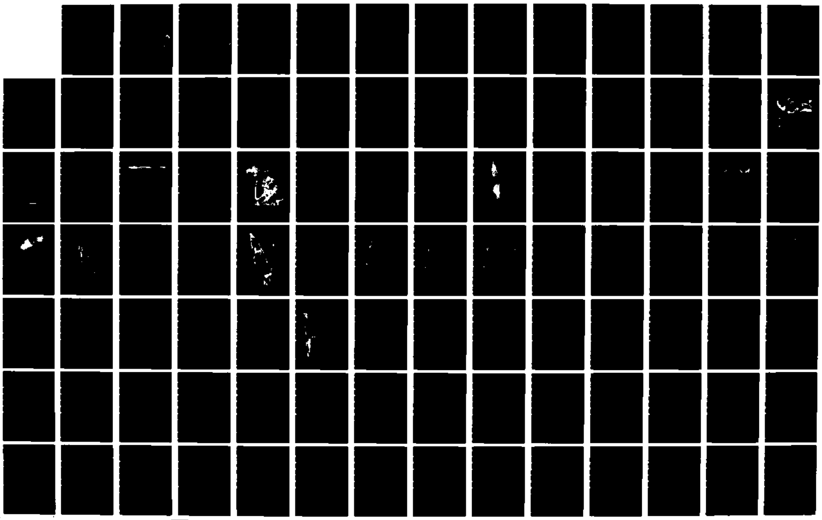
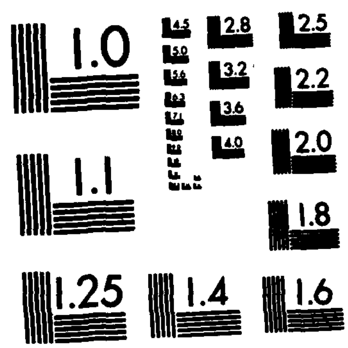
AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981 1/7

UNCLASSIFIED F/G 5/1 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A123745

CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN:
A PREDICTIVE STUDY

Sue Ann Curtis
James W. Hatch

with contributions by

Carl A. Bebrich
Ira C. Beckerman
Christopher E. Hamilton
Charles C. Kolb
Carl L. Romanek
Gary S. Webster
Randolph J. Widmer

Prepared for U.S. Army Corps of Engineers

by

Argonne National Laboratory

1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A123 745
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)* Cultural Resources in the Southern Lake Erie Basin: A Predictive Study	5. TYPE OF REPORT & PERIOD COVERED Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Curtis, S.A.; Hatch, J.W.; Bebrich, C.A.; Beckerman, I.C.; Hamilton, C.E.; Kolb, C.C.; Romanek, C.L.; Webster, G.S.; and Widmer, R.J.	8. CONTRACT OR GRANT NUMBER(s) Support Agreement no. NCB-IS-79-19-KO
9. PERFORMING ORGANIZATION NAME AND ADDRESS Argonne National Laboratory, Division of Environmental Impact Studies, 9700 S. Cass Avenue, Argonne, Illinois 60439	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Buffalo 1776 Niagara St., Buffalo, N.Y. 14207	12. REPORT DATE 1981
	13. NUMBER OF PAGES 592
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)* Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES Prepared in conjunction with the U.S. Army Engineer District Buffalo and Great Lakes National Program Office, US. Environmental Protection Agency, Region V, Chicago programmatic study of U.S. Lake Erie Natural Gas Resource Development.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)* Cultural resources, predictive study, U.S. waters of Lake Erie, historic resources, archeological resources, shipwrecks, submerged cultural resources, paleo-environment, prehistory and ethnohistory, probable site distributions, underwater survey methods, terrestrial survey methods , culturally sensitive areas, modeling subsistence-settlement systems, mitigation.

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)* A predictive study of cultural resources along the southern portion of Lake Erie bordering the States of Ohio, Pennsylvania and New York. The study covers both underwater cultural resources and upland areas bordering the Lake and indicates areas with probabilities for containing cultural resources of high, medium and low sensitivity. Includes discussions on paleo-environment, prehistory, ethnohistory, historic resources, probable site distributions, site discovery methods, shipwrecks and mitigation. An extensive list of references is included.

CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY

Sue Ann Curtis
James W. Hatch

with contributions by

Carl A. Bebrich
Ira C. Beckerman
Christopher E. Hamilton
Charles C. Kolb
Carl L. Romanek
Gary S. Webster
Randolph J. Widmer

Prepared for U.S. Army Corps of Engineers

by

Argonne National Laboratory

1981

This report was prepared for the U.S. Army Corps of Engineers, Buffalo District, Buffalo, New York and the Great Lakes National Program Office, U.S. Environmental Protection Agency, Region V, Chicago, Illinois by Argonne National Laboratory, Division of Environmental Impact Studies, 9700 South Cass Avenue, Argonne, Illinois, 60439.

The facilities of Argonne National Laboratory are owned by the United States Government. Under the terms of a contract (W-31-109-Eng-38) among the U.S. Department of Energy, Argonne Universities Association and the University of Chicago, the University employs the staff and operates the Laboratory in accordance with policies and programs formulated, approved and reviewed by the Association.

EXECUTIVE SUMMARY

The text of this study has been structured around three basic themes: 1) the presentation of substantive findings that resulted from a review of the cultural-historical and environmental literature; 2) recommendations based on federal and state regulatory controls concerning the management of cultural resources in the Lake Erie Basin; and 3) the use of a conceptual framework--the cultural-ecological approach--to structure the collection and presentation of substantive findings and to provide a scientific basis for cultural resource management.

The cultural, environmental, and conceptual data used in the descriptive and analytical sections of the study are organized into eight chapters. Chapter 1 establishes the purpose and conceptual approach selected for meeting the study objectives. The environmental setting of the study area is discussed in Chapter 2; the characterizatic of the major environmental factors are reconstructed back into time for e cultural periods studied in later chapters.

Chapters 3, 4, and 5 review the cultural history of the Lake Erie Basin region from prehistoric times through the ethnohistoric and historic periods, with emphasis on recognizing developmental trends in regional settlement patterns. Chapter 6 focuses on establishing guidelines as to where prehistoric archeological sites are more or less likely to be found in the study area. Emphasis is placed on developing a predictive model for recognizing types of physiographic settings attractive to local inhabitants for certain kinds of settlements and associated subsistence activities.

Terrestrial and submerged locations with a high probability for containing cultural resource sites are assigned a high sensitivity rating requiring intensive survey to locate unknown sites. Locations with fewer expected sites are rated as having a medium to low sensitivity, requiring less intensive survey efforts. Based on this rating system, all areas within the one-mile lakeshore corridor would require an intensive survey. Surveys of varying intensities would be needed for submerged locations depending on each location's potential for containing sites and sunken ships. A survey of the geologic history would also be conducive to the preservation of the cultural resource in question.

Major state-of-the-art field methods for site discovery, both on land and under water, are discussed in Chapter 7. Methods are evaluated as they relate to use in the Lake Erie setting; comparative costs for land versus underwater work are determined. Chapter 8 summarizes the conclusions and major points reached in the preceding chapters. Study findings are related to project objectives.

The overall objective of the study was the assessment of the cultural resource potential of the Lake Erie Basin and the formulation of guidelines for managing these resources should natural gas development take place. From the data gathered, it was determined that both the one-mile-wide lakeshore corridor and the lake bottom have a significant potential for yielding cultural resources of scientific and historical importance. These resources may span some 13,000 years of human settlement in the area and may include prehistoric and ethnohistoric archeological sites as well as historic structures and shipwrecks.

While the lakeshore, taken as a whole, was found to have a high potential for yielding prehistoric and historic cultural resources, the lake bottom presented a more variable picture. Nevertheless the overall cultural resource importance of the study area was found to be sufficiently high to warrant the conclusions that: 1) a well-designed cultural resource management program must be made an integral part of environmental lease conditions and 2) such programs are both feasible and compatible with natural gas development procedures as outlined in the "Draft Programmatic Environmental Impact Statement: U.S. Lake Erie Natural Gas Resource Development."

In order for industry to execute well-planned cultural resource surveys and to anticipate the kinds of construction and/or operational contingencies that may be necessary to avoid impacts to sites, prospective lessees must be informed. The regulatory agency responsible for lease management can establish useful guidelines for survey requirements and a research design needed for meeting these requirements in a technically acceptable manner. Such guidelines and their implementation can be made part of the lease condition.

CONTRIBUTORS

Bebrich	B.A.	1966	University of California, Los Angeles
	M.A.	1971	Pennsylvania State University, Anthropology
Beckerman	B.A.	1974	Rice University, Anthropology
	M.A.	1978	Pennsylvania State University. Anthropology
Curtis	B.S.	1967	Indiana University of Pennsylvania, Art Education
	M.A.	1971	Pennsylvania State University, Anthropology
	Ph.D.	1975	Pennsylvania State University, Anthropology
Hamilton	B.A.	1970	Florida State University, Anthropology
	M.A.	1977	Florida State University, Anthropology
Hatch	B.A.	1970	University of Georgia, Anthropology
	M.A.	1974	Pennsylvania State University, Anthropology
	Ph.D.	1976	Pennsylvania State University, Anthropology
Kolb	B.A.	1962	Pennsylvania State University, History/Anthropology
	M.A.	1965	Pennsylvania State University, Anthropology
	Ph.D.	1979	Pennsylvania State University, Anthropology
Romanek	B.A.	1960	Pennsylvania State University, History
	M.A.	1964	Bucknell University, History
	Ph.D.	1969	Pennsylvania State University, History
Widmer	B.A.	1970	Florida State University, Anthropology
	M.A.	1978	Pennsylvania State University, Anthropology
Webster	B.A.	1976	Boise State University, Social Science
	M.A.	1978	Pennsylvania State University, Anthropology

CONTENTS

	Page
EXECUTIVE SUMMARY	iii
CONTRIBUTORS	v
LIST OF FIGURES	xi
LIST OF TABLES	xiv
ACKNOWLEDGEMENTS	xvi
1. INTRODUCTION	1-1
1.1 General Statement	1-1
1.2 Statement of Purpose	1-2
1.3 Scientific Contributions	1-3
1.4 Statement of Theoretical Approach	1-4
2. PALEO-ENVIRONMENT	2-1
2.1 Introduction and Statement of Purpose	2-1
2.1.1 Study Areas: Water	2-1
2.1.2 Study Area: Land	2-2
2.1.3 Chapter Content	2-2
2.2 Geomorphology	2-5
2.2.1 Preglacial Geology	2-5
2.2.2 Glacial Geology	2-10
2.2.3 Hydrology of Early Lake Erie	2-13
2.2.4 Transformations of the Natural Landscape	2-18
2.2.5 Summary and Conclusion	2-32
2.3 Climate	2-33
2.3.1 Modern Climate	2-33
2.3.2 Prehistoric Climate	2-35
2.3.3 Conclusions	2-35
2.4 Soil	2-35
2.4.1 Soil Surveys	2-36
2.4.2 Soil Characterization: Catena Construction	2-38
2.4.3 Conclusions	2-45
2.5 Vegetation	2-48
2.5.1 Reconstruction of the Vegetation: Baseline Descriptive Data	2-49
2.5.2 Inventory of Tree Species	2-59
2.5.3 Factors that Determine Vegetation	2-59
2.5.4 The Forest in 1800: A Model	2-62
2.5.5 Paleovegetation and Paleoclimate	2-65
2.5.6 Reconstructed Vegetational History	2-73
2.5.7 Paleoclimate	2-76
2.6 Fauna	2-79
2.6.1 Fish Resources of Lake Erie	2-82
2.6.2 Land Animal Resources	2-84
2.6.3 Conclusions	2-87

CONTENTS

	Page
2.7 Productivity of the Natural Environment for Prehistoric Inhabitants	2-88
2.7.1 Analytical Assumptions	2-88
2.7.2 Factors Affecting Four Major Food Resources	2-89
2.7.3 Ratings for Agriculture	2-91
2.7.4 Ratings for Walnut	2-99
2.7.5 Ratings for Oak and Hickory	2-100
2.7.6 Conclusions	2-114
2.8 Summary and Discussion	2-114
3. PREHISTORY	3-1
3.1 Introduction	3-1
3.1.1 Organization	3-2
3.1.2 Approach	3-2
3.2 Archeological Background	3-3
3.2.1 Paleo-Indian Period	3-4
3.2.2 Archaic and Transitional Periods	3-13
3.2.3 Woodland Period	3-36
3.3 Settlement Modes	3-81
3.3.1 Constructing Descriptive Modes	3-81
3.3.2 Modes of Cultural Adaptation	3-83
3.4 Settlement Modes: A Field Evaluation	3-88
3.4.1 Ohio: Zones 1-3	3-89
3.4.2 Settlement Modes in Zone 4: Southwestern New York Lowlands	3-123
3.4.3 Settlement Modes in Zone 5: Western New York Lowlands	3-127
3.5 Summary and Discussion	3-136
3.5.1 Early Paleo-Indian Period	3-137
3.5.2 Late Paleo-Indian Period	3-137
4. THE ETHNOHISTORY OF THE LAKE ERIE SHORELINE AND ITS IMMEDIATE REGION	4-1
4.1 Introduction	4-1
4.2 The Region	4-2
4.2.1 The Political Units	4-2
4.2.2 Ecological Considerations	4-4
4.3 Regional Chronology	4-4
4.4 Ethnohistory	4-15
4.5 Research Results	4-16
4.5.1 Introduction	4-16
4.5.2 Zone Ia	4-17
4.5.3 Zones Ib and IIa	4-22
4.5.4 Zones Ic and IIb	4-23
4.5.5 Zones Id and IIc	4-25
4.5.6 Zones Ie and IId	4-27
4.6 Ethnographic Research	4-31
4.6.1 Methods	4-31
4.6.2 Traditional and Modified Culture Patterns	4-32
4.6.3 The Cattaraugus Reservation	4-34

CONTENTS

		Page
4.7	Ethnohistoric Problems	4-36
4.8	Summary Discussion	4-39
5.	THE HISTORIC RESOURCES OF U.S. LAKE ERIE AND ITS ADJACENT SHORELINE	5-1
5.1	Introduction	5-1
5.2	The Lake Erie Shoreline	5-1
5.2.1	Historical Background	5-1
5.2.2	Shoreline Historic Sites Inventory	5-2
5.2.3	Summary	5-6
5.3	Lake Erie Shipping	5-6
5.3.1	Historical and Technological Background	5-6
5.3.2	Archeological and Historical Perspective	5-18
5.3.3	Location and Classification of Lake Erie Shipwrecks	5-22
5.3.4	Conclusion	5-27
5.4	Summary and Discussion	5-27
6.	DISCUSSION OF PROBABLE SITE DISTRIBUTIONS	6-1
6.1	Introduction	6-1
6.2	Probable Distributions of Prehistoric Sites in the Lake Erie Basin	6-2
6.2.1	Terrestrial Prehistoric Sites	6-2
6.2.2	Submerged Prehistoric Sites	6-9
6.3	Summary and Discussion	6-12
7.	METHODS FOR SITE DISCOVERY IN THE LAKE ERIE BASIN	7-1
7.1	Introduction	7-1
7.2	Methods for Terrestrial Surveys	7-1
7.2.1	Surface Surveys	7-2
7.2.2	Buried-Site Surveys	7-2
7.2.3	Discussion of Method Applications	7-3
7.3	Methods for Underwater Surveys	7-4
7.3.1	Indirect Underwater Search Procedures	7-4
7.3.2	Direct Underwater Search and Sampling Procedures	7-18
7.3.3	The Study of Shipwrecks	7-21
7.3.4	Study of Submerged Archeological Sites Other Than Shipwrecks	7-23
7.3.5	Procedural Recommendations for Underwater Archeology in Lake Erie	7-26
7.4	Costs	7-27
7.5	Discussion of Survey Methods	7-28
8.	SUMMARY AND DISCUSSION	8-1
8.1	General Statements	8-1
8.2	Chapter Summaries	8-3
8.3	Limitations	8-8
8.3.1	Paleoenvironmental Reconstruction	8-8
8.3.2	Modeling Subsistence - Settlement Systems	8-8
8.3.3	Determinants of Prehistoric Site Placement	8-9
8.4	General Standards for Historical Preservation Projects	8-10

CONTENTS

		Page
APPENDIX A.	ENGLISH EQUIVALENTS FOR COMMONLY USED METRIC UNITS	A-1
APPENDIX B.	USGS TOPOGRAPHIC MAP ARRANGEMENT, LAKE ERIE	B-1
APPENDIX C.	SEQUENCE OF GLACIAL CHANGE ON THE GREAT LAKES	C-1
APPENDIX D.	GLOSSARY OF SOIL TERMS	D-1
APPENDIX E.	AN INVENTORY OF TREE SPECIES PRESENT IN THE LAKE ERIE SHORE AREA ca. 1800	E-1
APPENDIX F.	NATIVE FISHES OF LAKE ERIE	F-1
APPENDIX G.	INVENTORY OF HISTORIC PROPERTIES	G-1
APPENDIX H.	AN INVENTORY OF LAKE ERIE SHIPWRECKS	H-1
APPENDIX I.	CORRELATION FACTORS	I-1
APPENDIX J.	FEDERAL AND STATE AGENCIES AND NATIONAL ORGANIZATIONS CONCERNED WITH HISTORIC PRESERVATION	J-1
APPENDIX K.	EVALUATION OF SOURCE MATERIALS FOR ETHNOHISTORY OF THE RESEARCH AREA	K-1
APPENDIX L.	PROTOHISTORIC SITE INVENTORY AND SOURCES FOR ETHNOHISTORIC DATA	L-1

LIST OF FIGURES

Figure		Page
2.1	Paleo-ecological Zones for Analysis	2-4
2.2	Lake Erie and Its Tributaries	2-5
2.3	Geologic Map of the Great Lakes Region	2-6
2.4	Cross-Section of Bedrock Stratigraphy for the Lake Erie Basin	2-7
2.5	Geologic Map of the Western End of Lake Erie with a Portion of the Findlay Arch	2-8
2.6	Geologic Cross-Section of South Bass and Kelley's Islands in Western Lake Erie	2-9
2.7	Reconstructed Preglacial Drainage Pattern for the Western Basin	2-9
2.8	Glacial Map of Michigan Showing the Cary Substage	2-11
2.9	Inferred Bathymetry of Lake Erie	2-12
2.10	A Reconstructed Map of Early Lake Erie, ca. 12,500 B.P.	2-15
2.11	Postglacial History of Lake Erie Water Levels	2-16
2.12	Diagrams of Glacial Deposits	2-19
2.13	Distribution of High-Energy Wave Zones in Lake Erie	2-21
2.14	Lake Erie Shoreline, ca. 10,000 B.P.	2-22
2.15	Topography of Pleistocene Deposits	2-23
2.16	Isopach Map of Lake Erie Recent Mud	2-24
2.17	Lake Erie Bottom Material Distribution	2-25
2.18	Elevation Contours on Reflecting Horizon b	2-27
2.19	Elevation Contours on Reflecting Horizon c	2-28
2.20	Elevation Contours on Reflecting Horizon d	2-29
2.21	Elevation of Top of Till Underlying Western Lake Erie	2-30
2.22	Distribution of Surficial Sediments in Lake Erie	2-31
2.23	Average Precipitation for New York, Pennsylvania, and Ohio	2-34
2.24	Schematic Cross-Section (N-S) of the South Shore of Lake Erie	2-40
2.25	Vegetation Associations of the Glacial Till Plain	2-63
2.26	Synthesis of General Sequence for Northern Ohio	2-68
2.27	Reconstructed Vegetational History for Five Selected Areas Near Lake Erie	2-74
2.28	Dominant Holocene Forest and Climate for the Western and Eastern Areas of Lake Erie	2-75
2.29	Diagram Showing Pollen Percentages, Birch-Seed Percentages, and Charcoal/Pollen Ratios	2-80
2.30	Possible Soil Moisture Situations for Agricultural Production	2-92
2.31	Evaluation of Soil Series under Modern Climate Conditions	2-93
2.32	Evaluation of Soil Series under Wetter Climate Conditions	2-94
2.33	Evaluation of Soil Series under Drier Climate Conditions	2-95
2.34	Evaluation of Walnut Soils under Modern Climate Conditions	2-101
2.35	Evaluation of Walnut Soils under Wetter Climate Conditions	2-102
2.36	Evaluation of Walnut Soils under Drier Climate Conditions	2-103

LIST OF FIGURES

Figure		Page
2.37	Evaluation of Oak and Hickory Soils under Modern Climate Conditions	2-108
2.38	Evaluation of the Catena for White Oak-Shagbark Hickory under Modern Climate Conditions	2-109
3.0	Spatial and Temporal Distribution of Settlement System Modes I-XII in the Survey Area	3-82a
3.1	Settlement Mode III: Oak-Hickory Soils, Wetter Regime	3-95
3.2	Settlement Mode III: Walnut Soils, Wetter Regime	3-96
3.3	Settlement Mode III: Huron River Oak-Hickory Soils, Drier Regime	3-97
3.4	Settlement Mode III: Huron River Walnut Soils, Drier Regime	3-98
3.5	Settlement Mode III: Huron River Oak-Hickory Soils, Modern Regime	3-99
3.6	Settlement Mode III: Huron River Walnut Soils, Modern Regime	3-100
3.7	Settlement Mode V: Huron River Oak-Hickory Soils, Drier Regime	3-105
3.8	Settlement Mode V: Huron River Walnut Soils, Drier Regime	3-106
3.9	Settlement Mode VI: Huron River Oak-Hickory Soils, Drier Regime	3-108
3.10	Settlement Mode VI: Huron River Walnut Soils, Drier Regime	3-109
3.11	Settlement Mode VI: Huron River Oak-Hickory Soils, Modern Regime	3-110
3.12	Settlement Mode VI: Huron River Walnut Soils, Modern Regime	3-111
3.13	Settlement Mode VIII: Portage River Oak-Hickory Soils, Modern Regime	3-112
3.14	Settlement Mode VIII: Portage River Walnut Soils, Modern Regime	3-113
3.15	Settlement Mode VIII: Portage River Agricultural Soils, Modern Regime	3-114
3.16	Settlement Mode IX: Black River Oak-Hickory Soils, Wetter Regime	3-117
3.17	Settlement Mode IX: Black River Walnut Soils, Wetter Regime	3-118
3.18	Settlement Mode IX: Black River Agricultural Soils, Wetter Regime	3-119
3.19	Settlement Mode XI: Black River Oak-Hickory Soils, Modern Regime	3-120
3.20	Settlement Mode XI: Black River Walnut Soils, Modern Regime	3-121
3.21	Settlement Mode XI: Black River Agricultural Soils, Modern Regime	3-122
4.1	Major Indian Trails and Paths, ca. A.D. 1570-1750	4-6
4.2	Distribution of Tribes, ca. A.D. 1570	4-8
4.3	Distribution of Tribes, ca. A.D. 1600	4-9
4.4	Distribution of Tribes, ca. A.D. 1649-1657	4-10
4.5	Distribution of Tribes, ca. A.D. 1660	4-11
4.6	Distribution of Tribes, ca. A.D. 1700	4-12
4.7	Distribution of Tribes, ca. A.D. 1750	4-13
4.8	Distribution of Tribes, ca. A.D. 1800	4-14
5.1	Shipwreck Areas A-E Along the Lake Erie Shoreline	5-3
5.2	Example of a Cargo Canoe	5-8
5.3	York Boat Being Rowed	5-8

LIST OF FIGURES

Figure		Page
5.4	York Boat Under Sail	5-9
5.5	Remains of Two 18th Century Bateaux Found by Scuba Divers	5-9
5.6	Bateau	5-10
5.7	Line Drawing of the Saratoga	5-11
5.8	Examples of a Schooner and a Brig	5-11
5.9	Illustration of a Canal Boat	5-13
5.10	Great Lakes Clipper; Schooner Challenge	5-13
5.11	Illustration of the Constellation	5-14
5.12	Whaleback Barges	5-16
5.13	NOAA Navigation Chart for Lake Erie, Part 1	5-24
5.14	NOAA Navigation Chart for Lake Erie, Part 2	5-25
5.15	NOAA Navigation Chart for Lake Erie, Part 3	5-26
7.1	The Electromagnetic Spectrum, Customary Divisions	7-7
7.2	Flow Chart Representing the Evolution of a Shipwreck	7-22

LIST OF TABLES

Table		Page
2.1	The Seven Zones of the Project Study Area	2-3
2.2	Classic Lake Stages in the Erie Basin	2-12
2.3	Radiocarbon Dates for Lake Erie	2-17
2.4	Status of Soil Survey Information in Counties Bordering Lake Erie	2-37
2.5	Soil Catena for Modern Soil Series	2-41
2.6	Definition of Drainage Classes	2-43
2.7	Soil Catena for Older Soil Series	2-46
2.8	Drainage-Soil Modes for Vegetation in Ashtabula County	2-61
2.9	Tentative Correlation of Climatic Changes During the Past 2200 Years	2-81
2.10	Order of Yield of Principal Commercial Species	2-84
2.11	Class I and II Soils for Agriculture: Modern Climate	2-96
2.12	Class I and II Soils for Agriculture: Wetter Climate	2-96
2.13	Class I and II Soils for Agriculture: Drier Climate	2-97
2.14	Class I and II Soils for Agriculture	2-98
2.15	Class I and II Soils for Walnut: Modern Climate	2-104
2.16	Class I and II Soils for Walnut: Wetter Climate	2-105
2.17	Class I and II Soils for Walnut: Drier Climate	2-106
2.18	Class I and II Soils for Walnut	2-107
2.19	Class I and II Soils for White Oak and Shagbark Hickory: Modern Climate	2-110
2.20	Class I and II Soils for White Oak and Shagbark Hickory: Wetter Climate	2-111
2.21	Class I and II Soils for White Oak and Shagbark Hickory: Drier Climate	2-112
2.22	Class I and II Soils for White Oak and Shagbark Hickory	2-113
4.1	Tribal and Zonal Occupations	4-18
4.2	Land Sales, 1826	4-31
4.3	Seneca Cermonies Held at the Cattaraugus Reservation	4-36
5.1	Sail and Steam Vessels on U.S. Lake Erie	5-17
5.2	Cross-Section Data for Lake Erie, 1851	5-19
5.3	Enrolled Tonnage for Lake Erie Port Districts	5-20
5.4	Cumulative Number of Wrecks per District by Year	5-20
5.5	Longitudinal Comparison for Buffalo Creek District	5-21
5.6	Sources for Shipwreck Information	5-22
6.1	Archeological Sensitivity Ratings by Zone for Terrestrial Sites	6-14
6.2	Archeological Sensitivity Ratings by Basin for Submerged Sites	6-16

LIST OF TABLES (Cont.)

Table		Page
7.1	Archeological Discovery Techniques for Terrestrial Surveys . . .	7-5
7.2	Comparison of Search Techniques	7-19
7.3	Archeological Discovery Techniques for Shipwreck Sites	7-21
7.4	Relevant Environmental Attributes for Class 1-5 Shipwrecks . . .	7-24
7.5	Archeological Discovery Techniques for Submerged Aboriginal Sites	7-25
7.6	Summary of Archeological Survey Techniques and Their Current Applications	7-29

CHAPTER 1

INTRODUCTION

Sue Ann Curtis and James W. Hatch

1.1 GENERAL STATEMENT

There has been increasing interest in developing the natural gas resources in the central and eastern basins of Lake Erie. In 1977, New York and Pennslyvania removed existing bans on offshore drilling, and Ohio permitted its ban on drilling to expire in 1978. Although developmental interests in natural gas production are evident, the concerns about improving the environmental quality of the lake continue to remain strong. Because the lake has so many uses, including fishing, transportation, recreation, and water supply, any new development must be evaluated in terms of its environmental compatibility with these other uses.

In anticipation of application for federal permits for various kinds of natural gas development actions, the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (USEPA) have entered into an Interagency Agreement. Through their combined effort, an environmental impact statement has been prepared on a programmatic level to evaluate the environmental acceptability of natural gas resource development in Lake Erie. The results of this study will be used at the federal level to determine if natural gas development in Lake Erie can be accomplished in an environmentally acceptable manner. If the determination favors development, the study will also be used to establish the circumstance, in the form of minimum federal guidelines, under which this development could be permitted.

The scope of the programmatic study is broad and considers many aspects of the natural and human environments. One of these aspects involves assessment of the cultural resources on the lake bottom and along the shore. This report attempts to fill this need and at the same time lay the groundwork for a cultural resource management program should natural gas development take place. This report is a separate support document to the "Draft Programmatic Environmental Impact Statement: U.S. Lake Erie Natural Gas Resource Development" prepared by the Argonne National Laboratory, Division of Environmental Impact Studies. This supplement has been prepared as a separate document because of the lengthy treatment required for such a study and because of the sensitive nature of the information on site locations included.

Cultural resource management is included in this environmental impact study in order to comply with the spirit and letter of a number of federal laws. These laws include the Coastal Zone Management Act of 1972, the National Environmental Policy Act of 1969, the Historic Preservation Act of 1966, the

Archeological and Historic Preservation Act of 1974, the Indian Religious Act of 1978, and Executive Order 11593. Taken in combination, the direction indicated by these laws is for the development of a program to protect and preserve cultural resources that may remain in an area to be developed as part of a federal action.

These laws have been instituted to protect a part of our nation's heritage that is disappearing at an ever-increasing rate. Because cultural resources are nonrenewable, their disturbance or destruction by land development, erosion, unauthorized collecting, and vandalism is an irreversible and irretrievable loss. The individual sites and groups of sites that still remain are a critical laboratory for understanding changing patterns of human use and adaptation to the natural environment over time.

The term "cultural resources" has appeared in the published literature rather recently and has been variably defined. For the purpose of this study, a "cultural resource" is defined as a structure or object that has historic, prehistoric, ethnohistoric, architectural, and/or scientific importance. While structures are entirely human-made, objects may be natural as well as human-made. For example, a clay source, herbs, or a boulder in a specific ("sacred") place may be among the known objects of importance to ethnohistoric peoples and Native Americans. Depending on the context in which some objects are found, natural objects of importance may also be recognized for prehistoric peoples.

The term "cultural resource site" will also be used throughout this report. A "site" denotes the location where a structure and/or object was used by members of a specific sociocultural group. Sites are defined by spatial boundaries that enclose an area where human activities associated with the individual cultural resource took place. Material debris and modifications of the associated soil, rocks, etc., generally occur within this boundary but may be redeposited elsewhere due to natural processes. It should be noted that definition of site boundaries can be a technical problem that must be evaluated for specific sites, chronologies, and cultural affiliations.

1.2 STATEMENT OF PURPOSE

The primary objective of this document is to provide a generic assessment of the cultural resources of the Lake Erie Basin and to provide guidelines for managing these resources. Emphasis is placed on identifying the kinds of prehistoric, ethnohistoric, and historic cultural resources that may remain on the bottom of Lake Erie and on the adjacent lakeshore. Moreover, an assessment of the probabilities for finding resources within the basin is presented. These two types of information are important for effective management of the natural gas development of the lake for essentially three reasons.

First, the information can be used to structure the research design and aid in the selection of survey methods used to investigate specific lake bottom and lakeshore locations. Generalizations provided in this study about the physical nature of the cultural resource remains and geological contexts that are likely to be found in various areas of the basin should prove useful in developing effective survey strategies.

Second, this information can be used by planners to help assess differential time and effort expenditures that may be necessary for managing the cultural resources of select lease tracts. Generalized statements about the probability for finding sites, in particular topographic settings, contributes to more accurate cost and time estimates for lease development. Areas having higher site densities and a greater frequency of sites with complex or fragile structures would be more expensive to survey and mitigate. Moreover, longer lead times would be necessary for developing tracts that contain these more sensitive areas.

Third, the data presented on site types and the probabilities for finding sites of different temporal and cultural affiliations contribute to a better definition of cultural historical problems. Recognition of these problems and the kinds of data that may contribute to their solution will also help establish criteria for evaluating individual sites and districts that may be eligible for local, state, and federal registers. Should locations of such sites and districts eventually lead to their nomination, this could be construed as an important spin-off benefit of development.

Once specific lease tracts are defined, this study can be used in two ways: 1) to aid a regulatory agency in developing effective guidelines for leasees on how cultural resource impact studies are to be conducted and 2) to assist leasees in identifying, evaluating, and mitigating cultural resources impacted by this development project.

1.3 SCIENTIFIC CONTRIBUTIONS

In addition to contributing information that can be used for management decisions, a generic evaluation of the cultural resources of this area will also provide an opportunity to contribute to the methodological, theoretical, and cultural-historical problems specific to the prehistory, ethnohistory, and history of the Lake Erie Basin. Therefore, two secondary research objectives were identified as a part of this study.

The first focuses on the integration of various kinds of published site-specific cultural and environmental data for several natural areas within the Lake Erie Basin. Synthesis of these separate studies is essential for 1) identifying subsistence-settlement patterns for various time periods; 2) understanding the function of certain types of sites; and 3) determining the past and present natural settings in which sites are found.

The information about subsistence-settlement patterns can be used to construct predictive models about where, or at least under what conditions, sites are most likely to be found. These models can then be tested against extant studies not used in their generation, or these models can be used as a basis for structuring future survey investigations.

The second objective focuses on developing a methodological approach to integrate various kinds of cultural and environmental data through time and across space. The approach used in this study is based on the conceptual framework of cultural ecology first advanced by Julian Steward (1955) and later elaborated by Willey (1953), Sanders (1965), and Curtis (1971). This approach has been successfully applied in a variety of widely separated natural environments and should prove useful for future studies in the Lake Erie Basin.

1.4 STATEMENT OF THEORETICAL APPROACH

The conceptual framework used in this study is a cultural-ecological approach in which humans are viewed as an integral part of the total ecological system. The creation of cultural objects, structure, sites, and settlement systems is viewed in part as an adaptive response to specific micro-macro environmental conditions, i.e., as an adaptation to the natural environment. They may also reflect the interaction of sociocultural systems and subsystems. Together, these natural and sociocultural systems and subsystems constitute the total adaptive milieu in which people function.

Cultural systems interact with the natural environment most directly through their techno-economic subsystems. The acquisition of food, shelter, and raw materials are basic human needs that can be fulfilled in a variety of ways strongly structured by the spatial and temporal distribution of these resources in the natural environment. Humanity's spatial and temporal distribution is thus directly linked to the always uneven availability of the resources required.

A key methodological problem confronting archeological investigations of any area is the identification of appropriate units of observation. Both cultural and natural environmental systems present almost endless variety. The choice of variables to study and the limiting of their numbers to a manageable level are therefore necessary methodlogical tasks.

Measurement units used to make these studies are also variable. Since the literature used to prepare this study employed both English and metric units, conversion factors have been provided in Appendix A.

The site and the settlement systems have long been recognized as fundamental cultural units of archeological study. They reflect the segmentation of human society into social units that can optimally exploit natural resources while maintaining other essential cultural functions. From a cultural resource management perspective, the site is also the basic unit of study.

Insofar as the natural environment is concerned, cultural ecologists have come to recognize five major variables for understanding the structure of settlement systems and the distribution of sites that comprise them. These variables include 1) geology (geology and hydrography), 2) climate, 3) soils and soil productivity, 4) vegetation, and 5) terrestrial and aquatic fauna. These variables largely determine the spatial and temporal distributions and the abundance of subsistence resources. They also affect the suitability of the landscape for human settlement patterns in and around the natural resources being exploited.

Linking site functions and distribution to sociocultural and natural environmental factors is vital to understanding how and why settlement systems change over time. Insofar as this study is concerned, the discovery of relationships among these variables is of fundamental importance for predicting where, or at least under what circumstances, cultural resource sites are likely to be found. In a still broader context, such findings prove of value in developing hypothetic-deductive models of human adaptation in the Lake Erie Basin.

CHAPTER 2

PALEO-ENVIRONMENT

Ira C. Beckerman

2.1 INTRODUCTION AND STATEMENT OF PURPOSE

This chapter provides a description of the prehistoric natural environment. Emphasis is placed on discussing those factors that may have been directly important to the subsistence strategies of the prehistoric inhabitants who utilized this area as well as on other environmental variables that indirectly affected the nature of the local environment. By understanding how, why, and where prehistoric peoples exploited parts of their environments over time, better predictions can be made about an area's potential for having certain kinds and numbers of cultural resource sites.

The project area is defined as the U.S. side of Lake Erie plus a one-mile-wide corridor stretching from Toledo, Ohio, to Buffalo, New York. This area includes almost 14,000 km^2 (Carter 1977:7). The area of water surface on the U.S. side of Lake Erie covers approximately 12,900 km^2; the shoreline from Toledo to Buffalo is some 584 km long, thus the one-mile wide land corridor contains an additional 940 km^2.

The boundaries of this area do not correspond with natural environmental boundaries and are probably too small to contain the settlement-subsistence system of any one cultural group at any one point in time. For this reason, the paleo-environmental study should be expanded somewhat but not to the extent that the area is unworkably large or redundant. A compromise survey area of one U.S. Geological Survey (USGS) 7½-minute quadrangle in from the lakeshore would probably give more settlement information and allow a systematic interpretation without adding unduly to the workload. This is the unit of observation from which the literature search for prehistoric sites was conducted (see Chapter 3). At this latitude, 7½ minutes represents about 14 km, or more than 8 mi. The USGS 7½-minute quadrangles encompassing the area are listed in Appendix B. While this list represents more than 9,000 km^2, the total drainage basin into Lake Erie encompasses more than 46,000 km^2 on the U.S. side of the lake. Although the drainage basin may represent a "natural" unit of analysis for prehistoric settlement systems, it is far too unwieldy to be included in this study.

2.1.1 Study Areas: Water

Lake Erie, the fourth largest Great Lake, covers a total of 25,670 km^2 and is 390 km long and 90 km wide (Eichenlaub 1979). The average lake level is 173.9 m ASL, with a maximum depth of 64 m and an average depth of 19 m; the total volume of water is 484 km^3. The lake is divided into three basins: a deep Eastern Basin, a Central Basin, and a shallow Western Basin. One author specifies a fourth basin north of Sandusky, the Sandusky Basin (Sly 1976). The Western and Central basins are separated by a series of islands of which Bass and Pelee are the largest. Although the lake level is set at 173.9 m ASL, there are both annual and seasonal fluctuations; the lake is at a low level from November to March and at a high level from June to July. The lake level varies from 0.3 to 0.6 m per year (Langlois 1954; Herdendorf and Bradeich 1972). The level of the lake is determined by two factors: 1) inflow from its own drainage and drainage of the other Great Lakes (except Ontario) by way of the Detroit River and 2) the outflow into Lake Ontario, which is solely controlled by the elevation of the outlet at Niagara. Since 1860, the level of the lake has fluctuated between 173.0 and 174.7 m ASL (Sly 1976).

2.1.2 Study Area: Land

The land portion of the survey area encompasses three distinct physiographic provinces: the Eastern Lake section of the Central Lowlands; the glaciated Allegheny Plateau section of the Appalachian Plateau Province; and the Glacial Till Plain (Fenneman 1938). From Cleveland to the east, an escarpment separates the Allegheny Plateau from the Lake section. West of Sandusky, the Eastern Lake section widens rapidly to include the old Lake Warren lakebed. In essence, much of the environmental variability within the survey area is based on physiographic differences. The upland-lowland dichotomy is useful in distinguishing between different forest types, animal habitats, and soil characteristics important to prehistoric inhabitants. There are, however, several subtle environmental differences within these provinces that also have internal integrity with respect to flora and fauna. Because of these differences, the survey region has been divided into seven zones, which will be presumed to be internally consistent (Table 2.1 and Fig. 2.1). The initial division was based on geologic, edaphic, and glacial-historical factors that reflected the important variability in the survey area.

Several major streams drain into Lake Erie on the U.S. side. In Ohio, the Maumee River (at Toledo) is one of the most important and largest (17,000 km^2 drainage area) of these streams (Langlois 1954). The Portage, Sandusky, Huron, Black, Cuyahoga, and Grand rivers are also important in Ohio; each has a drainage area of more than 1,000 km^2. Further east, large streams are few and far between, with the notable exception of Cattaraugus Creek in Western New York (Fig. 2.2).

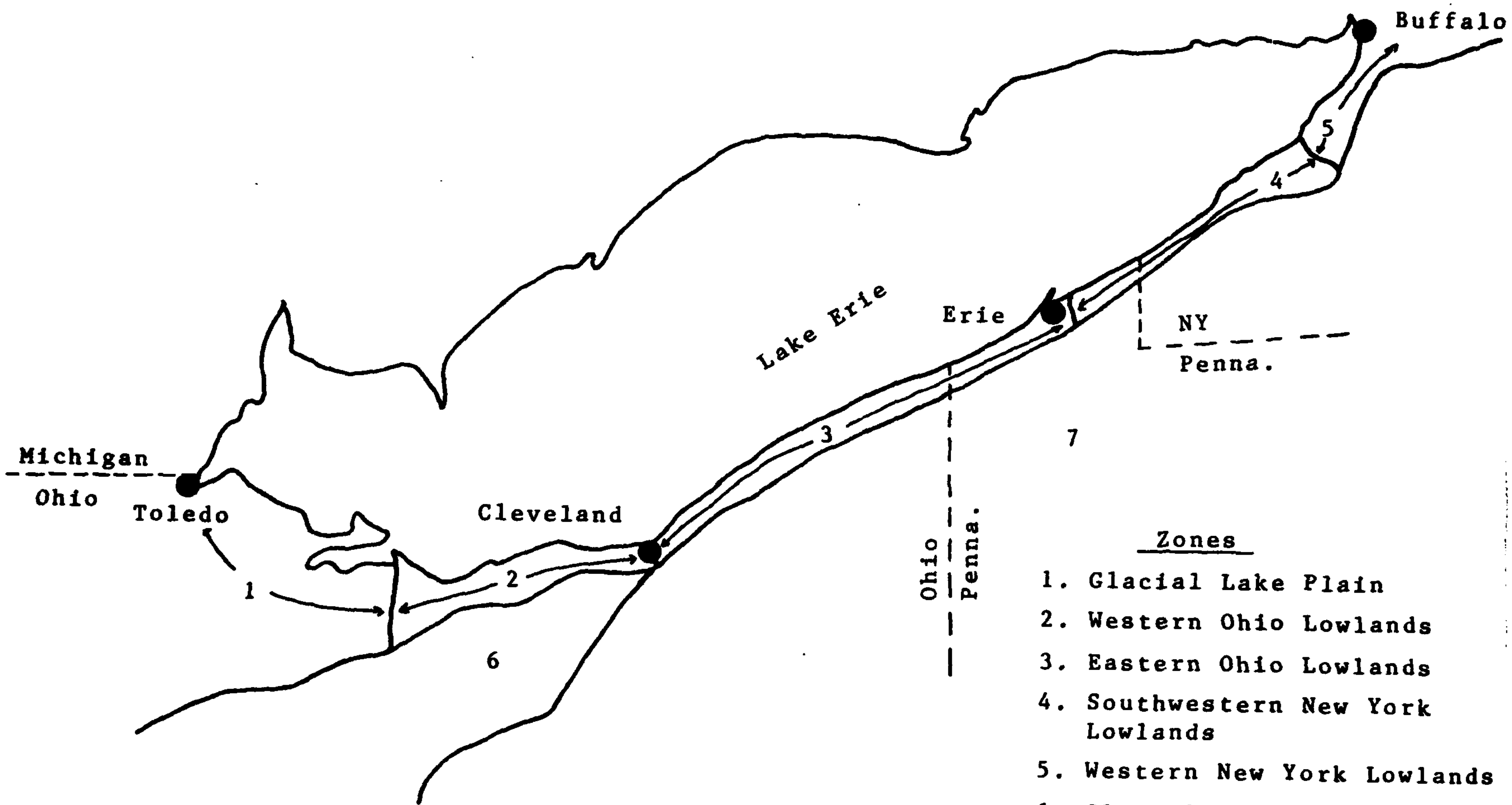
2.1.3 Chapter Content

Because of the complexity of characterizing the paleo-environments of the land and water areas, discussions have been subdivided into five major chapter subdivisions: geomorphology, climate, soils, vegetation, and fauna. Each subdivision corresponds to a major parameter of the natural environment. These environmental parameters are important for the analysis of a particular area for several reasons: 1) they are functionally interrelated and operate within the energy-nutrient framework; 2) they are easily recognized within the environmental system; and 3) they make data collection methodologically feasible for archeologists.

A section that qualitatively discusses the environmental productivity of the study area for prehistoric hunters and gatherers and agriculturalists follows the characterization of the five environmental components.

Table 2.1. The Seven Zones of the Project Study Area

Zone	Extent	Description
1 Glacial Lake Plain	From Toledo to Pipe Creek, near Sandusky	Consists of the old glacial Lake Maumee lakebed and is currently above water. There is no upland area associated with this zone.
2 Western Ohio Lowlands	From Pipe Creek to the Cuyahoga River	Corresponds to Fenneman's (1938) Central Lowlands Province; the Glacial Till Plain is its associated upland area.
3 Eastern Ohio Lowlands	From the Cuyahoga River to Mill Creek, at Erie, Pennsylvania	Is distinct from the two lowland zones further east in that it is extremely narrow and has a sublinear pattern of stream drainage (Strandberg 1967); the glaciated Allegheny Plateau is its associated upland zone.
4 Southwestern New York Lowlands	From Mill Creek to Silver Creek	Is wider than the Eastern Ohio Lowlands and has a subdendritic stream pattern.
5 Western New York Lowlands	From Silver Creek to Buffalo	Is much wider than Zone 4; the associated uplands for this zone are not found on the topographic sheets for the survey area.
6 Glacial Till Uplands	From Sandusky to the Cuyahoga River	Is the same as that defined in Fenneman (1938).
7 Allegheny Plateau Uplands	From the Cuyahoga River to Buffalo	Is the glaciated portion of the Allegheny Plateau as defined in Fenneman (1938).



