees in a landscape otherwise dominated by grasses and sedges.

PATCHINESS. A type and degree of spatial heterogeneity in an environment in which the patches are different habitat or vegetation types.

PERCENTAGE POLLEN COUNT. A method of pollen analysis where the percentages of pollen from different species are tallied; yields inferences on vegetational type but not relative densities of species (c.f. absolute pollen count).

PERIOD. A category in culture classification; a division of an archeological culture (q.v.) which has a relatively short duration.

PHASE. A category in culture classification; a division of an archeological culture (q.v.) which has a relatively short duration.

PLANKTON. Small organisms living in the water column and transported by its currents.

PLANO POINT. A type of large, parallel-flaked lanceolate point without notches; a diagnostic of the Late Paleo-Indian Period; largely confined to interior North America.

PLATFORM PIPE. A stone pipe with the bowl placed upon a flat platform, into which the stem would be inserted.

PLEISTOCENE. The glacial period immediately preceding modern (Holocene) times, pre-10,000 B.P.

POLLEN ANALYSIS. The study of pollen for the purpose of reconstructing past biological environments and climates.

POLLEN SPECTRUM. The range of species and their percentages of occurrence or rates of deposition.

PREDICTABILITY. The degree of consistency over space and time which an environment shows in resource density (q.v.)

PRIMARY RESOURCE. A resource whose resource density (q.v.), caloric return rate (q.v.), and immobility make it sufficiently attractive to draw settlemtn to it (c.f. secondary resource).

PROCESSING TIME. The amount of time required to make edible a resource after it has been extracted (for example, to skin, eviscerate, and cook a rabbit, to remove shells and leach tannic acid from acorns).

PRODUCTIVITY. The potential or actual ability of an area or zone to support life.

RADIOCARBON DATING. A method of obtaining absolute dating (q.v.) from organic materials; radiocarbon years do not exactly equal calendric years and radiocarbon dates must be corrected if they are to be used as calendric dates.

REFUGIUM (pl. refugia). An area where plant or animal species survive following extirpation from portions of their earlier range, usually due to climate change.

RELATIVE DATING. The ordering of cultural materials into a temporal sequence, usually based on stratigraphy (q.v.) or known patterns of cultural change (c.f.absolute dating).

RELATIVE SEA LEVEL. The relative position of ocean level and land; affected by both world-wide sea level changes and local vertical land movement (crustal warping, rebound, etc.) (c.f. eustatic sea level).

RESOURCE DENSITY. The abundance of a resource, measurable by biomass per area (q.v.) or other measures.

SEARCH TIME. The amount of time required to locate a resource.

SECONDARY DEPOSIT. A deposit of cultural or natural material which has been transported from its original place of deposition, as in fill soil or downslope wash.

SECONDARY RESOURCE. A resource which is not sufficiently attractive to draw settlement to it for specialized exploitation (c.f. primary source).

SEDENTISM. The degree to which a population maintains residence in a single or few locations.

SETTLEMENT PATTERN. The spatial structure of human activity areas, occupations, and communities.

SITE. A locus of human activity where material remains of that activity have been found (c.f. find spot).

SPACE-TIME UNIT. A unit of classification at any level in culture history.

SPIT. A curved shoreline feature made of sand, which protects water within it from storms and wave action.

STRATIGRAPHY. The superposition of one (soil) layer over another; the use of this superposition to discover depositional sequence.

SUBFOSSIL. The ancient remains of a plant or animal, composed of the original material of the organism (c.f. fossil).

SUBSISTENCE PATTERN. The structure of human exploitation of food resources, including species, quantities, seasons, techniques, and other factors.

SUBSTRATE. The surface on which an aquatic organism lives; for example. molluscs in a mudflat.

SWIDDEN. A system of agriculture where some plots are planted while others lie fallow and in which the location of planted and fallowed plots rotates regularly.

TEMPER. Aplastic material added to clay to prevent cracking when ceramics are fired.

TERRACE. A step-like landform rising above the flood plain in a valley.

TERRITORIALITY. A condition where a community actively defends an area of land as its own.

TIDAL AMPLITUDE. The elevational distance between high tide and low tide.

TRADITION. A category in culture classification having similarity of material culture over a considerable period of time; more than one tradition can exist in a region at a given time; traditions can cut across regions or periods (q.v.).

TRANSHUMANCE. The regular pattern of seasonal settlement shifts practiced by many societies; distinguished from nomadism by the regularity and repetition of an annual cycle.

TRELLIS STREAM PATTERN. A pattern of waterways where tributaries intersect a main stream nearby at right angles; characteristic of stream systems recently established.

TUNDRA. Sedge and grass areas with few or no trees and cold climate; presently confined to high latitudes but one in lower latitudes immediately after deglaciation; sometimes referred to as "tundra-like" in lower latitudes.

UNSTABLE ENVIRONMENT. An environment where populations of organisms fluctuate greatly from year to year.

VINETTE I WARE. Ceramic pottery with interior and exterior cord marking, defined for northeastern North America.

WEIR. A fence-like device built in rivers for the capture of fish; especially effective for anadromous fish (q.v.).

WOODLAND. A period of prehistory characterized by ceramic-making cultures; about 3000 B.P. to European contact in the sixteenth or seventeenth centuries A.D.

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