Zones

1. Glacial Lake Plain
2. Western Ohio Lowlands
3. Eastern Ohio Lowlands
4. Southwestern New York Lowlands
5. Western New York Lowlands
6. Glacial Till Uplands
7. Allegheny Plateau Uplands

Fig. 2.1 Paleo-ecological Zones for Analysis

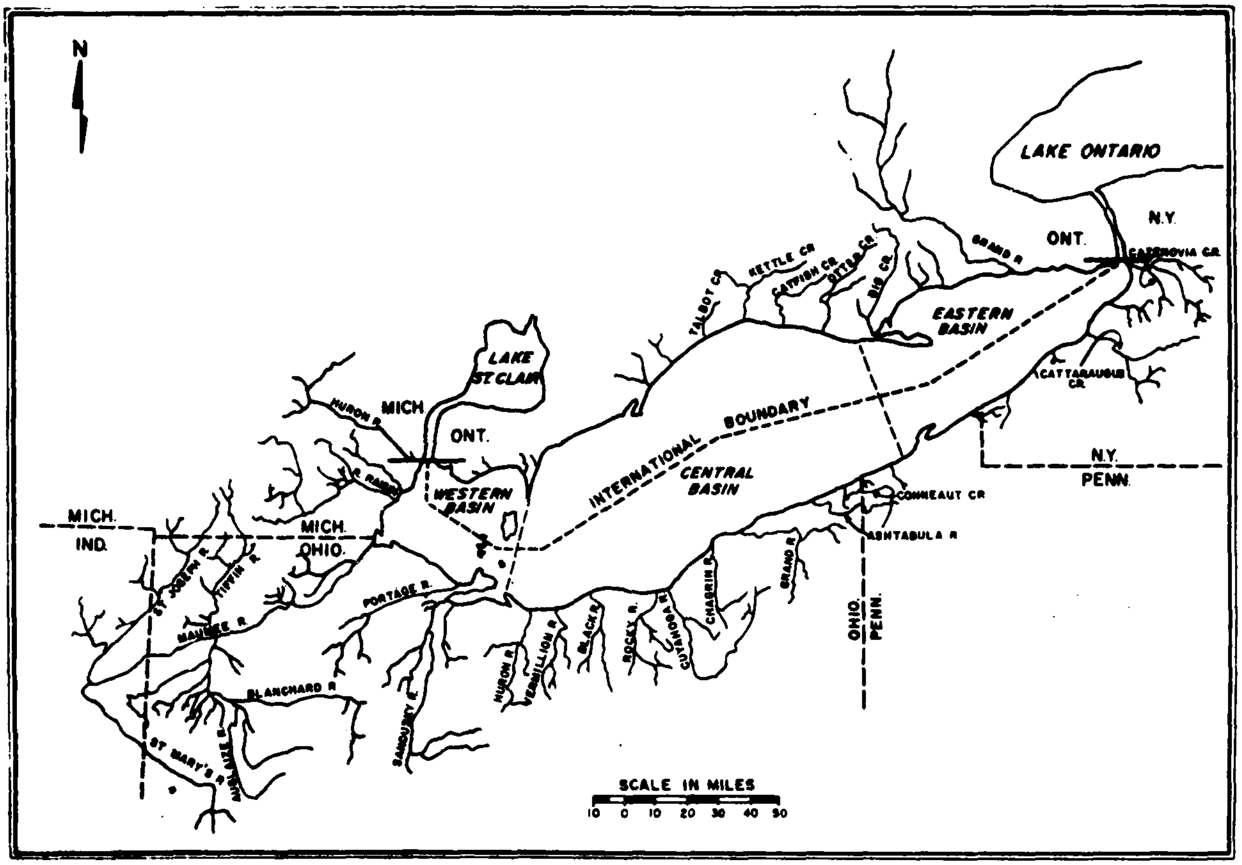


Fig. 2.2. Lake Erie and Its Tributaries. Source: Van Meter and Trautman 1970, p. 66.

2.2 GEOMORPHOLOGY

This section presents a description of the physical factors that created the lake and the landforms of the study area. Processes, such as glaciation, are described as they relate to the characterization of the lake bottom and lakeshore during the time periods when prehistoric and historic inhabitants would have utilized this area. Processes identified for the study area are also reviewed as they relate to burying and exposing cultural resource sites.

2.2.1 Preglacial Geology

Although most of the important influences on the topography and soil formation resulted from Pleistocene events, prior geologic history did play a role. Consequently, a discussion of the preglacial geology is presented here.

Most of the Lake Erie Basin is underlain by glacial till and/or lacustrine sediments from the classic lake stages of the late Quaternary. Under these layers, however, are Paleozoic sediments. In the eastern part of the Basin one finds Niagaran Dolomite, composed of Silurian dolomitic limestones and shales (Fig. 2.3). These resistant dolomites form the Niagara Escarpment,

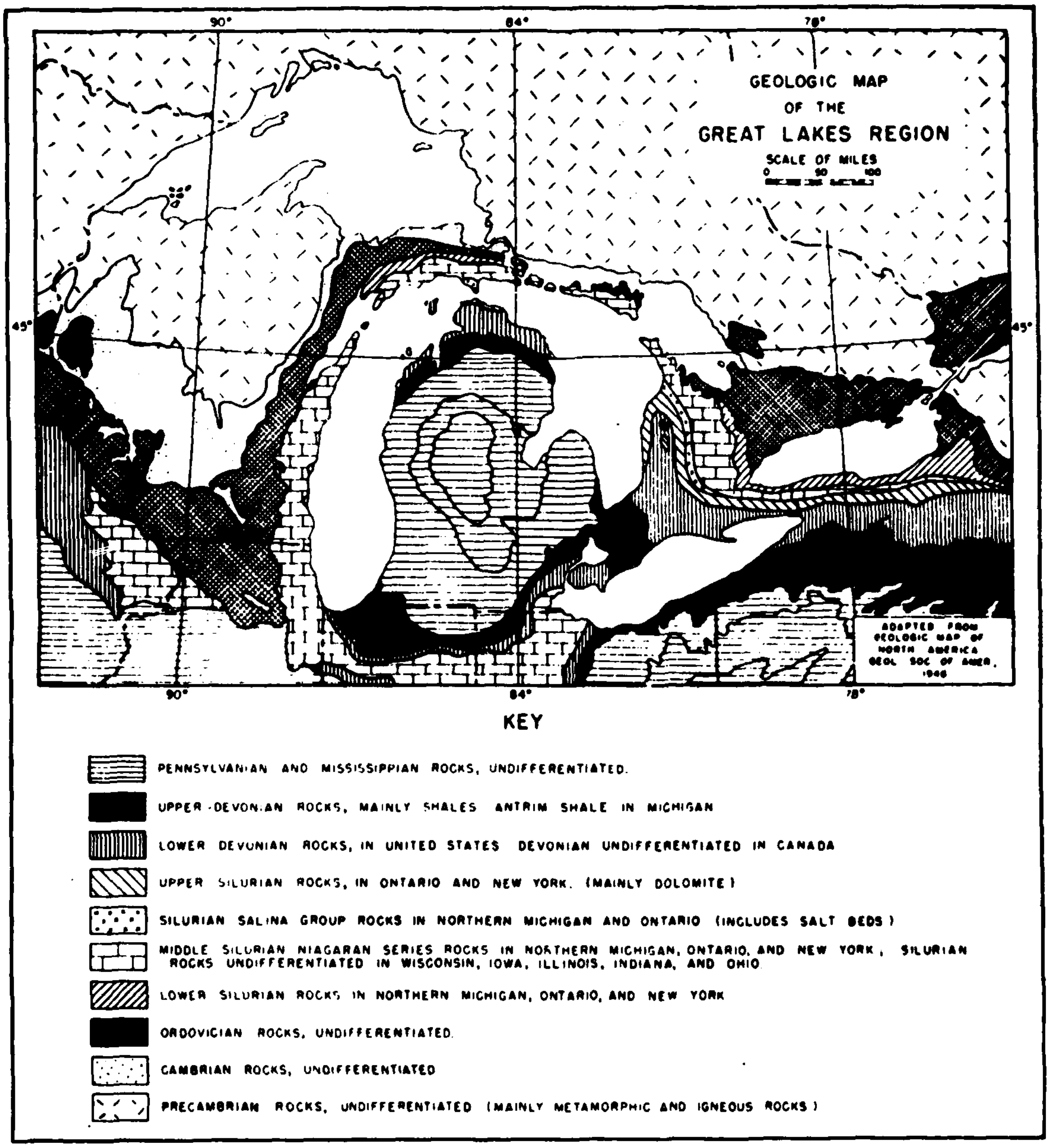


Fig. 2.3. Geologic Map of the Great Lakes Region. Source: Hough, Jack L., Geology of the Great Lakes, University of Illinois Press, Urbana, 1958, p. 14. Copyright 1958 by the Board of Trustees of the University of Illinois.

which, to a large extent, controls the outlet for modern Lake Erie. Upper and Lower Devonian formations underlie much of the northern part of the Basin; in the southern part, Lower Devonian limestones give way to Upper Devonian shales (Fig. 2.4). These shales are particularly soft and have a strong dip; this accounts for the depth of the Eastern Basin of the lake (Herdendorf 1972). In the Central Basin, these shales are wider but have a lesser dip; this explains the shallower and broader topography (Herdendorf 1972:338). The northeast-southwest direction of Lake Erie is controlled by the Appalachian Geosyncline's orientation on the shales. To the south and east of the shales are the sandstones and shales of Pennsylvanian and Mississippian age; their resistance to weathering led to the formation of the escarpment of the Appalachian Plateau. Western Basin topography is largely controlled by the presence of the Findlay Arch (Fig. 2.5). The occurrence of resistant dolomitic rocks in this region resulted in the islands of the Western Basin. The Sister and Bass islands derive from Lower Bass Island Dolomite, while Pelee and Kelleys islands were formed from Columbus Limestone (Figs. 2.5 and 2.6).

If the Paleozoic is characterized as an era of deposition, the succeeding eras were ones of erosion (with the exception of the Pleistocene). The earliest record of these erosion and uplift cycles can be found in late Tertiary materials; tracing these cycles into the Great Lakes Basin is problematic due to subsequent glacial action (Hough 1958:86). Despite this, the effects of those cycles on the landscape is important to the topographic history of the Basin. During the advance of an ice sheet, the gross topography of the surface would have directed the movement along existing drainage patterns. Several authors have attempted to reconstruct the preglacial drainage for the Great Lakes. One reconstruction for the Western Basin was done by Hobson, Herdendorf, and Lewis (1969) (Fig. 2.7). Any attempted reconstruction of the Early Lake Erie land surface, which is presently under water, should include the preglacial drainage pattern since it would have very roughly resembled the preglacial pattern.

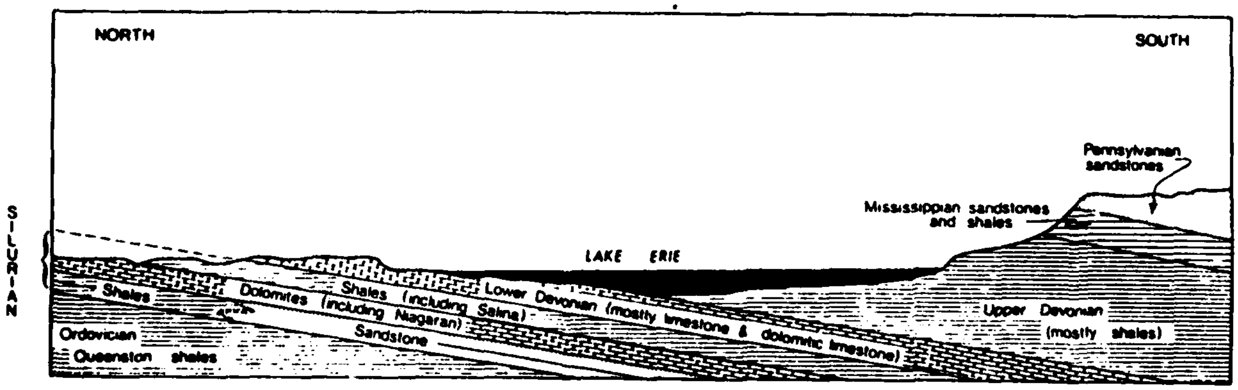


Fig. 2.4. Cross-Section of Bedrock Stratigraphy for the Lake Erie Basin. Source: Sly 1976, p. 357. Reproduced by permission of the Minister of Supply and Services Canada.

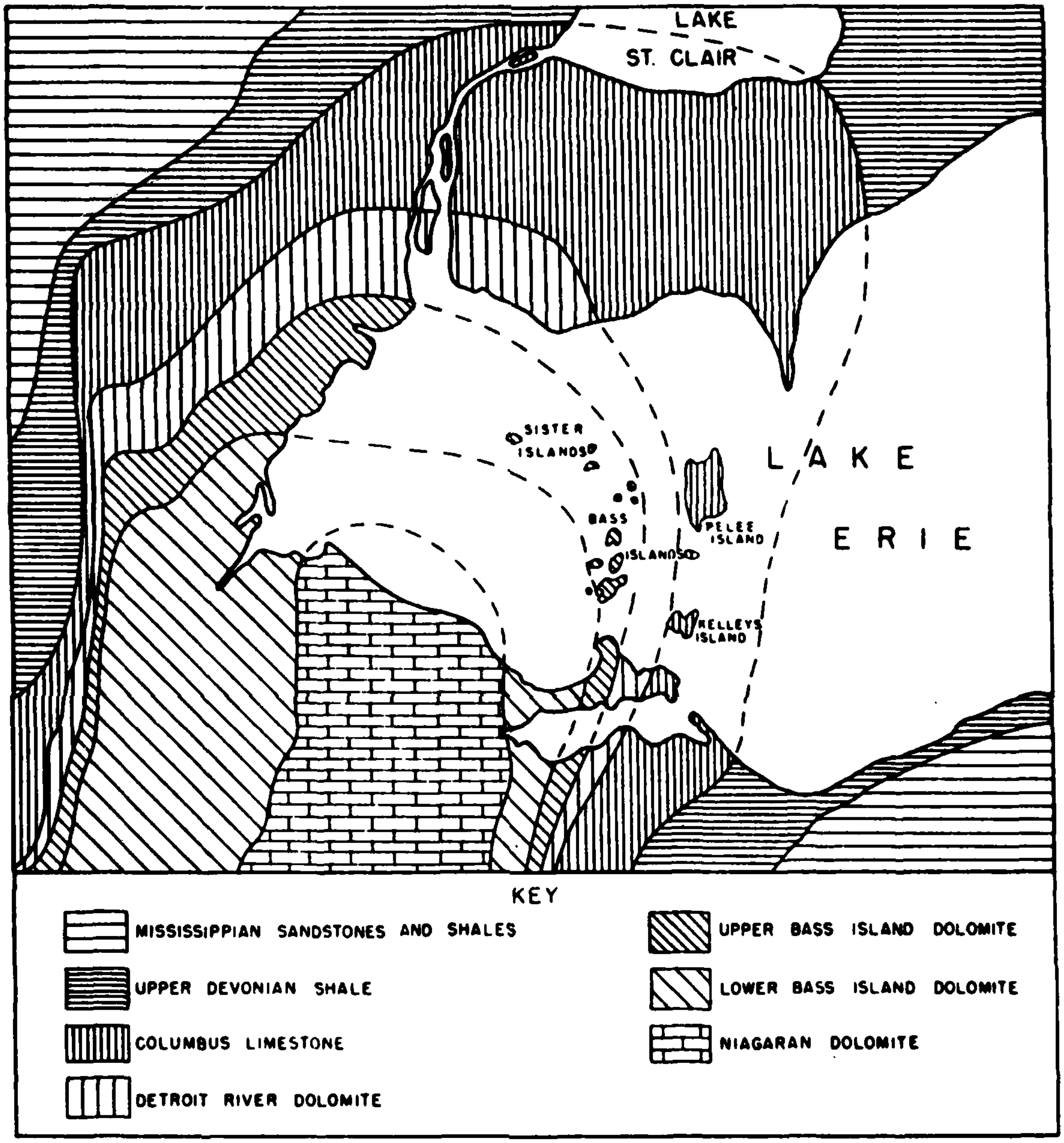


Fig. 2.5. Geologic Map of the Western End of Lake Erie with a Portion of the Findlay Arch. Source: Hough, Jack L., Geology of the Great Lakes, University of Illinois Press, Urbana, p. 28. Copyright 1958 by the Board of Trustees of the University of Illinois.

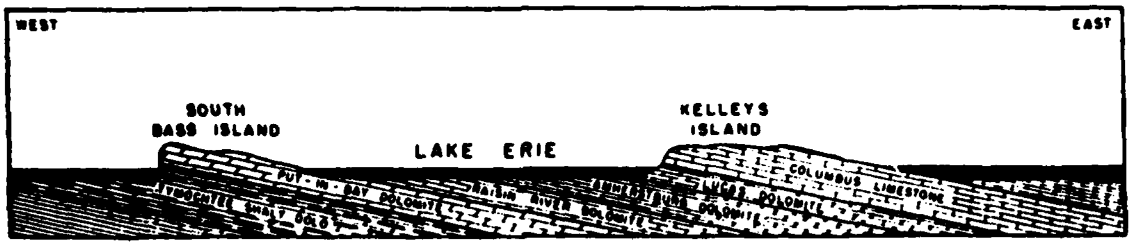


Fig. 2.6. Geologic Cross-Section of South Bass and Kelleys Islands in Western Lake Erie. Source: Hough 1958, p. 28.

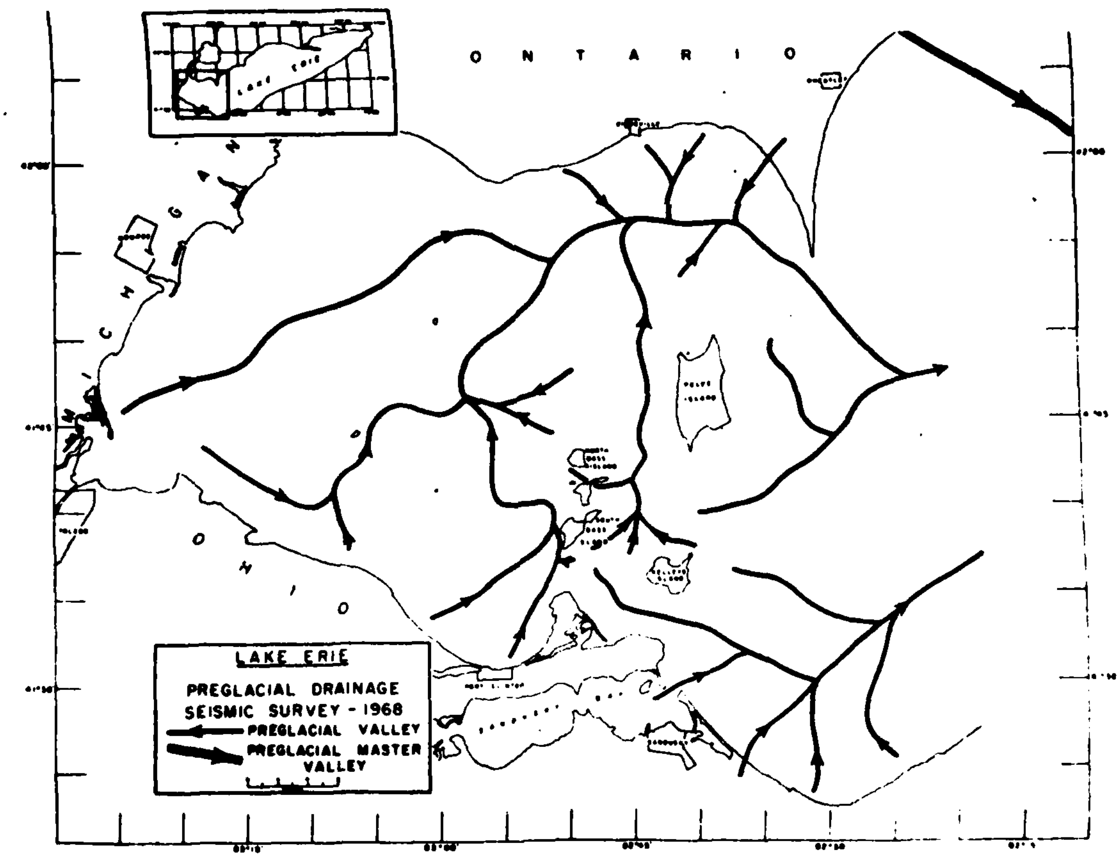


Fig. 2.7. Reconstructed Preglacial Drainage Pattern for the Western Basin. Source: Hobson, Herdendorf, and Lewis 1969, p. 219.

2.2.2 Glacial Geology

Although there have been four glacial stages in North America--Nebraskan, Kansan, Illinoian, and Wisconsin--only the effects of the Wisconsin are visible in the Lake Erie Basin. Pre-Wisconsin stages undoubtedly worked the land surface, deposited till, created moraines, and fostered lake-laid sediments, but the record has been largely obliterated in the Basin by the last ice advance. The Wisconsin glaciation was the most recent and best preserved of the stages. Beginning around 70,000 B.P.*, the Wisconsin has been divided into as many as seven substages: Farmdale, Shelbyville-Iowan, Bloomington, Cary, Port Huron, Valders, and Cochrane (Hough 1958:94). The modifying power of glacial scouring on the landscape was so strong that, within the survey area, all deposits prior to the Cary substage have been reworked or altered out of their original contexts. Consequently, there is virtually no expectation that archeological remains, had there been any prior to Cary, are preserved *in situ*.

The Cary substage dates from about 16,000-13,500 B.P. (Dorr and Eschman 1970:161) or 14,000-18,000 B.P. (Lewis 1966). At its maximum extent, it covered the area from northern Indiana through central Ohio and into southwestern New York (Hough 1958) (Fig. 2.8). The first ice-free areas in the region were established after 14,000 B.P., when the Erie ice lobe of the Cary substage retreated north and east from the Fort Wayne Moraine (Sly 1976:359). The glacial meltwaters formed Lake Maumee I (highest Lake Maumee) in northwestern Ohio at an elevation of about 800 ft. (Hough 1963). What has become known as the classic lake stages followed in the next 1000 to 1500 years, culminating in Early Lake Erie, at 12,500 B.P. The lake stages and elevations are listed in Table 2.2. Hough's (1958) lake reconstructions of these stages are presented in Appendix C, Figures 1-16.

Lake Maumee I, formed by the retreating Erie lobe, discharged to the west, over the Fort Wayne Moraine, to the Wabash River. The ice lobe stopped in the middle of the Lake Erie Basin, forming the Long Point-Erie Moraine (Norfolk) and probably the Erieau and Pelee moraines, too (Fig. 2.9). With the continued retreat of the Huron lobe, the lake gained a new discharge to the Michigan Basin via the Imlay ice margin channel to Lake Saginaw. This Lake Maumee II formed beaches as far east as Pennsylvania. Lake Maumee III was formed when an advance in the Huron lobe cut off the Imlay channel, restoring discharge to the Wabash River. There was also a small advance in the Erie lobe, probably halted at the Pelee Moraine.

---

*Archeological time is customarily expressed in one of two ways: 1) as calendrical time related to the Christian era (A.D. or B.C.) or 2) as years before the present (B.P.). After the advent of radiocarbon dating, the *present* was defined as A.D. 1950; all B.P. dates are calculated from that base date. Most of the dates used in this report are based on radiocarbon dates, which can deviate by as much as several hundred years from true solar time. Such errors/deviations are inherent in archeological time. For this reason, the dates given must be regarded as approximations of true solar time; they should not be treated as absolutes.

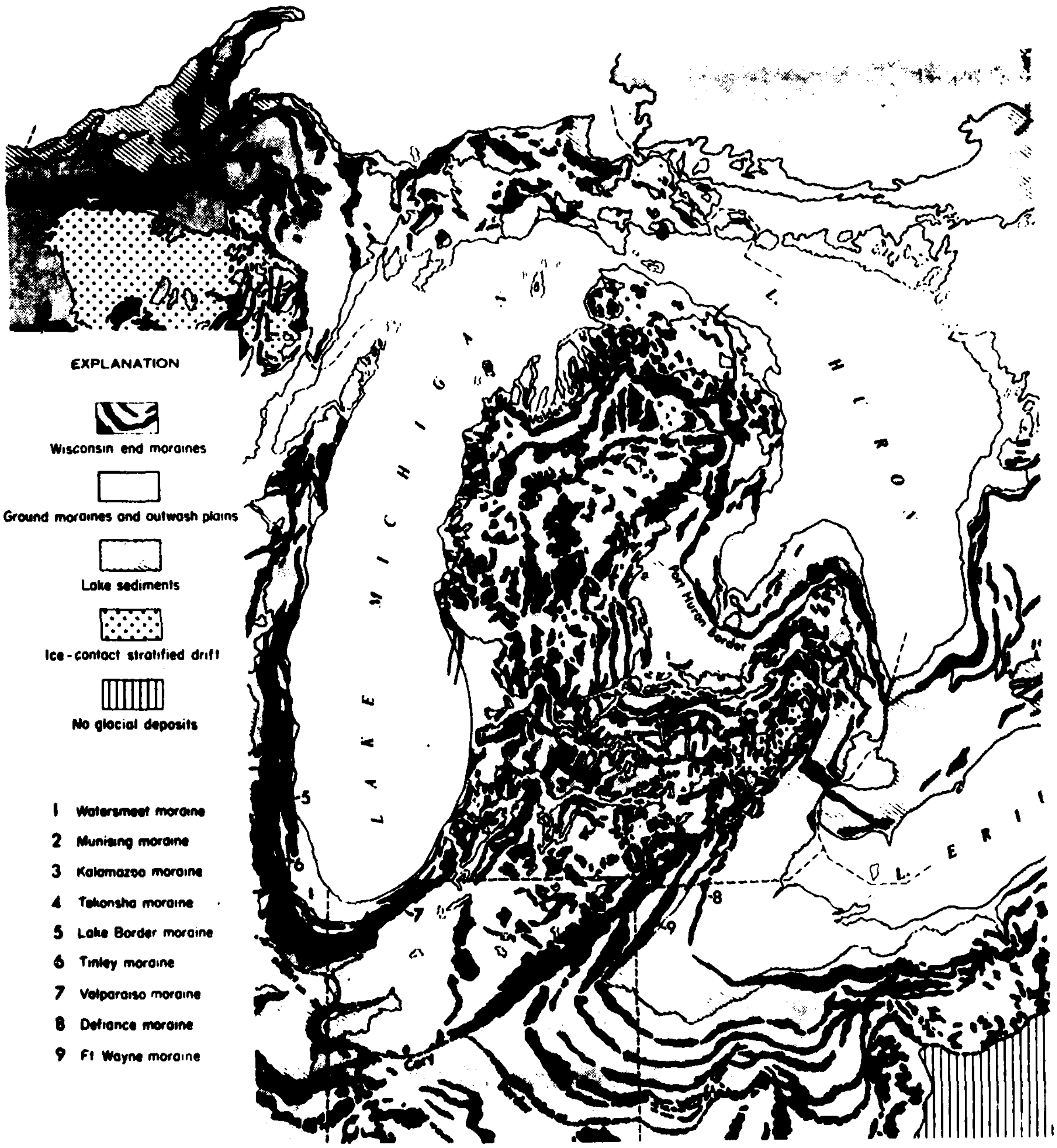


Fig. 2.8. Glacial Map of Michigan Showing the Cary Substage. Source: Dorr and Eschman 1970, p. 160. Modified from Glacial Map of the U.S. East of the Rocky Mountains, Geological Society of America, 1959.

Table 2.2. Classic Lake Stages in the Erie Basin[a]

Name	Elevation[b] (ft)
Maumee I	800
Maumee II	760
Maumee III	790
Arkona I	710
Arkona II	700
Arkona III	695
Ypsilanti[c]	543[c]
Whittlesey	738
Warren I	690
Warren II	680
Wayne	658
Warren III	675
Grassmere	640
Lundy	620
Early Algonquin	605
Early Lake Erie	470±

[a]Following Lewis 1966.

[b]Elevation is original altitude above sea level.

[c]A suggested low-level lake stage.

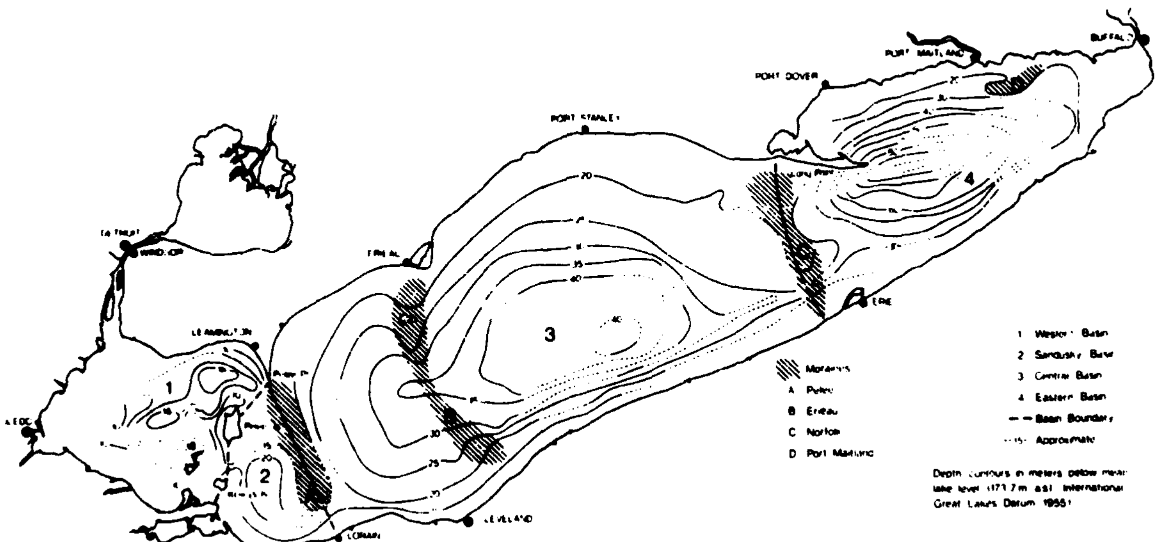


Fig. 2.9. Inferred Bathymetry of Lake Erie. Contours were drawn on top of glacial deposits relative to the present lake level. Source: Sly 1976, p. 360. Reproduced by permission of the Minister of Supply and Services Canada.

With the retreat of both the Huron and Erie lobes, most of the Erie area was inundated, forming Lake Arkona I; drainage was again into the Michigan Basin by way of the Grand River. Lakes Arkona II and III differed only in that the outlet was gradually cut down by the Grand River. Lake Arkona III is dated at 13,600 B.P. (Lewis 1966:57).

Several authors have suggested that a low-level lake stage, Lake Ypsilanti, followed Lake Arkona III (Hough 1958; Lewis 1966; Kunkle 1963; Dorr and Eschman 1970). Much of the evidence for Lake Ypsilanti comes from the location of shallow-water deposits well below the lowest Arkona level (695 ft.) just south of Cleveland (Hough 1958:147); this lake would have been made possible by the further retreat of the ice front. Around 13,000 B.P., a strong readvance by the Huron and Erie lobes led to the formation of Lake Whittlesey. The Erie lobe established the Lake Escarpment moraines in New York and the Ashtabula moraines in Pennsylvania and Ohio. The Long Point-Erie Moraine was also, in large part, built at this time. Lake Whittlesey discharged into Lake Saginaw. Three radiocarbon dates from Whittlesey deposits bracket it between 12,660 and 12,920 B.P. (Lewis 1966:Table 3).

For the remaining 200 to 500 years before early Lake Erie, a sequence of lakes are documented (see Appendix C). Although each lake was the result of retreating ice, the margin remained at or near the Ontario Basin, blocking drainage to the east. Around 12,500 B.P., the Erie lobe retreated to the point where the Mohawk Valley Outlet was exposed (Sly 1976:359). The last level of Early Lake Algonquin was 605 ft.; the elevation of the Niagara Escarpment was approximately 130 ft. lower (Fairchild 1932). Once this outlet was opened, Early Lake Algonquin literally drained into the newly formed Lake Iroquois. In approximately two weeks, lake levels went from 605 to 470 ft. (Forsyth 1973).

The beginning of Early Lake Erie was contemporaneous with the formation of Lake Iroquois. Until recently, it was thought that the classic lake sequence took place from before 14,000 B.P. to 9,000 B.P., implying a longer and more gradual sequence of events (Hough 1958:282). Two dates for Lake Iroquois, 12,080 and 12,660 B.P. (Karrow et al. 1961), and a date of 12,650 ± 170 B.P. for swamp forest material in the Pelee Basin (Lewis 1969) cast doubt on that view. It is now thought that the entire sequence took at most 1500 years (Forsyth 1973).

2.2.3 Hydrology of Early Lake Erie

Once the Niagara Outlet had opened, the level of Lake Erie was controlled by the elevation of that outlet and not by the presence of glacial ice. The weight of the ice had, however, depressed the elevation of the outlet some 115 to 150 ft. below the present height (Lewis 1966, 1969; Sly 1976). Following deglaciation from the area, isostatic rebound raised the elevation of the outlet to approximately 55 ft. below the present level by 11,000 B.P. (Lewis 1969).

Events north of the Lake Erie Basin continued to affect the flow of water into the lake. In about 12,500 B.P., Lake Erie received outflow from Early Lake Algonquin (Hough 1958:293). During the Two Creeks Interstadial, dated at 11,800 B.P. (Broecker and Farrand 1963), retreating ice allowed the Trent Valley Route to open for the direct discharge of Huron Basin waters (the

Kirkfield Stage of Lake Algonquin) into Lake Iroquois, bypassing Lake Erie entirely (Lewis 1966:59). With the advance of Valders ice in 11,400 B.P., Main Lake Algonquin was formed in the Huron Basin. Again, the discharge from that lake was diverted into Lake Erie via the St. Clair and Detroit rivers. Final retreat of the ice, past North Bay, Ontario, permitted discharge of the Huron Basin to the sea via the Mattawa-Ottawa Valley. This situation remained stable until isostatic rebound in the Huron Basin returned discharge to Lake Erie via the St. Clair and Detroit rivers during the Nipissing Great Lake Stage. Since then, some 6000 to 4000 years ago, the drainage has remained the same.

Within the Lake Erie Basin, Lake Erie waters have taken several distinct forms due to variations in topography, isostatic rebound, and discharge into the lake. At the time of the Great Flood (12,500 B.P.) the Western and Central basins were drained, with only a small lake left in the Eastern Basin and possibly small lakes in the other two basins (Forsyth 1973). The exact configuration of the "lake" at this time is uncertain, due to the presence of the Long Point-Erie Moraine which separated the Central and Eastern basins. Thus, the elevation of any distinct lake in the Central Basin was controlled by that moraine, rather than by the Niagara Outlet. There is a breach in the moraine ten miles northwest of Erie, Pennsylvania, which could have been the outlet into the Eastern Basin (Wall 1968).

Complicating this picture are the effects of rebound. Apparently all of the glacial rebound after 12,500 B.P. occurred east of the Lake Grassmere hinge line, which lies east of the Port Huron Moraine (Long Point-Erie Moraine) (Lewis 1966). Thus, only the Eastern Basin would have been affected by the rebound. Although the exact elevation of the first lake in Lake Erie at this time is not known, an archeologically conservative estimate of 420 ft. ASL will be used; this is 150 ft. below current lake level (Forsyth 1973). Using this elevation, along with the correction for isostatic rebound to the east of the hinge line, a reconstructed map of Early Lake Erie can be drawn (Fig. 2.10). This map resembles the one presented in Lewis (1966). The elevation of the eastern outlet of Early Lake Erie was controlled by the Niagara Outlet; the Central Basin outlet is conservatively presumed to have been no higher than the Niagara Outlet. This is in accord with seismic information for that area (Wall 1968).

At that time, the Central Basin was much shallower than the Eastern Basin. This, along with a constant water level and heavy inputs of sediments from the Portage and Maumee rivers, led to a clogging of the basin with sediment (Wall 1968). This eutrophication led to marsh-like conditions in the Central Basin, a point that becomes important in discussing the food productivity of the region for prehistoric inhabitants as well as for local fauna. The argument for a shallow central basin lake is strengthened by trace-element oxygen and carbon data from carbonate shells. In a site 14 mi. southeast of Erieau, Ontario, at a depth of 80 ft., higher O^{18} content in shells showed either climatic improvement, higher evaporation rates from a rather shallow lake, or both (Fritz, Anderson, and Lewis 1975).

The shallow-water period in the Central Basin ended either when the elevation of the Niagara Outlet reached the elevation of the top of the Long Point-Erie Moraine, inundating the basin from the east, or when the return of drainage waters from the Huron Basin during the Kirkfield stage led to an

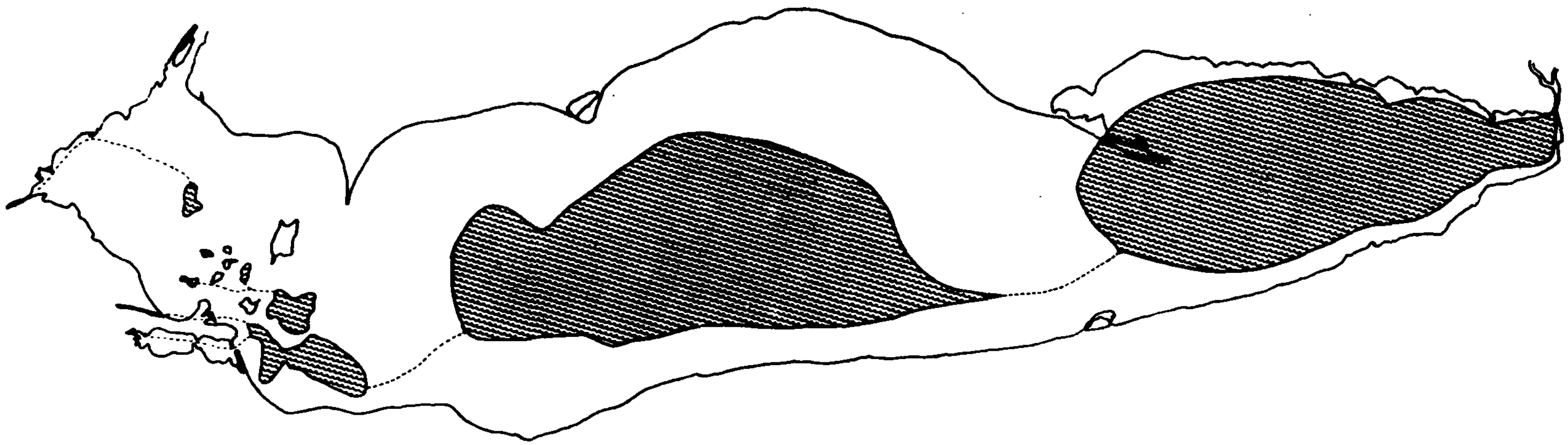


Fig. 2.10. A Reconstructed Map of Early Lake Erie, ca. 12,500 B.P.
Source: Lewis 1966.

increased water level (Wall 1968). Fairly stable conditions prevailed for the next 6000 years, as the only rises were from rebound of the Niagara Outlet (Fig. 2.11 and Table 2.3). Even in 8800 B.P., the Central Basin was much lower than it is today. Fluvial scouring of the Cuyahoga River at that time suggests that the river was graded to lower water levels (Barry Miller, personal communication).

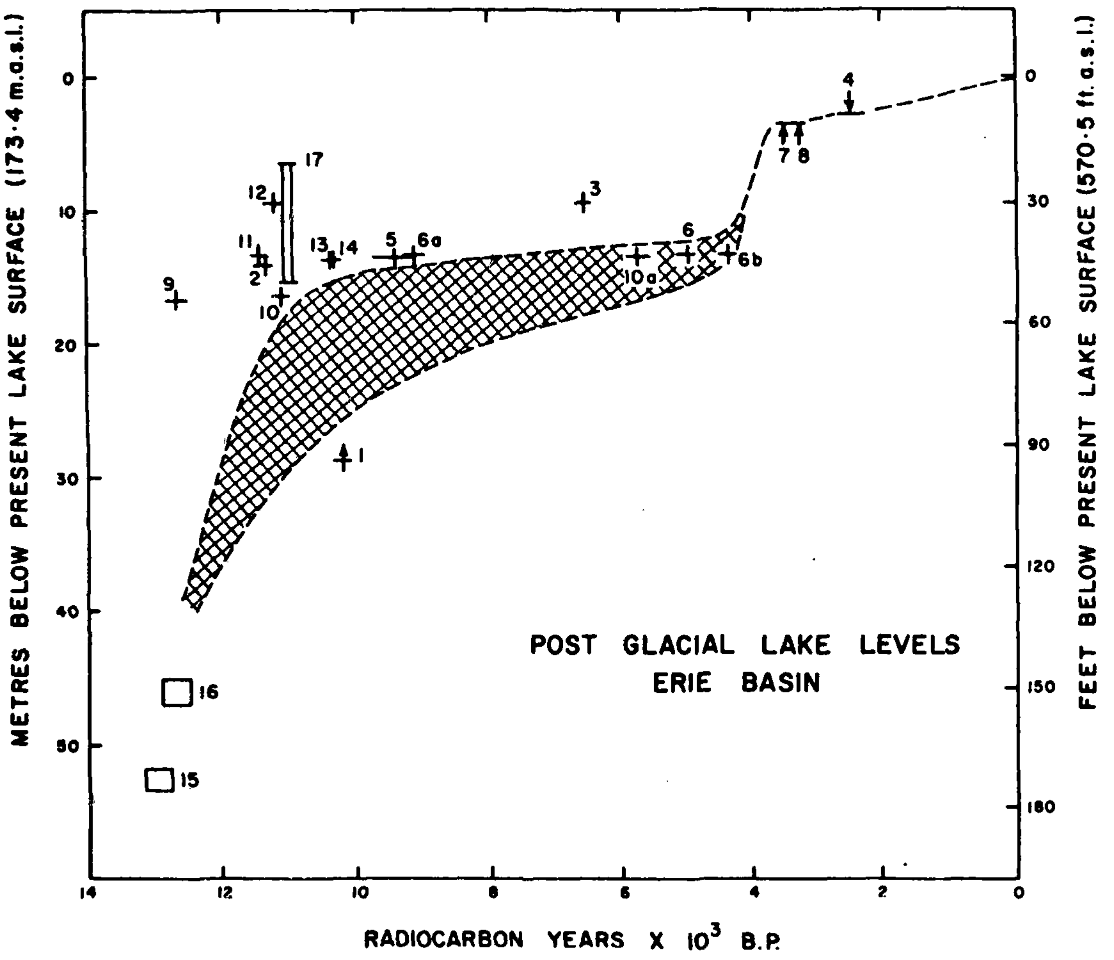


Fig. 2.11. Postglacial History of Lake Erie Water Levels. Points are keyed numerically to entries in Table 2.3. Source: Lewis 1969, p. 267.

Table 2.3. Radiocarbon Dates for Lake Erie[a]

Entry No.	Date (B.P.)	Lab No.	Site	Depth below present lake level (ft.)	Remarks
1	10,200 ± 180	GSC 330	2226	93.5	Driftwood in Central Basin mud
2	11,300 ± 160	GSC 382	1240	45.9	Base of plant detritus western Lake Erie
3	6,500 ± 134	OWU 110	Portage River mouth	30.2	Oak driftwood at base of plant detritus
4	2,500 ± 270	OWU 275	Terwilliger Pond, South Bass Island	9.8	Subaerial peat
5	9,400 ± 315	OWU 350	W33	43.0	Plant detritus from borings
6	5,097 ± 175	OWU 35	W34	42.7	Plant detritus from borings
6a	9,115 ± 210	OWU 319	W32	42.7	Plant detritus from borings 1 mi. south of W33
6b	4,335 ± 135	OWU 318	W31	42.7	Plant detritus from borings 2 mi. south of W33
7	3,520 ± 100	I 3992	Redhead Pond, Point Pelee	11.5	Gyttja
8	3,310 ± 100	I 3993	Big Pond, Point Pelee	11.5	Gyttja
9	12,650 ± 170	I 4040	68-6	54.8	Basal plant detritus
10	11,140 ± 160	I 4041	68-6	53.5	Top of plant detritus
10a	5,750 ± 180	GSC 1165	68-6		Organic silt
11	11,430 ± 150	I 4035	68-16	44.6	Basal plant detritus (replicate of Site 1240)
12	11,200 ± 180	GSC 1136	68-20	25.9	Basal plant detritus
13	10,370 ± 150	I 4034	67-10	45.9	Basal organic detritus
14	10,340 ± 150	I 4033	67-10	45.3	Top plant detritus

[a]Source: Lewis 1969:268.

The Western Basin, when drained, was transformed into a swamp forest, with several small lakes in topographic depressions. Encroaching water from the Central Basin did not exert a strong influence in the Western Basin until after 5000 B.P. Plant detritus at a depth of 43 ft. below the present lake level has been dated at both 5097 ± 175 and 4335 ± 133 B.P. (Lewis 1969). Between that time and 3500 B.P., the lake rose to 11.5 ft. below its present level. This rise was presumably due to the change in drainage of the Huron Basin. From that time, the lake level rose slowly to its present level. Material in Terwilliger's Pond in the Western Basin dated at 2500 B.P. puts the lake level at about 10 ft. below the present level (Ogden and Hay 1968). Historically, Lake Erie has been known to fluctuate as much as 5 ft. in depth (Langlois 1954). These short-term changes correlate with precipitation; the lowest levels in recent history occurred during the great drought of the early nineteen thirties.

2.2.4 Transformations of the Natural Landscape

In order to understand how the archeological record may have been obscured from view or destroyed, it is important to look at the natural processes on the landscape that would have been most likely to alter our recognition of such sites. The two primary types of processes were glacial and lacustrine. Not only did these have an impact on archeological site location, but they also effected changes in soil conditions and microtopography, which, in turn, affected the vegetational cover.

2.2.4.1 Process

Glacial action can be broadly divided into erosional and depositional. Glacial erosion is accomplished by either plucking or abrasion (Dorr and Eschman 1970:147). Plucking occurs when water under an advancing glacier seeps into the cracks of the bedrock and, upon freezing, forces the bedrock loose; abrasion occurs when rock material on the bottom of a glacier scours the topographic surface as the glacier advances. The Great Lakes were, to a large extent, excavated by glacial scouring over pre-existing drainage systems (Hough 1958:113).

Glacial deposition occurs in two basic forms: unsorted and sorted sediments. Unsorted sediments, or till, are left when melting glaciers deposit the material they pick up in transit directly upon the landscape; most common of these are morainal deposits (Fig. 2.12). Terminal moraines, which mark the furthest advance of glacial ice, leave larger amounts of material in one place than do ground moraines, which are produced by steadily retreating ice. The amount of material deposited at any one place is largely determined by the amount of time the edge of the glacier spends there.

Unlike glacial till, which is made up of unsorted sediments of from clay to boulder size, glacial outwash consists of well-sorted sediments (largely coarse sizes, usually sands and gravels). Examples of outwash deposits include outwash plains, kames, kame terraces, and eskers. Outwash deposits are formed by the transport of glacial sediments by glacial meltwater to another location. Sorting is accomplished by water action. Occasionally, blocks of ice become separated from the main glacial body, and outwash deposits surround this ice. When the ice melts, it leaves a depression, known as a kettle hole. In the Lake Erie Basin, these low areas often became swamps or marshes.

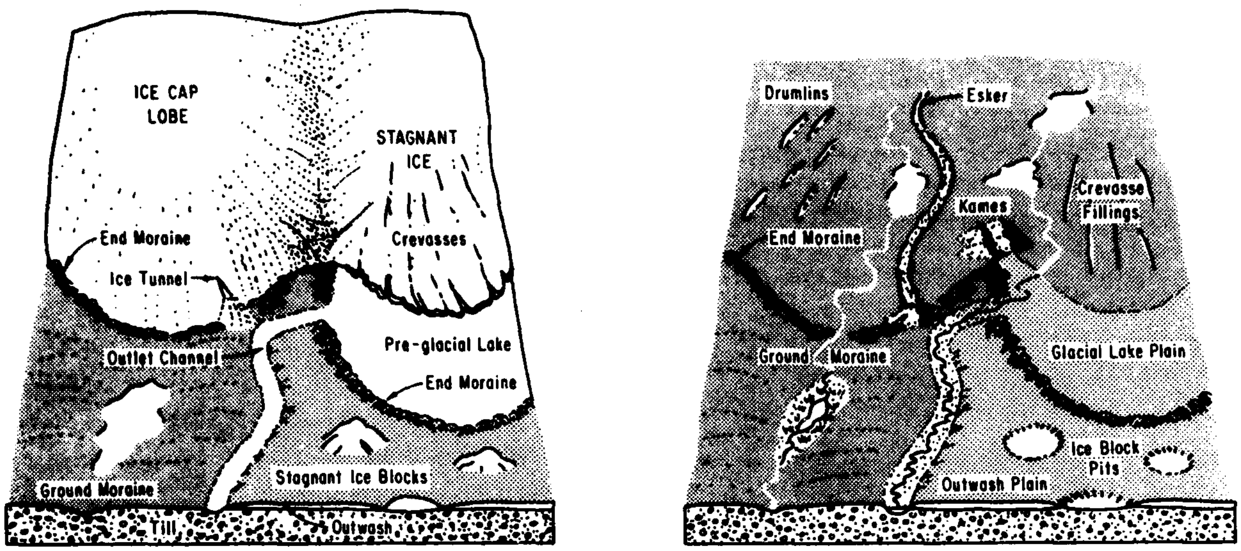


Fig. 2.12. Diagrams of Glacial Deposits. These generalized diagrams show the "before" and "after" relationships between glacial ice and deposits and landforms found in glacial drift. Source: Modified drawing based on Dorr and Eschman 1970, p. 147.

Lacustrine deposits also dominate the Lake Erie Basin topography, due mainly to the classic lake stages. Bottom deposits, those occurring on the bottom of lakes, can derive from shore, inland, or other bottom sediments (Hartley 1961b). The texture of these sediments ranges from fine clays to coarse gravels, but their size is limited by the energy that the waves or currents in the lake and in contributing streams have to transport them. Waves have enough energy to stir fine sand at a depth equal to one half the wavelength (Dorr and Eschman 1970:205). Although useful energy exists below that depth, it is much more limited in strength (Hough 1958:34). Thus, wave energy is usually confined to nearshore effects (Hartley 1961b). In Lake Erie, the shallowest of the Great Lakes, the wave effects are m... greater than in the other Great Lakes, especially in the Western Basin. econd major determinant of sediment location is bottom topography. Sediment thicknesses tend to correlate well with lake bathymetry (Herdendorf 1972:339; Thomas, Jacqueth, and Kemp 1976:339).

Near the shore, wave action tends to transport material according to both the height of the wave and the degree of slope of the offshore area. Wave energy is translatable into wave height, and waves deform and lose energy when the depth of water is from one to two times the wave height. Therefore, a gentler offshore slope breaks the waves further offshore and has less effect on the shore (Carter 1976). Accretion of sand deposits can occur when the lake level is lower than normal. Fluctuating lake levels can lead to the development of dune sands (Dorr and Eschman 1970:227). Erosion of the shore line occurs through wave action or mass wasting (Carter 1976). During periods of storms, shore erosion can occur much more dramatically and quickly (Hough 1958:32).

2.2.4.2 Archeological Considerations

Given the facts that 1) the bottom topography of present-day Lake Erie has undergone considerable modification by glacial and lacustrine forces and 2) that much of the lakebed was exposed and habitable for long periods in prehistory, it is important to try to assess how these physical forces influenced archeological materials. Three specific questions must be addressed: 1) Under what conditions could archeological materials have been preserved in situ on the lake bottom? 2) Where might these in situ materials be located in the lake? 3) How accessible are these materials to the archeologist for research purposes, or, with a different emphasis, how accessible are they to destruction by drilling and related operations?

Looking at the map of Early Lake Erie (see Fig. 2.10) one can see that much of the surface now under water was exposed at 12,500 B.P. It must thus be assumed that all of the land surface now inundated by the lake may have been utilized in prehistoric times. A hypothetical scenario would show the following: an archeological site could have been formed if artifacts deposited near an older lakeshore were inundated by water and sediment at some later date. Sedimentation would have effectively sealed the site, and, if the site was not disturbed, would have provided an archeological context as valid as those found on land. The kind of sediment would be important in diagnosing the possibility that such a scenario could have occurred at a particular spot. If no lake sediment were found over exposed bedrock, glacial till, or glaciolacustrine clay, the implication would be either that there has been an equilibrium between transport and depositional forces over time or that transportational forces have been stronger, such as in a high-energy wave action (Thomas, Jacquet, and Kemp 1976). Since the possibility of the former is small, it may be presumed that the archeological record has been removed from context and has been secondarily deposited.

Sediments reflecting high-energy wave action, such as those showing high positive skewness and high positive kurtosis, would also indicate disturbed contexts spatially mapped as high-energy zones (Fig. 2.13). Since sufficient information on earlier historic and prehistoric wave patterns was not available, no maps could be produced. The presence of a high-energy zone (Zone A) also implies extensive mixing of sediments by suspension and reworking. Low-energy zones, as defined by low positive kurtosis and negative skewness, would provide the least possibility of mixing and reworking of sediments. These areas would be stable and would reflect the best chances for in situ preservation of materials. One problem with the argument just developed is that it does not take into full account the effect of rising lake levels. High-energy zones are caused by wave action; thus, in shallow areas, waves of a certain height have far greater impact on the bottom surface than they would in deeper water. In general, the energy of a wave is released when the depth of water is 4/3 times the height of the wave (Eichenlaub 1979). Because the level of Lake Erie kept rising over a long period of time, most areas were exposed to high-energy wave action at some time, even if only briefly. Possible exceptions could include topographic situations in which wave action would not be found, such as in protected coves. Also, areas already capped by

Fig. 2.13. Distribution of High-Energy Wave Zones in Lake Erie. Source: Thomas, Jacquet, and Kemp 1976, p. 398. Reproduced by permission of the Minister of Supply and Services Canada.

eroded land sediments would be less exposed to high-energy zones for much longer periods than others. The area between the 12,500 and 10,000 B.P. shorelines (Fig. 2.14) and between the 5,000 and 3,500 B.P. shorelines would have been less affected since the lake edge moved relatively rapidly through these areas. Conversely, the greatest damage from wave action probably occurred between the 10,000 to 5,000 B.P. and the post-3,500 B.P. shorelines areas, due to the relative stability of these shorelines.

The determination of the topography of the Early Lake Erie land surface has been made by several researchers; to make their determinations, they relied primarily on echosounding and corings data (Hartley 1961a and b; Lewis 1966; Wall 1958; Hobson, Herdendorf, and Lewis 1969; Thomas, Jacquet, and Kemp 1976). Although bathymetric maps have been used in analyses, modern bathymetric maps of the lake bottom are not adequate for reconstructing the Early Lake Erie topography since the modern lakebed contains, in places, very deep and recent clays (Graves 1977). Lewis (1966) used the technique of echo-soundings to differentiate various unconsolidated sediment materials as well as consolidated sediments such as bedrock below the current lake bottom. In addition, depths of these various horizons were recorded for up to 20 m below the water-mud interface. The topography of glacial till deposits were mapped along with the thicknesses of recent deposits, and an areal map of surficial sediments was developed (Lewis 1966) (Figs. 2.15-2.17).

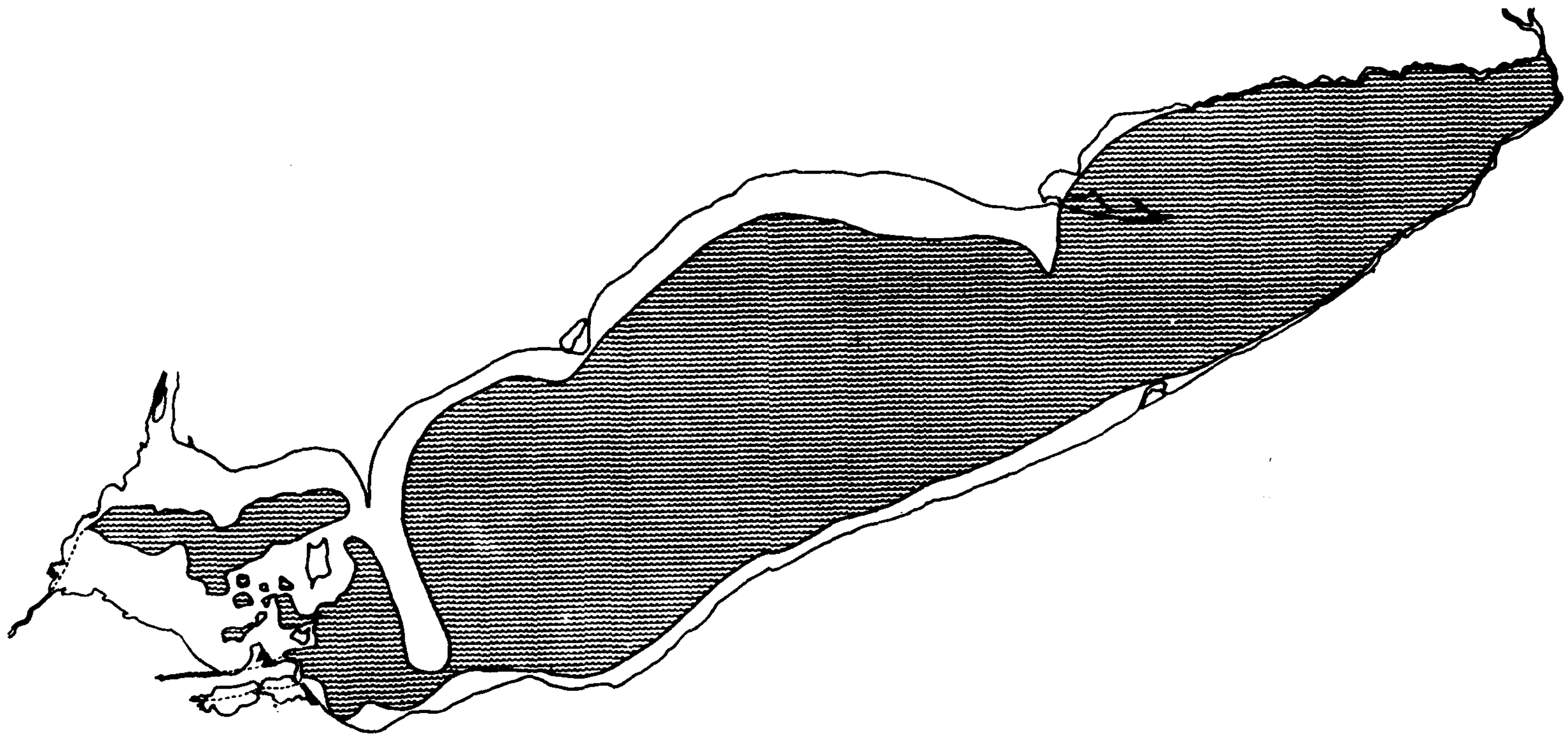


Fig. 2.14. Lake Erie Shoreline, ca. 10,000 B.P.
Source: Lewis 1969.

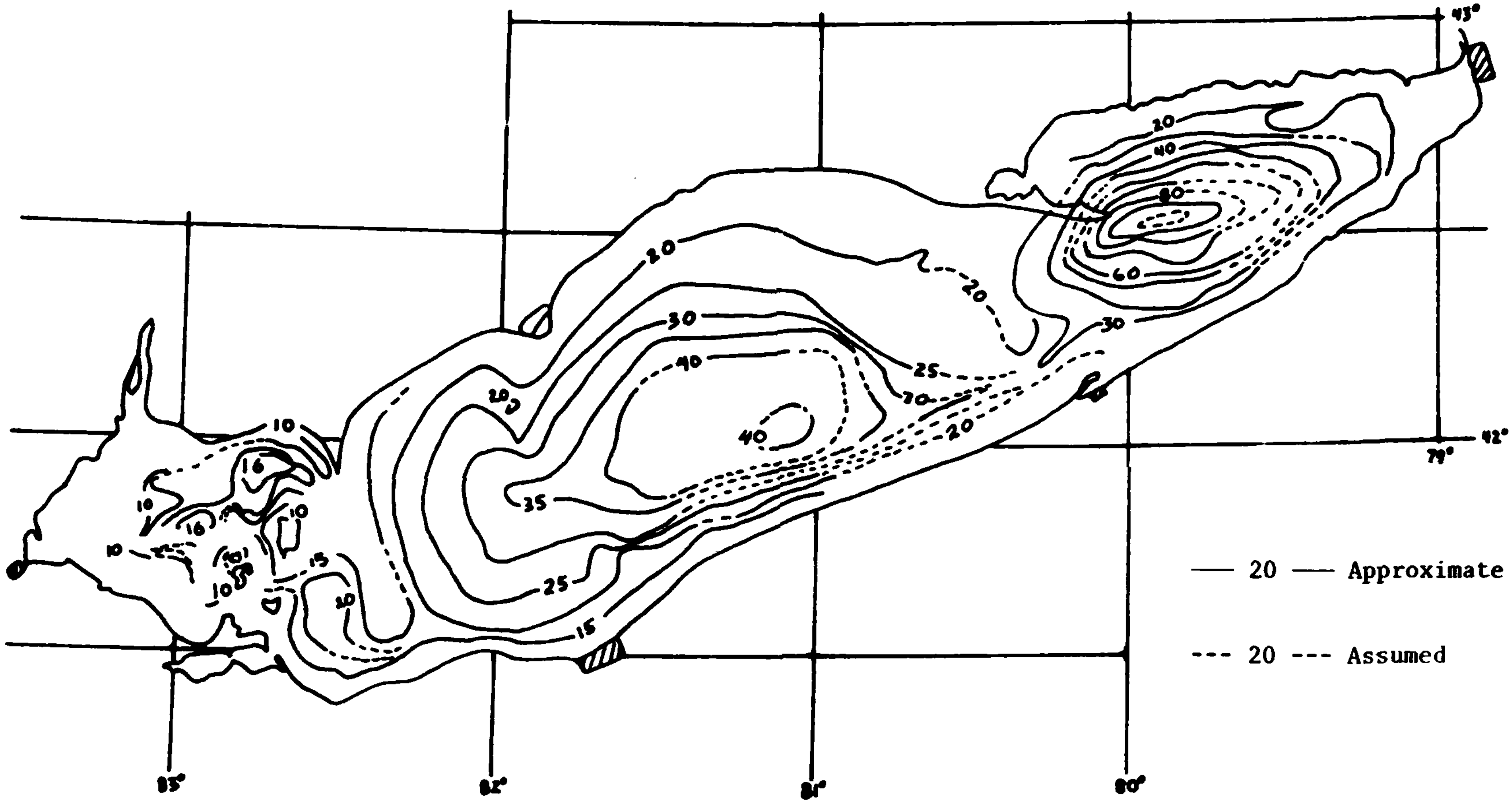


Fig. 2.15. Topography of Pleistocene Deposits. Depth contours are given in meters below the mean lake level of 173.7 m/ A.S.L. Source: Lewis 1966.

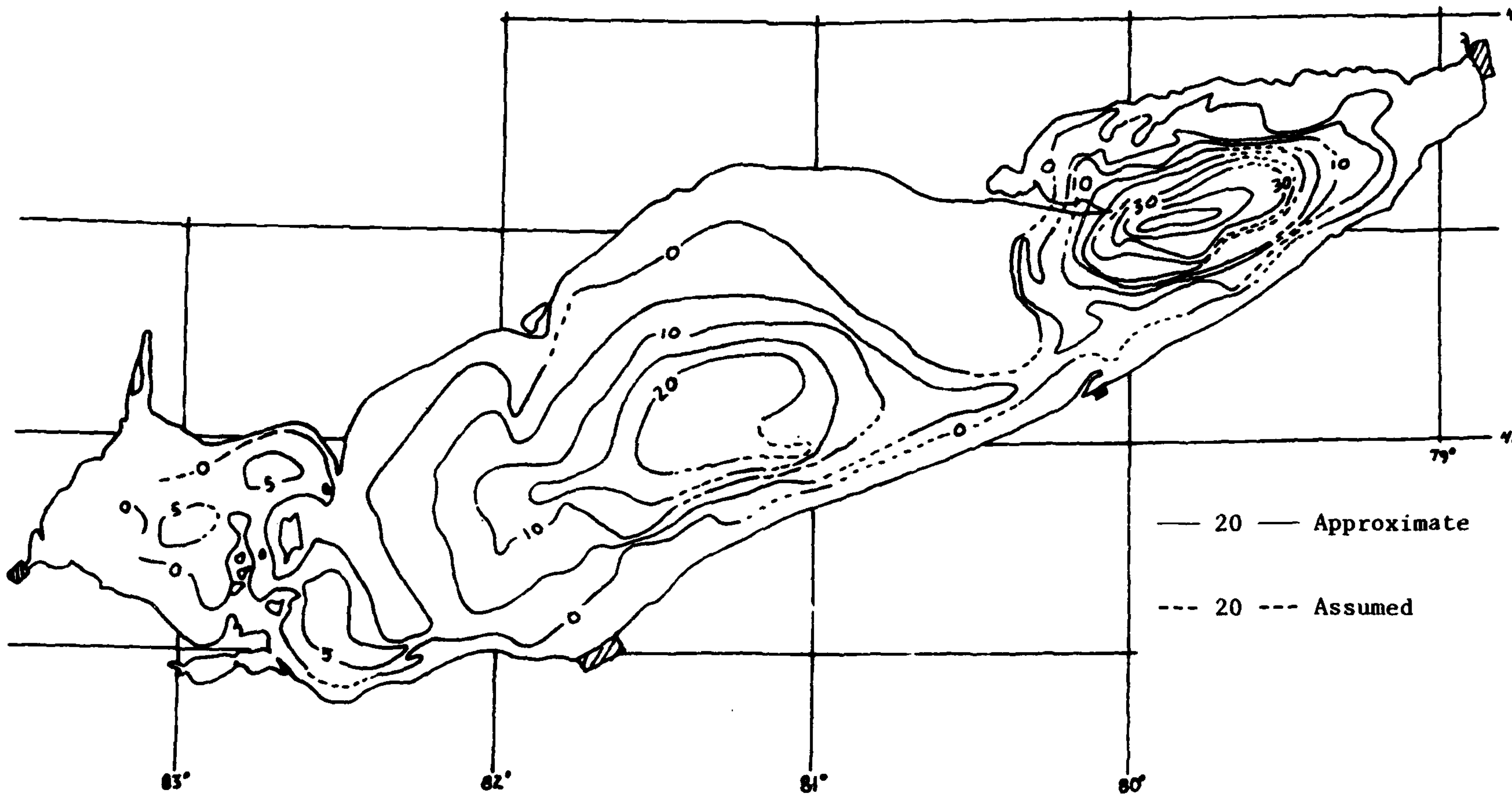


Fig. 2.16. Isopach Map of Lake Erie Recent Mud. Depth contours are given in meters. Source: Lewis 1966.

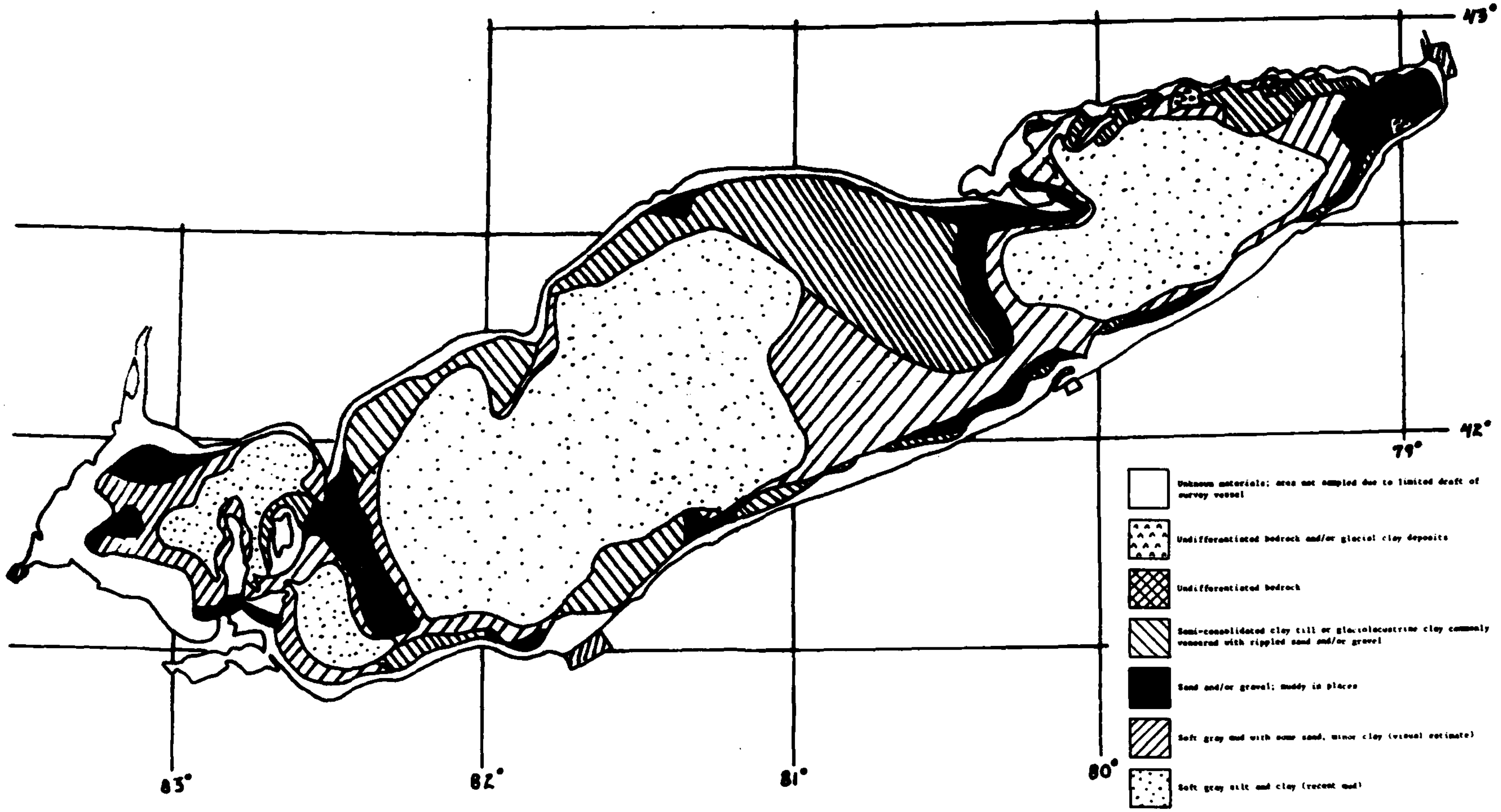


Fig. 2.17. Lake Erie Bottom Material Distribution.
Source: Lewis 1966.

In a sub-bottom reflection survey of the Central Basin, Wall (1968:101) noted four distinct reflector horizons which he designated a, b, c, and d. These were interpreted as being the surfaces of shallow-water deposits; compact, glaciolacustrine clays; glacial till; and bedrock. These horizons were not necessarily continuous over the area. The interpretation for prehistoric occupation would be that horizon b would be the post-12,500 B.P. land surface where it was not covered by water by the early lake. Where horizon b is not found, the horizon c glacial till would have been the surface. If neither b nor c were found, horizon d bedrock would have been exposed (Figs. 2.18-2.20). A seismic survey of the Western Basin of Lake Erie was also conducted, resulting in a map of the elevations of the top of glacial till (Hobson, Herdendorf, and Lewis 1969:215) (Fig. 2.21). Sediment sampling and acoustic profiling of the entire lake was carried out, resulting in the distinction of three major units within the lake: till and bedrock; glaciolacustrine clay; and postglacial muds (Thomas, Jacquet, and Kemp 1976). The spatial distribution of each of these units on the lake bottom was mapped (Fig. 2.22).

Using a combination of a map of the postulated lake level at 12,500 B.P., Lewis's (1966) isopatchyte map showing sediment thicknesses for recent sediment, and the distribution of surficial sediments in Thomas, Jacquet, and Kemp's (1976) map, it should be possible to derive the areas of highest archeological sensitivity within the current Lake Erie shoreline border. For the period from 12,500 to 10,000 B.P., the area with the highest sensitivity should possess three attributes: 1) have been above water in 12,500 B.P.; 2) be covered by less than 5 m of recent sediment; and 3) have either postglacial mud, or possibly soft gray mud and sand, over glacial clay as the surficial material (see Fig. 2.17). These sensitive zones, which are the ones most likely to contain preserved materials, are most accessible to the bottom surface. The intersection of these three zones, as well as those for later lake levels, will be discussed in Chapter 6.

Sedimentation rates for postglacial deposition have been measured using various techniques for the three basins. In the Islands area of the Western Basin, Hartley (1961b) calculated an average rate of 10.2 cm/century based on an age of 4000 years for inundation of the Western Basin. Lewis (1966:36) estimated an average rate of 6 cm/century for the Central Basin. Between 12,500 and 5,700 B.P., sedimentation rates were very low in the Central Basin (Kemp, MacInnes, and Harper 1977). Modern rates, since 1850, appear to have been much greater, ranging from 35 to 166 cm/century in the Western Basin to 125 cm/century in the Central Basin and to 240 cm/century in the Eastern Basin (Kemp et al. 1974). Since 1935, rates have jumped to three times the previous levels. Based on estimates of the rates of erosion from the shoreline, an average uniform thickness of 2.5 cm/century was estimated to have been deposited, although this estimate assumed that all areas receive the same amount of sediment (Herdendorf 1972).

Aside from development, shoreline erosion constitutes the greatest threat to existing archeological resources on land. Because of the threat of shoreline erosion to homes and businesses, much quantitative work has been done. As early as the 1840s, it was recognized that the shoreline around Cleveland was rapidly receding (Williams 1949:16). It was estimated that 218 ft. from the city front were lost between 1796 and 1842. Studies of maps and aerial photographs (1876-1973) show major changes in the shoreline of Lake County, Ohio (Carter 1976). Early in the period, the rate of recession ranged from 1 to

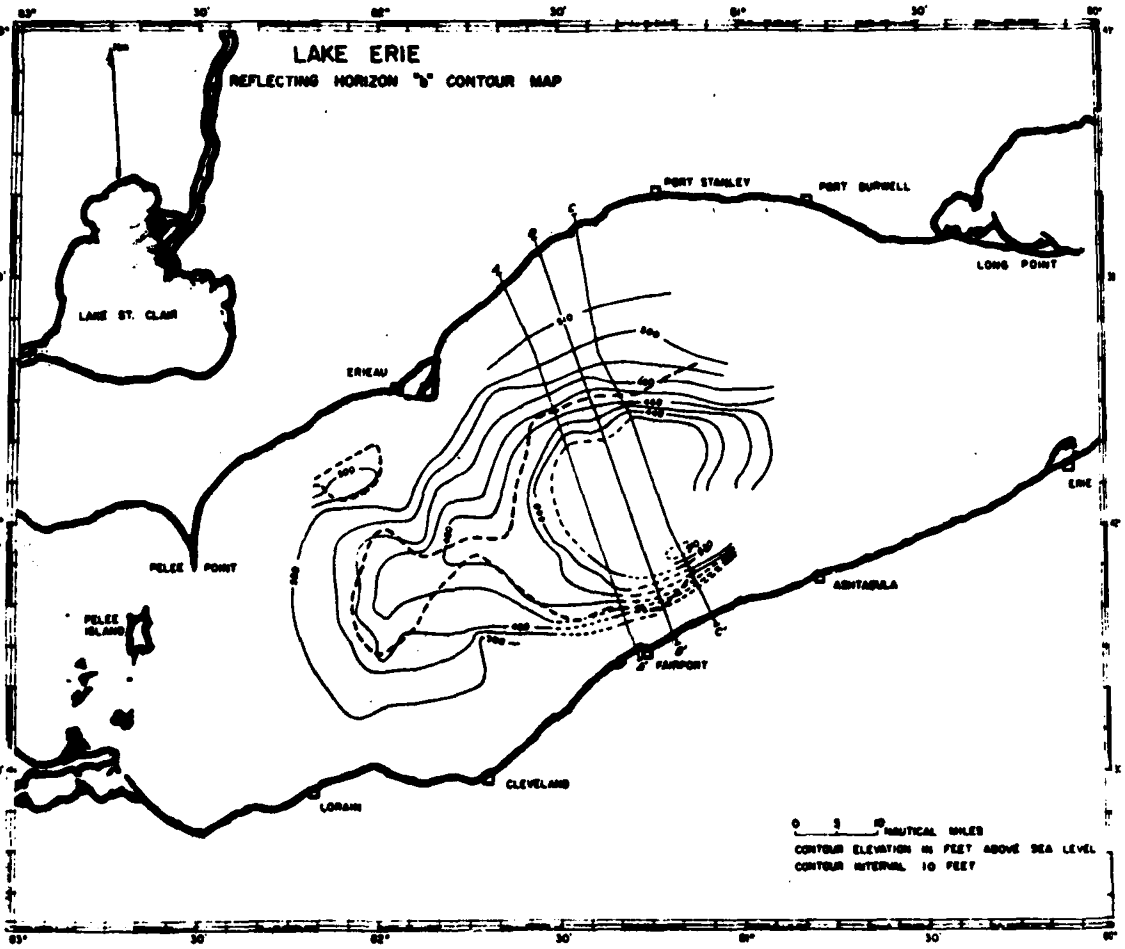


Fig. 2.18. Elevation Contours on Reflecting Horizon b. Area of occurrence of horizon a is outlined by heavy dashed line. Source: Wall 1968, p. 96.

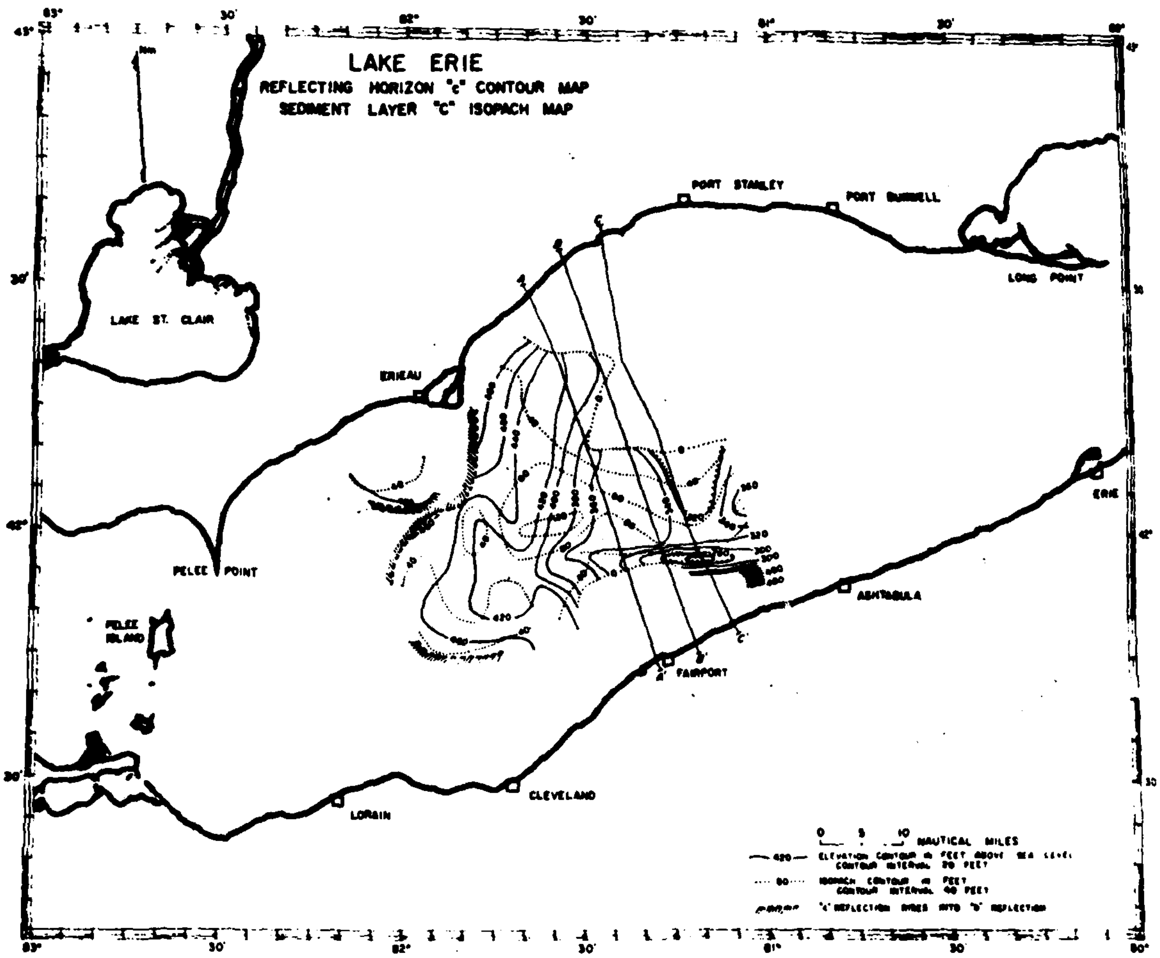


Fig. 2.19. Elevation Contours on Reflecting Horizon c.
Source: Wall 1968, p. 98.

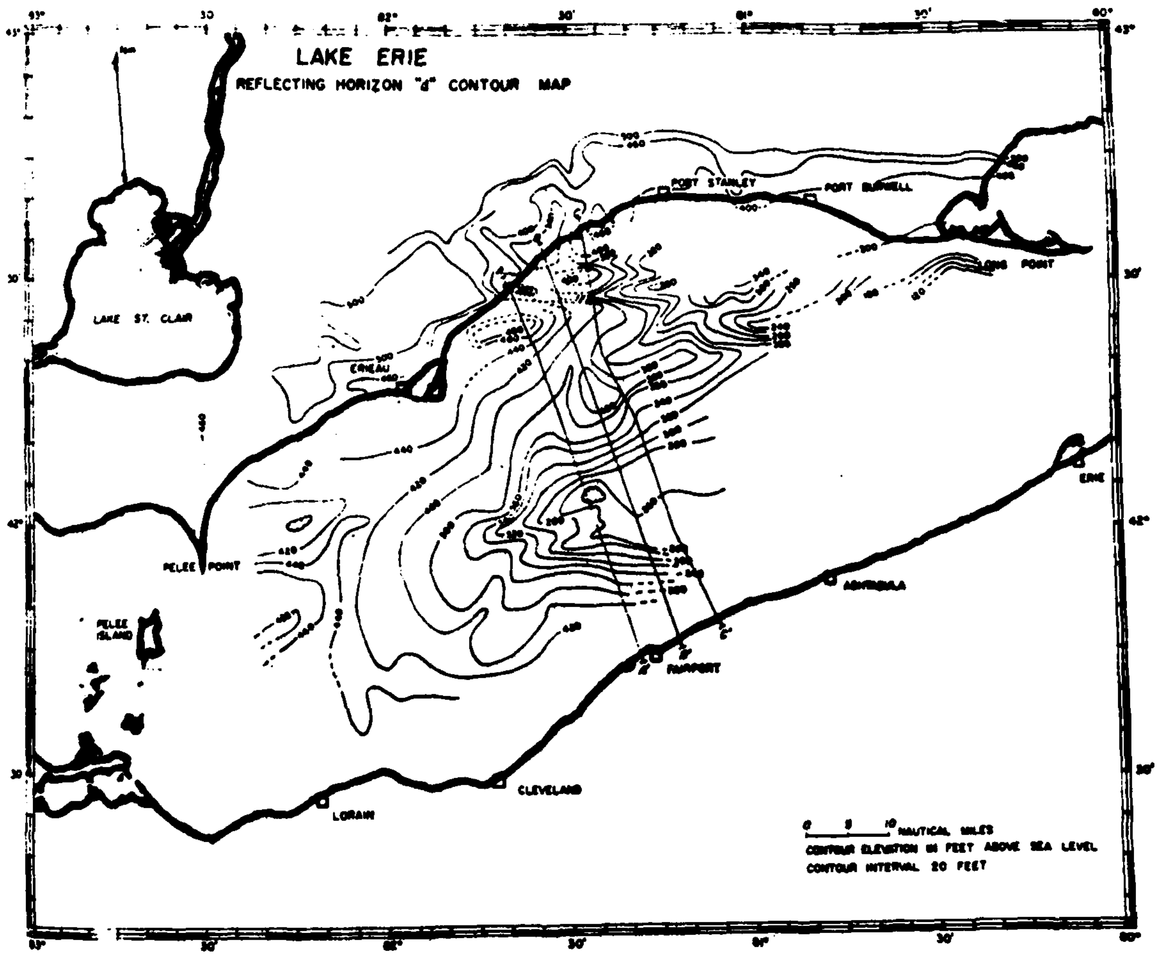


Fig. 2.20. Elevation Contours on Reflecting Horizon d.
Source: Wall 1968, p. 97.

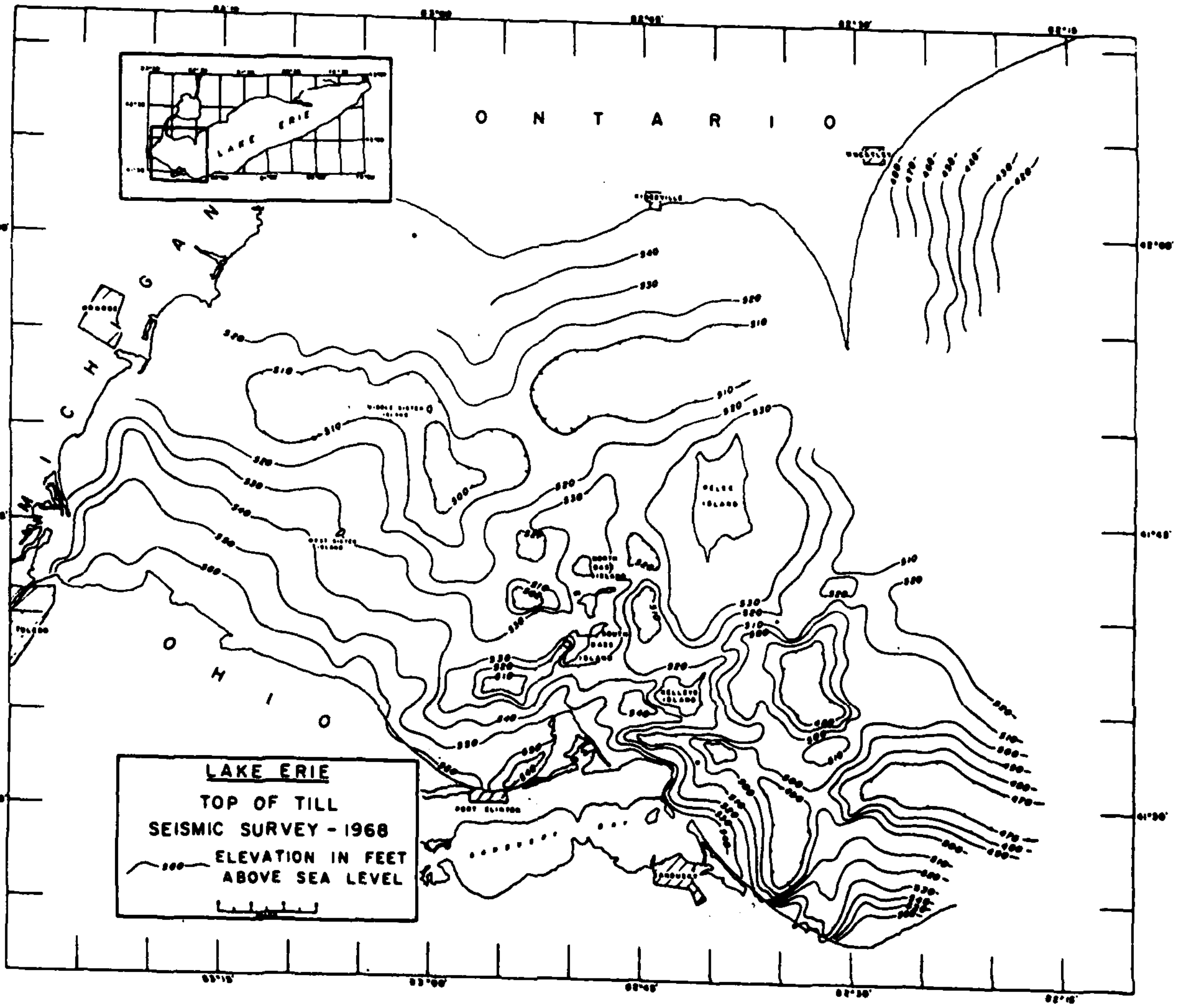


Fig. 2.21. Elevation of Top of Till Underlying Western Lake Erie. Source: Hobson, Herdendorf, and Lewis 1969, p. 215.

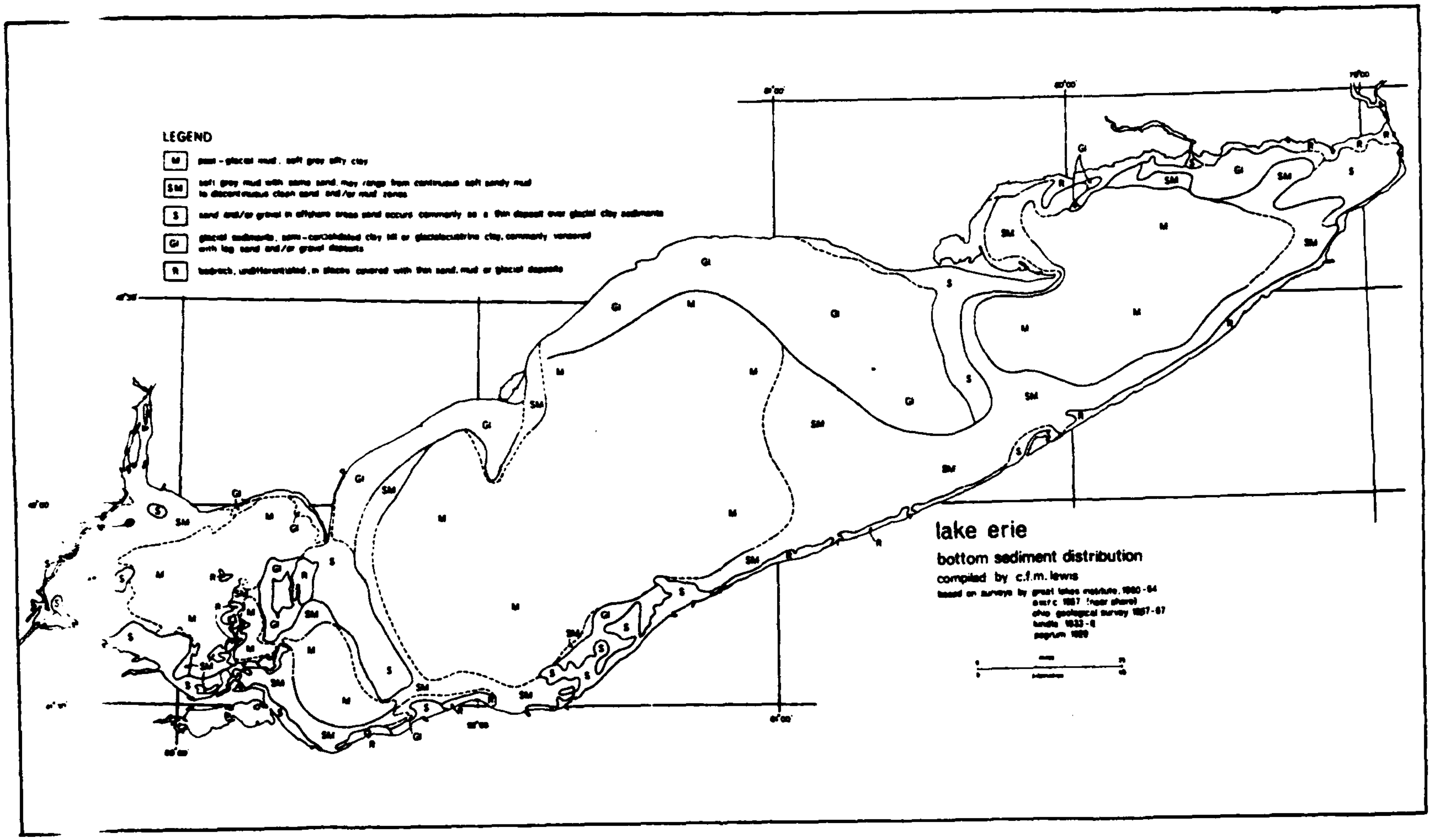


Fig. 2.22. Distribution of Surficial Sediments in Lake Erie. Source: Thomas et al. 1976, p. 388. Reproduced by permission of the Minister of Supply and Services Canada.

3 ft. per year, dropping to less than 1 ft. per year after 1937. Offsetting this drop was an increase in variability in the rates, going from very slow (<1 ft./yr.) to rapid (5 to 7 ft./yr.) early in the period to very slow to very rapid (7 to 9 ft./yr.) later in the period. It is estimated that approximately 2 million tons of sediment are eroded out of the shoreline in the survey area each year (Carter 1977). This translates loosely into a recession rate of very slow (less than 1 ft./yr.) to slow (1 to 3 ft./yr.), although some areas, notably Lake County, Upper Sandusky Bay, and Maumee Bay, have rates of up to 13 to 15 ft. per year. If these rates are constant with time, there would be nothing unusual about a shoreside village dating from AD 1000 now being 1500 to 2000 ft. into the lake from the current shoreline. The preservation of these sites would depend on micro-environmental conditions. It is possible that some sites have been preserved under circumstances where perishable remains may still exist.

2.2.5 Summary and Conclusion

The survey area, both within the current lake and along the shoreline, has been greatly modified in topography since the end of the last glacial advance. Preglacial geology has provided some of the important features of the landscape, such as the resistant sandstones that form the Appalachian Plateau and the Findlay Arch, which controls the Western Basin topography. The most important effects of the preglacial geology are related to how geologic surfaces reacted to glacial scouring. The deep parts in the Eastern and Central basins were largely the result of the presence of soft shales, which were scoured by glacial advance.

Of the Pleistocene's four glacial stages, only the Wisconsin was important to the survey area. Glacial advances during the late Wisconsin formed the morainal ridges that divide the lake basins. The final Cary substage advance eradicated any small landforms, and its retreat at 14,000 B.P. left a new series of moraines, eskers, and outwash plains. Retreat of the glacier north of the deep trenches scoured in the soft shale left the first of the pro-glacial lakes. The subsequent classic lake stages (over the next 1500 years) resulted in water levels ranging from 45 m below to 70 m above the present lake level. Final retreat of the glacier north of the outlet at Niagara resulted in a cataclysmic flood that literally drained the lake, resulting in a series of three interconnected smaller lakes. At this point, the lake level was 45 m below the present lake level of 174 m. Isostatic rebound at the Niagara Outlet resulted in a rapidly rising lake level, so that by 10,000 B.P., the level of Early Lake Erie was only 13 m below the present level. From 10,000 B.P. to 4,500 B.P., the lake remained relatively stable, but in 4,500 B.P. a change in the drainage of the Huron Basin into Lake Erie resulted in a rise in the lake level to 3 m below the present level. This particular change resulted in the inundation of the Western Basin, which had previously been a low marsh. From 4,500 B.P. to the present, the lake level has been rising gradually; current variations in lake level are on the order of ± 1.5 m a year.

The transformations effected on the land surface during its recent history have been through glacial or lacustrine actions. Glacial actions either removed or deposited unsorted (till) materials or well-sorted (outwash) materials. Lacustrine deposits have ranged in texture from coarse sand and gravel to fine mud. The texture of the deposited materials is controlled by the bottom topography of the lake and the degree of wave action. Lacustrine scouring has also been through wave action.

Archeologically, areas with the highest probability of preservation depend on their location with respect to old lakeshores. Sites created between 12,500 and 10,000 B.P. may have the best chance for preservation if they are located in an area that was above water during that period, covered by less than 5 m of sediment, and if that sediment is postglacial mud or soft gray mud and sand, indicating a situation of low wave energy. Sites adjacent to the fairly stable shoreline found between 10,000 and 4,500 B.P. had little chance of preservation due to the long-standing beach activity. Along the current shoreline, sites formed during the last 2000 years suffer potential destruction in that the shoreline of Lake Erie is receding at a rate of from 13 to 15 ft. per year in some places. The effect of this recession is that a village along the shore of Lake Erie in 2000 B.P. could conceivably be located 2000 ft. offshore today, or it could have been destroyed by wave action. Wave action is most severe between Sandusky and Erie, Pennsylvania.

2.3 CLIMATE

This section briefly describes the climatic characterization of the study area, and compares these specific characteristics to those in the surrounding region. The baseline is modern.

2.3.1 Modern Climate

Four major controls exert influence over the climate of the survey area: latitude; continentality; air masses and atmospheric disturbances; and the modifying effects from Lake Erie (Eichenlaub 1979). Latitude differences in the survey area are relatively unimportant.

Lake effects are those "weather and climatic features which primarily result from modifications imposed by the Great Lakes" (Eichenlaub 1979:81). Lake Erie affects temperatures on the surrounding land largely by ameliorating the differences in extrema. The land warms more rapidly than the lake and the lake cools more slowly than the land. Generally speaking, the influence of the Great Lakes raises the January average temperature by about 5 degrees Fahrenheit, the absolute minima by 10 degrees, and the annual minima by 15 degrees (Visher 1943). Along the lake shorelines, the effects are less visible. In the summer, the lakes depress the average July temperature by 3 degrees and the annual absolute maximum by 5 degrees. One of the most important results of the temperature effects is the increased length of the frost-free period.

The effects of the warmwater temperature on the lower air layers causes pronounced instability in the air (Remick 1942). A direct result of this is severe snow-flurry conditions in the fall. The overall annual precipitation for the Lake Erie area is 34.5 in./yr. (Herdendorf 1972). As most of the prevailing winds come from the north and west, moisture is picked up over the lake and added to the atmosphere; this shows up as an increase in the mean number of days with measurable precipitation from the windward side to the leeward (Eichenlaub 1979:88). In spite of the increased number of days with measurable precipitation, the average daily rainfall decreases (Visher 1943). In the summer, lake effects decrease precipitation in the area, and in the late autumn and winter they increase precipitation (Fig. 2.23).

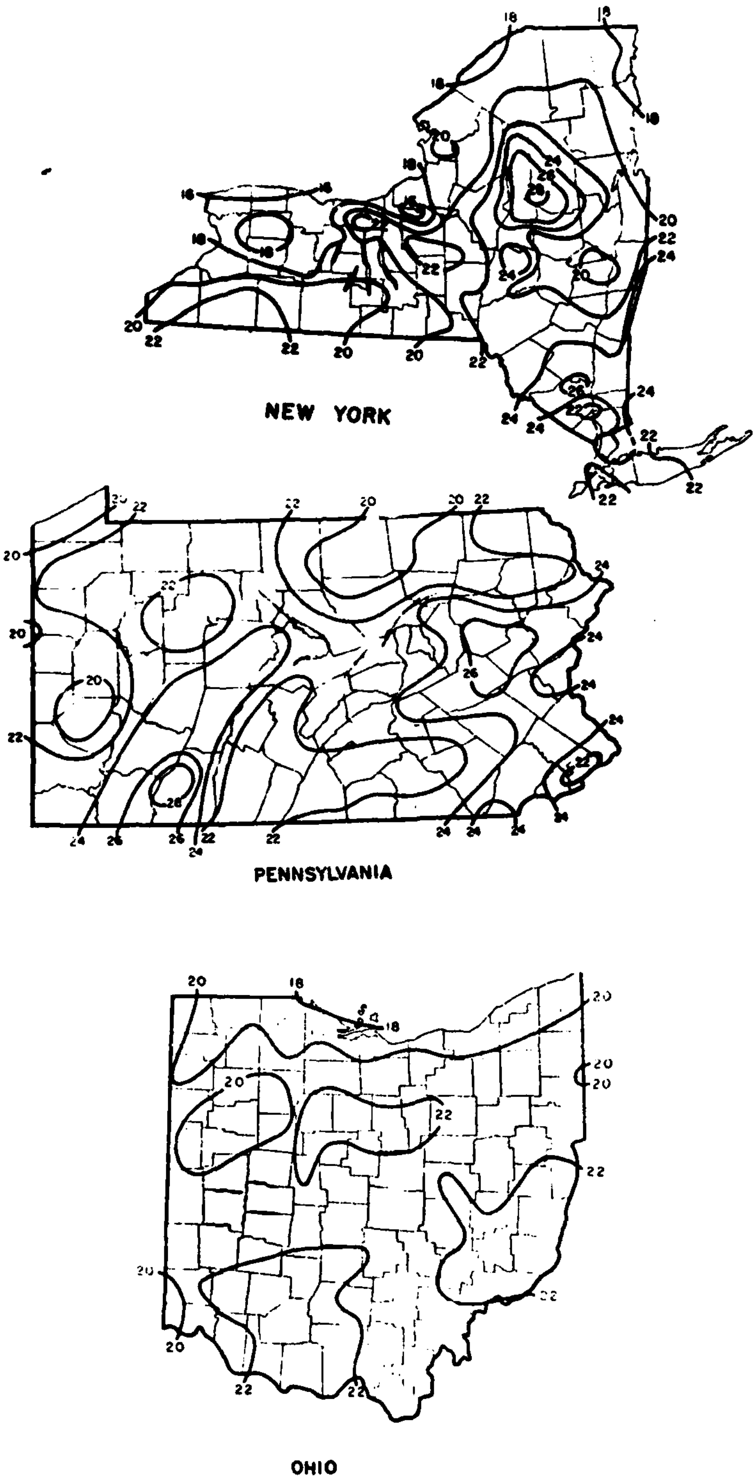


Fig. 2.23. Average Precipitation for New York, Pennsylvania, and Ohio. Averages, given in inches, are for the months of April to September, inclusive. Source: USDA 1941.

2.3.2 Prehistoric Climate

The previous section presented a brief description of current climatic conditions and regional trends in temperature and moisture. The information discussed reflects only the trends observed since meteorological data have been collected for this area; it is not expected to be applicable for describing conditions for the last 10,000 years. Major climatic trends must, therefore, be reconstructed on the basis of several kinds of data derived from other environmental disciplines such as the study of micro- and macro-vegetation, fauna, and pollen. For this reason, the reconstruction of the climate has been included in Section 2.5 of this chapter and will be discussed as a part of the vegetational reconstruction made for the study area over time.

2.3.3 Conclusions

The lake is an important local influence on the climate. Land close to the lake is moderated in temperature, being cooler in summer by 3 degrees Fahrenheit, and warmer in winter by 5 degrees, compared to inland areas. The lake also exerts strong effects on precipitation. The prevailing winds, which usually come from the west, pick up moisture over the lake and deposit it on the shore. This means that some areas, especially from Erie, Pennsylvania, to Buffalo, New York, receive greater than average amounts of rainfall and snowfall. This effect carries inland for a few miles. Winds also intensify on the leeward side of the lake, concentrating their effects at Buffalo and to the south.

2.4 SOIL

Much of the physical, climatic, and topographic variability of the survey area is reflected in its soils. "Soil" is defined as "the collection of natural bodies occupying portions of the earth's surface that support plants and that have properties due to the integrated effect of climate and living matter, acting upon parent material, as conditioned by relief, over periods of time" (USDA 1951:8). Soils reflect many of the micro-environmental differences that will be used later to reconstruct presettlement forest vegetation, and this information is used for prehistoric site analysis. Soil-survey information is the central thread that ties together the paleo-ecological reconstruction of the study area. This information is important to the analysis of spatial distributions of sites and, therefore, to settlement pattern analysis for two reasons. First, the entire survey area has been mapped spatially by either soil phase or soil type. This means that the information from soils is spatially complete; there are no spatial data deficiencies in the onshore region. Second, the soils information for any given location is qualitatively comparable to that for any other location. In many cases, quantitative distinctions can be made between locations. Soil terms used in this section are defined in Appendix D.

2.4.1 Soil Surveys

Conducting soil surveys is a time-consuming activity; it takes a number of years to complete each soil survey. Although the modern U.S. soils survey was begun around the turn of the century, not all the counties in the country have been mapped. Fortunately all the counties in the survey area that border Lake Erie have been mapped at least once. Unfortunat⁻ly, not all surveys are "modern" in the sense that they follow the conventions noted in the Soil Survey Manual (USDA 1951). From the west, there are recent published survey reports for Erie, Lorain, Lake, and Ashtabula counties, Ohio, and for Erie County, Pennsylvania. Reports for Lucas, Ottawa, and Sandusky counties, Ohio, and for Cattaraugus, Chautauqua, and Erie counties, New York, were published prior to 1945. Lucas, Ottawa, Sandusky, and Cuyahoga counties, Ohio, and Cattaraugus, Chautauqua, and Erie counties, New York, are in various stages of survey. Airphoto mappings for Cuyahoga, Lucas, and Erie counties, New York, have been completed for the survey area; copies for relevant portions of the survey area were obtained from the respective county soil conservation services. Airphoto maps for portions of Chautauqua County were also obtained. Ottawa and Sandusky counties had just begun airphoto mapping and maps were not in existence for the survey area. The soils analysis for this part of the survey region was therefore based on a combination of recent and older published and unpublished soils survey reports (Table 2.4).

Because of the large number of soil series in the survey area (156 from the modern group and 79 from the older group), each with up to several soil types and each type with possibly several soil phases, it was necessary to reduce the variety for the purposes of simple description and for later analysis. This was accomplished through the consideration of the factors important to soil formation and to determining original vegetational cover.

Soil formation can be thought of as occurring in two steps: the accumulation of parent materials (their interaction with climate, fauna, flora, topography, and underlying unconformities) and the differentiation (with time) of horizons in the profile (Simonson 1959). Horizonation can be thought of as the combination of one or more of four kinds of changes: additions; removals; transfers; and transformations. Classically, it has been thought that five major soil-forming factors act to create the soil body through the above-mentioned mechanisms.

2.4.1.1 Parent Material

The various kinds of parent material in the survey area that are dominant in the soil-formation process depend on the topography. In the Central Lowlands, lacustrine deposits are important. Many of these lake-laid deposits date from the glacial lake stages. When areas were under deep water, fine-grained sediments were deposited at the same time that coarse-grained sands and gravels were formed into beaches along the shorelines of these lakes. Lacustrine deposits range in texture from very heavy clays to gravels, with all grades in between. Distance from the shoreline largely determined how fine a sediment was deposited. In addition to lacustrine deposits, portions of the Lake Plain were covered in glacial till and, where rivers empty into the lake, parent material is largely alluvial. There may be outwash at the intersection of till deposits and lakebed. The parent material of the Glacial Till Uplands is mainly glacial till and alluvium; there is some bedrock where

Table 2.4. Status of Soil Survey Information in Counties Bordering Lake Erie

County	Published Report	Progress Report	Reference
OHIO			
Lucas	Series 1934, No. 24	1977	(USDA 1943, 1977)
Ottawa	Series 1928, No. 26	None	(USDA 1928)
Sandusky	Series 1917, pp. 1079-1138	None	(USDA 1923)
Erie	1971		(USDA 1971)
Lorain	1976		(USDA 1976)
Cuyahoga	None	1978	(USDA 1978a)
Lake	1979		(USDA 1979)
Ashtabula	1973		(USDA 1973)
PENNSYLVANIA			
Erie	Series 1957, No. 9	1972[a]	(USDA 1960, 1972)
NEW YORK			
Cattaraugus	Series 1935, No. 12		(USDA 1940)
Chautauqua	Series 1914, pp. 271-326		(USDA 1919)
Erie	Series 1929, No. 14		(USDA 1929)

[a]Erie County, Pennsylvania Soil Interpretations, an update.

high outcrops were covered by glacial ice. The glaciated Appalachian Plateau, which also contains glacial till as a parent material, has a large portion of sandstone, limestone, and shale bedrock. Notable along the Portage Escarpment are Pennsylvanian-aged formations. Alluvial material can be found where streams wind through the plateau. Throughout the region, in both upland and lowland contexts, organic matter from bogs and marshes provides parent material for soils; these soils are not mineral soils in the process of being formed.

2.4.1.2 Relief

As a soil-forming factor, relief has a large effect on soil drainage in the survey area. Much of the area is low-lying and level, so that either a small gradient or a short but rapid rise in elevation can radically improve the soil drainage characteristics. In the glacial lake plain from Lake Maumee, a rise of from 20 to 50 ft./mi. could have had important consequences for site quality of tree species and, presumably, for soil water characteristics. Another reason relief is so important in the survey area is the impermeable nature of the till. Where till is impermeable, groundwater does not seep into the water table but rides along the top of the till, forming a perched water table (Meinzer 1923). Any relief in this situation will prevent poor soil drainage. Elevation differences on the lake plain, even in coarse-textured materials, can cause a shift in drainage classes (e.g., Colonie to Elnora).

2.4.1.3 Climate and Time

Climate does not appear to have been a major factor in creating differences in soils in the survey area; most of the survey area shares the same climatic regime. It is possible that microclimatic differences could have played a part on the lake plain between beach ridge and lakebed situations; this is conjectural.

Nor does time seem to have been a major factor in the soil formation of this area. In general, all soils in the survey region are younger than 15,000 years. Alluvial soils are much younger. Still the time since the last glaciation is very short for soil formation processes. Many of the soils reflect their young age and imperfect drainage in their classification as entisols and inceptisols. None of the soils considered were classified as oxisols and only a few as ultisols (USDA 1975).

2.4.1.4 Biological Activity

The final soil-forming factor is biological activity. Forest vegetation undeniably acts to improve the aeration of a soil by adding organic matter and in other ways altering the soil's properties (Buol, Hole, and McCracken 1973). The effects of swamp forest succession on drainage characteristics have been demonstrated in western Ohio (Sampson 1930a). Still, it is one of the desires of the analysis to be able to, in some sense, predict vegetation from soil, and, for this purpose, the effects of vegetation on soil must be held constant. Although such an assumption may not be entirely correct, it is necessary. The logical circumlocution around vegetational effects on soils focuses on the overriding effects of parent material and topography on soil formation and original forest vegetation. In 15,000 B.P., with the retreat of the glacier, the landscape was denuded of vegetation. Those species best suited to certain sites would slowly colonize some areas, while other species would be established in other areas. Thus each area would follow an independent trajectory, and some of the trajectories could be grouped. It would be expected that most of the trajectories could be reduced in number to a few major trends and that the overriding factor in these trends would be physical, i.e., geologic, and topographic. Variation in tree species would not be significant in creating different soil series.

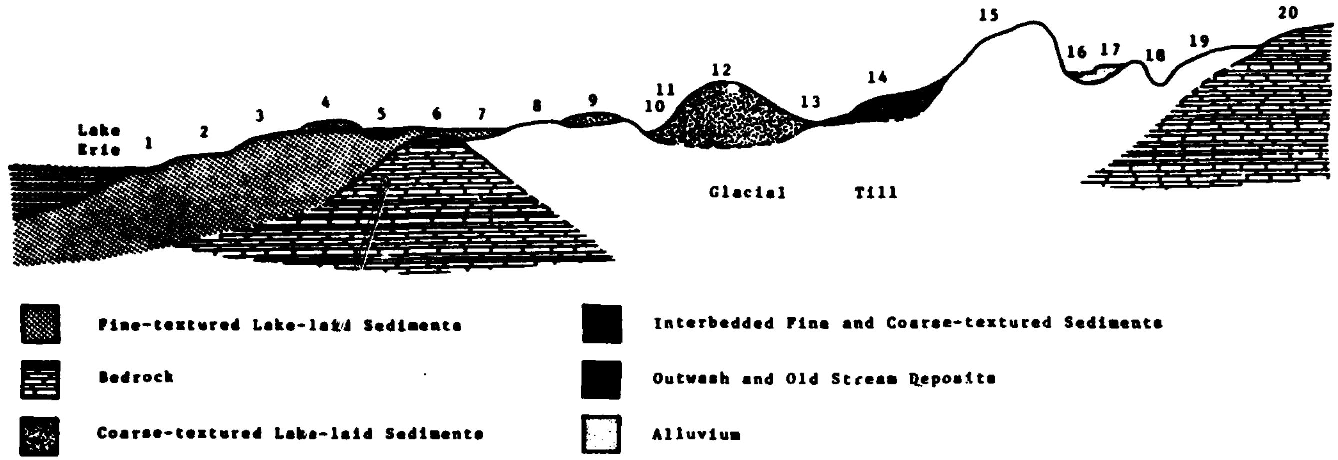
2.4.2 Soil Characterization: Catena Construction

What is the best way to address more than two hundred soil series, to reduce the variety to the most important variables? The method chosen was to construct a soil catena, a model that identifies differences in soil series based on the same parent material but varying in drainage classes. Soil parent material consists of the mass from which the soil solum develops (USDA 1951:147). Usually, but not always, the parent material lies directly below the solum and is designated as horizon c. Parent material has its greatest effect on the nature of the soil early in the formation sequence. Very old soils tend to be distinguished not by parent material but by other pedogenic factors (Buol, Hole, and McCracken 1973). In the relatively young soils of the survey area (less than 15,000 years old), however, differences in parent material do control much of the differences in various soil attributes. Parent material and drainage probably account for more of the variation between different soils than do any two other attributes; thus, the catena appears to be the best method to describe soils in the survey area.

The procedure followed in constructing the catena began with an examination of the published survey reports. A list of all soil series found in the survey-area counties bordering Lake Erie was compiled. For each soil series, where noted, the parent material and drainage class were listed. Most of the statements on parent material could be reduced to a few basic types. A few statements were clearly intergrades between two previously stated types. To facilitate interpretation and use of the catena, a schematic cross section of the shore area, from the lake to the uplands, was constructed; this schematic followed the style used in the Lucas County report (USDA 1977:10). The cross section was created to include all possible parent material situations found between Toledo and Buffalo (Fig. 2.24). Each situation was assigned a number. Situations varied by parent material and drainage class. All soil series were then recoded to fit one or more situations. Although the older soil surveys were not used to construct the table, each soil type in the old surveys was coded to fit one or more of the situations and was used in the same way as the new-survey soil series. This schematic formed the basis for distinctions in the catena parent material classes (Table 2.5).

In some cases, two situations were reduced to one parent-material class, e.g., the case of soils formed from underlying rock and soils formed from a thin layer of glacial till over underlying rock. In this example, in which it was often impossible to distinguish one situation from the other in the survey reports and in which the resulting soil series were close enough in the important characteristics (for vegetational reconstruction), a further division was not warranted.

The parent-material categories fall into five general subdivisions: residuum; glacial till; lacustrine deposits (glaciolacustrine); terrace and glacial outwash (glaciofluvial); and alluvium (USDA 1951:150). Organic soils are not included in the catenas. Subdivisions within these parent-material categories were made primarily on the basis of differences in texture of the material. Glacial till can range from coarse sandstones and shales to very heavy silty clays. Glaciolacustrine deposits again vary from clays deposited on the bottom of the lake to sandy and gravelly beach ridges. The variations in the lacustrine deposits were largely a function of the local wave energy, so that, in reality, these are artificially imposed divisions on a continuum. In certain circumstances, a change in lake level resulted in deposition of a different size of sediment. Loamy material over sands, such as those in Chili and Braceville, represent a movement from high energy to lower energy, while sands over silts, such as those found in Berrien and Ottawa, represent a low to high energy transformation. Sand and gravel beaches ultimately lie on top



KEY

Situation	Parent material and topography	Situation	Parent material and topography
1	Muck soils and marshland near lakeshore	11	Coarse-textured sediments on lower slopes, moderately well to somewhat poorly drained on beach ridges
2	Poorly drained fine-textured glaciolacustrine sediments	12	Coarse-textured sediments on upper slopes and beach ridges, well drained
3	Well drained fine- and medium-textured glaciolacustrine sediments	13	Interbedded glaciofluvial and coarse-textured glaciolacustrine sediments
4	Coarse-textured sediments overlying glaciolacustrine sediments	14	Glacial and stream outwash
5	Stratified sands, silts, and clays	15	Upland glacial till, moderately well to well drained
6	Thin glaciolacustrine sediments overlying bedrock	16	Poorly drained alluvial bottomlands
7	Thin glaciolacustrine sediments overlying glacial till	17	Well drained alluvium and first terraces
8	Lowland glacial till	18	Poorly drained glacial till in low-lying areas in the uplands
9	Coarse-textured sediments overlying glacial till	19	Thin glacial till overlying bedrock
10	Low-lying, coarse-textured sediments, poorly drained	20	Bedrock

Fig. 2.24. Schematic Cross Section (N-S) of the South Shore of Lake Erie. Includes topographic data and parent-material description for soils.

Table 2.5. Soil Catena for Modern Soil Series

Parent-Material Category	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained	Very Poorly Drained
RESIDIUM					
(underlying rock) and till over residium	Brecksville Dekalb Berks Casco Castalia Coyler Romeo	Gosport Rithcey Lordstown Weikert Londonville Manlius Upshur Dumbridge Randolph Wooster Alexandria	Darien Mitiwanga Lockport Fries	Prout Joliet Millsdale Allis	
TILL					
Sandstone, shale, and limestone	Wooster Alexandria	Langford Mardin Cardington Lewisburg	Dalton Erie Darien Bennington Volusia → Pyrmont	Ellery	Alden Pewamo
Medium-textured silts and silt loams		Cambridge Pierpont Ellsworth Platea →	Tiro Haskins Conneaut →		Illion
Shaly till weathered to silty clays and clays		Ellsworth Rittman St. Clair Mahoning →	Venango Wadsworth Tiro Elliott Nappanee	Frenchtown Sheffield Condit Brookston Birdsall →	Miner Trumbull Hoytville
GLACIOLACUSTRINE					
Lacustrine clays and silt clays		Geeburg Shinrock Lucas	Caneadea Fitchville Del Rey Fulton Darroch Metamora	Canadice	Birdsall Mermill Lorain Lenawee Toledo
Lacustrine silts, sand and silts	Mentor Sisson	Collamer Williamson Glenford Shinrock Tuscola Ottokee	Fitchville Minoa Kibbie Tedrow Wellington →	Sebring	Luray Colwood Lamson
Loamy material over sands	Chili	Braceville	Jimtown Digby Dixboro		Olmstead

Table 2.5. Continued

Parent-Material Category	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained	Very Poorly Drained
GLACIOLACUSTRINE (Cont.)					
Lacustrine sand and gravel beaches	Conotton Chenango ←--- Oblonie ←--- Otisville Oshtemo Chili Balmore Oakville Spinks Araport Tyner ---→	Elnora Vaugnsville ---→	Red Hook Stafford Jimtown	Kingsville ---→	Grenby Gilford
Lacustrine sand over silt, clays, or till	Ottawa Metea ---→	Berrien Claverack	Painesville Bixler Rimer ---→	Swanton	Wauseon
Stratified sands, silts, and clays		Williamson Bogart Rawson	Jimtown		
GLACIOFLUVIAL					
Predominantly sandy and gravelly outwash	Conotton Howard Chenango Oshtemo	Phelps Bogart Galen	Fredon ---→ Red Hook Euclid Stafford Digby Wilmer	Washtenaw	Halsey Atherton Hill[illegible]ove
Heavy-textured stream outwash	Unadilla	Rawson Solo	Haskins		
ALLUVIUM					
	Chagrin Tioga Ross	Lobdell Eel Medway Seward	Orrville Senecaville Shoals Ceresco Wayland ---→	Holly	Sloan

of glacial till or lake-laid clays, but are too thick to have the lower sediments affect the soil-formation processes.

Drainage classes follow the conventions set by the U.S. Department of Agriculture (1951) and are summarized in Table 2.6. With construction of the catena, each soil series was evaluated by the criteria set and entered into a group. In a few cases, a single soil series was entered into two groups; this occurs with well-drained and moderately well-drained, coarse-textured, lacustrine deposits and terraces and outwash. Among modern series, two kinds of information were used to assign soil series to a particular group. When available, data from USDA Form 5s (on file at the Pennsylvania State University's Department of Agronomy, Soil Survey Office, 310 Tyson Building), were used; these forms are unified for the United States and form the basis of modern soil survey descriptions. When these forms were not available, the most recent soil surveys were used to assess the series. In some cases, two surveys would list one series as having two different drainage classes. When this occurred, the more recent, or more complete survey, was accepted.

Table 2.6. Definitions of Drainage Classes[a]

Drainage Class	Definition
Excessively drained	Water is removed from the soil very rapidly. Excessively-drained soils are commonly very coarse-textured, rocky, or shallow. Some are steep. All are free of mottling related to wetness.
Somewhat excessively drained	Water is removed from the soil rapidly. Soils are free of mottling related to wetness.
Well drained	Water is removed from the soil readily, but not rapidly. Water is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. These soils are mainly free of mottling.
Moderately well drained	Water is removed from the soil somewhat slowly during some periods. Moderately well-drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum and/or periodically receive high rainfall.

Table 2.6. Continued

Drainage Class	Definition
Somewhat poorly drained	Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for longer periods of time. Free water is commonly at or near the surface for long enough during the growing season so that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in the layers below plow depth. Poor drainage is the result of a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these factors.
Poorly drained	Water is removed so slowly that the soil is saturated for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, or nearly continuous rainfall, or a combination of these.
Very poorly drained	Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very-poorly-drained soils are commonly level or depressed and are frequently ponded.

[a]"Drainage class" refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized.
Source: USDA 1978b.

The soil series from the earlier surveys were also assigned to a topographic situation on the basis of descriptions within the reports. In the earliest reports, a soil type seemed to be equivalent to a present-day soil series. Drainage class information did not conform to modern taxa; drainage classes were usually divided into good, imperfect, or poor. An attempt was made to place these drainage classes into the modern groups. The results are shown in Table 2.7 as an equivalent soil catena, although the groups are filled by soil types instead of soil series.

Soils in the United States are currently classified according to a hierarchical taxonomic system known as the Seventh Approximation (USDA 1975). This system of classification allows for standardization and flexibility in adding new information. One of the most useful characteristics of the system is the ability to slide up and down a hierarchy of categories from soil order to soil series, depending on the level of specificity desired. At the top, soil orders were conceived to show distinctions of the "dominant forces in shaping the character of the soil" (USDA 1975:71).

In the survey area, the vast majority of soil series are in the alfisol or inceptisol soil orders. In addition, there are a few entisols, histosols, and mollisols, and very few ultisols. No vertisols or oxisols were noted in the survey. The sequence from entisol through oxisol represents, in general, a developmental sequence reflecting time, drainage, parent material, or slope. Because all soils within the survey are similar in chronological age (i.e., postglacial), differences in the orders are mostly due to parent material and drainage.

Most glacial till series are alfisols, indicating high base saturation and an argillic horizon, and, in most cases, the maximum soil development. Many of the fine-grained lake-laid sediments are also alfisols, although in the poorly-drained areas many mollisols appear. The diagnostic mollic epipedon for this order indicates a grassland condition, probably a wet prairie, although many areas that had better drainage at one time are now very poorly drained due to the rising lake level. In the marshy areas, most soils are organic histosols. Among the more coarse-textured parent-material derived soils, there is a tendency toward less profile development, due both to the sandiness of the material and to low moisture. This is demonstrated by the presence of more soils in the entisol and inceptisol soil orders. Most of the alluvial sorts are also inceptisols, indicative of the continuous addition of parent material in the form of alluvial sediment.

2.4.3 Conclusions

Soil-survey information forms the basis of the reconstruction of the prehistoric vegetation in the survey area. Soil-survey information is useful in this regard because it provides one hundred percent coverage of the area and because soil-mapping units are in different locations. Information is available for some counties bordering the lake. For some counties, there are modern surveys that record soil information at the phase level; for the others, there are older surveys (completed before 1945) that have information mapped at the soil-type level.

Five soil-forming factors account for the differences in soils: parent material, relief, climate, biotic factors, and time. Time is held constant in

Table 2.7. Soil Catena for Older Soil Series

Parent material	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
Residuum (underlying rock) and till over residuum	@[a] Lordstown shsil[b] @ Lordstown sil @ Farmington sil @ Farmington l @ Farmington chl * Randolph sil * Randolph l * Randolph stl # Lordstown shl @ Aurora shl @ Aurora sil	+ Lordstown sil + Lordstown stsil + Dekalb sil + Dekalb stsil + Leetonia cosl + Cattaraugus sil	* Hilldale cl # Volusia sil # Volusia cl @ Aurora sicl @ Allis sil @ Allis sicl @ Volusia sil @ Angola sil @ Alden sil @ Erie sil + Volusia sil + Hornell sicl	+ Aurora sicl + Aurora sil + Ernest sicl + Ernest sil	
TILL					
Sandstone, shale, and limestone	* Catawba sil * Catawba fsl * Catawba gl # Wooster gl # Wooster fsl # Wooster sil @ Wooster gl @ Otisville gl + Wooster gsil + Wooster gl + Wooster sil + Bath gsil	* Catawba l --------→ @ Langford sil + Hardin sil + Canfield sil + Langford sil	+ Fremont sil		* Brookston cl * Brookston c * Happanee scl * Happanee l
Silts and silt loams			@ Marion sil @ Mahoning sil @ Mahoning, steep ph.	@ Lyons sicl, light text. ph. + Erie sil	
Shaly till weathered to silty clays and clays	* Catawba fsl	* Danbury cl @ Langford sic	* Danbury sicl @ Angola sicl --------→	@ Darien sicl @ Mahoning sicl + Mahoning sicl + Mahoning sil	@ Lyons sicl @ Alden sicl + Chippewa sicl
GLACIOLACUSTRINE					
Lacustrine clays and silt clays		* Lucas sil	@ Fulton sil @ Toledo sil @ Canadea sil + Mahoning sil + Canadea sil * Toledo l * Fulton l --------→ # Dunkirk sicl	* Toledo cl * Fulton sicl * Fulton sil # Dunkirk c @ Fulton sicl @ Toledo sicl @ Schoharie sicl @ Poygon sicl @ Canadea sicl + Mahoning sicl	* Toledo sicl * Sono sic + Lorain sicl
Lacustrine silts, and sand and silts			@ Fulton sil, light text. ph @ Schoharie sil @ Poygon sil + Tyler sil	@ Lorain sicl + Tyler sicl	
Loamy materials over sands		@ Braceville sil	+ Braceville sil	@ Newton l	@ Wolcottsburg l @ Maumee l
Lacustrine sand and gravel beaches	@ Palmyra gl @ Palmyra l @ Palmyra scl @ Palmyra vfsl @ Palmyra fsl @ Ottawa vfs @ Groton l @ Groton, gr phase + Chenango gls * Fox gl * Rodman g # Dunkirk g # Dunkirk gl	# Dunkirk vfsl		# Clyde l	* Maumee fs
Lacustrine sand over silt, clay, or till	* Danbury vfsl @ Berrien fsl @ Berrien vfsl	* Fulton vfsl # Dunkirk vfsl @ Schoharie l @ Cazenovia l @ Cazenovia sil	* Toledo vfsl	# Dunkirk l @ Poygon l @ Poygon vfsl	* Wauseon fsl

Table 2.7. Continued

Stratified sands, silts, and clays	* Lucas vfsl		@ Canadea vfsl	@ Poygon l + Lorain sil + Lorain fsl	
GLACIOFLUVIAL					
Predominantly sandy and gravelly outwash	# Chenango gl # Chenango fsl # Chenango sil @ Chenango sil @ Chenango l @ Chenango shl @ Chenango vfsl @ Chenango fsl @ Palmyra gl @ Palmyra l @ Palmyra shl @ Palmyra vfsl @ Palmyra fsl @ Groton l @ Groton, grav. ph + Chenango gl + Chenango gsil + Chenango gsl + Chenango sil + Unadilla sil + Unadilla fsl + Otisville gl + Mentor fsl	@ Tonowanda l @ Ontario gl	@ Newton vfsl	@ Newton sil @ Newton l @ Wolcottsburg sil	# Papakating fsl
Heavy textured stream outwash	@ Mentor sil	@ Dunkirk sil @ Tonowanda sil	@ Mahoning sil, steep ph.	# Tyler fsl @ Tonowanda sicl @ Wolcottsburg sil @ Wolcottsburg sicl	@ Chippewa sil @ Maumee sil
ALLUVIAL					
	* Genesee fsl @ Genesee sil, high bottom @ Chagrin sil, high bottom + Tioga sil + Tioga fsl + Genesee fsl + Genesee sil + Pope sil + Chagrin sil	# Genesee sil @ Genesee sil @ Chagrin sil	* Eel sicl ----→ @ Eel sil ----→ + Middlebury sil	* Tyler sil + Tyler cl + Genesee l + Holly sicl + Wayland sicl + Atkins sil	# Papakating cl

[a]County location key:

* = Ottawa County, Ohio

= Chautauqua County, New York

@ = Erie County, New York

+ = Cattaraugus County, New York

[b]Textural class key:

sh	shale	fs	fine sand
shsil	shaly silt loam	ls	loamy sand
shl	shaly loam	sl	sandy loam
chl	cherty loam	fsl	fine sandy loam
stl	stony loam	vfsl	very fine sandy loam
stsil	stony silt loam	l	loam
g	gravel	sil	silt loam
gl	gravelly loam	cl	clay loam
gsl	gravelly sandy loam	sicl	silty clay loam
gsil	gravelly silt loam	scl	sandy clay loam
gls	gravelly loamy sand	sic	silty clay
cosl	coarse sandy loam	c	clay

USDA 1951:139

these considerations in that all these soils date to after the end of the Pleistocene. Thus, time is not an important factor in determining the soil differences. Since climatic variations around the lake are negligible, climate is not an important factor in the differences. Biotic factors, from plants and animals, were held constant because these were effects we wished to study under variation of differing soil types and other soil-forming factors. Parent material and relief were thus the two most important soil-forming factors under consideration. Parent material directly relates to topography in that lowland versus upland distinctions are caused by glacial or preglacial effects. Where applicable, alluvial deposits were taken under consideration. In addition, the distance from the current lakeshore is a function of lacustrine processes associated with the sequence of lake stages. Relief is particularly important in that the drainage around the lake is generally poor; any rises in elevation, including gradual slopes, can drastically improve the drainage characteristics of a soil.

There are many defined soil series throughout the lakeshore area--too many to consider individually. A soil catena has, therefore, been constructed to reduce the variability in the series to a manageable size. All series listed in the newer soil reports are grouped by the two-dimensional technique of the catena. The series from the older soil reports were first interpreted for parent material and drainage, then fit into the same catena created for the newer series. Organic soils were not included in the analysis because they would have had no impact on any of the three types of vegetation studied in Section 2.7.

The use of the soil taxonomic scheme (USDA 1975) to evaluate and organize series into higher taxonomic orders made possible very broad comparisons of the series. The majority of the soil series in the lake area are alfisols and inceptisols. The remainder are mostly entisols, histosols, and mollisols. No vertisols or oxisols were found. Differences in the soil taxonomic orders were due largely to parent material and drainage. Glacial till soils and well-drained lake-laid sediments of fine texture tended to be alfisols. Poorly drained, fine-textured lake-laid sediments were mostly mollisols. Very-poorly-drained, marshy soils were histosols. Coarse-textured lake-laid soils were either entisols or inceptisols. Most of the alluvial soils were inceptisols.

2.5 VEGETATION

This section presents a qualitative description of the forest conditions of the three-state project area for the year A.D. 1800. It is important to present a description of conditions that closely parallel the natural setting at the time it was utilized by historic, ethnohistoric, and prehistoric peoples. Although a descriptive baseline for this time period does not exactly characterize the natural setting for earlier occupations, forests of this period would have presented a dynamic equilibrium that is no longer visible. This is due to the effects of modern land-use practices; these have significantly altered the natural vegetation through timbering, artificial drainage systems, and agricultural practices.

The 1800 baseline was selected for analysis because early and extensive data are available, particularly original land-warranty information. Records of witness trees in presettlement forests are of particular importance for assessing species composition for specific habitats (and the data base for 1800 is relatively good). Thus, this time period is better known than are preceding or subsequent decades. With respect to the prehistory of the area and its paleovegetation, the year 1800 is "modern," and correspondence to present climatic and soil conditions will be assumed.

For this reason, the 1800 baseline is combined with other paleovegetational and paleoclimatological data to reconstruct and project the vegetational setting back through time. These same data are also used to construct a description of the prehistoric climatic moisture and temperature trends. Reviews of methodological issues and interpretive assumptions are included in the subsections focusing on the prehistoric eras.

2.5.1 Reconstruction of the Vegetation: Baseline Descriptive Data

Obviously a quantitative, small-scale description of the presettlement vegetation (with mapped zones of forest associations) is not readily available for any site-specific area along the lakeshore. On a broad scale, such maps do exist for counties (cf. Gordon 1940) and for states (Gordon 1966). This broad scale is adequate for gross statements of human adaptation to the study, but inadequate for answering other questions. The desirable alternative would be to isolate those variables associated with forest composition and growth that can be reconstructed and then mapped on a small scale. For many different forest types noted in the survey area, certain microtopographic, hydrological, edaphic, and regional determinants can be specified so that a unified theory of reconstructed vegetation can be developed and applied. The literature on both the original forest vegetation and the physical determinants of such vegetation is vast and, sometimes, contradictory. This is understandable, considering that work in the Northeast can be traced back to the early part of the twentieth century (Sears 1925; Braun 1916; Bray 1930). The approach used to develop this chapter will be to briefly summarize the data and methodology available as developed by others for the three states: Pennsylvania, Ohio, and New York. The major determinants that control the vegetational mosaic in these settings will be identified, sorted, and synthesized, along with some species-specific information, to form a model of vegetation amenable to soil mapping. Finally, each major area will be described qualitatively in accordance with these stated variables.

2.5.1.1 Nineteenth and Twentieth Century Descriptions

The first naturalists to systematically note the native vegetation in the Lake Erie Basin did so early in the nineteenth century. Thomas Nuttall recorded vegetation on a trip from Erie, Pennsylvania, to the Huron River, noting sandy beaches from the Ohio state line to Berlin Heights in Erie County, and the vast prairie from the Huron River to Sandusky Bay (Graustein 1950/51). A decade later, William Darby described the terrain and vegetation from Buffalo to Put-in-Bay. The Grand Island east of Buffalo was noted to have a mix of "hemlock, sugar maple, elm, oak, and linden" (Darby 1819:155). At Presque Isle, Pennsylvania, Darby noted cedar trees and cranberry bushes growing on the sand spit (Darby 1819:211). Of the Connecticut Reserve (northeastern Ohio), he was particularly flattering, finding "timber, hickory, sugar maple, black walnut, elm, oak, and other trees indicative of deep strong soil" (Darby 1819:178). On the Danbury Peninsula, near Sandusky, black walnut trees were noted:

> I found the surface rising from the bay by gradual acclivity, to at least 30 feet elevation. Soil a deep black loam, and mixed with sand and pebble; timber, black walnut, shagbark hickory, white oak, elm, linden, ash, and sycamore, with a shrubbery of alder, sumach and grape vine. On no land of whatever quality did I ever before see so much black walnut on a given space. This tree, whose existence is unerring proof of uncommon fertility, is here the prevalent timber, and is found of enormous size and height. (Darby 1819:980)

Darby found the shores of the bay around Sandusky to be slightly above the water, in some places flat and marshy, a condition which existed until this century when farmers reclaimed much of the land by draining it.

The earliest modern studies also relied on surveys of existing vegetation, but in a more controlled manner. In a study of 353 woodlots in Wayne County, Michigan, Brown (1917) made a distinction between species forming like-commensal forests, species forming unlike-commensal forests, and species able to form both. Like-commensal forests are those composed of one tree species; examples included tamarack, birch, aspen, and larix. Unlike-commensal forests are composed of different species, such as beech, silver maple, and sassafras. Species that could be segregated but were also found in mixed situations include black oak, hard maple (sugar maple), shagbark hickory, and sycamore. Finally, Brown noted that the major associations formed a continuum from dry sites to wet sites. Black oak, sassafras, birch, hickory, hard maple, beech, silver maple, and sycamore reflected this spectrum from very dry to wet sites. Hard maple and beech were assessed as being in optimal conditions.

The old Lake Maumee Basin, which encompasses much of northwestern Ohio and all of the survey area west of Sandusky, was known historically as the Great Swamp and supported a swamp forest community, generally recognized as elm-ash-soft maple. Within that community, successional phases were recognized, based on differing drainage conditions (Sampson 1930a). On the lake plain, the vegetation preceding the development of the swamp forest included aquatic communities followed by marshes and wet prairies, or willow-poplar associations of low sandbars. On floodplains, swamp forest communities evolved from both alder and willow-poplar associations and stream valley bogs. The association found on the wettest sites was composed of American elm, black ash, and red or silver maple, with wet adapted oaks, sycamore, cottonwood, sour gum, willow, and yellow birch and aspen. Upon better drainage, white ash, big shellbark hickory, and burr oak entered, along with some American hornbeam, buckeye, box elder, honey locust, and hackberry.

A third stage of the swamp forest occurred with better drainage and included the entrance of red elm, linden, cherry, mulberry, shagbark hickory, dogwood, red oak, yellow oak, butternut hickory, and hophornbeam. On the best-drained sites in the swamp forest, tulip tree, butternut, walnut and magnolia entered. This was the last phase of the swamp forest before the entrance of beech and hard maple.

Sampson claimed that the major controlling factor for these variations was light, moisture gradient, and soil aeration acting in concert. The soil-moisture gradient reflects slope of the landscape and elevation of low ridges, implying depth to water, seasonal or permanent. Sampson (1930a:345) presented a chart organized to present the habitat range of species, the order of invasion, transitional phases, variation in relative abundance, and the relation of secondary forests.

Sampson (1930b) also studied the northeastern Ohio mixed mesophytic forest. The mixed mesophytic forest consists of a variety of tree species with differing combinations locally dominant; no single set would allow the forest to be designated by a binomial or trinomial term. This type of association tends to occur on moist sites with adequate drainage. In northeastern Ohio, species of importance included beech, sugar maple, black maple, red maple, tulip, magnolia, chestnut, white oak, red oak, and white ash (Sampson 1930b:361). A mixed mesophytic community also contained secondary species in quantities greater than would normally be found in a beech-maple association. These include red elm, black walnut, butternut, linden, black cherry, sour gum, flowering dogwood, pignut, bitternut, shagbark, mockernut hickory, red mulberry, and American elm.

The mixed mesophytic community was placed in a transitional position between the drier oak-chestnut community and the beech-hard maple association, but this placement is not entirely correct. The mixed mesophytic community has a wider soil-moisture gradient than the beech-maple, so that it could appear on either side of beech-maple moisture conditions. Thus, under wetter conditions (and depending on slope direction), the oak-chestnut community would be invaded by mesophytic species before beech and hard maple. During the better-drained phases of the swamp forest, mesophytic species would also appear before beech or hard maple.

The local habitats under which a mixed mesophytic community would be found includes slopes of valleys too dry for beech and maple, but surrounded by beech and maple on more level spots. In addition, mixed mesophytic communities could be found on slopes of hills of the interlobate moraine between oak-chestnut and beech-maple, according to local moisture conditions. Soil conditions with available water and good internal drainage favor the mixed mesophytic community, whereas soils with poor internal drainage and heavier texture favor the beech-maple; droughty soils favor the oak-chestnut. Soils supporting mixed mesophytic communities would include Wooster loam and gravelly loam, Volusia loam, and Dunkirk sand (these soil types are from the pre-1930s soil surveys).

The specific dynamics of the beech-maple forest, so important in the vegetation of northern Ohio, were examined in a remnant forest 16 mi. northeast of Cleveland (Williams 1936). The North Chagrin Reservation, located on a poorly drained Volusia clay loam, was a beech-maple forest that had undergone little alteration since settlement. The area had been selectively logged and the chestnut that was originally there died during the blight at the turn of the century. Four major vegetation units were identified: 1) a forest "mixture" of beech, hemlock, red oak, and chestnut dominants was located on spurs; 2) hemlock, sugar maple, and tulip tree, but no beech were located between the spurs in deep ravines (this zone was considered transitional to the swamp forest); 3) an elm-basswood-red maple-black ash association, similar to Sampson's swamp forest, was located on the western edge of the reservation; and 4) the prevalent beech-sugar maple forest occupied the interior of the reservation. Incidental dominants in the beech-maple forest included white and red oak and shagbark hickory. Red maple seeds were abundant in the forest, but did not germinate well, nor did the saplings compete well. Understory vegetation was characterized as very good, supporting a tremendous amount of seeds, fruit, and other food reserves, although the meaning of this to virgin conditions is in doubt due to the selective deforestation of the reservation.

The analysis of the original forests in Cuyahoga County (Williams 1949) represents a major ecological work relevant to northeastern Ohio. Cuyahoga County is pivotal for an ecological analysis of the northern Ohio region in that it contains three of the physiographic provinces cited by Fenneman (1938): Lake Plain, Glaciated Appalachian Plateau, and Till Plain. In addition, Cuyahoga County crosscuts four of the zones defined in the survey area: the Western Ohio Lowlands, the Eastern Ohio Lowlands, the Glacial Till Uplands, and the Allegheny Plateau Uplands.

Using physiographic, topographic, climatic, and edaphic parameters, Williams isolated a number of forest types. The basis of his reconstructed vegetation for the year 1796 is a survey of remnant forest stands, both within and around the county. He also relied heavily on ecological studies and historical accounts of the first forests in the area. Prevalent in the eastern highlands was the closed beech-maple forest, composed primarily of beech and sugar maple, although red maple, tulip tree, white ash, cucumber, and tupelo were also to be found. The modern understory consisted of hophornbeam, flowering dogwood, and shadbush as well as shrubs of witch hazel, spicebush, maple-leaved viburnum, red-berried elder, and purple flowering raspberry. Beech-maple forests were also found in the southern highlands and on better-drained, but not dry, sites within the lake and till plains. Finally, this association was found locally on the slopes of valley walls, in ravines between ridges, and on gullies in the lake cliff.

Swamp forests of American elm, red maple, and black ash occurred on wet sites within the upland beech-maple forest. Other species included basswood and an understory of American hornbeam. On the lake and till plains, the swamp forest consisted of American elm, black ash, and silver maple; also associated were slippery elm, burr oak, swamp white oak, and bitternut hickory. Another type of swamp occurred in some places on the lake plain; pin oak dominated either in dense stands or along with swamp white oak, burr oak, silver maple, red maple, tupelo, and cottonwood. Swamps were also a major component of the more poorly drained portions of the till plain.

The drier portions of the lake and till plains supported a mixed oak forest, including black oak, white oak, red oak, tulip tree, and white ash as dominants. Black oak was particularly abundant on the old glacial lake beach ridges. Out on the sandbars and at beaches along the current lakeshore, sandbar willow, black willow, cottonwood, and occasionally basswood, burr oak, and red oak were noted.

The more mesic areas in the uplands, such as those along the edges of gorges, within ravines, and on spurs overlooking valleys, supported stands of hemlock and white pine. Hemlock would often be found in pure stands. On the edges of this type of area with the beech-maple forest, a beech-hemlock association would be found. Along ridges of the southern highlands, an oak-hickory-chestnut association composed of white oak, red oak, black oak, scarlet oak, chestnut, shagbark hickory, pignut hickory, and white ash would dominate.

Finally, in areas where glacial till was thin or nonexistent over shale bedrock on the cliffs of the valley walls, red cedar and common juniper would be found.

Braun's Deciduous Forests of Eastern North America (1950) synthesized much of the work previously mentioned. The beech-sugar maple forest region encompassed all of the immediate survey area and much of the adjacent area. The forest was characterized as beech, this being the most abundant species, with sugar maple in the understory. In the lower-lying parts of the association, maple was dominant. Within the beech-maple forest region were prairie communities that were relics of the post-Pleistocene dry period and phases of the swamp forest as described by Sampson (1930a). Within the area of the Great Swamp, beech-maple forests were located only on knolls or low ridges. Sandy or gravelly morainal ridges were characterized as oak-hickory forest type. Little variation occurred within the beech-maple forest type; the changes were limited to stages of succession and topography.

White oak became an important constituent on the southern margin of the beech-maple forest type. In a forest near Canfield (Mahoning County), Ohio, on the Glaciated Allegheny Plateau, a stand of the following composition was noted:

Fagus grandi folia	40.1%
Acer saccharum	25.5
Quercus alba	14.8
Acer rubrum	7.7
Oxydendrum arboreum	5.6
Quercus rubra	1.4
Betula spp.	1.4

Differing forest types were related to topography. In Trumbull County, Ohio, mixed mesophytic stands were restricted to slopes with good available water and internal drainage. On the till and lake plains, low relief or minor differences in elevation determined swamp forest types versus beech-maple. The more compact, poorly aerated and poorly drained soils supported hydromesophytic trees such as swamp white oak and American elm.

The most comprehensive and detailed synthesis of presettlement forest vegetation applicable to northern Ohio was undertaken by Gordon in The Natural Vegetation of Ohio in Pioneer Days (1969). The use of original land surveys of Ohio, along with primary vegetational surveys conducted by Transeau and Sampson in the 1930s, historical accounts, biogeographic rules, and ecological principles resulted in a synthesis and companion map (Gordon 1966). Within the survey region, seven distinct vegetation types were noted: 1) beech forests; 2) mixed oak forests; 3) oak-sugar maple forests; 4) elm-ash swamp forests; 5) mixed mesophytic forests; 6) prairie grasslands; and 7) freshwater marshes and fens. The seven types, as abstracted from Gordon (1966), are summarized below.

1. Several types of beech forests existed in northern Ohio in 1800. The beech-sugar maple forest, as described by Williams (1949) included 40% or more mature beech trees with sugar maple, northern red oak, white ash, white oak, black cherry, and shagbark

hickory. The following species were noted as being common in the understory:

- *Hepatica acutiloba* DC
- *Claytonia virginica* L.
- *Erythronium americanum* Ker.
- *Dicentra cucullaria* (L.) Bernh.
- *Dentaria laciniata* Muhl.
- *Dicentra canadensis* (Goldie) Walp.
- *Anemonella thalictroides* (L.) Spach.
- *Osmorhiza claytoni* (Michx.) Clarke
- *Polygonatum biflorum* (Walt.) Ell.
- *Arisaema triphyllum* (L.) Schott.
- *Podophyllum peltatum* L.
- *Viola papilionacea* Pursh.
- *Actaea alba* (L.) Mill.
- *Phlox divaricata* L.
- *Geranium maculatum* L.
- *Pilea pumila* (L.) Gray.

A hemlock-beech type confined to stream gorges of the Allegheny Plateau was noted; it was characterized by a very thin ground cover: Canada mayflower, partridge-berry, and wintergreen. In northeastern Ohio, hemlock was associated with species of mixed mesophytic forests on some uplands south of the Grand River and in wetlands over peat deposits. A beech-maple-tulip tree association was noted in those areas occurring below the spring level of V-shaped valleys and stream terraces. In this moister condition, red maple was more common than sugar maple. With the exception of sugar maple, beech woods were generally relatively free of undergrowth. Beech forests were not considered to be climax forests, rather, they would become mesophytic hardwoods of red oak and basswood.

2. Mixed oak forests were another component in northern Ohio. Characterized as a white oak-black oak-hickory association, they included not only black oak, but scarlet oak, shagbark, pignut and mockernut hickories, and, in the swamp forest habitats within this association, big shellbark hickory. On fertile river terraces and till plains, bitternut hickory was important. In the naturally dissected Allegheny Plateau, a white oak type formed. Low-lime, acidic soils of northeastern Ohio, which were well drained and sandy, supported an oak-chestnut type. Further west, on the Glacial Till Plain, forests in the vicinity of the prairie grasslands were mainly of the white oak-black oak-shagbark hickory type. The soils that correspond to this association, such as the Miami-Kendallville-Fox soil association, are subject to drought.

3. The oak-sugar maple forest, especially characteristic of the Island Area in Lake Erie, consisted of white oak, red oak, black walnut, black maple, sugar maple, white ash, red elm, basswood, black cherry, and shagbark hickory. This forest was characterized by an absence of beech, and was associated with highly calcareous and fertile soils, such as those derived from rocks and gravels of limestone, dolomite, and shaly limestone. On the Bass Islands in Ottawa County, the predominant forest association was oak-maple-basswood; this was

correlated with the Catawba and Toledo soil series. Understory vegetation included

- Bicuculla cucullaria
- Camassia scilloides
- Campanula americana
- Geranium Robertianum
- Hydrophyllum appendiculatum
- Hydrophyllum virginianum
- Impatiens pallida
- Laportea canadensis
- Polymnia canadensis
- Rubus occidentalis

4. The elm-ash swamp forest was commonly found on flat, poorly drained areas. Some of these forests succeeded the natural drainage of wet prairies and marshes in the glacial lake basin. Three species were dominant in the swamp forest: white elm, black and/or white ash, and silver and/or red maple. Very wet phases would have contained sycamore and cottonwood. Swamp forests also invaded peat bogs where the peat was shallow or consolidated as muck. Better drained forest types included the elm-black ash-soft maple; burr oak-big shellbark hickory; red oak-basswood; and tulip tree-black walnut. On outwash aprons with lighter-textured soils, there was a transition to the wet beech forest type. An association of elm-ash-silver maple-burr oak was characteristic of the lake plain; on poorly drained silty clays of low-lime content there would have been more pin oak and red maple. Shrubs in the swamp forest understory included

   - Benzoin aestivale
   - Grossularia cynosbati
   - Viburnum acerifolium
   - Viburnum prunifolium
   - Cornus pacemosa
   - Xanthoxylum americanum

   Ferns included

   - Onoclea sensibilis
   - Botrychium virginianum
   - Asplenium augustifolium
   - Athyrium thelopterodes
   - Phegopteris phegopteris
   - Adiantum pedatum

   Grasses included

   - Cinna arundinacea
   - Glyceria nervata
   - Hystrix hystrix

5. The mixed mesophytic forests occupied primarily the slopes of the Allegheny Plateau and outliers in the glaciated areas. As described by Sampson (1930b), they included beech, sugar maple, black and red maple, tulip tree, magnolia, chestnut, white and red oak, and white ash, in that order, and were considered transitional between dry sites of oak-chestnut and moist sites of beech-maple.

6. Prairie grasslands in western Ohio consisted of two basic types: wet prairies and dry prairies. Wet prairies were composed of wet or water-covered species, such as those of Phragmites and Calmagrostis. More mesic prairies consisted of

Andropogon gerardi
Andropogon scoparius
Panicum virgatum
Sorghastrum nutans

A number of broad-leaved forbs were also found in wet prairies; they included

Asclepias
Aster
Helianthus
Lespedeza
Latris liatris
Ratibida
Rudbeckia
Ruellia
Silphium
Solidago
Veronicastrum

Dry prairies and hill prairies were located near the edge of bluffs composed of massive limestone, dolomitic rocks, and cherty-limy shales. In Erie and Ottawa counties, the following species were noted:

Allium cernuum
Blephilia celiata
Carex crawei
Galium pilosium
Houstonia canadensis
Lithospermum canescens
Lobelia leptostachys
Lobelia spicata
Monarda fistulosa
Panicum flexile
Polygala verticillata
Sabatia angularis
Scutellaria parvula
Silphium trifoliatum
Sisyrichium albidum
Thalictrum revolutum
Verbena angustifolia
Verbena structa
Viola sagittata

7. The principal grasses that formed in freshwater marshes and fens were giant reed-grass, slough grass, and big bluestem. These grasses formed in nearly pure stands, but were disturbed by grazing animals. Gordon, who disagreed with Transeau's hypothesis of a climatically determined prairie peninsula, argued for the importance of local hydrographic conditions in creating grassy tracts. Fens

were defined by Gordon to apply to a distinct vegetation that correlated to hard (high carbonate) artesian groundwater. Fen plants grew on alkaline marshy peat, often marl.

In a study of the presettlement forests on South Bass Island, two main communities were found (Hamilton and Forsyth 1972). Sugar maple and hackberry were associated with deep soils, such as Catawba (Hoytville), which had good available moisture. Less important species included black walnut and red elm. On drier sites, white oak dominated, with Northern red oak, chinkapin oak, and shagbark and pignut hickories as associates. A third community, one of minor extent, existed on shallower Randolph series (Romeo) soils, with an association of hackberry and blue ash, with less abundant beech and red elm, sugar maple, chinkapin oak, and Eastern hophornbeam as subdominants. The authors thought that the original forests on the island were predominantly sugar maple and hackberry, with very little oak or hickory.

One of the early phytogeographic approaches in the New York area was The Development of the Vegetation of New York State (Bray 1930). The Lowland Plain, Zone B, consisted of chestnut, oak, hickory, tulip tree, poplar, and other species. The Upland, Zone C, was characterized by sugar maple, beech, yellow birch, hemlock, white pine, and other species. Bray believed that the development of vegetation was influenced by the substratum and the resulting influence of the vegetation upon the substratum; the description of the successional stages followed by vegetation was a major contribution to the field. On the Lake Plain, the stages went from marsh plants to marsh meadow to marshy shrub or swamp shrub consisting of willows and alders. Swamp forest of red maple, black ash, and elm followed and, finally, a climax forest of maple, beech, birch, hemlock, and white pine was established. The action of vegetation upon the substratum was noted as critical. Two major types of successionals were noted: one where there was an excess of moisture and one where the soil was droughty.

In the first case, aquatic vegetation was followed by marsh vegetation, which invaded at approximately the mean water table. At high water, these plants were submerged; at low water, they were exposed. The next stage occurred where the soils were habitually exposed, leading to the formation of mineral soil and the establishment of a marsh meadow stage consisting of grasses and sedges. During the swamp shrub stage, alder thickets invaded along with the following shrubs:

Dasiphora fruticosa
Myrica gale
Rosa carolina
Cornus stolinifera
Nemopanthas mucronak
Viburnum cassinoides
Aronia melancarpa
Vaccinium corymbosum

The swamp forest stage formed as trees that became established began to mound earth within the swamp land, creating locally drier sites. The dry soil sequence differed in that, originally, sand deposits with very little organic matter established heath shrub and blueberry. By gradual conditioning of the soil, other species became established, including white pine, oak, chestnut, and tulip tree.

A survey of the vegetation in and around the Niagara Region described habitats of many of the important tree species (Zenkert 1934) as well as some of the postsettlement vegetational changes. Chestnut was originally common on the morainic slopes and ridges, as well as on the sandy soils in the wooded tracts along Lake Erie (old beach ridges?). Beech was described as shunning limestone areas in which the topsoil was too thin. Butternut was common in the rich woods and on bottomlands, black walnut was rather common in the same habitats. Shagbark hickory was common and abundant; pignut hickory was abundant in dry to damp woods, while bitternut hickory was localized in wet woods and low, damp ground. Finally, the American elm was distributed on clayey or calcareous soils on low ground. On moist to dry sandy shores, the following herbaceous species were noted as characteristic:

Corispermum hyssopifolium
Cycloloma atriplicifolium
Salsola Kali, var. tenuifolia
Cakile edeniula, var. lacustris
Polanisia graveolens
Lathyrus maritimus, var. glaber
Strophostyles helvola
Euphorbia polygonifolia
Physalis heterophylla
Agrostis alba, var. maritima
Ammophila breviligulata
Triplasis purpurea
Cenchrus pauciflorus
Elymus riparius
Elymus canadensis
Eragrostis Purshii
Eragrostis cilianensis
Sporobolus cryptandrus
Cyperus Sweinitzii
Cyperus erythrorhizos
Carex communis
Carex radiata

The presettlement forest composition of Cattaraugus County was reconstructed using original land-warrantee survey information and some reconnaissance of still virgin tracts (Gordon 1940). The land surveys took place between 1798 and 1809. Cattaraugus County is located mainly within the glaciated part of the Allegheny Plateau. In addition to the preparation of a presettlement vegetation map, Gordon attempted to correlate forest composition with soil types. The oak-chestnut association consisted of white oak, red oak, chestnut oak, chestnut, and black oak (which included Northern red oak). In mixed mesophytic forests, red oak, beech, chestnut, red maple, black birch, white ash, and black cherry dominated. Shrubs were important in the understory. Mixed mesophytic forests were located on wetter sites than were the oak-chestnut associations. Beech-sugar maple forests lacked hemlock and yellow birch, but contained basswood, beech, sugar maple, white ash, black cherry, and white pine as dominants. Hemlock-beech occurred as a variety of the beech forest; it differed from the mixed mesophytic forest in that it lacked undergrowth. Bottomland hardwood forests included cottonwood, sycamore, American elm, silver maple, black willow, and butternut. On flats in the floodplain and in swamp forests, the white pine-American elm association predominated. On the wettest sites in peat bogs, a black spruce-tamarack association was found. With respect to correlation of vegetation with soils, Gordon made the following observations. Podzols (Tionesta series) tended to support hemlock, white pine, red maple, cherry, beech, and cucumber. The DeKalb series correlated with the hemlock-beech association and with yellow birch, water beech, and American elm. The well-drained DeKalb silt loams tended to support a mixed mesophytic forest, while the podzolized Volusia series supported hemlock, beech, sugar maple, yellow birch, basswood, and white pine. Canfield, a better-drained series, supported sugar maple, basswood, white ash, hophornbeam, and black cherry. Wooster, the best drained morainal soil, supported a hardwood dominant forest.

Braun's (1950) beech-maple forest region continued uninterrupted from Ohio into Pennsylvania and New York but there were some differences noted for the margins. In New York State, the upland had affinities to the oak-chestnut region, but was separated by the Allegheny Plateau. There were more northern bogs and bog communities with northern conifers present, including northern white cedar, tamarack, and white pine.

2.5.1.2 Utility of Descriptive Data

The previous section is useful in identifying tree species and understory species present in the presettlement forests of the study area. Information was also presented about trends in the association of individual tree species including where these tree groups were likely to occur on a particular kind of landform in the lakeshore area of Ohio, New York, and Pennsylvania.

The creation of species lists and distributional trends is important to developing a working model that can be used to reconstruct the forest cover for a site-specific area. When combined with other paleo-ecological data, the information in this section can also be used to generate vegetational patterns for these same sites for earlier periods of time.

2.5.2 Inventory of Tree Species

An inventory list of tree species that would have existed in the three-state project area along the lakeshore in 1800 is presented in Appendix E. The specific locations of each species and its association with other combinations of trees would have depended upon the environmental conditions of a given site.

2.5.3 Factors that Determine Vegetation

Most of the literature reviewed for this study based the reconstruction of original forest vegetation on the explicit variables that the authors thought controlled most of the variation within the particular survey areas. Although there were a wide variety of forest and vegetational settings, only a few parameters were emphasized by most of the authors as determinants of forest type. The most important parameters included soil, drainage, geology, topography, and aeration. Other, less important, parameters were historical and successional, light, local exposure, and intercompetition with other species.

2.5.3.1 Soil

Early studies often looked for the correlation of soil types with forest types. The mixed mesophytic forest of northeastern Ohio was thought to be correlated with Wooster and gravelly loams, Volusia loam, and Dunkirk sands, soils with good internal drainage and with adequate soil moisture (Sampson 1930b). At the same time, caution in using soil types was claimed in that soil type actually reflects a complex of factors and may not delimit the single most important factor (Sampson 1930a). In addition, more than one forest type was often found on a particular soil type. In retrospect, much of the problem with soil type-forest type correlations lay in the inadequate detailing of both. More recent soil series probably correlated with older soil types in degree of specificity. Second, the incorporation of several factors acting to produce a particular soil type can be useful in that soil can be a single best measure of the interaction of the important factors. Other authors have used soils to indicate forest types. Gordon (1940) found podzols, such as the Tionesta and Volusia series, to be correlated with the hemlock-pine-northern hardwood forests in Cattaraugus County. Mixed mesophytic forests were found on the well-drained DeKalb silt loams; DeKalb generally produced hemlock-beech-birch-elm forests. An ash-sugar maple-basswood forest was located on Canfield soils, which were well drained. Hardwood forests were dominant on the best-drained morainal soils, the Wooster series.

2.5.3.2 Drainage and Soil

Drainage and soil have been used in tandem to reconstruct vegetation (Sampson 1930a and b; Shanks 1953; Williams 1949; Braun 1950). In a study of the relationship of soils to vegetation in Ashtabula County, Gordon (1969) constructed a model with varying drainage and vegetation according to specific soil series (Table 2.8). More specifically, fragipans were associated with beech-sugar maple, while podzolized soils were associated with yellow birch and hemlock. The most ambitious attempt to correlate soil to vegetation was attempted for the state of Indiana, using original land-warrantee survey data and modern soil-survey reports (Lindsey, Crankshaw, and Qadir 1965). By superimposing early land warrantee surveys over modern soil maps, each witness tree could be located on a particular soil type; in all, more than 70,000 trees were located on 357 soil types. The large number of soil types was concatenated to 87 by using a soil catena and drainage-aeration profile. It was found that topography and surface texture played an important role. For example, Crosby silt loam supported a beech-maple forest, while Crosby loams supported a mixed forest, and Crosby sandy loam led to the oak-hickory forest. Parent material was also important. Soils from chert-free limestone or from Wisconsin glacial drift were associated with beech-maple. Chert limestones of Illinoian drift were associated with mixed forest, and loess and sandstone and shaly material was associated with oak-hickory. Soils within a given catena tended to be more optimal for the development of one of the three main forest types. In summary, the study claimed that

> It seems clear, then; that soil texture, drainage profile, and catena-related attributes of substrates all exert a strong influence in determining forest types in Indiana and that, while one or the other may be effective in particular cases, we cannot attribute overwhelming influence to any one of them, in general (Lindsey, Crankshaw, and Qadir 1965:160).

Table 2.8. Drainage-Soil Model for Vegetation in Ashtabula County[a]

Forest Vegetation Types	Swamp Forest	Beech-Sugar Maple Wet Beech	Mixed Mesophytic	Oak-Hickory	Chestnut-Oak
Drainage Class	Poorly Drained	Somewhat Poorly Drained	Medium Well Drained	Well Drained	Excessively Drained
Soil Series	Frenchtown Sheffield Kingsville Atherton Canadice Conneaut Swanton	Venango Platea Red Hook Caneadea	Cambridge Pierpont Williamson Elnora Claverack Braceville	Chenango	Colonie Otisville
Habitat Classes	Wet	Wet-Mesic	Mesic	Dry-Mesic	Dry

[a]Source: Gordon 1969 (Ohio Biol. Surv. Bull., n.s. Vol. 3, no. 2; reproduced by permission of the Ohio Biological Survey).

In a witness-tree survey of Shelby County, western Ohio, Shanks (1953:464) also emphasized the importance of soil properties, noting that "shifts in forest composition from one major soil area to another were due to soil moisture and aeration changes and competitive interrelationships of species."

2.5.3.3 Geology

Geology has also been an important associate variable for forest reconstruction, both by itself and as related to parent material in soil formation. Similarities between the glacial geological map and vegetation map of Ohio were suggested by Forsyth (1970). In the areas within the survey region, a mixed oak (dry) prairie was correlated with the limestone bedrock high, with some sand. Swamp forest, characteristic of the western part of the survey area, was correlated with very flat land with very clayey till. The predominant beech-maple forest was associated with the Wisconsin till plain, especially ground moraines and end moraines. The mixed oak (wet) forest of northeastern Ohio was associated with very flat land with lake clay and silt. The mixed mesophytic forest in Ohio was associated with the Appalachian north-facing escarpment (sandstone) cut by deep valleys. Individual tree species were also conditioned. Dry oaks, such as white oak, black oak, chestnut oak, and scarlet oak, were found in areas of abundant sandstone bedrock exposures or on hilly, well-drained sand and gravel deposits such as kames. Wet oaks, such as pin oak and swamp white oak, were on poorly drained clayey till plains of western Ohio. In the Black Swamp, the clayey soils with extremely flat ground provided the basis for the swamp forest, but where the glacial lake had left sandbar deposits, oak openings were found. On the dolomitic rises of Wood and Ottawa counties, an unusual mixture--including chinkapin oak, blue ash, black walnut, and hackberry--predominated. In the Islands areas, sugar maple was added to this mixture.

2.5.3.4 Aeration

Drainage and aeration are both indices of soil moisture conditions. Although well-drained soils can be poorly aerated, while poorly drained soils may have good aeration, this is not usually the case. In the swamp forest of western Ohio, the soil moisture gradient was estimated using slope and elevation of low ridges and knolls (Sampson 1930a). While this would be a reasonable estimator for the lowland forests in the western area, it would not be as accurate for the uplands. Brown (1917) found that soil moisture conditions were strong indicators of forest type. In the glacial till plain, aeration, drainage, and topography are the important indices for forest type (Braun 1950).

In some cases, forest vegetation conditions the soil moisture setting; different forms of vegetation can result in different moisture regimes (Sampson 1930a). Especially in the western area, trees can act to improve the aeration in the soil. It is hypothesized that subsequent generations of elm, wet maples, and blue beech transformed marshy soil conditions to somewhat poorly drained conditions, amenable to beech and sugar maple. One can only guess at the historical factors that transformed one marsh into a forest and left another marsh to remain as such. Random processes no doubt acted upon the landscape, and it is only in general that the successions from elm swamp forest to beech-maple to oak-hickory have taken place on the landscape. For a reconstructed vegetation at year 1800, the changes to the soil moisture conditions are not overly important. In trying to reconstruct the vegetational history since the Pleistocene, successional changes on the landscape become critical in a small-scale reconstruction.

2.5.4 The Forest in 1800: A Model

This section presents a reconstruction of the forest setting along the lakeshore in 1800. The study area lies within a band along the lake that is about 8 mi. wide and included in the 60 map units listed in Appendix B. The descriptive material presented in this section is subdivided into six subsections, each of which concerns a different forest that is projected into a locational setting.

The forest associations reconstructed for these seven locations (see Fig. 2.5) reflect the interplay of the factors discussed in the previous section that are known to affect forest composition and the inventories of tree species that were historically observed in the area and described in Section 2.5.1.

2.5.4.1 Glacial Till Plain

The vast majority of the forest in the survey area was of the elm-ash-soft maple type, with American elm, black ash, red and silver maple, and cottonwood as the major species. The topographic conditions for this forest are in poorly drained lowlying contexts (Fig. 2.25). As one approached the lake, successively more poorly drained positions were encountered: first came an elderberry-willow-buttonbush association, then a grass sedge (wet) meadow, and finally a cattail-bullrush marsh along the lakeshore. Away from the lake, on high knolls on the plain and on sloping ground, the forest changed to a burr oak-big shellbark hickory association or a red oak-basswood association. On

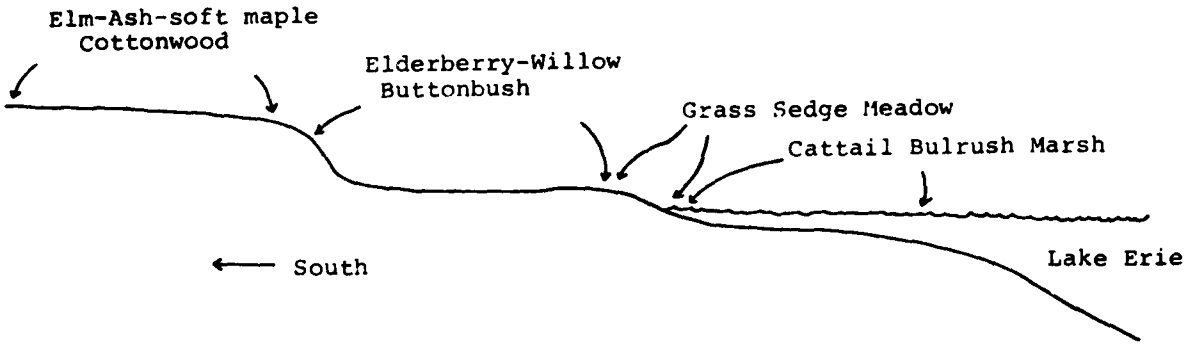


Fig. 2.25. Vegetation Associations of the Glacial Till Plain. Source: Gordon 1969 (Ohio Biol. Surv. Bull. n.s. Vol. 3, no. 2; reproduced by permission of the Ohio Biological Survey, The Ohio State University).

the richest, most fertile ground, where there was outwash of gravelly till, a tulip tree-black walnut association could be found.

2.5.4.2 Western Ohio Lowlands

There were essentially two components to the western Ohio Lowlands: the true lowlands composed largely of a mixed mesophytic forest and an area in which the dolomitic highlands came practically to the water's edge. In the true lowlands, the American elm-red maple-black ash association dominated the wetter sites. Associated were slippery elm, burr oak, swamp white oak, and bitternut hickory. On the better-drained areas within the lake plain, red oak, white oak, tulip tree, and white ash could be found. On the beach ridges, three different associations could be found as one traveled east (Sampson 1930a). Toward the eastern part of Sandusky, sandy ridges contained beech and tulip tree. At Erie County, oak-chestnut and oak-hickory were the dominant associations. From Berlin Township to the east, beech-maple forests could be found on the beach lines, with oak-chestnut and oak-chestnut-tulip tree on the driest sites. Basically, wherever limestone outcrops occurred, chestnut would not be found. Because the associations on the dolomitic outcrops are closer to upland types, a discussion of these will be deferred until the section on Glacial Till Uplands.

2.5.4.3 Eastern Ohio Lowlands

The lake plain would have been very similar to that of the Western Ohio Lowlands, with the exception that hemlock began to be an important species in the eastern end of the eastern Ohio lowlands. Beach ridges would have comprised beech-maple-hemlock forests. And black walnut was replaced by butternut in bottomlands and rich woods.

2.5.4.4 Southwestern and Western New York Lowlands

These areas had essentially the same forests as did the Glacial Till Plains and western Ohio Lowlands. Most of the lake plain was very homogeneous along much of the south shore area (Braun 1950). To the east, increasing proportions of butternut, chestnut, and hemlock would probably have been the only quantitative differences.

2.5.4.5 Glacial Till Uplands

Geologically, the Glacial Till Uplands included not only the south shore region, but the Islands area in western Lake Erie as well (Hamilton and Forsyth 1972). The Glacial Till Uplands could be divided into areas where limestone outcroppings formed the predominant landscape and an area controlled by glacial till. In the high limestone areas, the overriding factor was the high lime content and the fertile soils that this produced. Species that do well with high pH, such as black walnut, hickories, and oaks, flourished. On wetter sites, a wet oak association dominated. These oaks included pin oak, swamp white oak, and burr oak. Bitternut hickory was probably an important constituent. On slightly drier sites, shagbark hickory, chinkapin oak, blue ash, black walnut, and hackberry were important. On the driest sites, white oak and red oak, with some black oak, would have been found. In the Islands area, an area with highly calcareous soils, an oak-sugar maple association would have been dominant. Other important species would have included black walnut, white oak, red oak, black maple, sugar maple, white ash, red elm, basswood, and black cherry. An alternate hypothesis of the vegetation suggests that oak was not abundant in the Islands area. This hypothesis suggests that a sugar maple-hackberry association would have dominated on deeper limestone soils and a hackberry-blue ash association on shallower limestone soils (Hamilton and Forsyth 1972). White oak would have been found on drier sites along with red oak, chinkapin oak, and assorted hickories as associates.

The rest of the Glacial Till Plain, away from the high limestone ridges, would have supported a poorly drained adapted forest. Much of the area would have contained American elm, black ash, and silver maple. On better-drained sites, beech, tulip tree, white ash, basswood, cucumber, and tupelo would have been found, and, on the driest sites, such as on beach ridges, a white oak-black oak-shagbark hickory association would have been dominant.

2.5.4.6 Allegheny Plateau Uplands

The large Allegheny Plateau Uplands was a region of strong relief; several subdivisions are needed to sufficiently describe the area. From the west to the east, there was a dividing line near the Ohio-Pennsylvania border that marked an increase in annual precipitation. To the east of this line, hemlock became a very important tree, along with white pine and other species in the hemlock-white pine-northern hardwoods forest type (Braun 1950). To the west of this line, beech-maple upland forests were dominant. Scattered throughout the region were mixed mesophytic forests. It is sometimes hard to isolate these mesophytic forests from the hemlock-white pine-northern hardwoods forests in that they tended to intergrade into each other. The beech-maple forest was mainly composed of American beech and sugar maple, with an understory of red maple; it was ubiquitous in northeastern Ohio areas associated with moist, but not wet, sites. Associated with the beech-maple forest were tulip tree, white ash, cucumber, and tupelo. Under imperfect drainage or low topographic position within the uplands, a swamp forest containing elm, black ash, and red maple associated with swamp white oak, bitternut hickory, and basswood developed. In more mesic situations, such as on north-facing slopes and in coves, a mixed mesophytic forest could be found. Principal species were beech, sugar maple, black maple, red maple, tulip tree, magnolia, chestnut, white and red oak, and white ash. Further to the east, hemlock became important in the mix.

In southwestern New York, the addition of hemlock and white pine to the forest gave it a distinctive character. For this reason, Braun (1950) chose to define this forest as another forest region, the hemlock-white pine-northern hardwoods forest type. Moist sites still had the characteristic beech-maple forest, but on wetter sites, a hemlock-beech association formed. In the poorly drained flats, a white pine-American elm association could be found. Chestnut, birch, cucumber, white and red oak, cherry, sugar maple, and ash were all constituents of this forest. In peat bogs, black spruce and tamarack were also common.

2.5.5 Paleovegetation and Paleoclimate

In the previous section, a model that characterized the 1800 vegetation along an 8-mi. corridor of the lakeshore was presented. However, this is a static model characterizing regional subareas for only one point in time. During occupation of this area, the environment was cyclic and large- and small-scale differences are expected to have occurred. Important changes that would modify both the assumptions underlying the model that identifies the species in any given area as well as what the physical environment supporting these species was like may have taken place since the end of the Pleistocene. Questions of vegetational and and climatic history have been traditionally addressed through the analysis of pollen samples from stratigraphic contexts. Changes in glacial geology and soils have already been discussed. If it is possible to detail the vegetational and climatic history of the region, then it is theoretically possible to reconstruct the forest vegetation in any region at any point in time; this can be done by using the palynological evidence combined with the analogical use of historical inventories.

2.5.5.1 Palynology

Palynology, the study of pollen, is the main base on which paleovegetational and paleoclimatic reconstructions rest. Used cautiously, it can give valuable insights. Still, there are a number of assumptions associated with pollen analysis that have recently come under question. These assumptions are critical to the traditional theories of vegetation and climatic reconstruction. Whether or not these assumptions are being violated is being openly debated at present.

Pollen rain settles on a lake, drops to the bottom, and is sealed by lake sediment. At the precise location of the sediment core, the sample could be representative of the pollen rain. But pollen rain does not derive from the vegetation in a one-to-one correspondence. At this point, it is only safe to assume that the pollen rain derives from the vegetation in a systematic manner, with some species-specific uniformity.

Janssen (1966) defined three kinds of pollen rain: local, extralocal, and regional. Local rain included only the immediate vegetation close to the sampling point. Extralocal was defined as pollen from species on slopes and uplands near the site.

Janssen concluded that only regional pollen could register climatic change, as both local and extralocal pollen could be greatly affected by immediate conditions. By comparing groups of pollen samples from current stands in Minnesota, he demonstrated that the regional rain was fairly stable, but that there was a slight overrepresentation of pine and oak and an underrepresentation of spruce. He concluded that not only must the regional rain be the unit considered, but that it was also important to consider other species in pollen competition as well as the production and dispersal mechanisms.

Miller (1973) also used local pollen rain to attempt to correct for under- or overrepresentation of species through their pollen production. His R values, a kind of fudge factor, corrected the pollen percentages by a factor that represents each species' pollen production tendencies. He also attempted to compute R values for species in late presettlement times, using the pollen cores from his samples dated to the period along with the reconstructed vegetation from the original land-warrantee surveys. His results showed a consistent trend: birch, pine, hemlock, oak, and elm were overrepresented in the pollen profile; beech was proportionally represented; poplar, maple, hickory, ash, and basswood were underrepresented.

A second critical issue, one which has sparked a vigorous controversy, is that of determining how vegetational change reflects climatic change. Changes in pollen percentages and species composition could relate to changing moisture and temperature ranges, which would allow some species to thrive and would cause others to be restricted. An interruption in the natural succession of the forest into a previously deforested area (such as the deglaciated part of Ohio) could also be a symptom of climatic change. An early position on this was developed for northern Ohio (Sears 1942b). Undisturbed forest sequences appeared to have followed a progression toward increased mesophytism. Yet Sears noted two time periods during which there were retrogressions. He suggested that this was due to improper moisture balance, although any of three factors--space, light, or moisture balance--could have resulted in this phenomenon. "A less favorable water balance might produce just this result. Beech is noticeably sensitive to drought. Apparently the most reasonable explanation of the observed retrogression lies along this line" (Sears 1942:76).

In the ideal, tree species have climatic limits to growth and best development. Outside these limits, the species would either not be found or would be greatly reduced in number. One of the problems with using this assumption is that a great number of species are adapted to a wide variation in temperature and precipitation (Fowells 1965). In addition, there are at least three other possible mechanisms that could account for changed vegetation percentages: genetic change, disease, and succession. The decrease of hemlock around 5000 B.P. has been hypothesized as possibly due to disease, rather than to the start of the xerothermic, as is usually thought (Davis 1967b; Miller 1973:77). Wright (1976b) argued that much of the vegetational change in eastern North America was due to differing migration rates of tree species into areas deforested by glaciation and not to climatic change. Given the fact that there are several arguable assumptions in palynological interpretation, which will again become important in the interpretation of the climatic history of the survey region, it is still possible to address the literature with a healthy skepticism.

The work of Paul B. Sears and his students, which has dominated the palynological literature, provides virtually all of what is known about the paleovegetation of the survey area. Sears's original five-part sequence is no longer in common use, but the general synthesis of events has long been accepted. Stage I was a period of a spruce-fir association, dated to the Late Wisconsin. Stage II was defined by a pine maximum, with some oak and hickory entering the profile. Stage III showed an increase in beech, and was described as reflecting increasing mesophytism. Stage IV was characterized by an oak-hickory maximum and has since been labeled the xerothermic, hypsothermal (Deevey and Flint 1957), or altithermal. Finally, Stage V was characterized by the resurgence of beech. Stages II and IV were considered periods of retrogression, characterized by a probable decrease in available moisture to plants.

Potter (1947) analyzed the pollen profiles of several bogs in northcentral Ohio, including six in counties adjoining Lake Erie. The data was analyzed only for arboreal genera: Abies, Picea, Pinus, Tsuga, Betulaceae, Fagus, Quercus, and Carya. The New Haven Bog (#12) was incomplete and late, but the Peru Bog (#13) showed Sears's Stages I and II. Early in the sequence, there was only spruce and fir, but, before the pine maximum in Stage II, hemlock, beech, birch, oak, and hickory were noted. The period after the pine maximum was truncated from the profile. The New Holland Bog (#14) also showed this sequence from Stage I to II. The Hartland Center Bog (#15) showed Stages I and II in more detail, but again was truncated after the pine maximum. The best profile came from Camden Lake Bog (#17). Stage I showed spruce and fir, with some pine. The pine maximum was noted briefly in the profile. With the elimination of fir, came the establishment of oak, hickory, and beech. The beech maximum of Stage III was visible as well as the oak-hickory maximum of Stage IV. During Stage IV there was also a decrease in beech. The final profile in the lakeside counties, which came from Birmingham Bog, also showed a sequence from Stages I to IV. This profile differed from the others in that spruce remained during the pine maximum; there also seemed to be a small oak maximum at the end of Stage II as well as during Stage IV. Potter synthesized these and other profiles into a general sequence for northern Ohio (Fig. 2.26). Period I was characterized by a spruce maximum, with some pine, oak, and fir. Period II was a pine maximum with some spruce, more oak, and some birch. Period III was the beech maximum, with some pine and birch but no spruce; beech, oak, and hickory were also present in fair quantities. Period IV, the oak-hickory maximum, contained oak and hickory in quantity, along with some pine and little beech. Period V, the present, had less oak and hickory, but much less beech and more birch. In general, this sequence supported the Sears scheme.

The Soden Lake, Michigan, profile also generally followed the Sears scheme (Cain and Slater 1948). A complete sequence taken in 6-in. intervals showed the pine maximum, but there was no pronounced xerothermic Stage IV. Stage V also was barely visible in the profile.

2.5.5.2 Review of Literature on Dated Pollen Profiles

The radiocarbon revolution provided the opportunity to tie stages or changes in the pollen sequence to absolute dates. Typically, radiocarbon dating was first used to date highly diagnostic perturbations in the profile,

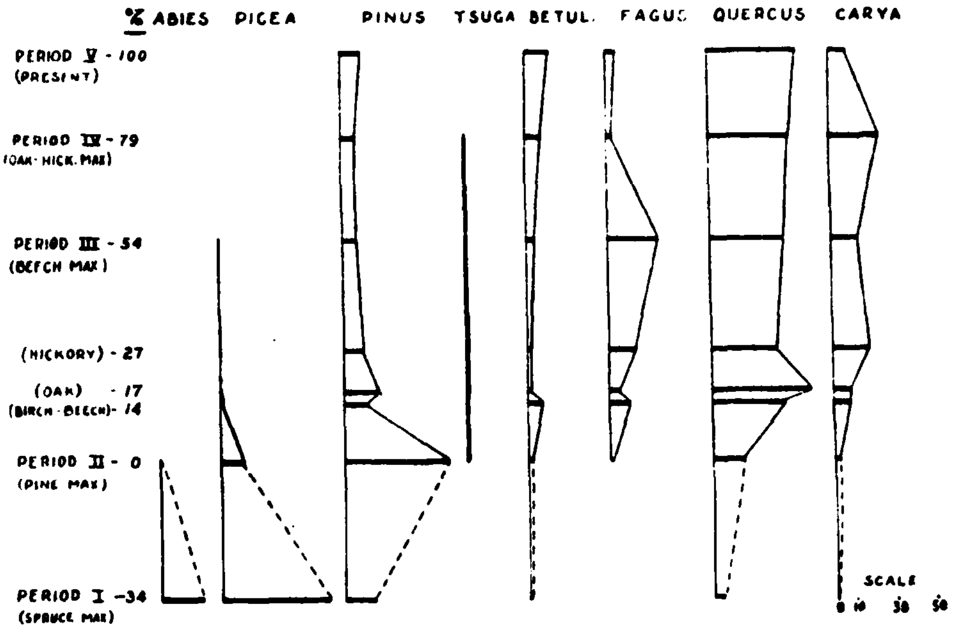


Fig. 2.26. Synthesis of General Sequence for Northern Ohio. Composite bog profile of five complete bogs. The average percentage distance between the pine maximum and the top is given for each principal period of maximum and for three lesser periods of Betulaceae, Fagus, Quercus, and Carya. Source: Potter 1947, 411.

such as the pine maximum or the oak-hickory maximum. Three bogs in the Hartstown Bog area of northwestern Pennsylvania were analyzed for pollen: Crystal Lake, Mud Lake, and Dollar Lake (Walker and Hartman 1960). A radiocarbon date of 9310 % 150 B.P. located the pine maximum in the Crystal Lake profile. Another date at a lower level (39 ft.) was recent and was rejected as being contaminated. Crystal Lake, the most complete profile, generally supported the Sears sequence: an initial fir-spruce maximum with some oak and pine, followed by a pine maximum, then an oak-hemlock maximum with increased beech. Next came a beech-oak stage accompanied by hickory and basswood and a decrease in hemlock. Finally, there was an increase in pine and hemlock, with a decrease in oak and beech. The differences were in a long pine maximum, and also in that pine remained an important part of the vegetation throughout the sequence. During the xerothermic period, a significant decrease in hemlock was noted; there was no corresponding increase in oak and hickory. This pattern appeared in other New York and Pennsylvania profiles. Based on the presence of Graminae and other open ground genera, the possibility of an initial park-tundra type of vegetation was hypothesized, beginning at around 13,500 B.P. Shifts in spruce and fir may have been due to ice advance and retreat from the Valders stage. The fir maximum was dated around 11,000 B.P., based on the extrapolation of the sole radiocarbon date with the surface level, dated as A.D. 1900. The entry of hemlock at the apparent expense of pine was thought to have been successional behavior. Sears's oak-hickory maximum showed a marked increase of birch, maple, basswood, willow, and elm, with a slight increase in chestnut and ash. This mix corresponds well with the prairie peninsula in Indiana today.

A truncated profile at Sunbeam Prairie Bog, in west-central Ohio on the Indiana border, showed the spruce "collapse" to have occurred around 10,600 B.P. ± 150 (L-550B) (Kapp and Gooding 1964). At that time there was a jump in pine, oak, hickory, hornbeam, and birch percentages. There was no evidence in the profile for the effects of the Valders ice advance, which occurred within the time span of the profile.

At New Paris Cave, in western Pennsylvania, only one pollen profile was recorded (Guilday, Martin, and McCrady 1964). The profile from Sinkhole Number 4, at an elevation of 1500 ft., came from a well-drained upland habitat. Containing a Late Pleistocene sequence predating 11,300 B.P., the profile showed jack pine, spruce, sedge, and grasses indicative of an open boreal woodland. There was, however, more pine and less sedge pollen than at Cranberry Glades, a bog some distance to the south in western Virginia. The authors very clearly stated that the reconstructed Late Pleistocene vegetation was not pure tundra.

Silver Lake, a bog in Logan County, Ohio, is located 7 mi. southwest of Bellefontaine, at an elevation of 1090 ft. Two pollen cores were taken, one for analysis and one to provide radiocarbon dates (Ogden 1966). In all, 13 dates were taken and, through averaging and correction for contamination, a series of dated phases were derived. Three basic zones were noted in the pollen profile: spruce-fir, transitional, and deciduous. No attempt was made to use the subdivisions created for other areas. Zone 1, the earliest level, was interpreted as a black spruce forest type. Evidence of sedge and grass pollen, along with other open-country indicators, such as Saxifraga oppostifolia and Polygonum bistorta, supported the notion of a tundra-like vegetation early in Zone 1. Ogden believed, however, that identification of individual species was difficult and that the evidence for a tundra phenomenon was equivocal without fruits or seeds. No radiocarbon dates exist for that level. Zone 2 was interpreted as a return to open-country conditions, with a decrease in tree pollen and a collapse of the spruce forest. Zone 3a, beginning at 9800 B.P., marked the elimination of spruce from the area and an initial maximum of elm, hornbeam, and hophornbeam, followed by a beech and walnut maximum. Zone 3b, from around 4400 to 1310 B.P., showed a minimum of beech with a hickory maximum. Zone 3c showed a wide variety of species, including oak, hickory, beech, ash, elm, maple, walnut, sweetgum, cherry, and basswood. Ogden thought that this pollen variety could have resulted from drier oak-hickory uplands mixed with northern slopes of beech-maple forests. Zone 3d, marked by the influx of Ambrosiae, began in A.D. 1780, the onset of the settlement period (Ogden 1966).

An analysis of four small lake basins on the Allegheny Plateau of southwestern New York showed a complete and dated vegetational history for the region (Miller 1973). Protection Bog (elevation 1410 ft.), Houghton Bog (1400 ft.), Allenberg Bog (1620 ft.), and the Genessee Valley Peat Works

(1620 ft.) all showed essentially the same sequence or parts of the sequence following deglaciation. Using Deevey's terminology for the sequence, Zone T appears to have been an herb pollen zone found at the lower levels of Allenberg Bog. Interpretation of this zone was for a par-tundra vegetation. Analogs of the "T" pollen profile were found in a pollen sample from the modern boreal forest-tundra ecotone at Fort Churchill, Manitoba (Miller 1973:59). At that site, white spruce with lesser amounts of black spruce were scattered about the landscape. Jack and red pine were also present in Zone T, and sedge, grass, and herb communities dominated the landscape. Zone A, starting around 12,000 B.P., showed a spruce-dominated forest with variations among the four bogs. Both black and white spruce were in the forest mix. An analogy to the open boreal woodland of central Quebec was made. In addition, jack and red pine with balsam fir and tamarack were found in the arboreal pollen. Miller believed that the small percentages of oak, black ash, hornbeam, and hophornbeam came from protected areas nearby. Zone B began around 10,500 B.P. with the spruce collapse and the influx of white pine. The pine maximum at Protection Bog was dated at 9030 ± 150 B.P. In general, Zone B appears to have been a white pine-oak forest. Miller divided some of his Zone B assemblages into a lower pine-birch and upper pine-oak subzone. The lower subzone was associated with highs in hornbeam, hophornbeam, black ash, and poplar, along with high birch values. The upper part was dominated by white pine and oak, with some sugar maple. The duration of Zone B seems to have been some 1500 to 2000 years.

Zone C-1 began the period of the "modern" forest in southwestern New York. There was a major increase in hemlock pollen in Zone C-1; this appears to have been a successional event, although the mechanisms are in question (Miller 1973:73). The presence of hemlock, beginning at 8500 B.P., was correlated with a stable vegetation that lasted until 4300 B.P. The only long-term changes were steady increases in beech and decreases in oak. Miller believed that the forest was at this time very similar to that just prior to colonial settlement.

Zone C-2 was defined as the interval between the hemlock maxima. The lower boundary of C-2 was abrupt and was dated at 4390 ± 110 B.P. (I-3550) at Protection Bog. The hemlock decline was balanced by increases in beech, sugar maple, birch, oak, and hickory. To a lesser extent, white pine, ash, and hornbeam-hophornbeam also increased. One perplexing fact was the noted increase in mesophytic species such as maple, beech, and sweet birch; such increases do not usually occur during times of warmer and drier climates. Miller (1973) suggested that the entire vegetational change in Zone C-2 may have been due solely to the removal of hemlock. The end of Zone C-2 was indistinct; this is understandable if a succession of hemlock at the end of the period accounted for the shift back to a hemlock maximum. An end date of 1270 ± 95 B.P. (I-3549) was suggested for Zone C-2 at Protection Bog.

Zone C-3a represented the return of hemlock to the forest maximum. In addition, a distinct spruce increase at Allenberg Bog marked a possible shift to a moister and cooler climate. Zone C-3b, the settlement period, was well marked by increases in non-arboreal pollen (NAP) and was dated at A.D. 1800.

Pretty Lake, a eutrophic marl lake in Lagrange County, northeastern Indiana is at an elevation of 966 ft. above sea level (Williams 1974). It is located in the Steuben Morainal Lake Area of the Northern Lake and Moraine

Region. The pollen sequence at Pretty Lake began around 15,000 B.P. with the retreat of the Cary substage. There was no evidence of vegetation prior to 14,300 B.P., and the first vegetation indicated an extremely cold tundra. A Cyperaceae maximum assemblage (Zone 1a) with high NAP and very low pollen rain supported this interpretation. Beginning around 13,800 B.P., spruce, fir, and tamarack enter into the profiles, indicating an open park-like woodland of black spruce (Zone 1b). An analogy was made to the forests around Port Huron. At 13,300 B.P., the Port Huron stage began; this is reflected in the profile in the form of a low total pollen rain, a decrease in arboreal pollen, and a continued fir-spruce-tamarack maximum. After 13,000 B.P., an ash-spruce-NAP maximum was interpreted to indicate a tundra environment (Zone 1c). The upper part of Zone 1c was interpreted to correspond to the Two Creeks Interstadial, which began around 12,600 B.P. and ended at 10,700 B.P. (Ogden and Hay 1968). In the last phases of Zone 1c, the Valders ice advance led to a boreal parkland condition.

Zone 2 (10,652-9 588 B.P.) was characterized by a pine-birch maximum and was considered to be similar to the modern pollen rain from the mixed coniferous-deciduous forests of Ontario. This zone was thought to be the transition period between spruce-dominated and deciduous-dominated forests. Zone 3a (9588-6100 B.P.), called an oak maximum, was thought to have been similar to the maple-basswood forests of southeastern Minnesota. Progressive drying during this period may have led to the establishment of a prairie at some point. Zone 3a was subdivided into three subzones: an older maple-basswood forest, a subsequent prairie or oak savannah, and a younger maple-basswood forest. Zone 3b (6100-4436 B.P.), a beech-elm maximum, reflected a mixed mesophytic forest with less oak. The next zone, Zone 3c (4436-1685 B.P.), the oak-hickory maximum, contained a sharp rise in hickory and oak and a decrease in beech, maple, walnut, and elm. Interpretation was for an open oak-hickory forest. Zone 3d (1685-670 B.P.) was characterized by a beech maximum and a decrease in oak and hickory; there were also slight increases in elm, hornbeam-hophornbeam, and sycamore. The last presettlement zone, Zone 3e (670-150 B.P.), showed a return to oak-hickory and a warmer, drier climate. Zone 3f was interpreted as the European intrusion. In general, the Pretty Lake sequence showed shifts in vegetation due to 1) gradual warming; 2) intermittent dry periods; and 3) differential migration of species. Williams thought that the profile reflected continuous warming from the end of the Valders until 1500 B.P., followed by a cooling trend, and then another warming trend.

Battaglia Bog, a Portage County, Ohio, bog located on Kent Age glacial till, showed an early sequence of pollen for the period 16,500 to 9,000 B.P. (Shane 1975). The bog began its collection of pollen in 16,500 B.P. with the glacial retreat. Located within 30 mi. of the southern glacial margin during Zone 1a, from 16,500 to 13,600 B.P., the profile reflected a cool-to-cold climate with a spruce-fir dominant forest. Shane believed that the low percentages of the grasses Graminae and Cyperacea indicated a lack of any tundra environment at this time. Zone 1b, from 13,600 to 11,000 B.P., reflected fluctuating spruce and birch percentages; this is indicative of an unstable environment. The transition to Zone 1b was radiocarbon dated at 13,640 ± 210 B.P. Zone 2 (11,000-9,000 B.P.) contained the pine maximum, which was thought to have lasted for only a hundred years and was radiocarbon dated at 10,060 ± 160 B.P. Shane suggested that northeastern Ohio may have been a muskeg-like environment at that time, which, upon entering a time of rapid warming and drying climate, dried quickly to produce a rapid hardwood succession with a brief pine stage preceding the hardwoods. Zones above level 2 were obliterated due to previous plowing and draining.

2.5.5.3 Lake Bottom Pollen and Plant Remains

In addition to the paleobotanic information from bogs on the south shore of the lake, there are identified plant remains and pollen from the lake bottom itself. A series of three cores taken in the Central and Western basins shows a complete profile beginning with Sears's Zone I (Lewis, Anderson, and Berti 1966). Zone I corresponded to the spruce maximum, with a brief fir maximum. At the top of the zone, hemlock and tamarack probably invaded along with other hardwood species. Although the Zone II pine maximum is present in the profiles, the subsequent Zone III hemlock and beech maxima are not visible. Instead, there appears to be an initial oak-hickory maxima representative of Sears's Zone IV. In addition, other species such as birch, ironwood, oak, elm, maple, ash, basswood, and walnut appear to increase in percentage in the profiles. Both profiles indicate a Zone V with slight increases in pine, hemlock, birch, beech, and ash; and a decrease in oak, basswood, and walnut. Differences in the Central Basin versus Western Basin cores appear to be evident in less maple, elm, and hickory in the Central Basin cores. This variation may be due to differences in sampling intervals between the two sets of cores or to differences in forest composition. It must, however, be remembered that the Central Basin was under water during much of the sequence (since about 10,000 B.P.), while the Western Basin was not inundated until after 4000 B.P. Differences in pollen dispersion may be discounted in that pine, which is very evident in the core, has a very low dispersion distance (Wright 1952). The two cores probably represent two different classes of phenomena. The Central Basin set represents pollen transported from the south (or north) shore at some distance, while the Western Basin pollen is from the more immediate area. The importance of elm, maple, and hophornbeam and hornbeam in the Western Basin profile is in keeping with the basin's presumed swamp forest vegetation, while the importance of oak, ash, and pine may reflect south shore conditions or pollen transported from northwestern Ontario or Michigan.

Pollen evidence for the Central Basin (from a core southeast of Erieau, Ontario) shows the spruce pollen rise dated at 12,730 ± 200 B.P. (Fritz, Anderson, and Lewis 1975). In the Western Basin, specifically at Pelee Basin, there is evidence for a low level swamp environment at this time (12,650 ± 170 B.P.) (Lewis 1969). The swamp forest evidently remained characteristic of the Western Basin throughout its above-water history. At Terwilliger's Pond at Put-in-Bay, pine and cedar tree stumps and a buried swamp forest dated at 2500 ± 270 B.P. show the persistence of swampy conditions (Stevenson and Benninghoff 1969). In addition to the macrobotanic remains, the late swamp forest environment is supported by the presence of a buried organic solid.

Several authors (e.g., Wright 1971; Bernabo and Webb 1977; and Braun 1950) attempted syntheses of the vegetational history of eastern North America, an area broader than that covered by Sears. What is evident in these reports is the lack of homogeneity in events across an area of that size. One critically argued point is whether or not a tundra existed south of the ice margin during the Late Pleistocene and Early Holocene. Wright (1971) argued the presence of tundra only in New England and northeastern Minnesota during the

Late Wisconsin. During the Main Wisconsin, the area south of the ice margin was dominated by boreal forest, although this forest was not analogous to the boreal forest of today. The situation in North America was unlike that of Europe at this time in that there was no southern mountain mass to act as a barrier to warmer climate; the region in North America was also much farther south than that in Europe. Wright thought it unlikely that a full glacial tundra existed in northeastern Pennsylvania during that time, although he did accede to the idea of tundra-like environments at higher elevations, e.g., 810 m in western Maryland. One problem with the Late Wisconsin pollen records is the high percentages of pollen from thermophilious species, especially in the Great Lakes region.

At the end of the Wisconsin, Wright postulated a strictly warming climatic trend without a major climatic reversal. This was contrary to another opinion which stated that there was a reversal that allegedly resulted from the Valders ice advance at 11,400 B.P. Wright thought that the effects of this trend were not felt in the pollen profile due to the lack of effect the trend had on the climate and, consequently, the vegetation. The early Holocene was characterized by a spruce collapse, where, in a few decimeters of sediment (a few hundred years), spruce percentages drop from 50 to 5 percent in the profile. In Ohio, the spruce was replaced by oak at about 10,500 B.P. Although Wright acknowledges the presence of a warm interval, from 4000 to 1500 B.P., he argued that it probably was not contemporaneous in the Midwest and Northeast. The problems in interpreting the hypsithermal have largely been due to the fact that it was a time-transgressive geographical phenomenon (Wright 1976). In summary, Wright argued for a return to a tripartite phasing, after von Post; a phasing that emphasized temperature rather than moisture.

2.5.5.4 Isopolls and Isochrone Maps

Another approach to vegetational history reconstruction has been the tracing of changing patterns through time via isopoll difference and isochrone maps (Bernabo and Webb 1977). Using data on spruce, pine, oak, herbs, and a birch-maple-beech-hemlock (BAFT) group from 62 pollen cores in the Northeast, Bernabo and Webb mapped out each of the five groups in 1000-year increments from 11,000 B.P. to the present. Although the use of all the available data in percentage form might be suspect, the results appear to be consistent with interpretations for the survey-corridor area identified by the authors in the previous section. Visible in the maps is the time-transgressive nature of the spruce collapse to the northeast (Bernabo and Webb 1977:84). In addition, the maps traced the changes in pine and oak distributions as well as the history of the prairie/ forest ecotone. Most interesting was the history of the BAFT group. During both hemlock maxima, before and after the xerothermic, the boundary line between the BAFT group and the outside fell near the Ohio-Pennsylvania border.

2.5.6 Reconstructed Vegetational History

In attempting to synthesize the available pollen literature to reconstruct the vegetation of the survey area over time, a premium was placed on information that had the following attributes: 1) secure radiocarbon dates for as many periods as possible; 2) both arboreal and non-arboreal pollen in the cores analyzed; 3) geographic proximity or analogical similarity to the survey area; 4) consistency with other profiles within the area; and 5) completeness of the sequence. On this basis, five site-specific studies were chosen as best expressing the situation in the survey area: Pretty Lake, Battaglia Bog, Silver Lake, Hartstown Area, and southwestern New York (Miller 1973) (Fig. 2.27). Only three of the sites--Pretty Lake, Silver Lake, and southwestern New York--showed a complete sequence and sufficient radiocarbon dating.

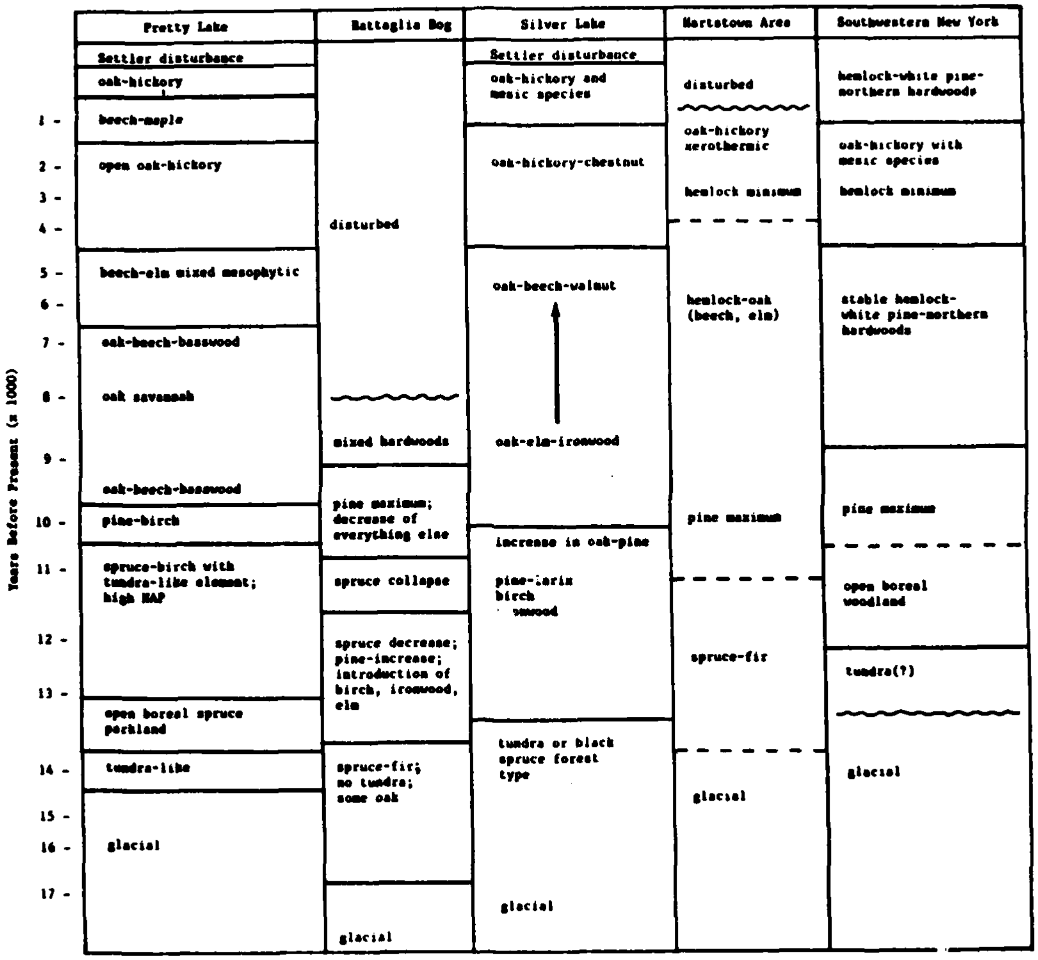


Fig. 2.27. Reconstructed Vegetational History for Five Selected Areas Near Lake Erie. Based on an interpretation of palynological data for the sites. Sources: Pretty Lake (Williams 1974), Battaglia Bog (Shane 1975), Silver Lake (Ogden 1965), Hartstown Area (Walker and Hartman 1960), southwestern New York (Miller 1973).

On the basis of these five studies, and using other available evidence to complete the synthesis (e.g., Potter's 1947 study, which has no dating, but does have reasonable pollen information), two major pollen sequences were worked out. One pollen sequence was constructed for the eastern half of the survey area (to the Ohio line) and one for the western half (Fig. 2.28). In essence, the western half followed the sequence proposed by Williams (1974) for northeastern Indiana, although less emphasis was placed on the presence of tundra vegetation at 13,500 B.P. in the survey area. In addition, the dates were adjusted slightly so that the influences of vegetational change came from the west. Events in northern Ohio were generally placed a few hundred years later than events in Indiana, although great synchroneity appears to be evident at the start of the xerothermic.

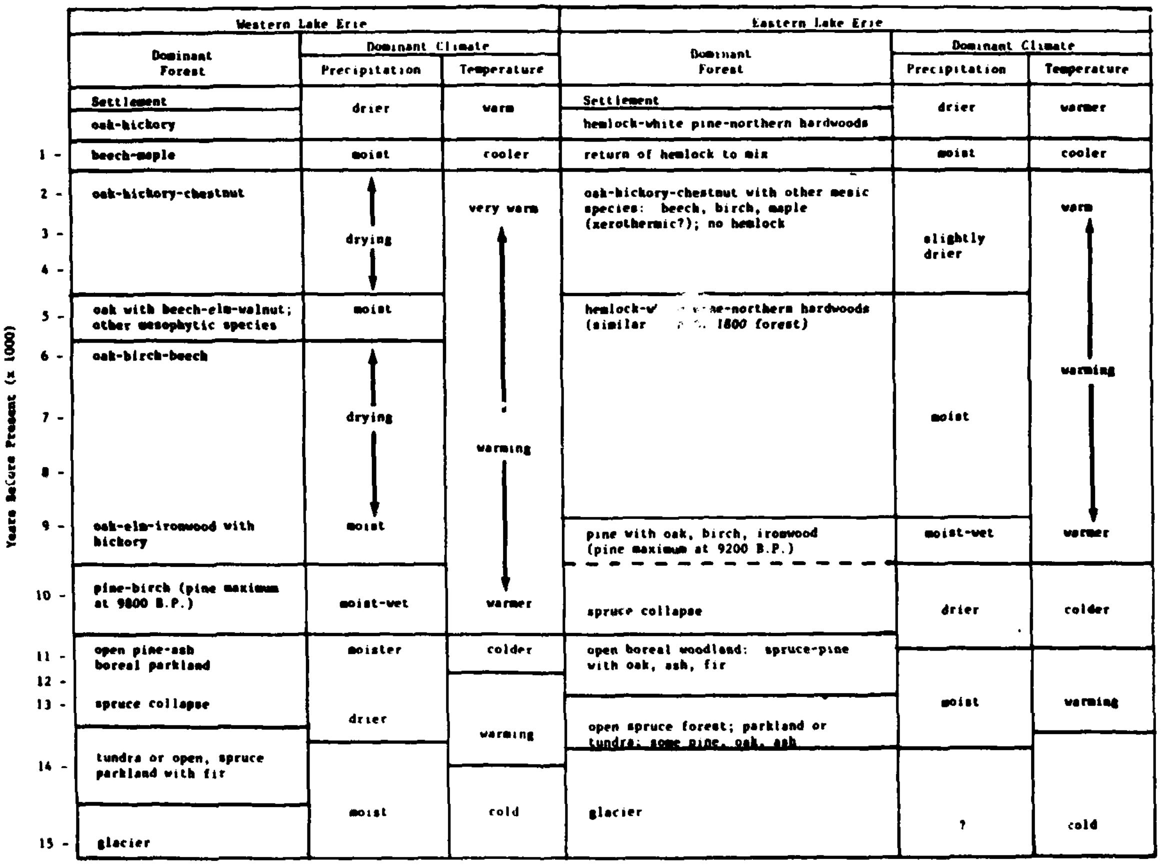


Fig. 2.28. Dominant Holocene Forest and Climate for the Western and Eastern Areas of Lake Erie. Based on an interpretation of palynological evidence. Small percentages of oak and other thermophilic species exist in the pollen profiles at 13,000 B.P. and after.

After deglaciation (around 14,000 B.P.), an open spruce parkland forest established itself in the western area. Associated with this forest was fir (abies) and small percentages of thermophilic species, such as oak. Although the spruce collapse has been dated at around 13,000 B.P., other tree species did not replace spruce. Instead, a period of low pollen rain suggests an open pine-ash boreal parkland; whether this should be classed as tundra or as open country is currently under debate. Wright's argument for open woodland seems compelling. At 9,800 B.P., the pine maximum signaled changes in the environment and the end of the glacial epoch. Birch was an important component in that forest. With the collapse of the pine forest a few hundred years after the maximum, thermophilic species invaded and led to the establishment of an oak-elm-ironwood forest indicative of the kinds of conditions that would have been expected in the area at that time. After deglaciation, the early Holocene environment would have been moist and cool, but warming rapidly. Soils in the area would have been very young, with much standing water. Conditions would have been ideal for an elm swamp forest. Most of the oak pollen from this early period would probably have been from wet oaks. Subsequent drying would have led to the oak-beech-birch forest seen in the profile. Maple would have been an important constituent in this forest. Immediately before the start of the xerothermic, a moister situation would have created a more mesophytic situation as demonstrated by the presence of beech, elm, and walnut, along with oak. The xerothermic in the west probably began at about 4400 B.P. and continued until 1400 B.P. The collapse of the xerothermic at that time would have led to the reemergence of beech with maple and other mesophytic species. Around 600 B.P., a drying of the area brought a return to oak-hickory forests. Settlement was placed at 200 B.P.

The eastern Lake Erie profile is similar to that for western Lake Erie, with two notable exceptions. First, with the singular exception of the start of the xerothermic, the entire sequence lags behind the western half. Second, because of the importance of hemlock and white pine in the region, the nature of the forests differs, although the climatic interpretations remain fundamentally the same. Also, the pine maximum is projected to have remained for a longer period. The eastern Lake Erie sequence closely follows that of Miller's (1973) work. After deglaciation, an open spruce forest parkland or tundra (as claimed by Miller) invaded the area. The spruce collapse is dated much later than in the west, at 10,000 B.P., with the pine maximum at 9,200 B.P. At this point in time, the sequence diverged significantly from that in the west with the establishment of a very stable hemlock-white-pine-northern hardwoods forest, similar in composition to what was found in the area 200 years ago.

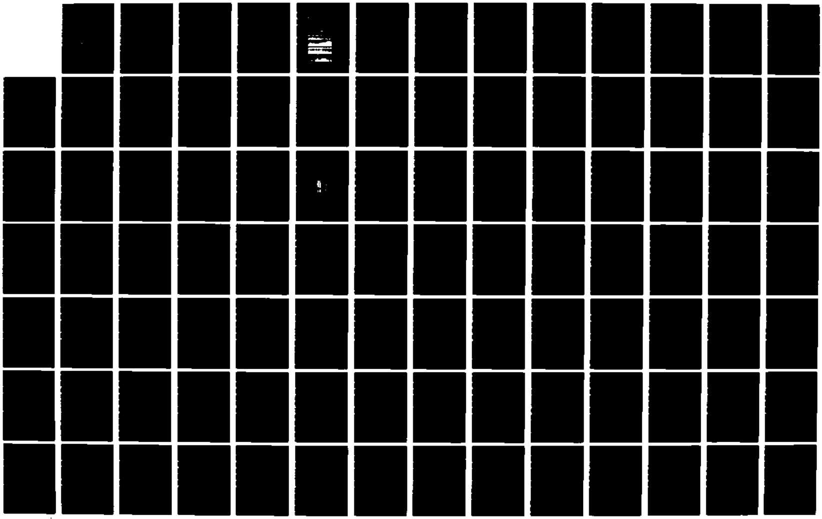
The start of the xerothermic at 4400 B.P. was signaled by a hemlock decline rather than an oak-hickory decrease. The return of hemlock to the forest at 1200 B.P. ended the xerothermic. During that period, oak-hickory-chestnut forests probably co-occurred with beech-birch-maple forests on mesic slopes. A widely diversified forest after 1200 B.P. implies a mixed mesophytic forest condition, changing around 500 B.P. to a hemlock-white pine-northern hardwood forest as described by Braun (1950).

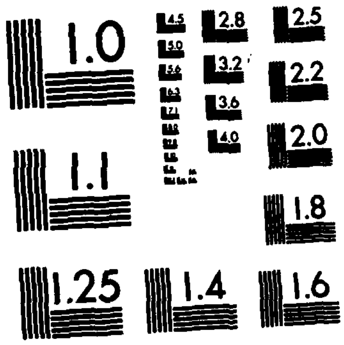
2.5.7 Paleoclimate

Much of the paleoclimatic reconstruction for this region was accomplished through the study of changing plant species in pollen cores. Notable exceptions included the use of isotopic oxygen and carbon in carbonate shells in

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981 2/7

UNCLASSIFIED F/G 5/1 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Lake Erie (Fritz, Anderson, and Lewis 1975) and the study of forest-fire frequencies in north-central Wisconsin (Swain 1978). Interpreting climatic change from pollen requires several assumptions, the most important of which is that changes in species composition reflect climatic changes in the form of temperature and precipitation. Explanation of changes due to succession, wind changes, and disease are not emphasized. Other problems come from the inability to describe pollen on the species level. For example, oak-hickory is usually interpreted as reflecting a warm, dry climate. However, if the oak is chinkapin or swamp white oak and the hickory is bitternut, the moisture conditions would be similar to those found on a river bottom or swamp. Conversely, black oak and mockernut hickory would reflect moisture conditions consistent with a sand ridge. The second major problem with using pollen to reflect climate is that many of the trees used for this type of study can tolerate a wide range of climatic conditions. Oak, hickory, beech, and maple are all found throughout the eastern United States under most relief, elevation, latitude, and longitude conditions (Fowells 1965). It is no wonder that the species that do best in most conditions are also best represented in the pollen profile, and most often used as climatic markers. Finally, pollen, a food source for microfauna, is movable and decays differentially depending on where it falls. The interaction of these factors alone requires careful reconstruction of past events after observation of present pollen cores.

The paleoclimatic interpretations in Figure 2.28 reflect information derived from pollen analysis. The western Lake Erie sequence is essentially that of Williams (1974) for Pretty Lake; the eastern Lake Erie sequence is derived from Miller (1973). In both sequences, from 10,000 B.P. to 1500 B.P., temperatures are seen as warming without interruption. This generally follows Wright (1976a). More important to the vegetational history are the trends in precipitation; tree species apparently tolerate wider ranges in temperature than in precipitation (Fowells 1965). Precipitation also probably played a larger role in prehistoric agriculture in that, with increased rainfall, much of the beach ridge could be cultivated. In addition, the lake plain was well protected against frost so that small perturbations in temperature would have had no consequential effect on agricultural economics.

Recently attempts have been made to tie the climatic changes in specific areas to the overall climatic pattern for the continent (Webb and Bryson 1972). The major argument made is that the climate of a particular spot is regulated by both northerly and southerly air masses. It is the shifting of these jet streams to the north or to the south that produce climatic changes, especially in the Great Lakes (Eichenlaub 1979). The interpretation of the late glacial climate was that it was a colder, snowier, cloudier, and moister environment than today's (Webb and Bryson 1972). There was a more northwesterly flow with four months of southerly flow during the warm season. With the transition at the start of the Holocene, the Pacific south winds became the prevailing air mass during the winter. As a result, the increase in the July mean temperature was three times that of any change during the rest of the Holocene. After 9500 B.P., there was an increased flow of westerly air in central Minnesota and, presumably, the rest of the Northeast. The continuation of this increase led to a maximum penetration of westerly air at 7200 B.P. and a resulting two-inch decrease in precipitation. After 7200 B.P., the westerly flow decreased and precipitation increased. After 4700 B.P., there was little change in the climate; cooler conditions have prevailed for the last 2000 years. According to Webb and Bryson (1972), it is a combined measure of temperature and precipitation that is important for vegetation. The precipitation minus the potential evaporation (effective moisture) changed from a positive 20 in. per year at 16,000 B.P. to 12 in. at 10,000 B.P. It decreased to 2 in. at 8000 B.P. and stabilized at about 2 to 6 in. per year after that.

The dramatic changes at the end of the Pleistocene are indicated in isotopic carbon and oxygen from carbonate shells in Lake Erie (Fritz, Anderson, and Lewis 1975). After 12,500 B.P., the higher O^{18} content of the shells indicate either a climatic improvement or higher evaporation rates from a rather shallow lake (Central Basin of Lake Erie), or both. If the increase was strictly due to a climatic improvement, the average annual land surface temperature would have increased on the order of from 7 to 10 degrees Celsius. Isotopic data also supported a climatic maximum at around 9000 to 7600 B.P., corresponding to an annual average increase of from 5 to 8 degrees Celsius.

The most difficult interpretation is that for the last two thousand years. Regrettably, this is also the time period during which the most rapid cultural evolutionary change occurred. Although there seems to be some consensus among palynologists that the xerothermic ended in the Lake Erie area around 1400 B.P., there is little agreement about and little information on climatic events subsequent to that time. Basically, there appear to be two schools of interpretation for post-xerothermic climatic interpretation in the region.

Interpretation 1, best represented by Williams (1974), suggests a fairly consistent cooling period with increased moisture that continued until 600 B.P. (later in the east). This was followed by the drier conditions that we see today. Given the intervals of data in pollen profiles (200 to 300 year units), this interpretation is well supported in the data. Miller's (1973) interpretation for southwestern New York, differs in that he contends that it was the hemlock return to prominence that signaled the end of the xerothermic; this may or may not have implied cooler, moister conditions. Miller believes that the information supports a view of increased mesophytism and diversity, with elevational variation, a more complex situation than one implying simply cooler and moister conditions.

Interpretation 2, best represented by Wendland and Bryson (1974), attempts to search for small-scale synchronized climatic variation through the use of historical documentation, tree-ring information, and varve data. The sequence that emerged is known as the Blytt-Sernander climatic sequence. The major problem with using this sequence is that it was developed in Europe with European data. Given the problems visible in the pollen record for essentially a homogeneous physiographic area in eastern North America, and the variability this area contains, there may be grave difficulties in transposing a European sequence to North America (Wright 1976a). The fallacy of doing so is clearly evident in the superposition of a cooling, moistening period upon a time period in which the local pollen sequence clearly shows warming and drying (Graves 1977). Any transatlantic, or worldwide scheme, though attractive to archeologists (Wendland and Bryson 1974), falls apart under careful scrutiny, largely because of the time-transgressive nature of climatic change and vegetational history (Wright 1976a; Bernabo and Webb 1977).

The attractiveness of the European data is understandable in that the information needed for a detailed small-frequency interpretation in the Northeast is not really there. First, preservation precludes the use of tree rings for virtually any period predating the last 200 to 300 years. Second, most pollen researchers have sampled cores in large time periods, so that a truly fine-grained interpretation cannot be made (Swain 1978). The best hope for better control over the pollen sequence comes from the use of varve deposits since the chronology of these deposits can be established fairly readily. Use of pollen, charcoal, and seed data from a varved lake in northern Wisconsin provided a basis for the reconstruction of a detailed forest-fire history, which was, in turn, interpreted climatically (Swain 1978). Pollen samples at ten-year intervals allowed for the detail and control that had been missing from previous interpretations. Climatic interpretations were based mainly on fire frequency and changes in percentage composition of birch, hemlock, and white pine (Swain 1978:63). Temperature interpretations were not made for the area, and precipitation was measured through relative increases or decreases in available moisture for plant growth (Swain 1978:59). The terms "moist" and "dry" thus apply only with regard to a zone relative to other zones in the same profile. Zone 2 (1700-1150 B.P.) (Fig. 2.29), which is described as dry (Table 2.9), most closely resembles modern conditions around Lake Erie. One of the problems with using the Swain interpretation is that the scale of change appears to be much smaller than in other reports. Thus dry, as represented in Zone 2, may or may not be as dry as the dry of the xerothermic, even though Zone 2 appears to be contemporaneous and, in fact, may be the trace of the xerothermic in the Hell's Kitchen Lake profile. On the positive side, the northern Wisconsin profile and the northeastern Pennsylvania profile appear to be consistent after 1200 B.P.; that is, they may bracket the Lake Erie area climatically.

In summary, although it may be possible to arrive at a finer gradation of climatic change for the Lake Erie area through the use of varve data by Swain (1978) and possibly others, the problems of interpretation are such that, for now, it is analytically "safer" to use the broader scheme, such as the one proposed by Williams (1974). In Indiana, the xerothermic ended at 1600 B.P., resulting in a cooler and moister climate. At 600 B.P., the weather ameliorated until it was warmer and drier and, with minor fluctuations, this is the climate we see today. The implications for the Lake Erie area is that modern climate shares a close affinity with that of the xerothermic and that the intervening period was one of cooler and moister conditions. Within that context, any small-term perturbations that can be seen may be ignored in the overall reconstructions.

2.6 FAUNA

This section presents a discussion of the aquatic and terrestrial fauna in the lake and on the lakeshore. The content of this discussion emphasizes a characterization of species likely to have been of major importance to the prehistoric inhabitants during the periods they occupied this area. Emphasis has been placed on identifying the major aquatic and faunal species known to have been present in this area prior to European settlement. These species are assumed to have generally occurred throughout the last 6000 years of the cultural-historical sequence although the densities and distributions of individual species may have varied significantly. Prior to 6000 B.P., and after the glacial retreat, the environmental setting, including flora and

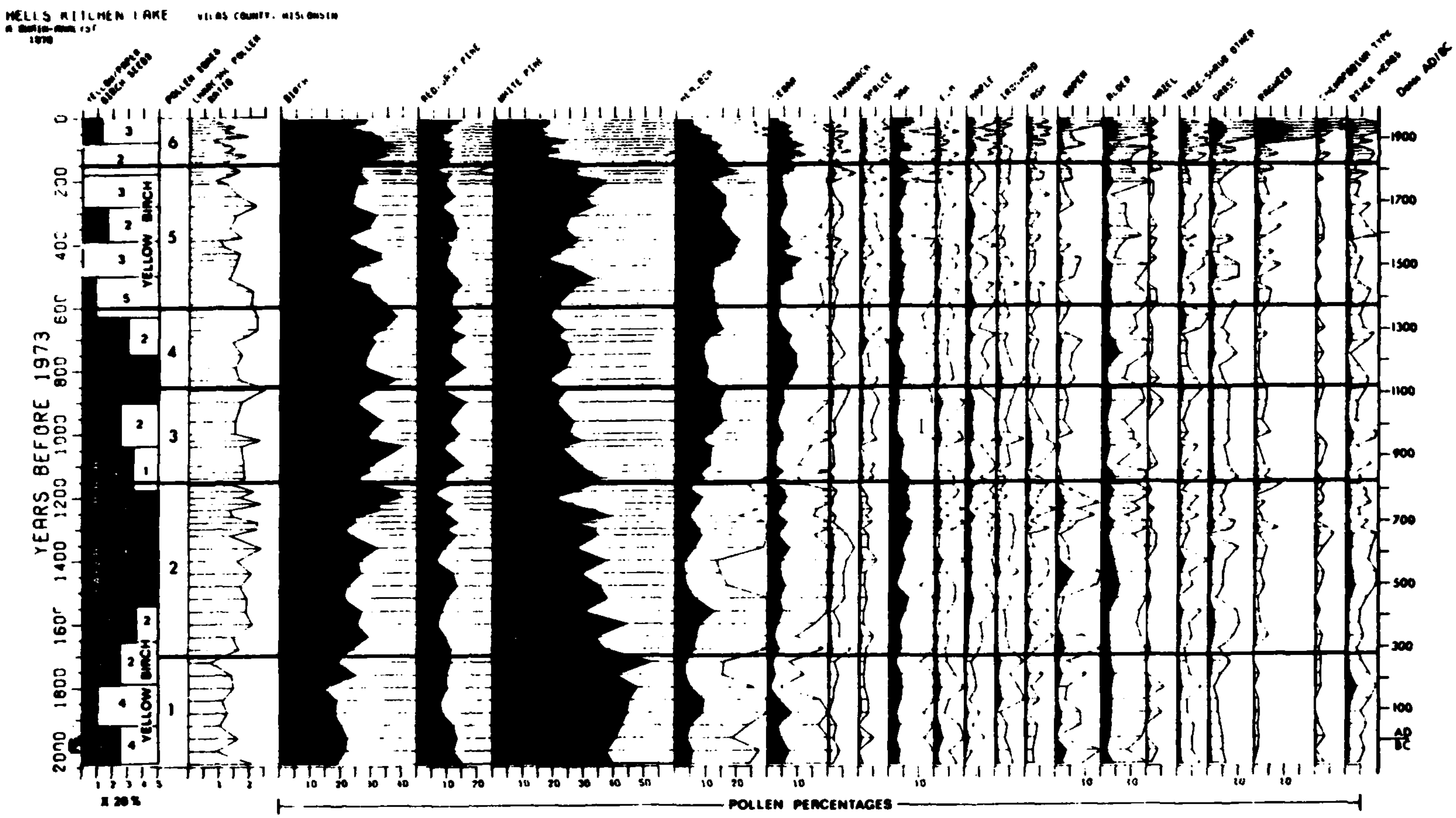


Fig. 2.29. Diagram Showing Pollen Percentages, Birch-Seed Percentages, and Charcoal/Pollen Ratios. The numbers shown in the profile of birch seeds indicate the number of seeds of each species found at each level. Source: Swain 1978, 60.

Table 2.9. Tentative Correlation of Climatic Changes during the Past 2200 Years[a]

Years B.P.	Northwestern North America (glacial activity)	Southwestern United States (tree rings)	Northern Wisconsin (pollen, seeds, charcoal)	Northeastern Pennsylvania (pollen)	Northern Canada (shifts of forest-tundra border)
	Contraction[b]	Warm, dry---	Historical	Historical	
	--------	Warm, moist	disturbance	disturbance	
		--------	--------	--------	
200		Cool, dry			
	Expansion	--------	"Moist"	"Moist"	South
400					
		Cool, moist			
600	//////////	--------	--------	--------	//////////
		Warm, dry	"Dry"	"Dry"	
800	Contraction				

		Warm, moist	--------	--------	

1000	//////////		"Moist"	"Moist"	
	Expansion	Cool, dry			
1200	//////////	--------	--------	--------	North
1400		Cool	"Dry"	Warm and moist?	
1600	Contraction	--------			
			--------		//////////

1800					
		Warm	"Moist"	Cool and dry?	
2000					South
2200		--------	--------		
					//////////

[a]Data inferred for glacial activity, tree rings, pollen, and soils at various locations in North America. Source: Swain 1978, 66.

[b]Dashed lines (--) represent boundaries dated by tree rings, varves, or historic records. Slash marks (///) represent boundaries dated by C^{14}.

fauna, would have been very different. Data are insufficient to make a usable reconstruction.

2.6.1 Fish Resources of Lake Erie

Lake Erie was an extremely rich fish habitat until recently. In terms of commercial fishing, Lake Erie consistently led all other Great Lakes in production and accounted for more than half of the total Great Lakes catch for many years (Leach and Nepszy 1976). Annual commercial catches from the lake varied from 15 to 50 million pounds per year during the period from 1885 to 1924 (Langlois 1954:288). In the Western Basin, the most productive area in the lake, the yield was 17.2 pounds per acre as late as 1952 (Langlois 1954:344). In addition to the high productivity of the lake, it supported a wide variety of species. There are (or were) 114 native freshwater species in the lake, many of which are listed in Appendix F (Christie 1974). Since the beginning of commercial fishing in 1815, many changes have taken place in the lake; these changed the nature of the fish community. These natural and cultural changes in the lake also made modern ecological data on the lake inapplicable to the situation prior to European settlement.

The natural environmental factors found to be most important in fish production are the morphometric factors of the lake itself (Langlois 1954:342): basin shape and depth. In the other Great Lakes there was a close correlation of the mean depth and fish productivity. Lake Erie partially violated this correlation by being three times as productive as the prediction. This can be explained by the fact that Lake Erie is composed of three basins with varying depths. The mean depth of the lake includes the deep Eastern Basin, which had a lower production factor. The sizable Western Basin, however, is very shallow and was highly productive. Although it encompasses only 13% of the area of the lake, it has an average depth of 7.4 m and was the site of the most important spawning and nursery grounds in the lake (Regier and Hartman 1973). Another key to the productivity of the lake is in the marshlands along the southwestern shore. These areas provided important feeding grounds for many fish species and were themselves of very high primary productivity, on the order of 1000-3500 g/m^2 per year (Whigham et al. 1978). Such freshwater wetlands are in some cases more fertile than saline wetlands, considered to be among the most productive areas in the world.

An important factor in the diversity of species of the lake is its location. Lake Erie is on the southern edge of northern fish species distribution and on the northern edge of southern fish species (Langlois 1954). In this sense, the lake is a fish ecotone, accomodating more species than either a purely northern or southern habitat. In addition, the variability in the lake between the three basins accounts for much of the variety. The Western Basin is homolimnon and supports warmwater species; the Central and Eastern basins are deep enough to have a metalimnon and hypolimnon and to support coldwater fishes, which were highly valued (Regier and Hartman 1973).

Early fishing records and historical documentation provide valuable information on the nature of the fish resource base in presettlement times. There are problems with using this information in that fishermen often kept only the prize of the catch and discarded the rest. In addition, as records improved, so did technology. By the time of detailed documentation of annual catch by species and area, a wide variety of fishing methods, most technologically advanced, were used. Changes in methods resulted in a different structure of the fish catch. In addition to fishing-method changes, physical changes to the habitat through forest clearing, sediment loading, etc., altered the composition of the fish population.

There is some consensus on the former presence of the following prized species in the lake. Sturgeon, northern pike, muskellunge, white bass, yellow perch, cisco, whitefish, lake trout, sauger, smallmouth and largemouth bass, channel catfish, walleye, and freshwater drum were all considered important in the nineteenth century (Applegate and Van Meter 1970; Regier and Hartman 1973; Leach and Nepszy 1976) when much of the technological change in fishing occurred; this resulted in different species being intensively fished at different times. In 1815, seine fishing began in the Maumee River (Applegate and Van Meter 1970). Early fishermen used weirs and dragnets. Weirs were constructed out of brush, and most of the intensive fishing was in tributaries and close to shore. This earliest pattern might be considered to most closely parallel Indian fishing methods. The earliest species taken in numbers included muskellunge, sturgeon, white bass, and yellow perch. Other species such as burbot, sucker, catfish, and freshwater drum were also taken, but were not prized.

This pattern continued until the 1850s when the gill net and the pound net were introduced. At this time, deepwater fishes such as cisco, whitefish, and lake trout became accessible and also highly desirable (Applegate and Van Meter 1970). Interestingly enough, sturgeon, a massive fish now rarely seen but highly prized, was considered a nuisance in that it tended to break the nets. Until methods of preservation were developed twenty years later, sturgeon were caught and burned in piles along the beaches (Regier and Hartman 1973). After 1870, sturgeon became a prized fish and produced up to 5 million pounds a year until it became rare. Sturgeon are slow to mature and are greatly affected by changes in spawning beds; it is possible that a combination of overfishing and destruction of beds led to a near extinction of the species (Applegate and Van Meter 1970). Improvements in net construction and the introduction of steam lifters in the 1880s and 1890s allowed fishing on a massive scale (Leach and Nepszy 1976). After that period, most of the formerly prized species were being taken in much smaller numbers or had disappeared.

The destruction of the Lake Erie fishing industry can be well documented on the basis of the size and quality of the catches. Under these criteria, degradation of the habitat can be traced to the 1850s, with the loss of muskellunge. Sturgeon were rare after the 1880s. By the turn of the century, lake whitefish and lake trout had decreased rapidly (Regier and Hartman 1973). After 1915, northern pike were gone, and lake herring disappeared ten years after that (Applegate and Van Meter 1970). During the 1930s and 1940s, second-quality species such as walleye, blue pike, white bass and whitefish comprised the important species. In addition, catches began to level off. Smelt were introduced into the lake in 1953. During the 1950s, whitefish, blue pike and sauger declined in abundance; whitefish disappeared after 1955, blue pike disappeared after 1959, and sauger after 1960. Yellow perch and walleye became the important species in the 1960s. The order of yield of the principal commercial species of fish over the last sixty years dramatizes the changes to the lake (Table 2.10).

Table 2.10. Order of Yield of Principal Commercial Species[a]

1908	1950	1966
Cisco	Blue pike	Yellow perch
Blue pike	Walleye	Smelt
Carp	Yellow perch	Carp
Walleye	Freshwater drum	Freshwater drum
Northern pike	Whitefish	White bass
Sauger	Carp	Walleye
Yellow perch	White bass	Channel catfish
Lake whitefish	Channel catfish	Suckers
Suckers	Cisco	Goldfish
	Suckers	Bullheads

[a]Source: Applegate and Van Meter 1970.

A number of explanations have been offered as to why so many of the prized species in Lake Erie are no longer available in any appreciable quantity. Overfishing by the industry has long been offered as the main explanation. While overfishing may have contributed to the decline of such species as muskellunge and sturgeon, some authorities believe that it would not have been the main factor in the decline of such species as lake trout, which were never taken in large numbers, or northern pike, which, along with many other fish species, reproduce rapidly. Greater emphasis has been placed on the destruction of spawning grounds and feeding areas. Beginning in the 1850s, dams were constructed on many of the major rivers into the lake, thus obstructing the rivers to spawning fish. Marshes, which provide spawning grounds and feeding grounds for many species of fish, were systematically drained by farmers. Finally, the clearing of forests for farmland brought massive erosion, the result of which was depositing sediments into the lake. Increased turbidity of the water reduced the effectiveness of light on the shallow bottom in the Western Basin, cutting off primary productivity. Heavy loading of nutrients also increased the growth of certain forms of algae at the expense of others. This also led to a change in the fish population.

2.6.2 Land Animal Resources

In addition to the rich aquatic habitats that existed in the Lake Erie area, semi-aquatic and terrestrial faunal resources were abundant. The degree to which these particular food resources were utilized by the prehistoric inhabitants is obscured by the great changes in the natural environment effected by European settlement in the last 200 years. For this reason, only a general picture of the distribution and importance of these species can be drawn.

Of all the animal species found in the survey area, the vast majority were so small as to have been unimportant economically to prehistoric groups. Others, though of larger size, were also unimportant due to the infrequency with which they occurred in the environment. Except during extremely stressful conditions, it is unlikely that prehistoric groups would have utilized species smaller than 100 grams in weight. These smaller species fall into three broad categories in terms of habitat: lowland swamps and bogs; brushy and grassy areas; and climax forest. Small mammals which would have been found in lowland, wet conditions included the starnose mole (Condylura cristata Linn.); northern water shrew (Sorex palustris Richardson); and the southern bog lemming (Synaptomys cooperi Baird) (Burt 1957). Small mammals inhabiting grassy or brushy areas included hairytail mole (Parascalops breweri Bachman); masked shrew (Sorex fumeus Miller); least shrew (Cryptotis parva Say); least weasel (Mustela rixosa Bangs); prairie deer mouse (Peromyscus maniculatus bairdi Hoy and Kennicott); and the white-footed mouse (Peromyscus leucopus Rafinesque). Small mammals of the forested areas included the smoky shrew (Sorex fumeus Miller); short-tail shrew (Blarina brevicauda Say); short-tail weasel (Mustela erminea Linn.); eastern chipmunk (Tamias striatus Linn.); southern flying squirrel (Glaucomys volans Linn.); woodland deer mouse (Peromyscus maniculatus gracilis Le Conte); boreal redback vole (Clethrionomys gapperi Vigors); pine vole (Pitymys pinetorum Le Conte); and the woodland jumping mouse (Napaeozapus insignis Miller) (Burt 1957).

A substantial portion of the survey area along Lake Erie is in a swamp or bog state, unable to reach full climax forest because of the poor drainage characteristics there. In a study of the biotic communities of northeastern Ohio, Aldrich (1943) differentiated between a bog type prisere and a swamp type prisere, implying that a bog successional transformation would be more likely in a cooler, more acidic soil situation than a swamp transformation (Aldrich 1943:370). If this distinction holds, the low, poorly drained biomes in northern Ohio can be broadly characterized as swamp, and the low, poorly drained biomes in southwestern New York and Pennsylvania as bog. Aldrich discussed four pre-climax stage bog communities with regard to plants, fish, birds, and mammals. The first bog stage is a floating plant stage characterized as a Nymphaea Advena Consocies, with the primary dominant plant being the large yellow water lily. The important fish species include carp, golden shiner, black bullhead, yellow perch, blue gill, common sunfish, and black crappie. No birds, amphibians, or mammals are permanently associated with this stage, although the common newt, bullfrog, and various turtles, and migratory waterfowl use this habitat seasonally. The heath stage of the bog type is characterized as a Chamaedaphne Calyculata Consocies, with leatherleaf as the primary dominant plant, and the Appalachian song sparrow and Canada shrew as the important permanent wildlife. This stage evolves into the high shrub stage characterized as a Nemophanthus-Alnus association. The primary dominant plants are purple chokeberry, mountain holly, hoary elder, and tall blueberry; important wildlife includes the Canada shrew, short-tailed ehrew, and the northern deer mouse. Also found in this habitat are the eastern hairy woodpecker, the northern downy woodpecker, and the black-capped chickadee. The final subclimax stage of the bog type is the subclimax forest characterized as larix-maple-birch associations, and including tamarack, red maple, and yellow birch as the primary dominants. Important wildlife in this habitat includes the northern downy woodpecker, black-capped chickadee, northern blue jay, tufted titmouse, Canada shrew, smoky shrew, short-tailed shrew, southern red squirrel, northern deer mouse, and eastern meadow vole. Also found are the northern barred owl, New York weasel, southern flying squirrel, gapper red-backed vole, and Mearns cottontail.

Three successional swamp stages were also discussed by Aldrich. The Oecodon-Typha association characterizes the emergent vegetation stage. The primary dominant plants composing this habitat are the broad-fruited bur reed, broad-leaf cattail, and swamp loose strife. The most important wildlife for this stage is the common muskrat, although the Canada shrew, common mink, and eastern meadow vole are also present. The high shrub stage of the swamp biome is characterized by the Cephalanthus-Alnus association, with smooth alder and buttonbush being the primary dominant plants. The most important avian wildlife inhabiting this association are the black-capped chickadee, eastern cardinal, northern downy woodpecker, and eastern hairy woodpecker. The important animal species are Canada shrew, short-tail shrew, northern deer mouse, eastern meadow vole, and Mearns cottontail. Also present are eastern raccoon, New York weasel, common mink, and eastern red fox. The final subclimax stage of the swamp biome is the subclimax forest, characterized by maple-ash-elm associations. Primary dominant species are red maple, silver maple, white elm, swamp white oak, pin oak, and white ash. The most important avian and animal species in this habitat are the tufted titmouse, white-breasted nuthatch, northern blue jay, eastern cardinal, Canada shrew, short-tail shrew, northern deer mouse, and eastern meadow vole. Other important species include Appalachian ruffed grouse, northern downy woodpecker, eastern hairy woodpecker, and northern barred owl, as well as Virginia opossum, star-nosed vole, eastern raccoon, New York weasel, common mink, eastern red fox, southern red squirrel, small eastern flying squirrel, and Mearns cottontail.

Unfortunately, the animal species associated with the bog and swamp biomes only roughly reflect the situation before European settlement. The beaver, which had once existed in the area in great numbers, had been extirpated since 1838 (Kirtland 1838). Also gone from the area are elk, black bear, timber wolf, Canada lynx, fisher, otter, swallow-tailed kite, turkey, passenger pigeon, raven, and timber rattlesnake. Most of these species were important to prehistoric economic adaptations. In addition, populations of deer, hare, porcupine, slate-colored junco, and gray squirrel were greatly reduced at the time of settlement. Conversely, populations of red fox, New York weasel, fox squirrel, muskrat, marsh hawk, cardinal, and American crow experienced radical increases due to increased openings in the forest (Aldrich 1943).

Larger game mammals that would have been important to prehistoric inhabitants in the entire area around Lake Erie included black bear (Ursus americanus Pallus) weighing from 225 to 475 lb. and residing in heavily wooded areas and along swamps; beaver (Castor canadensis Kuhl), weighing some 30 to 60 lb. and residing along wooded streams and lakeshores; elk (Cervus canadensis Erxleben), weighing 500 lb. and residing in forests with open meadows; white-tailed deer (Odocoileus virginianus Zimmerman), weighing from 150 to 300 lb. and residing primarily along border areas between forests and openings; and moose (Alces alces Linn.), weighing from 725 to 850 lb. and residing in forested regions with numerous lakes and swamps (Burt 1957). Of lesser importance, but still likely to have been included in the diet, were muskrat (Ondatra zibethica Linn.) weighing from 800 to 1600 g and residing in marshes, ponds, lakes, streams, etc.; porcupine (Erethizon dorsatum Linn.), weighing from 9.5 to 19 lb. and residing in forested areas; eastern cottontail (Sylvilagus floridanus J.A. Allen), weighing some 900 to 1800 g and residing on brush edges of swamps and forests; raccoon (Procyon lotor Linn.), weighing from 12 to 36 lb. and residing in wooden areas along streams; woodchuck (Marmota monax Linn.), weighing from 5 10 lb. and residing in forests and areas of heavy brush; and eastern gray squirrel (Sciurus carolinensis Gmelin), weighing some 340 to 680 g and living in large, hardwood forests. Other mammals that may have been taken, but probably were not an important component of the diet were the opossum (Didelphis marsupialis Linn.); Eastern mole (Scalopus aquaticus Linn.); long-tail weasel (Mustela frenata Lichtenstein); mink (Mustela vison Schreber); river otter (Lutra canadensis Schreber); badger (Taxidea taxus Schreber); striped skunk (Mephitis mephitis Schreber); red fox (Vulpes fulva Desmarest); gray fox (Urocyon cinereoargenteus Schreber); coyote (Canis latrans Say); bobcat (Lynx rufus Schreber); thirteen-lined ground squirrel (Citellus tridecemlineatus) red squirrel (Tamasciurus hudsonicus Erxleben); eastern fox squirrel (Sciu niger Linn.); fisher (Martes pennanti Erxleben); wolverine (Gulo luscus Li and mountain lion (Felis concolor Linn.). Of these less important species, the otter, mink, foxes, and fisher probably provided important hides for clothing.

2.6.3 Conclusions

Lake Erie and its shoreline provided a rich faunal food habitat for prehistoric hunters. The lake had the richest fishing waters at the time of settlement in the early nineteenth century and remained so for more than 100 years. High productivity may also have characterized many prehistoric periods. This situation changed greatly after commercial fishing was introduced in 1815; because of improved procurement technology and the destruction of feeding and spawning grounds, the productivity of the lake for fishing was drastically reduced.

Of the three basins in the lake, the Western Basin was by far the richest due to the vast areas of marshy ground and shallow waters. In all, 114 species of fish are (were) native to Lake Erie; of these, sturgeon, northern pike, muskellunge, white bass, yellow perch, cisco, whitefish, lake trout, sauger, smallmouth and largemouth bass, channel catfish, walleye, and freshwater drum were prized. The earliest patterns of fishing in the lake (the use of seining) produced muskellunge, sturgeon, white bass, and yellow perch in great numbers; burbot, sucker, catfish, and freshwater drum were also taken in significant numbers. It might be inferred that this fishing method most closely resembled that of prehistoric societies, hence the species taken might also reflect prehistoric diet. Since then, the order of fishes taken has shifted to more soft-fleshed species. As of 1966, the top five species taken commercially were yellow perch, smelt, carp, freshwater drum, and white bass.

Land faunal resources came from three zones: lowland swamp; open, grassy and brush terrain; and full forest. It is unlikely that open grassy terrain would have been extensive in the survey area, with the exception of the western part of the survey area where natural wet prairies were common. In lowland marshy ground, migratory waterfowl would also have been important dietary items. In forested areas, important game species would have included black bear, white-tailed deer, and, occasionally, moose. Woodchuck, squirrel, rabbit, and other small mammals, while not prized, would have commonly been included in the prehistoric diet.

2.7 PRODUCTIVITY OF THE NATURAL ENVIRONMENT FOR PREHISTORIC INHABITANTS

It was previously argued that soils data provided a means of reconstructing forest vegetation. In this section, a methodology for associating several types of vegetation thought to have been important to prehistoric economies with specific soil types will be presented. In addition, an algorithm for rating those vegetation types on those soils will be discussed, as will a means for bringing this analysis back from year 1800 to the beginnings of the post-Pleistocene forest.

Three types of vegetation will be emphasized: 1) oak-hickory forest; 2) walnut species; and 3) maize for prehistoric agriculture. The reasons for selecting these particular vegetational types over others lies in the belief that oak acorns, shagbark hickory nuts, black walnuts, and butternuts were principal pre-agricultural vegetable foods in the survey region for both humans and animals and that the choice of better soils for agriculture was important to prehistoric farmers. The adaptation of Archaic peoples to tree nuts is well documented archeologically (Asch, Ford, and Asch 1972).

2.7.1 Analytical Assumptions

The initial assumption, beyond that of diet, is that archeological sites were in some way optimally located with respect to the food environment. That is, sites were located, under certain constraints, so that the distance to the principal available food was minimized. In this case, principal available food refers to nuts during the Archaic periods and to nuts and agricultural products during the Woodland periods. This is clearly a simplification of the problem, made in the belief that much of the diet was composed of these items. The constraints on site location were probably 1) nearness to potable water; 2) dry conditions for camps (i.e., not damp or wet); and possibly 3) defensible positions during later periods. Of necessity, this model precludes any consideration of fishing stations or other aquatic or semi-aquatic adaptations. It also, to some degree, excludes hunting adaptations except in those cases where game and people were keying to the same resources. This is often true for deer, turkey, and, to some extent, bear, but not for muskrat, beaver, elk, etc.

The second assumption made is that, as far as tree nuts are concerned, site quality can be equated with nut productivity. This assumption is not tested here, although an argument can be made that better sites for tree growth allow trees to devote more energy to the production of mast (Wilde 1958).

The third assumption is that certain tree species fare well on some soils and do poorly on others, and that it is in the soil that this relationship holds, not in external factors. Thus, if it is determined that a Chagrin silt loam is the best soil for walnut, then a Chagrin silt loam will always be the best soil for walnut, unless changes in the environment affect the inherent soil properties.

A fourth assumption, related to the third, is that it is the associated properties of the soil that are important for a particular tree species, not the soil itself. Properties critical to one species may not be critical to another. In general, parent material, texture, temperature, ph, nutrient status, and climate and moisture relations are the most important (Pritchett 1979:19). The availability of the tree is another important factor.

2.7.2 Factors Affecting Four Major Food Resources

The ultimate goal of this analysis is the production of a series of maps showing the distribution of each principal food group in space and back through time. A distinction will be made on each map between the best probable sites for that species development and mast production, and lesser sites, by degrees. Each archeological site can then be evaluated with respect to these four important vegetable types--oak, hickory, walnut, and maize--to better interpret site function, adaptation, prediction of site location, etc. Because of the climatic differences through time, each of these four plant species will be evaluated on the set of soils under 1) modern conditions, 2) wetter climatic conditions, and 3) drier climatic conditions. Archeological sites or phases dated to a particular time and climate can then be matched with an appropriate spatial map of vegetation.

The method proposed for reconstructing each plant-resource type spatially consists of first deciding what the important parameters for each type are. The important parameters include both limiting factors and soil properties that are important for best development. Then the constructed soil catena is reduced by categories according to the limiting factors for that species. For example, oaks, particularly white oaks, are limited by poor drainage. Therefore, all soil catena categories that are poorly drained and very poorly drained, as a drainage class, would be eliminated and all soil series within those categories would be considered inappropriate for white oak growth. If, for example, shallow soils were also limiting, then all categories with that attribute would be removed from consideration, along with the member soil series. What is left is a subset of the original catena, containing those categories, which on the basis of parent material and drainage class alone, could conceivably support white oak production.

While this paring operation reduces the number of soil series to be examined, it does not result in the final list. In the second phase of the evaluation, the remaining categories are rated on the basis of existing information as either favorable for development (F) or marginal for development (M) on the basis of parent material and drainage class. At this stage, it is assumed that each soil series (or type in the old system) is equivalent to any other soil series within that particular category.

The first evaluation is always made for modern conditions. In the past, it is likely that climatic regimes wetter or drier than that of today would have had a sizable impact on soil moisture. In a study of the trees growing around a newly impounded dam, Broadfoot (1973) found that some species dramatically improved their growth due to a higher water table and improved capillary action in the root zone. Conversely, other species, such as the turkey oak, fared poorly because the root zone was smothered by the raised water table (Broadfoot 1973:3). Finally, the deposition of sand, by the backwater in certain areas, impeded the growth of trees. In another study correlating soil moisture and slope position, it was found that there was "a consistent tendency for decreasing moisture contents upslope from the stream" (Helvey et al. 1972:955). In general, rainfall effects in the deeper layers, such as would constitute the root zones, would be felt some weeks after any particular storm. In addition, the effects of added rainfall would be felt in increased moisture content of the soil more in midslope and upslope positions than in coves (Helvey et al. 1972:957).

Extrapolating these results into the Lake Erie area, it is possible to see that the beach ridge areas, under a wetter precipitation regime, would increase soil moisture content and possibly raise the zone of capillary water closer to the root zone or surface. This would result in improved conditions for those species that thrive in mesic situations, but also with good drainage. We can infer from the model of the hillslope hydrological cycle (Chorley 1978:5, Fig. 1.2) that in a beach ridge situation the water table would be raised resulting in the unsaturated zone of soil moisture storage closer to the surface on the upper slopes, improving conditions. However, on lower slopes, the saturated zone would also be closer to the surface, resulting in worse conditions. Topographic position on a beach ridge or any area of relief would determine whether or not increased rainfall would improve plant moisture conditions or detract from them. The same would hold true in reverse for drier conditions.

This evaluation is then transformed to drier conditions, under the following rules. It is assumed that the overriding condition for imperfectly drained soils is the presence of a fragipan. Thus a drier moisture regime would not significantly alter the moisture conditions on that soil; nor would a wetter moisture regime significantly affect the soil moisture regime under fragipan conditions. For soils without fragipans, but with imperfect drainage, drier conditions would shift better drained classes toward the (modern) poorly drained side. Somewhat poorly drained soils would improve in drainage, moving from restricted categories to marginal categories. Well drained soils would also shift from their previously held favorable category to a droughty marginal category. In essence, the drainage classes in the catena would shift one class to the right under drier conditions. Under wetter conditions, the drainage classes would shift one class to the left. Evaluation of series within categories would also reflect parent material. If a parent material listed as marginal is too heavy-textured to be optimal for a particular type of vegetation, it would probably be limiting under wetter conditions. Conversely, if a soil is too sandy and droughty to be optimal under modern conditions, it would surely be too droughty to be even marginal under drier conditions.

Once all categories for a particular vegetation type under a particular moisture regime are coded as either favorable, marginal, or restricted, each favorable or marginal soil series is listed. At this point, all soils in each list are treated as the same, but the favorable list is more likely to produce good soil types for a vegetation type than is the marginal list. It is at this stage that each soil series is weighed against every other according to more refined attributes than parent material and drainage class. Certain factors are important for each vegetation type. The closer a soil series fits those attributes, the more likely it is to be rated as Class I, or optimal. If a soil series has some of the essential attributes for that type, it is rated as Class II. Soils with few of the important attributes are rated as Class III. It is possible that some series are anomalous in the category in that they lack most of the attributes necessary for a particular vegetation type even though they share parent material and drainage class. In such cases, the soil series are dropped from the rating.

Although the specific factors by which soils are evaluated for a vegetational type differ to some degree by type, most of the evaluations are based on the same kinds of information: moisture conditions, as expressed in available water capacity; the presence of perched water, such as from a fragipan or clay pan, and drainage class; soil fertility as related to both agricultural use and site index, a measure of forest productivity; the soil taxonomic name at the subgroup level; the land capability class; and whether or not the soil series is mentioned in the surveys as being favorable for the particular vegetational type.

2.7.3 Ratings for Agriculture

Finding optimal soils for maize agriculture was the easiest problem to attack. The basic assumption was that modern agricultural productivity for corn reflected the aboriginal productivity for maize on a particular soil. The use of productivity ratings, however, was not the only criterion for evaluation. An extensive swidden system of cultivation, as envisaged for prehistoric inhabitants, clearly has advantages and constraints that differ from those of modern agricultural technology with respect to the soil. In addition to high fertility, other criteria for optimal agricultural potential were

1. Good surface drainage, e.g., well drained

2. Either a high available water capacity or the presence of perched water between 20 and 30 in. below the surface

3. A friable surface horizon, reflected in the textural class of the A horizon, coarser than or equal to a silt loam

In addition to criteria favoring agriculture, other criteria were considered to be restrictive. These were

1. Poor surface drainage, e.g., somewhat poorly drained to very poorly drained (see Table 2.5)

2. Heavy surface texture

3. Slope class greater than B (greater than 8% slope)

4. Droughtiness, e.g., low available water capacity without available subsurface water.

Soil moisture is very important to plants and it became apparent that in the lakeshore area soil water primarily came from either rainfall or groundwater. Too much water hindered root development; too little left the plants thirsty. Given the complexities of the topography (see Fig. 2.24), a total of seven possible soil moisture situations were envisaged (Fig. 2.30). Three of these provided optimal soil moisture; one was too droughty; and three were too wet.

The evaluations of each soil series under three climatic regimes--modern, wetter, drier--are presented in Figures 2.31-2.33 and Tables 2.11-2.13. An evaluation for the older soil-survey soil types was also made but only for modern climatic conditions (Table 2.14). It was thought that attempts to project these onto wetter and drier conditions presented too many difficulties, given the quality of evidence available.

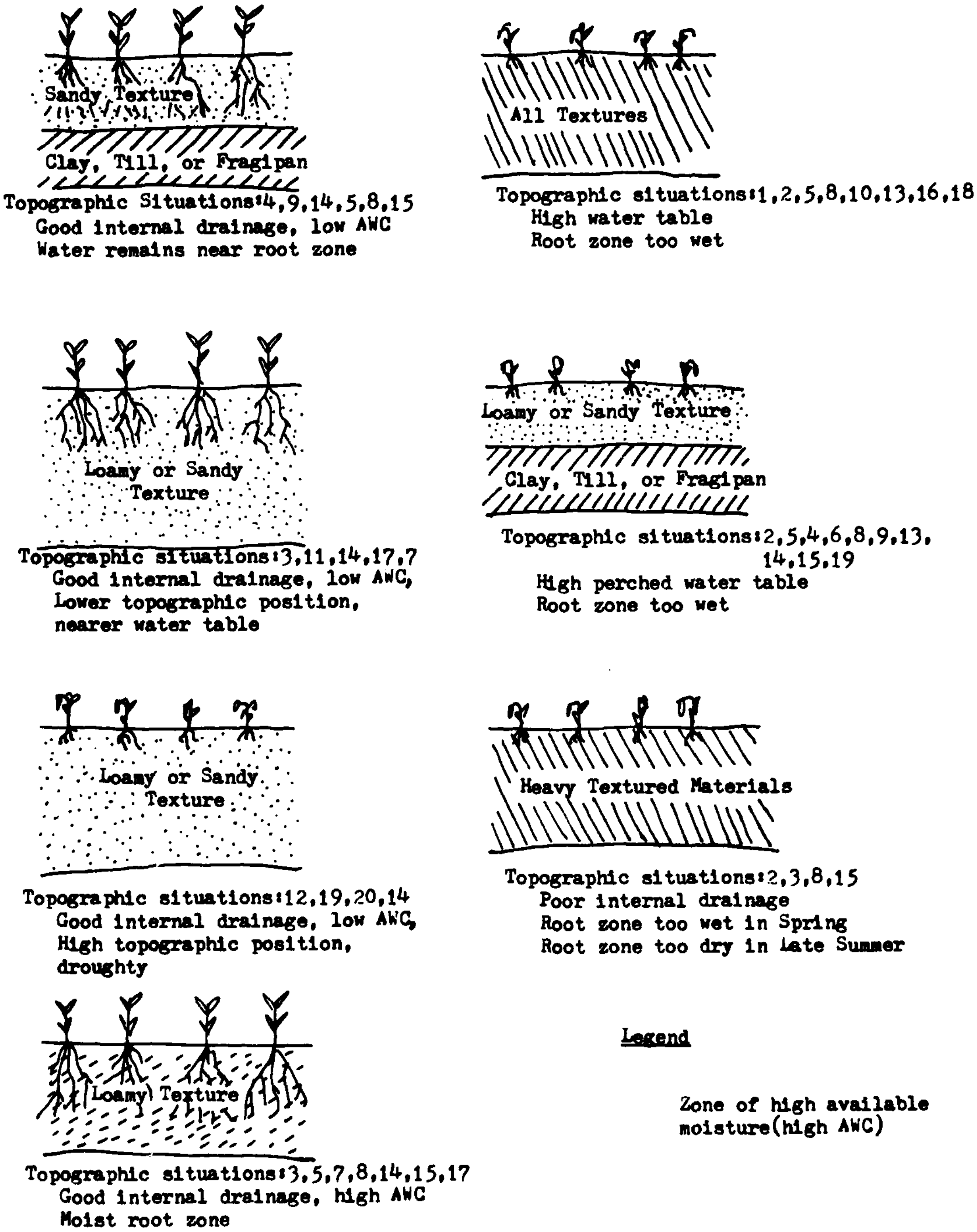


Fig. 2.30. Possible Soil Moisture Situations
for Agricultural Production.

Drainage Class

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
Shallow to bedrock	R	→	→	→	→	→	→	→	→
Coarse glacial till	R	F	M	M	R	→	→	→	→
Medium texture glacial till	R	F	M	M	R	→	→	→	→
Clayey glacial till	R	F	M	M	R	→	→	→	→
Lake clays and silty clays	R	F	M	M	R	→	→	→	→
Lake silts and sand and silts	R	F	M	M	R	→	→	→	→
Loamy material over sands	M	F	M	M	R	→	→	→	→
Sandy and gravelly beaches	M	F	M	M	R	→	→	→	→
Sand over silt, clays, or till	R	F	M	M	R	→	→	→	→
Stratified sands, silts, and clays	R	F	M	M	R	→	→	→	→
Gravelly and sandy outwash	M	F	M	M	R	→	→	→	→
Heavy textured stream outwash	R	F	M	M	R	→	→	→	→
Alluvium	R	F	M	M	R	→	→	→	→

Fig. 2.31. Evaluation of Soil Series under Modern Climate Conditions.

Drainage Class

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
Shallow to bedrock	R	→	→	→	→	→	→	→	→
Coarse glacial till	R	F	M	M	R	→	→	→	→
Medium texture glacial till	R	F	M	M	R	→	→	→	→
Clayey glacial till	R	F	M	M	R	→	→	→	→
Lake clays and silty clays	R	F	M	M	R	→	→	→	→
Lake silts and sand and silts	R	F	M	M	R	→	→	→	→
Loamy material over sands	M	F	M	M	R	→	→	→	→
Sandy and gravelly beaches	M	F	M	M	R	→	→	→	→
Sand over silt, clays, or till	R	F	M	M	R	→	→	→	→
Stratified sands, silts, and clays	R	F	M	M	R	→	→	→	→
Gravelly and sandy outwash	M	F	M	M	R	→	→	→	→
Heavy textured stream outwash	R	F	M	M	R	→	→	→	→
Alluvium	R	F	M	M	R	→	→	→	→

Fig. 2.32. Evaluation of Soil Series under Wetter Climate Conditions.

Drainage Class

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
Shallow to bedrock	R	——	——	——	——	——	——	——	→
Coarse glacial till	R	M	M	F	R	M	R	——	→
Medium texture glacial till	R	M	M	F	R	M	R	——	→
Clayey glacial till	R	M	M	F	R	M	R	——	→
Lake clays and silty clays	R	M	M	F	R	M	R	——	→
Lake silts and sand and silts	R	M	M	F	R	M	R	——	→
Loamy material over sands	R	M	M	F	R	M	R	——	→
Sandy and gravelly beaches	R	M	M	F	R	M	R	——	→
Sand over silt, clays, or till	R	M	M	F	R	M	R	——	→
Stratified sands, silts, and clays	R	M	M	F	R	M	R	——	→
Gravelly and sandy outwash	R	M	M	F	R	M	R	——	→
Heavy textured stream outwash	R	M	M	F	R	M	R	——	→
Alluvium	R	M	M	F	R	M	R	——	→

Fig. 2.33. Evaluation of Soil Series under Drier Climate Conditions.

Table 2.11. Class I and II Soils for Agriculture: Modern Climate[a]

Class I	Class II
Wooster	Chenango
Mentor	Belmore
Sisson	Cambridge
Howard	Collamer
Unadilla	Williamson
Chagrin	Tuscola
Tioga	Braceville
Ross	Berrien
Cardington	Claverack
Glenford	Bogart
Rawson	Galen
Phelps	Scio
Lobdell	
Eel	
Medway	

[a]Modern series.

Table 2.12. Class I and II Soils for Agriculture: Wetter Climate[a]

Class I	Class II
Mentor	Wooster
Sisson	Chili
Chenango	Conotton
Belmore	Oshtemo
Arkport	Spinks
Howard	Ottawa
Unadilla	Colonie
Chagrin	Otisville
Tioga	Cardington
Ross	Cambridge
Galen	St. Clair
Phelps	Collamer
	Glenford
	Ottokee
	Metea
	Rawson
	Lobdell
	Eel
	Medway

[a]Modern series.

Table 2.13. Class I and II Soils for Agriculture: Drier Climate[a]

Class I	Class II
Cardington	Lewisburg
Collamer	St. Clair
Glenford	Geeburg
Tuscola	Shinrock
Bogart	Lucas
Rawson	Claverack
Phelps	Vaughnsville
Scio	Cambridge
Lobdell	Ellsworth
Eel	Williamson
Medway	Braceville
Seward	Wooster
Sisson	Minoa
Howard	Dixboro
Unadilla	Bixler
Chagrin	
Tioga	
Ross	

[a]Modern series.

Table 2.14. Class I and II Soils for Agriculture[a]

Class I	Class II
Erie, New York	
Genesee silt loam	Palmyra shaly loam
Genesee silt loam, high bottom	Chenango silt loam
Chagrin silt loam, high bottom	Chenango silt loam, gravelly phase
Chagrin silt loam	Mentor silt loam
	Chenango loam, gravelly phase
	Mentor sandy loam
	Cazenovia loam
	Cazenovia silt loam
	Dunkirk silt loam
	Tonowanda silt loam
Cattaraugus, New York	
Tioga silt loam	Chenango gravelly loam
Tioga silt loam, high bottom phase	Chenango silt loam
Tioga fine sandy loam, high bottom phase	Unadilla silt loam
Genesee fine sandy loam	Unadilla fine sandy loam
Genesee fine sandy loam, high bottom phase	Mentor fine sandy loam
Genesee silt loam	Tioga fine sandy loam
Genesee silt loam, high bottom phase	Pope silt loam
Chagrin silt loam	
Chautauqua, New York	
Chenango gravelly loam	Wooster fine sandy loam
Chenango silt loam	Dunkirk gravelly loam
Genesee silt loam	
Ottawa, Ohio	
Danbury very fine sandy loam	Catawba silt loam
Genesee fine sandy loam	Catawba fine sandy loam
	Catawba gravelly loam
	Danbury clay loam
	Lucas very fine sandy loam
	Fox gravelly loam, beach ridge phase

[a]Older series.

2.7.4 Ratings for Walnut

Specific site qualities favorable to walnut, particularly black walnut, were mentioned in the literature. The following references provided useful information used in constructing the behavioral pattern for black walnut (and by extrapolation to white walnut or butternut):

Zenkert 1934	Gordon 1969
Forsyth 1970	Sampson 1930a
Braun 1950	Fowells 1965

On the basis of these references and sporadic comments in the older soil-survey reports, a walnut soil profile was developed. Conditions favoring walnut growth were

1. High soil fertility; good agricultural soils were also good walnut soils
2. Sandy or gravelly loam surface texture
3. Well drained, but moist
4. Tolerance of imperfect drainage, but not worse than somewhat poorly drained
5. Floodplain soils
6. Neutral or slightly alkaline pH

Restrictions on walnut included

1. Low fertility
2. Heavy surface texture
3. Wet sites
4. Droughtiness
5. High acidity

In the evaluation of the soil series for walnut, slopes greater than the C class (greater than 15%) were excluded from consideration. In operationalizing the soil series into phases, Class C slopes (8-15%), which were rated as Class I walnut soils, were automatically demoted to Class II; Class II were demoted to Class III, etc. Surface-texture soil types excluded from consideration for walnut were clay, sandy clay, sandy clay loam, silty clay, silty clay loam, silt, and sand. In the evaluation of the soil series, Class I walnut soils had a moderate to high available water capacity, a site index greater than or equal to those of Class II soils, an intensive corn productivity rating of 105 bushels per acre or better, and a specific mention in the Form 5's or survey report that that series supported walnut. Class II walnut soils had maximum corn productivity greater than or equal to 80 bushels per acre. If there was unimpeded drainage, Class II walnut soils had a low to medium available water capacity (AWC). If there was perched water, they had a low AWC. Soils that were droughty were not rated unless there was perched water. The evaluation of the catena for walnut, by category, is presented in Figures 2.34-2.36. Class I, II, and III soils for walnut are presented in Tables 2.15-2.17. The evaluations for the older soil survey soil types for modern climatic conditions are presented in Table 2.18.

2.7.5 Ratings for Oak and Hickory

There are essentially four categories of vegetation that fall under the rubric of oak-hickory forest (Fig. 2.37). The first is the classic white oak-shagbark hickory complex cited as the oak and hickory of the xerothermic. There is also a wet oak-hickory complex, found along streams and in swampy areas; this complex includes swamp white oak, pin oak, and bitternut hickory. A third complex is the oak-chestnut forest, with chestnut, chestnut oak, and white oak. Finally, there is a dry oak-hickory complex, with chestnut oak, black oak, and pignut hickory. Explained in simple terms of moisture conditions, these complexes inhabit four different situations. Not all the possible soil complexes for each will be enumerated, only the classic white oak-shagbark hickory complex will be considered with respect to soil. Included in this complex is *Carya tomentosa* (mockernut hickory). This complex was chosen over the others because white oak has the lowest tannin, and both the oak and hickories in the complex are the most productive and desirable from an aboriginal food viewpoint.

The rules for this complex are

1. Favorable sites are on fresh, fertile soils

2. Optimal sites are on medium-textured soils, such as loams and silt loams

3. Oak-hickory avoids very sandy and clayey sites

4. Shallow sites are avoided because of deep taproots

5. Oak and hickory avoid fragipan soils

6. Sites with well drained to moderately well drained drainage classes are preferred

In addition to the soil characteristics, soil phases with slopes greater than C class (15%) are excluded and Class I sites with C class slopes (8-15%) are reduced by one class rating. Surface-texture classes excluded are silty clay, clay, sandy clay, sand, and silt.

The evaluation of the catena for white oak-shagbark hickory, by category, is presented in Figure 2.38. Class I, II, and III soils for this oak-hickory complex are presented in Tables 2.19-2.21. The evaluations for the older soil survey soil types for modern climatic conditions are presented in Table 2.22.

Drainage Class

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
Shallow to bedrock	R	→	→	→	→	→	→	→	→
Coarse glacial till	R	F	M	M	M	M	R	→	→
Medium texture glacial till	R	M	M	M	R	M	R	→	→
Clayey glacial till	R	M	M	M	R	→	→	→	→
Lake clays and silty clays	R	M	M	M	→	→	→	→	→
Lake silts and sand and silts	R	F	M	M	M	M	R	→	→
Loamy material over sands	R	F	F	F	M	M	R	→	→
Sandy and gravelly beaches	R	M	F	F	M	M	R	→	→
Sand over silt, clays, or till	R	F	F	F	M	M	R	→	→
Stratified sands, silts, and clays	R	F	F	F	M	M	R	→	→
Gravelly and sandy outwash	R	M	F	F	M	M	R	→	→
Heavy textured stream outwash	R	M	M	M	R	→	→	→	→
Alluvium	R	F	F	F	M	M	R	→	→

Fig. 2.34. Evaluation of Walnut Soils under Modern Climate Conditions.

Drainage Class

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
Shallow to bedrock	R	→	→	→	→	→	→	→	→
Coarse glacial till	R	F	M	M	M	R	→	→	→
Medium texture glacial till	R	M	M	R	→	→	→	→	→
Clayey glacial till	R	M	M	R	→	→	→	→	→
Lake clays and silty clays	R	M	M	M	R	→	→	→	→
Lake silts and sand and silts	R	F	M	M	M	R	→	→	→
Loamy material over sands	R	F	F	M	M	R	→	→	→
Sandy and gravelly beaches	M	F	F	M	M	R	→	→	→
Sand over silt, clays, or till	R	F	F	M	M	R	→	→	→
Stratified sands, silts, and clays	R	F	F	M	M	R	→	→	→
Gravelly and sandy outwash	R	F	F	M	M	R	→	→	→
Heavy textured stream outwash	R	M	M	M	R	→	→	→	→
Alluvium	R	F	F	F	M	M	R	→	→

Fig. 2.35. Evaluation of Walnut Soils under Wetter Climate Conditions.

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
				Drainage Class					
Shallow to bedrock	R	—	—	—	—	—	—	—	→
Coarse glacial till	R	M	M	F	M	M	R	M	R
Medium texture glacial till	R	M	M	M	R	M	R	M	R
Clayey glacial till	R	M	M	M	R	R	R	R	R
Lake clays and silty clays	R	M	M	M	M	M	R	R	R
Lake silts and sand and silts	R	M	M	F	M	M	R	M	R
Loamy material over sands	R	M	F	F	M	M	R	M	R
Sandy and gravelly beaches	R	M	F	F	M	M	R	M	R
Sand over silt, clays, or till	R	M	F	F	M	M	R	M	R
Stratified sands, silts, and clays	R	M	F	F	M	M	R	M	R
Gravelly and sandy outwash	R	M	F	F	M	M	R	M	R
Heavy textured stream outwash	R	M	M	M	R	R	R	R	R
Alluvium	R	F	F	F	M	M	R	R	R

Fig. 2.36. Evaluation of Walnut Soils under Drier Climate Conditions.

Table 2.15. Class I and II Soils for Walnut: Modern Climate[a]

Class I	Class II
Mentor	Lewisburg
Sisson	Cambridge
Bogart	Ellsworth
Rawson	St. Clair
Phelps	Chenango
Chagrin	Geeburg
Tioga	Lucas
Ross	Williamson
Lobdell	Fitchville
Eel	Digby
Medway	Dixboro
Cardington	Wooster
Shinrock	Braceville
Collamer	Berrien
Glenford	Galen
Tuscola	Seward
Howard	Euclid
	Unadilla
	Scio
	Orrville
	Senecaville
	Shoals
	Ceresco

[a]Modern series.

Table 2.16. Class I and II Soils for Walnut: Wetter Climate[a]

Class I	Class II
Mentor	Wooster
Sisson	Braceville
Bogart	Berrien
Rawson	Williamson
Phelps	Seward
Galen	Belmore
Chagrin	Cardington
Tioga	Lewisburg
Ross	Cambridge
Lobdell	Shinrock
Eel	Williamson
Medway	Glenford
Chenango	Tuscola
Howard	Ottokee
Unadilla	Scio
	Orrville
	Senecaville
	Shoals
	Ceresco

[a]Modern series.

Table 2.17. Class I and II Soils for Walnut: Drier Climate[a]

Class I	Class II
Cardington	Lewisburg
Collamer	Vaughnsville
Glenford	Seward
Shinrock	Cambridge
Tuscola	Ellsworth
Bogart	Haskins
Rawson	St. Clair
Phelps	Geeburg
Chagrin	Williamson
Tioga	Jimtown
Ross	Digby
Lobdell	Dixboro
Eel	Chenango
Medway	Howard
Mentor	Euclid
Sisson	Orrville
Scio	Senecaville
	Shoals
	Ceresco
	Unadilla

[a]Modern series.

Table 2.18. Class I and II Soils for Walnut[a]

Class I	Class II
Erie, New York	
Genesee silt loam, high bottom	Schoharie loam
Genesee silt loam	Schoharie loam, light texture
Palmyra shaly loam	Chenango loam
Cazenovia loam	Chenango very fine sandy loam
Cazenovia silt loam	Tonowanda loam
Chenango silt loam	Ontario gravelly loam
Chenango silt loam, gravelly phase	Dunkirk silt loam
Chenango shaly loam	Wooster silt loam
Mentor silt loam	Wooster gravelly loam
Newton very fine sandy loam	Braceville silt loam
Chagrin silt loam, high bottom	Palmyra gravelly loam
Chagrin silt loam	Palmyra loam
	Groton loam, gravelly phase
	Groton loam
	Berrien fine sandy loam
	Berrien very fine sandy loam
Cattaraugus, New York	
Chenango silt loam	Wooster gravelly silt loam
Chenango gravelly silt loam, alluvial fan phase	Wooster gravelly loam
Unadilla silt loam	Wooster silt loam
Tioga silt loam	Braceville silt loam
Tioga silt loam, high bottom	Chenango gravelly silt loam
Genesee silt loam	Mentor fine sandy loam
Genesee silt loam, high bottom	Tioga fine sandy loam
Chagrin silt loam	Tioga fine sandy loam, high bottom
	Genesee fine sandy loam
	Genesee fine sandy loam, high bottom phase
	Pope silt loam
Chautauqua, New York	
Chenango gravelly loam	Dunkirk loam
Dunkirk very fine sandy loam	Dunkirk silty clay loam
Genesee silt loam	Dunkirk clay
Ottawa, Ohio	
Toledo very fine sandy loam	Eel silty clay loam
Lucas silt loam	
Fulton very fine sandy loam	
Lucas very fine sandy loam	
Danbury very fine sandy loam	
Genesee fine sandy loam	

[a]Older series.

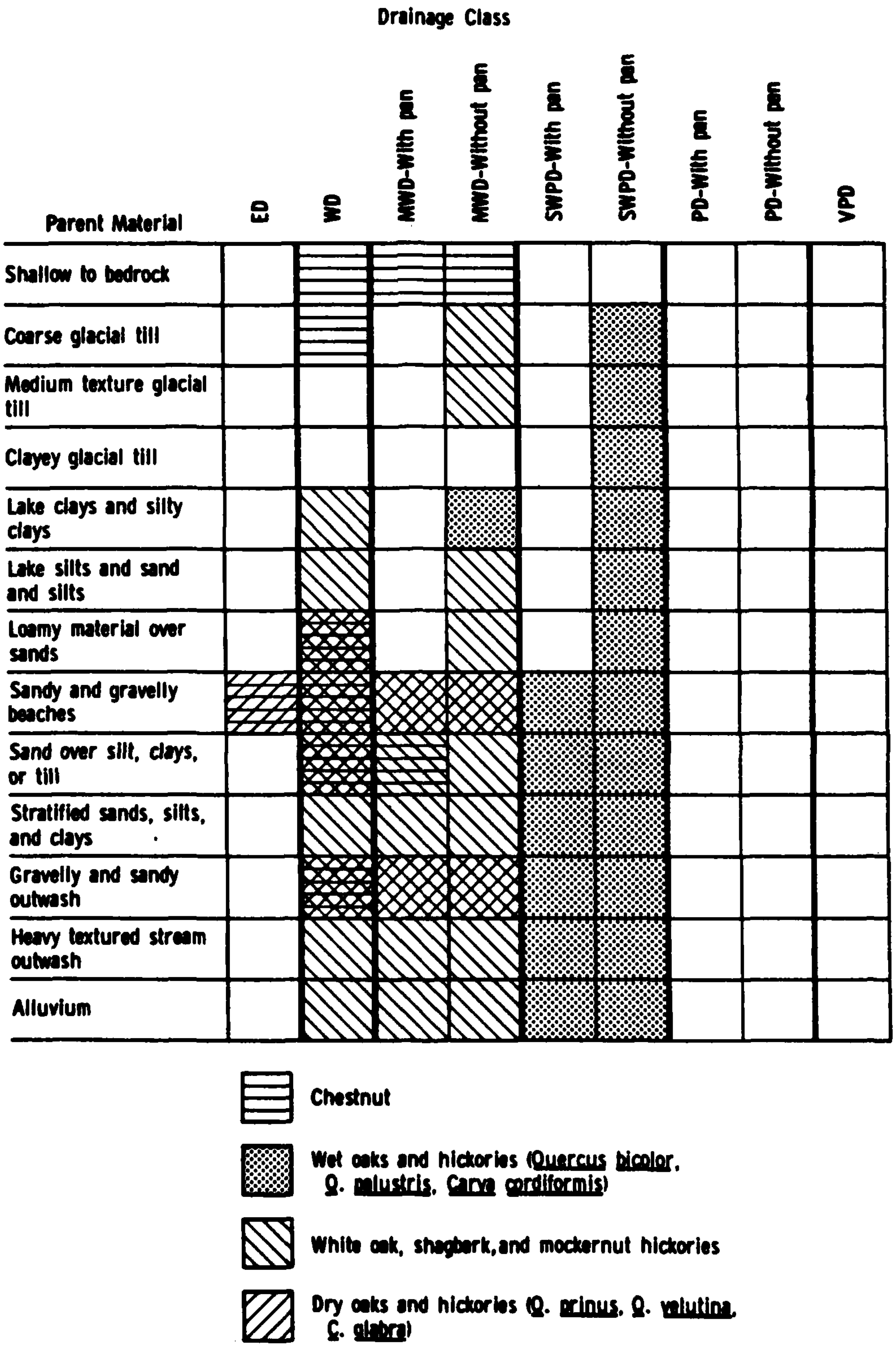


Fig. 2.37. Evaluation of Oak and Hickory Soils under Modern Climate Conditions.

Parent Material	ED	WD	MWD-With pan	MWD-Without pan	SWPD-With pan	SWPD-Without pan	PD-With pan	PD-Without pan	VPD
	Drainage Class								
Shallow to bedrock	R	R	R	R	R	R	R	R	R
Coarse glacial till	R	F	R	M	R	R	R	R	R
Medium texture glacial till	R	F	R	M	R	R	R	R	R
Clayey glacial till	R	R	R	R	R	R	R	R	R
Lake clays and silty clays	R	F	R	M	R	R	R	R	R
Lake silts and sand and silts	R	F	R	M	R	R	R	R	R
Loamy material over sands	R	F	R	M	R	R	R	R	R
Sandy and gravelly beaches	R	F	M	M	R	R	R	R	R
Sand over silt, clays, or till	R	F	M	M	R	R	R	R	R
Stratified sands, silts, and clays	R	F	M	M	R	R	R	R	R
Gravelly and sandy outwash	R	F	M	M	R	R	R	R	R
Heavy textured stream outwash	R	F	M	M	R	R	R	R	R
Alluvium	R	F	F	F	R	R	R	R	R

Fig. 2.38. Evaluation of the Catena for White Oak-Shagbark Hickory under Modern Climate Conditions.

Table 2.19. Class I and II Soils for White Oak and Shagbark Hickory: Modern Climate[a]

Class I	Class II
Mentor	Chili
Sisson	Oshtemo
Chenango	Belmore
Howard	Ottawa
Chagrin	Unadilla
Tioga	Lewisburg
Ross	Ellsworth
Cardington	Geeburg
Shinrock	Lucas
Collamer	Ottokee
Glenford	Vaughnsville
Tuscola	Berrien
Bogart	Metea
Rawson	Claverack
Phelps	Seward
Galen	Ceresco
Scio	Arkport
Lobdell	
Eel	
Medway	
Metamora	
Dixboro	
Senecaville	

[a]Modern series.

Table 2.20. Class I and II Soils for White Oak and Shagbark Hickory: Wetter Climate[a]

Class I	Class II
Mentor	Conotton
Sisson	Oakville
Chili	Arkport
Chenango	Ottawa
Oshtemo	Cardington
Belmore	Lewisburg
Howard	Ellsworth
Unadilla	Collamer
Chagrin	Glenford
Tioga	Tuscola
Ross	Berrien
Shinrock	Metea
Rawson	Claverack
Galen	Bogart
	Phelps
	Scio
	Lobdell
	Eel
	Medway
	Senecaville

[a]Modern series.

Table 2.21. Class I and II Soils for White Oak and Shagbark Hickory: Drier Climate[a]

Class I	Class II
Mentor	Oshtemo
Sisson	Belmore
Chenango	Unadilla
Howard	Lewisburg
Chagrin	Ellsworth
Tioga	Geeburg
Ross	Shinrock
Cardington	Lucas
Collamer	Vaughnsville
Glenford	Berrien
Tuscola	Metea
Bogart	Claverack
Rawson	Galen
Phelps	Ceresco
Scio	
Lobdell	
Eel	
Medway	
Seward	
Metamora	
Dixboro	
Senecaville	

[a]Modern series.

Table 2.22. Class I and II Soils for White Oak and Shagbark Hickory[a]

Class I	Class II
Erie, New York	
Chagrin silt loam, high bottom	Wooster silt loam
Genesee silt loam, high bottom	Wooster gravelly loam
Chagrin silt loam	Palmyra fine sandy loam
Genesee silt loam	Groton loam, gravelly phase
Braceville silt loam	Groton loam
Palmyra shaly loam	Berrien very fine sandy loam
Cazenovia loam	Schoharie loam
Cazenovia silt loam	Schoharie loam, light text phase
Chenango silt loam	Chenango fine sand loam
Chenango silt loam, gravelly phase	Ontario gravelly loam
Chenango loam	Otisville gravelly loam
Chenango loam, gravelly phase	Tonawanda silt loam
Chenango shaly loam	
Chenango very fine sandy loam	
Mentor sandy loam	
Mentor silt loam	
Tonawanda loam	
Newton very fine sandy loam	
Palmyra gravelly loam	
Palmyra loam	
Palmyra very fine sandy loam	
Chautauqua, New York	
Chenango gravelly loam	Dunkirk gravel
Chenango silt loam	
Dunkirk gravelly loam	
Dunkirk very fine sandy loam	
Genesee silt loam	
Cattaraugus, New York	
Chenango gravelly loam	Wooster gravelly silt loam
Chenango gravelly silt loam	Wooster gravelly loam
Chenango gravelly silt loam, alluvial	Wooster silt loam
Chenango silt loam	Braceville silt loam
Unadilla silt loam	Chenango gravelly sandy loam
Tioga silt loam	Unadilla fine sandy loam
Tioga silt loam, high bottom	Otisville gravelly loam
Tioga fine sandy loam	Mentor fine sandy loam
Tioga fine sandy loam, high bottom	Pope silt loam
Genesee fine sandy loam	Middleburg silt loam
Genesee fine sandy loam, high bottom	
Genesee silt loam	
Genesee silt loam, high bottom	
Chagrin silt loam	
Ottawa, Ohio	
Lucas silt loam	Fulton very fine sandy loam
Lucas very fine sandy loam	Rodman gravel, beach ridge phase
Danbury very fine sandy loam	Toledo very fine sandy loam
Genesee fine sandy loam	
Fox gravelly loam, beach ridge phase	

[a]Older series.

2.7.6 Conclusions

Three basic plant resources were considered to be most important for prehistoric peoples: oak and hickory nuts, walnuts, and maize from agricultural production. It was assumed that sites were located spatially to optimize their location to these resources, under the constraints of nearness to potable water, dry immediate site conditions, and (later) defensible positions. Each resource group was broken down into individual species for analysis and each species was identified for those attributes that would best isolate the soil series most favorable to it. Parent material and drainage class were the important parameters used in the first stage of culling. Those soils fitting these criteria were then evaluated individually on the basis of other finer characteristics, such as site index, productivity, base saturation, etc., to provide distinctions between soils that would have been most favorable for growth, soils that would have been less favorable, and those that would have been unfavorable. Each soil series was evaluated under modern climatic conditions as well as under wetter and drier climatic conditions to provide a better approximation of soils that would have been optimal during wetter and drier climatic episodes. The result is a set of three lists for each resource, specific soils for Class I, II, and III levels of productivity are rated under three different climatic regimes. Soils with a Class I or II rating for each resource form the basis of the correlation of important resources for prehistoric inhabitants and site locations.

2.8 SUMMARY AND DISCUSSION

(Sue Ann Curtis and James W. Hatch)

This chapter presented a description of the environmental makeup of the project area and focused on five environmental factors: geology, climate, soils, vegetation, and fauna. Because technologies associated with Euro-American colonization and development of the area led to extensive environmental changes, a baseline date of A.D. 1800 was selected for the description provided. Before 1800, human impact on the environment was relatively minor. The reconstruction for the date selected provided a comparative baseline for assessing earlier periods of prehistoric settlement in the area.

The environmental data presented are important for predicting the kinds of cultural resource sites for different chronological periods and cultural affiliations as well as their locations. In addition, the descriptive information that was synthesized and the environmental reconstructions that were made represent contributions to the state-of-the-art knowledge about this area. Such information could be incorporated into future environmental statements. The reconstructed data on prehistoric environments generated as part of this study are new for this area and contain conclusions about methods and interpretations applicable to archeological and historical studies in general.

Conclusions reached in the geomorphology and hydrology sections help identify those areas on shore and in the current lake bottom where cultural resource sites may be present. The current shoreline has changed over time and ´lmost all of the present lake bottom would have been dry and available to prehistoric occupation of the area. As the lake expanded over previously occupied areas, the mechanics of the wave action removed soil in some areas and deposited it in others. Thus, some well-preserved archeological sites may still exist, particularly those dating to 12,500-10,000 B.P. and 500-3,500 B.P.

Wave-induced erosion of the present shoreline was identified as one of the major threats to cultural resource sites remaining in this zone.

The section on climate discussed the meteorological effects of the lake for the immediate area and noted that the number of frost-free days was greater for some shore areas than for areas further away from the lake; the shore area may also have had greater amounts of snow. Temperature and moisture differences would have affected the kinds of vegetation present along the lakeshore and the area's agricultural potential. These factors would, in turn, be reflected in the settlement-subsistence strategies of the prehistoric inhabitants.

Soils in the study area have been characterized by various soil scientists; the data generated are complex and lengthy. Abstracting a useful level of detail for archeological-environmental projects presents a problem. The catena approach was used to identify and characterize important soil patterns that can be used in vegetational reconstructions and assessments of agricultural potential. It was pointed out in the text that soil surveys of different dates exist and the same soil class names may not be strictly comparable if they are used in the same analysis.

In the vegetation section, major effort was given to synthesizing available historic data that describe the forests around the 1800 baseline prior to European disturbance. Discussions were organized by state and physiographic subdivision and were combined in Appendix E, which inventories the tree species that would have existed in the three-state project area along the lakeshore. After presenting an assessment of the factors that affect forest type, a model was constructed for the forest types in the region's major physiographic settings for the 1800 baseline. This model was projected back into time by using available paleovegetational and paleoclimatological data to characterize the dominant forest and climate in western and eastern parts of the Lake Erie Basin over time. In general, vegetation and climate changes occurred later in the eastern areas than they did in the western. The basic forest composition continued to differ between the eastern and western areas through many parts of the prehistoric and early historic sequence.

The section on fauna was limited to describing the kinds of terrestrial and aquatic species likely to have been present in the study area in prehistoric and early historic times. A brief section on the historic factors that affected the local fauna represented today was provided. Attention was given to the high productivity levels of the lake; Lake Erie was a very rich source of fish, particularly the Western Basin, and the shoreline provided a large number and variety of mammals and waterfowl. These combined factors would have made this area attractive to hunters and gatherers. Moreover, the close proximity of lake, stream, and land environments would have increased the diversity and availability of food resources within an area that could be controlled by a single sociopolitical group. Such diversity of resources in these major environmental zones and in the ecotones that separate them would have had survival value for both animals and people. Had the major food resource in any one zone been greatly reduced by a natural disaster, the resources of adjacent zones could have filled the nutritional deficit.

In the last section of this chapter, the environmental data were used to predict the suitability of the study area for acorn, walnut, and maize production. These food resources were probably staples in the diet of prehistoric populations, depending on the time period involved. Each of the resources was correlated with general soil types, making it possible to identify and evaluate the productivity of the micro-environments surrounding a given prehistoric site.

CHAPTER 3

PREHISTORY

Randolph J. Widmer and Gary S. Webster

3.1 INTRODUCTION
(Sue Ann Curtis and James W. Hatch)

This chapter will present a characterization of the prehistoric periods of the study area and provide guidance on locating unknown cultural resource sites. The nontechnical reader will be introduced to the kinds of research and procedures necessary for site prediction; the archeological readership will be given a critical review of previous settlement research and a theoretical and methodological framework for executing future settlement research.

Compared to the information on known ethnographic, historic, and shipwreck sites discussed in later chapters in this report, it can be seen that the information given for prehistoric sites is more complex. This is true for several reasons. First, prehistoric sites are a product of nonliterate societies that left only their material remains to be located and interpreted. Although professional and amateur archeologists have inventoried many sites, systematic studies have been limited to small land tracts in the three-state study area. Most other sites were discovered accidentally. Therefore known site inventories for the lakeshore are incomplete and are, by themselves, not helpful for locating the vast majority of the unknown sites that almost surely remain. Rather it is the distributional patterns for site groups that we believe must be applied to site prediction if a more complete inventory is to be compiled.

Second, the time period during which humans have occupied various parts of the study area is much longer than the historic and ethnohistoric periods. Because of the time depth, small groups of people produced a large number of sites and a wide variety of site types.

Third, during any one time period, the material remains and associated cultural traditions varied from region to region. Therefore, developmental sequences appear to exist for different areas, and can be compared and contrasted at different points in time.

Because data on the distributional patterns of sites are complex, incomplete, and cover a long time period, generalizations about these patterns must be set forth and synthesized. The end result is the construction of models that characterize different sociocultural groups at different times. These models, however, must be checked against actual cultural and environmental field information as well as comparable data from some other areas.

3.1.1 Organization

This chapter is organized into four sections: 1) a literature review of the descriptions of regional prehistory over time, with emphasis on site distribution and function; 2) a presentation of a series of modes characterizing prehistoric cultural adaptations to the study area; 3) case studies in which the mode are evaluated for their on-the-ground characteristics and environmental correlates; and 4) a discussion summarizing predictive patterns for site locations. Within each of these sections, the information presented is separated into the regional zones identified in Chapter 2 as they correspond to the states of Ohio, New York, and Pennsylvania.

The subdivision by states was made because of the greater collector interest and more intensive professional effort within Ohio, the combined effects of which have resulted in vastly superior site-file information for Zones 1 through 3. As a result, the discussion pertaining to the Ohio zones has been organized diachronically and centers around maps that show the location of sites and potentially important resources in some detail. Zones 4 and 5 have been organized by sub-region within each zone, and we have relied on the sparse site-file data to provide support for the mode.

3.1.2 Approach

The organization of this chapter's sections and the regional cultural and environmental data they contain reflect the cultural ecological approach that is the pervasive theme intregating this document. This approach takes the position that site type and selection by prehistoric inhabitants resulted from economically rational, patterned behavior. In the simplest sense, people want to fulfill a goal, whether it be obtaining a certain food resource or finding a dry place to sleep, with the least amount of effort. Thus, for example, if all other decision-making factors are equal, families and groups will plant corn on the most productive soil and collect nuts in areas with the greatest number of nut trees with the best yields. They will tend to return to the same places if the resource yields remain high. In this way, they can obtain optimum and expected returns for the least amount of effort.

The seasonal scheduling of where individuals, families, and groups go and the mechanisms for changing the schedule over the short- and long-term due to environmental and cultural factors is viewed in an adaptive context. Within the territory of a sociopolitical group, the group's adaptation to the specific microenvironmental conditions of its territory is expected to be reflected in its settlement and subsistence systems. Sites associated with food collection and processing are expected to be found in the most productive environments for the type of resource being exploited. Recognition of these sites and their association with favorable environments can then be used to generalize about the seasonal schedules of prehistoric peoples at certain points in time. Thus, housing location would be determined in part by subsistence activities; other environmental considerations, such as wind, temperature, and strategic location, would also be considered.

These generalizations were used to create predictive settlement-subsistence models. Such models could then be applied to areas for which little or nothing is known about the locations of prehistoric sites. This would be important to structuring a research design. More survey time could then be allocated to investigating the locations with the highest potential for producing sites.

It should, however, be noted that a settlement-subsistence model, by its very nature, characterizes only those sites that are directly or indirectly correlated with subsistence and housing activities. Other types of sites would also be present in the settlement system of a group; these site types are called "residuals" and include burial areas, mounds, sacred locations, etc. It is expected that the location of these sites would be determined primarily by cultural, historical, and ideological factors, and not by environmental factors.

3.2 ARCHEOLOGICAL BACKGROUND

The purpose of this section is to present a comprehensive review of the prehistoric culture history of the Ohio, Pennsylvania, and New York portions of the Lake Erie Basin. This review summarizes and integrates existing data about the area and provides a resource base for the evaluation of existing prehistoric cultural resources remaining in the area. In addition, this section serves as the archeological base for generating a predictive model for characterizing subsistence-settlement systems of the southern Lake Erie Basin through time.

The section includes a discussion of the temporal and spatial context of the archeological resources in the project area as well as a treatment of existing hypotheses and models for subsistence-settlement patterns through time and space. It also presents current interpretations and explanations of archeological resources of the area, with emphasis on identifying the kinds of resources thought to be indicative of change. Pertinent geological and paleoenvironmental data are incorporated where useful.

Section 3.2 is organized into three major chronological periods: Paleo-Indian, Archaic/Transitional, and Woodland. Within each of these designated periods are some behavioral and material patterns commonly recognized across large geographic areas. Similarities and differences observed within the archeological remains of the Archaic and Woodland periods can be used to more finely divide these periods into Early, Middle, and Late temporal subdivisions. In total, eight temporal cultural subdivisions have been identified in the study area; these will be the units used for discussion.

Information about the prehistory for each of these eight time periods emphasizes data on the settlement and subsistence adaptations made to general as well as specific areas. A general description of the following has been provided: 1) the cultural characteristics associated with the period being discussed, 2) evidence for the environmental reconstruction o. .he time in question, and 3) site types for various environmental zones and the associated cultural traditions. The sections that provide descriptions of sites focus on understanding the local site types reported in the literature and possible site functions. When available, published data on models characterizing the settlement-subsistence systems of a local area have been provided.

3.2.1 Paleo-Indian Period

The initial human occupation of the southern Lake Erie Basin was influenced directly by the formation of present Lake Erie, a product of the glacial movements of the Pleistocene. Although there is a growing body of evidence suggesting that humans may have entered the New World as early as 40,000 B.P., human occupation of what is presently the Lake Erie Basin could not have taken place until the retreat of the last (Wisconsin) glacier.

3.2.1.1 Geological Constraints

Since the southern basin of the lake was covered by glacial ice, human occupation of the area could not have taken place until its retreat sometime around 14,000 B.P. (Goldthwaith 1958; Forsyth 1961, 1973). One of the results of this glacial retreat was the development of a series of glacially dammed lakes. The initial level of the lake that was formed in the Lake Erie area was considerably higher than that of the present lake, and it inundated all of the area of the present-day southern Lake Erie Basin to an elevation of 800 ft. Recent evidence indicates that the entire sequence of lake levels (Appendix C) in the Lake Erie Basin took place within a period of about 1000 years (Forsyth 1973). This series of lake levels was controlled by the position of the retreating glacier and its weight on the land. By around 12,500 B.P., during the period known as the Two Creeks Interstadial, the glacier had retreated past the Niagara Escarpment, providing a water outlet roughly 165 ft. lower than that of today. This resulted in a tremendous flood that all but drained the entire basin (Forsyth 1973). It was at this time that humans were first able to occupy the area. They were able to utilize a land surface that was considerably greater than today's.

3.2.1.2 Chronological Subdivisions

The Paleo-Indian period can be divided into two chronological divisions in the Northeast (Mason 1962, Prufer and Baby 1963; Quimby 1960; Ritchie 1965). The earlier complex is characterized by fluted points, the later by lanceolate points referred to as Plano. For convenience, the two periods within the Paleo-Indian era will be referred to as Early Paleo-Indian and Plano.

The Early Paleo-Indian era in the Lake Erie area dates from a maximal initial period of 12,500 B.P. (predicated on the glacial movements) and ended with the change to a modern holocene climate and vegetation thought to have taken place around 10,000 B.P. This terminal date is open to considerable debate since there are no good absolute dates available for this terminus in the Lake Erie region. Prufer and Baby (1963) suggested that the Plano complex dates to after 8500 B.P. (based on a radiocarbon date from Lake Lundy time); Forsyth (1973), however, questioned the validity of this date based on an overwhelming body of more conclusive evidence. Thus, the Plano complex material need not post-date 8500 B.P. This relieves another problem: the occurrence of two fluted points, one on Catawba Island and one on Kelley's Island. According to Prufer and Baby's interpretation, these points could have been deposited no earlier than 8500 B.P. Forsyth's interpretation, however, allows a deposition as early as 12,500 B.P., more in line with the temporal context of other fluted-point material at other sites in the Northeast.

3.2.1.3 Early Paleo-Indian Environmental Associations

Since there is no absolute chronological control of the internal sequence of the Paleo-Indian period, it is suggested that the two complexes be associated with environmental episodes. These episodes have been dated for the southern Lake Erie Basin by Mason (1962) and, to some extent, by Prufer and Baby (1963).

There appears to have been a fairly abrupt change in climate about 10,500 B.P.; spruce and fir were replaced by jack pine, birch, poplar, white and red cedar, and, in the lower, wetter sites, by black spruce, alder, and willow, and eventually pine. This change to a pine-oak period can be correlated with the appearance of Plano archeological material. This association of a culture complex and an environmental era makes sense in terms of reflecting a cultural-technological adaptation and is supported in part by the distributional data. This same approach has been expressed by Calkin and Miller (1977) for New York.

During the fluted-point or Early Paleo-Indian period, the environment in the areas now submerged in the lake consisted of extensive stands of mesophytic tree associations similar to those found on mainland areas to the south. Thus, a very uniform type of spruce-fir woodland environment can be visualized for the entire region of the Lake Erie Basin from 12,500 to 10,000 B.P. Concurrent with this climatic-vegetational association is a very consistent assemblage of tool types (aside from minor variations in projectile points) from Michigan to Nova Scotia (Funk 1977:17). This suggests a common adaptation to the spruce-fir forest environment distributed throughout the formerly glaciated region of the eastern Great Lakes. Ogden (1977) suggested that this region provided a broad game-rich corridor stretching from New York to the Maritimes by 12,000 B.P. as well as providing swamps, bogs, and glacial lakes in the area of the Lake Erie Basin.

The Early Paleo-Indian adaptation (ca. 12,500-10,000 B.P.) was primarily to the spruce-fir forest developing in the wake of the retreating glacier. More specifically, there is a consensus among archeologists working in the northeastern United States that the adaptation was primarily focused on one of the faunal elements associated with this environment--the barren ground caribou (Cleland 1965; Fitting, De Visschera, and Wahlo 1966; Funk, Fisher, and Reilly 1970; Funk 1972, 1977; Guilday 1969; Ogden 1977; Ritchie 1965; Ritchie and Funk 1973; Roosa 1977).

Other late Pleistocene fauna that may have been included in the diet include mastodon, mammoth, and bison (Ritchie 1969, Figure 3) as well as horse, deer, giant beaver, moose, and elk (Funk 1977:18). Quimby (1960) implied that the mastodon was an important, if not primary, prey of the early Paleo-Indian adaptation in the upper Great Lakes. He pointed out that the temporal and spatial distributions of mastodon finds correspond to the distribution of fluted points, suggesting utilization of this resource. He also pointed out that the fluted point was itself a technical adaptation to multiple jab and withdrawal, which would have been useful for procuring such a large prey species.

The importance of large animals to Paleo-Indian hunters is, however, generally debated among anthropologists. No direct association of mastodon or any of these other Pleistocene faunal forms with early Paleo-Indian assemblages has been found in the archeological remains of this area. Moreover, contemporary ethnographic examples of African hunters, such as the Mbuti (Abruzzi 1979), show that even when large prey animals such as elephants are present they are of minimal importance in the diet and are rarely actively hunted. Instead, the Mbuti hunt herding animals, which have a higher return of energy per unit of energy invested. Applying this energy-budget analogy to early Paleo-Indian hunters, it is doubtful that large game animals played an important role in shaping the subsistence-settlement systems of that time.

Although plant resources usually play a far greater dietary role than do faunal resources in most hunting-gathering adaptations (Lee and DeVore 1968), this was not the case with the early Paleo-Indian adaptation. Generally speaking, the closer a hunting-gathering adaptation is located to the polar region, the less importance is placed on exploiting plant resources. The spruce-fir forest in such an environment is characterized by a very uniform floral association, with few types of plants available for human use unless they are cycled through herbivores. Thus, the early Paleo-Indians, like the traditional ethnographic Central Eskimo, must have relied almost exclusively on fauna for their nutrient needs.

The subsistence pattern of the early Paleo-Indian period probably focused on exploiting the caribou. Because of this, the settlement-social system was adjusted to the behavioral and environmental (ecological) requirements of the caribou. This represents a focal adaptation in Cleland's (1976) terminology; an adaptation wherein scheduling of subsistence exploitation is predicated by a single or few food resources.

Sporadic traces of Early Paleo-Indian materials have been reported for the southern Lake Erie plain; these reported finds do not accurately represent the true settlement pattern of this period. Prufer and Baby (1963) conducted a county-by-county survey of Paleo-Indian projectile points for Ohio. Although their study includes extensive distributional data on fluted points, those found in non-glaciated areas or in areas outside the maximum extent of the glacial Lake Erie (i.e., Maumee, Whittlesey, etc.) will not be included in this discussion because points found in non-glaciated areas might reflect adaptations to environments that were not spruce-fir or that were not contemporary with that of the Lake Erie Basin. Most of the sites outside of the glacial lake area in Ohio are associated with major southward-draining rivers such as the Miami, Muskingum, and Scioto, rather than with northward-draining rivers. Since these do not drain into the Lake Erie Basin, they are not associated with the study area.

The area to the north of Lake Erie in Ontario, however, did have the same environment and was roughly contemporary with the glaciated or glacial-lake-covered areas to the south of the present-day lake. This region is in many respects a better region for the analysis of Early Paleo-Indian settlement patterns. It was not possible for Early Paleo-Indians to enter Ontario prior to the Port Huron glacial advance (13,500-12,500 B.P.) because glacial ice or glacial lakes covered the area surrounding this non-glaciated island of land, inhibiting access to it until after the Port Huron advance, when the area was rapidly drained (Hough 1963; Forsyth 1973). Hence, all occupation of this northern region by Early Paleo-Indians had to be post-12,500 B.P. unless one makes the implausible argument for a pre-Wisconsin (i.e., 20,000 B.P.)

occupation that developed the fluted-point technology parallel to, yet independent of, those groups residing to the south. The refilling of the lake after the isostatic rebound, ca. 10,000 B.P. did not inundate many of the small lakes and swampy areas and drainages that were left in the retreat of the Valders ice sheet north of Lake Erie. This had the effect of preserving much of the settlement information of the Paleo-Indian adaptation as a whole. Even more important, ongoing settlement studies of Early Paleo-Indian site distributions in this northern region provide an excellent data base for an interpretive analogy to the Lake Erie Basin Early Paleo-Indian adaptation.

Eleven Early Paleo-Indian sites or areas from which materials have been reported are known for the southern Lake Erie plain. Seven of these sites are clustered in an area of small drainages that flow into Lake Erie in the vicinity of Sandusky; the eighth site is located on the shore of Maumee Bay further to the west. To the east of Sandusky, there is an almost complete absence of Early Paleo-Indian sites or areas from which such material is known. Two other sites are known to exist on Port Huron moraines or beach ridges of the Cattaragaus drainage in the New York area of the lake (Ritchie 1965:4).

The majority of the sites in the Western Basin (five of ten sites) are located on knolls or beach ridges, areas of high topographic relief, ranging in elevation from 610 to 790 ft.

Seven of the ten sites located on ridges are cut by or are adjacent to creeks that flow into present-day Lake Erie. The other three sites (the one eroding from the shore of Maumee Bay and those of Catawba and Kelley's islands) are not presently associated with such a location, but might have been when the lake level was lower. In Michigan, the same situation exists at the Holocombe Site (Fitting, DeVisscher, and Wahlo 1966:3-4) as well as at several other sites of the Early Paleo-Indian period (DeVisscher, Wahlo, and Fitting 1970). All sites are situated on a sand ridge with an elevation of 615 ft.

In Ontario, north of present-day Lake Erie, a similar Early Paleo-Indian site distribution is noted. Storck (1978a and b) and Deller (1976b) both noted that Early Paleo-Indian sites occur on sandy beach ridges formed by the various glacial lakes. Unfortunately, a bias exists in these surveys, since only these glacial lake strandlines are the units of survey. Therefore, knowledge of Early Paleo-Indian settlement in areas not associated with these strandlines is not particularly good. One of the sites in Storck's survey was found on a drumlin rather than on the usual beach strand.

Garrad's (1971) survey of Early Paleo-Indian Ontario points present in amateur collections provided additional information on topographic setting and elevation. He cautioned that the survey in no way provided representative coverage of Ontario, but it did supplement existing knowledge of Early Paleo-Indian settlement patterns. Elevation for early Paleo-Indian sites varied from 578 to 900 ft. where known. The size of the area included between these elevations is somewhat larger than the areas to the south. Since Early Paleo-Indian sites are found on a broad range of geological and topographic features that include plains, sand and glacial tills, sandy loam plateaus, and old terraces, as well as the more familiar sandy beach ridge, a correlation of Early Paleo-Indian sites with beach ridges or strandlines alone represents only a high percentage of the possible range of settlement locations. *It does not* represent the sole settlement location as has been implied by previous studies.

In addition to this basic observation of a high correlation of Early Paleo-Indian sites on high ridges, knolls, or other topographic features, another pattern has been observed in Early Paleo-Indian settlement location. This is the clustering of a number of Early Paleo-Indian sites in a relatively confined area. This can be observed in 1) the Holcombe beach area, where four sites are closely associated spatially on the same beach ridge; 2) in the vicinity of the Heaman Site, where a number of sites and loci are found (Deller 1976a:16); 3) in the Huron drainage of the survey area; and 4) in Cattaragus Creek in New York. Thus a distinct pattern of clustering of sites in favorable environmental or topographic areas is noted.

3.2.1.4 Early Paleo-Indian Settlement-Subsistence Adaptations

Site distributions should be interpreted as an adaptation to resources rather than as a mere correlation with certain physiographic or topographic conditions if we are to develop a predictive model for site locations for the settlement system of this time period. To accomplish this, an understanding of the nature and distribution of the resources in the natural environment is essential.

Deller (1978:4-6) pointed out three ecological-behavioral characteristics of caribou that may be relevant to selection of Early Paleo-Indian settlement locations. First, the margin of former lakebeds adjacent to ridges or elevated areas exhibits a productive environment for caribou, and is capable of supporting larger numbers of animals than other areas. Second, low-lying boggy areas adjacent to lakebeds are very favorable for caribou foraging and browsing. Such bogs are frequently formed by retreating glaciers as the resultant beach ridges and moraines impound water behind them or restrict drainage. The Heaman Site (Deller 1976a) and the Holcombe Site (Fitting, DeVisscher, and Wahlo 1966) are classic examples of such site locations. The impounded bogs and swamps created behind the beach ridges and strandlines or moraines provided favorable habitats for caribou and other Pleistocene fauna hunted by the early Paleo-Indians; the nearby high, well-drained ridges, knolls, and moraines provided convenient and desirable camping locations. Third, well-drained ridge tops and beach strands provided the easiest routes for mass migration of caribou, which in modern times occurs in spring and autumn; the low bogs, swamps, or forests would have slowed down or impeded the progress of these migrations. Deller also suggested that the breaks along these high areas, where they were dissected by streams, probably provided natural impediments to the migration. Since caribou tend to course a linear obstacle crossing their path before they cross it (Spiess 1979:113), such breaks probably created ideal areas for hunters to intercept the caribou.

Early Paleo-Indian sites identified in the survey area and its adjoining region [including the Holcombe (Fitting, DeVisscher, and Wahlo 1966), Parkhill (Roosa 1977), and Heaman sites (Deller 1976a) of Ontario], have been interpreted as small hunting camps for a single nuclear family or a small number of families. Fitting, DeVisscher, and Wahlo (1966:117) suggested that the Holcombe Site was occupied by several families, but the discrete loci of occupation at the site could alternatively be interpreted as the repeated, seasonal use of a single general site area over a long period of time by a single family or small group of hunters. This pattern of site occupation is somewhat reminiscent of Nunamiut camp sites as described and analyzed by Binford (1978). It is possible that both male and female activities occurred at these sites. This can be implied if we assume that unifacial scrapers are usually associated with hide preparation and that such a task is normally indicative of female activity.

These sites may represent specialized hunting camps that were more intensively occupied than other known Early Paleo-Indian loci. These sites are located in or near the best areas for intercepting caribou during migrations or for general hunting. During other times of the year it is likely that the population would have been distributed in other kinds of locations where caribou or other fauna might have been attracted. Sites from other seasonal hunting periods when migrations were not occurring may also be associated with these ridges. Thus, the presence of other kinds of locations away from beach ridges and strandlines may reflect the seasonal locations of preferred game.

3.2.1.5 Early Paleo-Indian Sociocultural Organization

Fitting (1977) suggested that the Early Paleo-Indian people were tribally organized with segmentary lineages that allowed them to expand into new territories. This form of social organization is incongruent with what is known about contemporary hunters and gatherers in similar environmental situations (Lee and DeVore 1968). The basic kin pattern is more often along lines of ambilocal or patrilocal residence with no real lineage or clan system, since the population size and density in such environments is usually too low to maintain such kinship structures. There is no need to invoke a tribal-level segmentary-lineage kinship organization to explain the wide geographical range of similarly styled fluted points or territorial expansion. For example, central Australian aboriginal populations live in small dispersed local groups scattered over extensive continental areas but have a common language, material culture, mythology, and may belong to the same totem or marriage section even though separated by thousands of miles. Hence, mechanisms exist, even at low levels of population and a band level of social organization, to explain the distribution of similar traits across extensive areas. Therefore, based on available data and ethnographic analogy, we propose that during the Early Paleo-Indian period small extended or nuclear family groups were the maximal social units comprising the local group within the study area and that ethnic boundaries were nonexistent or else difficult to define.

It is extremely unlikely that all Early Paleo-Indian site clusters in the study area have been identified. No doubt site clusters exist in the Western and possibly the Central Lake Erie basins that were not covered by water during the period 12,000 to 8,000 B.P. (Forsyth 1973). This now inundated area, particularly the Western Basin, was unquestionably the most favorable area for Early Paleo-Indian occupation in the Great Lakes area. This is because this drainage area had the largest number of swamps, bogs, small lakes, and broad meandering drainages. These formed a nutrient sink, collecting water suspended nutrients from the drainage systems radiating out from and flowing into the basin from the north, south, and west. The overall production in the basin may have increased relative to areas that did not have swamps, bogs, etc. This may be why Prufer and Baby (1963) noted a general paucity of Early Paleo-Indian material adjacent to the present-day lake compared to the high density of Late Paleo-Indian material. This situation can be simply explained by reference to the lake level rise during this period. This rise was discussed in detail in Chapter 2.

It is believed that the general lack of Early Paleo-Indian sites in the eastern region of the lake plain is not an accident of survey bias, although such a bias might result in a misrepresentation of actual site density and settlement locations. There seems to be a good ecological reason for the general paucity of materials in the east. As the glacial ice retreated out of the Erie basin, draining the lake, the tremendous weight of the ice mass was no longer present and isostatic rebound occurred. This rebound of the land mass was almost 150 ft. in the eastern end of the lake (Forsyth 1973). There was, however, no rebound in the western part of the lake since there was no ice mass in this area. This differential rebound meant that the eastern area was drained more rapidly with a paucity of major swamps, bogs, lakes or broad river valleys. Wetlands, however, are the types of environmental habitats associated with high caribou productivity. Thus, an east to west continuum of site density from the Early Paleo-Indian period, may reflect the greater areas of now submerged swamps, bogs, river valleys, lakes, and low-lying areas known to be favorable to Paleo-Indian adaptations.

3.2.1.6 Late Paleo-Indian Environmental Associations

At about 10,500 B.P., an abrupt climatic change seems to have occurred in the Lake Erie Basin area; the spruce-fir forest was replaced by a pine-oak forest (see Chapter 2). During this time period, the Niagara Escarpment of the Eastern Basin was rising, allowing the lake to form. This process resulted in the gradual rising of the lake level to about 15 or 20 m below the present lake level. At 8000 B.P., the lake level stabilized at about 15 m below its present level (Forsyth 1973). Data from Ohio indicate that, at this time, there was also a shift in the distribution of sites from that found in the earlier (fluted-point) Paleo-Indian period (Prufer and Baby 1963).

Prufer and Baby (1963) noted that in Late Paleo-Indian times there were fewer sites in southern Ohio. Plano sites are now densest in the northwest; they become progressively less numerous as one proceeds eastward. There is almost complete absence of material east of Ohio.

Mayer-Oakes (1955b) defined a stemmed lanceolate point complex, which he termed the Panhandle Complex, for the upper Ohio Valley area. He believed that this complex might possibly date to the Early Archaic period. Dragoo (1959), who found these Stubenville lanceolate points of the Panhandle Complex in the upper levels of the Dixon and Rohr rock shelters, placed them in a Later Archaic context, a position also accepted by Prufer and Baby (1963). There may be a problem, however, in that many of the lanceolate points which are actually Plano in context are being mislabeled Stubenville and hence placed in a later and incorrect context. This may explain why few lanceolate Plano points are known for this eastern area.

Unlike the earlier fluted-point period, Plano points have a much more limited regional distribution. They extend only to the Allegheny Plateau and only as far south as the Ohio River. In other areas of the East, a different projectile-point form known as Dalton-Hardaway represents this time period (Mason 1962). These points occupy roughly the same temporal position although they seem to be replaced earlier by Archaic forms than is the Plano material. Some Dalton-Hardaway material has been reported from northwestern Pennsylvania (Johnson, Richardson, and Bohnert 1979), but in much smaller quantities than

Plano material from the same area. This material might be associated contextually with the later phases of Plano or else superceded it in this area.

Another unusual late paleo assemblage is known to occur in the Northeast at the Reagan Site in northwestern Vermont. This assemblage includes fluted, unfluted, pentagonal, and lanceolate Plano-like points (Funk 1977). These points are not reported elsewhere in the East except for a few artifacts from widely dispersed sites. Funk (1977:19) suggested that the Reagan Site may represent a terminal fluted-point tradition in the Northeast, contemporary with the Plano but without more definite chronological placement. At present, the site seems to contain both Early and Late Paleo-Indian components.

One of the patterns observed for the Plano period in the survey area is that there are a greater number of components and sites present than in the earlier Paleo-Indian period. At least 28 loci or sites containing Plano material have been recorded for the survey area.

Although the Plano occupation in the survey area appears to have been roughly three times as intense as that during the preceding Early Paleo-Indian period, the same <u>general</u> geographic density patterns observed for the Early Paleo-Indian period exist, with most of the occupation occurring on the Huron drainage and the other drainages of Erie County. This pattern can be direcly attributed to the rising lake level, which gradually inundated and removed the once favorable environment associated with the Early Paleo-Indian period. The favorable zones gradually moved radially out from the shoreline toward the interior; human occupation shifted in response. Therefore, the drainages to the south became more favorable than they had been in Early Paleo-Indian times. Still, as in the preceding Early Paleo-Indian period, much of the favored environment in terms of food resources and productivity is under the current lake. The increased number of Plano components and site loci are probably not attributable to population increase on a <u>regional</u> basis but instead represent a shift of the Early Paleo-Indian population and settlement pattern away from the originally drained lake basin as it began to fill.

This interpretation is supported to some extent by the data from Ontario, where no increase in Plano occupation relative to the fluted-point occupation is noted (Deller 1976; Storck 1978). Early Paleo-Indian and Plano complex material are often found on the same sites, but there are situations in which Early Paleo-Indian material is found to the exclusion of Plano material and vice versa. That Plano material should be found at previously unoccupied sites is not surprising since the forest zone shifted as the lake level rose. That some Paleo-Indian sites show no Plano occupation was probably related to a change in the character of the settlement pattern necessitated by the change in the adaptive strategy that occurred in the Plano period.

3.2.1.7 Late Paleo-Indian Settlement-Subsistence Adaptations

A reconstruction of the late Pleistocene/early Holocene environment, typical of the Plano period, is subject to considerable differences of opinion among archeologists. Such a reconstruction is, however, of extreme importance to understanding the Plano adaptation and settlement subsistence pattern. Reconstructions of the original environment during the Plano period (i.e., early Holocene, ca. 10,500 to 9,000 B.P.) have usually assumed a boreal forest type (Fitting 1968; Ritchie 1969; Rippeteau 1977). This forest type, which consisted of pine-spruce and pine forests unfavorable to human occupation, is no longer considered accurate; instead, a gradual shift from the original late Pleistocene spruce-fir forest to one of a mixed deciduous pine-oak forest type has been projected (Calkin and Miller 1977; Forsyth 1973; Davis 1967a,b; Miller 1973). The earlier interpretation of a boreal forest during this time period resulted from the direct interpretation of the high absolute amounts of pine in the pollen profiles. It is likely that these are overrepresented because of the much greater pollen production of Pinus compared to other species (see Chapter 2). Recent studies point out that all deciduous species tree pollen increases as well. Instead of a closed boreal forest, the modern reconstruction is thus one of a closed, mixed coniferous-deciduous forest. Thus, the Late Paleo-Indian or Plano adaptation might, in part, have been an adaptation to the gradual shifts in the location of forested areas as well as in the ecological composition of the forest. The adaptation itself lasted until approximately 9,000 B.P.

The Plano period can therefore be considered as an adaptation to a gradually shifting from spruce-fir to mixed pine-deciduous forest type, concurrent with a spatial shifting of the productive areas resulting from the filling of the lake basin. The character of the site location and settlement distribution indicate a continuation of the Early Paleo-Indian period trends. But, as has been pointed out, there were certain changes in site locations.

As the vegetation changed in type and distribution, hunting strategies also changed. During the early part of the Plano period, subsistence strategies still focused on the primary hunting of caribou but gradually, as the forest composition shifted from spruce-fir to closed mixed pine-deciduous forest, new modern faunal forms appeared. These eventually replaced the caribou. Guilday (1967) has dated a modern temperate climate faunal assemblage from Hosterman's Pit in Centre County, Pa., at 9200 B.P. It is expected that such modern faunal forms would be found slightly later in the Lake Erie Basin area because of its more northerly latitude.

Archeological investigations at the Mixter Site (Shane 1967b), located within the survey area on the Huron River, reveal the very tight spatial clustering of Plano material. Plano artifacts were found within a single circumscribed area of some 250 by 200 ft. on top of a beach ridge. Plano material was restricted to this one area of the site, while later Archaic material was found distributed over a much larger area. Deller (1976a) observed a similar tightly clustered intrasite distribution of Plano material at the Heaman Site in Ontario. A similar pattern was observed for the Plano material at the Sawmill Site, also on the Huron River drainage, but farther south, outside the project boundary (Smith 1960; Prufer and Baby 1963). The tight intrasite clustering of material, the high beach ridge or topographic feature location, and the areal clustering of sites was also observed for the Early Paleo-Indian period. Continuation of these patterns strongly suggests a continued emphasis on hunting and a lack of emphasis on plant resources, which are distributed over a broader area on ridges. The addition of different types of site locations to the basic Early Paleo-Indian site-distribution and settlement pattern during the Plano period can be considered as an adaptation to the different behavioral characteristics associated with the ever increasing frequency of modern faunal types through time. Thus, the Plano period can be viewed as a transitional adaptation as well as one of technological change.

3.2.1.8 Late Paleo-Indian Sociocultural Organization

There was no apparent change in population size or density on the regional basis from the earlier period. The increase in number of sites compared with the earlier period was apparently the result of population relocation resulting from the rising lake level and not of increasing population. There was probably little change in the social and political organization of the Plano period either at the minimal group level or the larger social or territorial level. Thus, the Plano period represents, as Fitting (1970) correctly stated, a hunting adaptation to a forest, a forest that was changing in composition. Vegetational changes were associated with a concurrent shift in faunal composition. This period, then, was a true transitional period in terms of processual aspects of culture as well as the artifactual elements.

3.2.2 Archaic and Transitional Periods

Sometime between 11,000 and 9,000 B.P., the closed mixed coniferous-deciduous forest had been established in the northeastern United States, and more particularly in the Lake Erie Basin (Ogden 1977:30). In response to this environmental shift, there was a shift in cultural adaptation to this more diversified biome. In ecological terms, the basic homogenous vegetational cover and few faunal types, characteristic of the northern polar and subpolar ecosystems, had been replaced by a warmer climate and a more diversified floral and faunal assemblage. Thus, as Cleland (1976) suggested, there was a shift from a focal to an early diffuse subsistencene and economic base. This shift most likely occurred during the Early Archaic period as Cleland recognized at the St. Albans Site, a known Early Archaic occupation.

This shift was made possible by the fact that the biomass was greater in the more temperate climate and that it was also distributed in a greater variety of forms. Because of this diversity of niches and species, successful adaptive patterns had to incorporate multiple resources. These resources now included both faunal and floral items. Thus, a different and quite distinctive distribution of sites was to be expected for this period. This pattern differed markedly from that observed in the preceding Paleo-Indian period.

The level of Lake Erie had been stabilized by this time at about 15 m below its present level. This stability lasted for about 5000 years, at which time there was a dramatic rise in the lake level. During those 5000 years, the water did not penetrate the Western Basin. The western islands were still land-locked. Forsyth (1973:23) thought that this stable lake level was a product of a gradual drying of the climate, climaxing with a xerophytic interval at about 4000 B.P.

3.2.2.1 Chronological Subdivisions

The Archaic period, originally defined by Ritchie (1932) for materials recovered from New York and later refined by Byers (1959), has been divided into three chronological subperiods: the Early, Middle, and Late Archaic (Fowler 1959). The Early Archaic period lasted from 8000 to 6000 B.C., the Middle Archaic period lasted from 6000 to 4000 B.C., and the Late Archaic extended from 4000 to 1000 B.C. (Fowler 1959; Griffin 1967).

The initial date of the Early Archaic in the survey area is probably somewhat later than in other parts of the eastern United States, because the deciduous forest stabilized itself a little later in the north than in the south. As a result, the Plano period extends a little later in the north than the traditional Hardaway-Dalton complexes in the south; an initial date of 7000 B.C., coincidental with the establishment of the deciduous forest, is suggested.

Northeastern archeologists have long thought that there was no Early or Middle Archaic occupation, or at best a minimal occupation, in the Northeast (Fitting 1968; Ritchie 1965; Dragoo 1959; Prufer and Baby 1963; Prufer and Sofsky 1965; McKenzie 1967). This opinion was based on the absence of Early Archaic materials in stratified contexts dated by early radiocarbon determinations and the belief that a boreal forest characterized the paleoenvironment. Contemporary paleoenvironmental reconstructions demonstrate that the environment was not as limited in resources for human exploitation as previously thought. The failure to recognize Early Archaic components in the northeastern United States also developed out of preconceived ideas about what should be present in this area. When Early Archaic material was present in mixed stratified contexts it was usually assigned a Late Archaic date. It should be pointed out, however, that Dragoo (1959:187) correctly noted that bifurcate points are the stratigraphically oldest material at the Rohr Site.

Fitzhugh (1972), in his survey of the Early Archaic, noted that the northern boundary for Early Archaic material extended across central Pennsylvania. Fitting (1966) also noted that a very sporadic distribution of Early Archaic bifurcate points is found in the Great Lakes area. More recent surveys have unequivocably demonstrated the existence of Early Archaic style material in surface contexts in the northeastern United States, particularly in the vicinity of the survey area (Calkin and Miller 1977; Brose and Essenpreis 1973; Bowen 1976; Johnson, Richardson, and Bohnert 1979; Brose 1977; Shane 1974a and b). The projectile point styles characterizing the Early Archaic period are found throughout the Northeast. These include such projectile point types as St. Albans and Lecroy bifurcate base (Broyles 1971), Lake Erie bifurcate (Fitting 1966), MacKorkle (Broyles 1971), and Kirk and Palmer (Coe 1964). The variability in these point types seems to represent differences in time or function rather than spatial or cultural distinctions.

Earlier research, which tended to misclassify or ignore the presence of Early Archaic components in the Northeast, should not be faulted since it was not until 1966 that the Lecroy projectile point was securely dated to Early Archaic contexts (Broyles 1966), although a single point had been found in the upper level of the lowest zone of the Stanfield-Worley Bluff site (DeJarnette, Kurjack, and Cambron 1962:99, Table 18) and was assigned an Early Archaic context. Kirk points also had well-established Early Archaic contexts in the stratified deposits of the Hardaway Site in the piedmont of North Carolina (Coe 1964).

The morphological affinity of southern Early Archaic projectile points such as Lecroy and Kirk is now recognized and these names have even been used to classify northern Ohio material (McKenzie 1967; Prufer and Sofsky 1965). Yet, in spite of this morphological similarity, these points are thought to be of a later origin in the north than in the south. Lecroy points in the northern Ohio area are referred to by the previously mentioned authors as Lake Erie bifurcates, and all Archaic material, including Lecroy and Kirk points, are thought to date after 3500 B.C. This assessment is predicated on the basis of the earliest date for an Archaic context in Ohio, 3360 ± 90 B.C. at the Rohr Shelter for an Early Archaic hearth (Dragoo 1959:238). Ritchie (1965) also thought that the earliest Archaic material in New York dated no earlier than 3500 B.C. A similar situation is found in Michigan, where Fitting (1970:65-67, 1963a and b, 1964b) acknowledged the existence of Early and Middle Archaic material, but, in Ohio and New York, he suggested that Early Archaic occupation in that area was only minimally represented before 3000 B.C. This belief is due to the presumption of poor environmental conditions for that period. This situation is somewhat supported by Brose and Essenpreis (1973) who characterize the environment of Monroe County in southeastern Michigan as being a homogeneous mixed oak-pine forest and recognize Early and Middle Archaic components (7000 B.C. to 3500 B.C.) in their survey. Nonetheless, they state that "there were not many components represented by distinctive artifact assemblages which could be unambiguously assigned to this period" (Brose and Essenpreis 1973:71). They also concur with the position previously stated by noting that "The period ca. 7500 B.C. to perhaps as late as 3500 B.C. is represented (typologically) only in its earlier portion, and only by the Satchell complex" (p. 71). An inspection of the published photographs from their survey reveals what appear to be numerous Early Archaic projectile points of various types. These types include Kirk and bifurcate forms.

Shane (1974a and b) recognized that all cultural periods are recorded in the Huron Valley area of north central Ohio and noted, in his survey of the Erie nuclear facility, that the bulk of the material is Archaic, with numerous Early and Middle Archaic components. Brose, Werner, and Wolynec (1977:31) list 97 Middle Archaic components out of a total of 251 components analyzed from survey data from Erie and Crawford counties, Pennsylvania, and Ashtabula County, Ohio. Brose (1977:9-10) also identified a few Early Archaic components and numerous Middle Archaic components in his survey of the U.S. Steel Plant area, Ashtabula County, located in the northeast Ohio region of the Lake Erie Basin and in Erie County Pennsylvania.

Besides survey data, stratigraphic evidence is mounting in the Northeast in areas adjacent to the Lake Erie Basin that supports the occurrence of these southern Early Archaic projectile point forms in early contexts, i.e., 8000 to 6000 B.C. Michels and Smith (1967) reported Lecroy and Kirk projectile points underlying laurentian material in a deep stratified context at the Sheep Rock Shelter in central Pennsylvania. Radiocarbon determinations indicated a context for these points between 6900 and 5100 B.C. Funk (1977:22) reported a date of 7430 ± 100 B.C., from the Gardepe Site on the Susquahanna River in New York, but was skeptical of the date because it was associated with Lecroy rather than Kirk projectile points, as the southern stratigraphic sequence would suggest. The Shawnee-Minisink site on the Delaware River, between Pennsylvania and New Jersey (McNett, McMillan, and Marshall 1977), produced Early Archaic projectile points including Lecroy and Kirk-like points. This material is stratigraphically situated below Late Archaic occupations and above Paleo-Indian occupations. Based on these recent data, most northeastern archeologists generally accept the occurrence of Early Archaic occupations in the Northeast (Dragoo 1976; Funk 1976, 1977; Calkin and Miller 1977; Ford 1974; and Brose 1977), a position that was not accepted as recently as ten years ago.

One effect of this recent recognition of Early Archaic material and occupation in the Northeast is a lack of the proliferation of phase or complex names for this material. Archeologists tend to discuss this Early Archaic period simply as a temporal unit. While regional variants of Early Archaic projectile point forms do exist within the northeastern United States, the temporal and cultural similarities are categorically recognized. This is in part due to the fact that projectile points alone distinguish this period from the later Archaic manifestations, particularly those of the Late Archaic period. Furthermore, it appears that the Early Archaic sequence that exists at the Saint Albans Site (Broyles 1966, 1971) and in the Little Tennessee River (Chapman 1977) is applicable for the Northeast as well (Murphy 1975; Fitzhugh 1972; Funk 1977).

3.2.2.2 Early Archaic Settlement-Subsistence Adaptations

Although the basic occurrence of Early Archaic material has been recognized in the Northeast, the underlying nature of this adaptation and its sociopolitical characteristics are poorly known. Ford (1974:392) believes that there was a single, uniform adaptation in the Northeast between 8000 and 5000 B.C. He also considers the settlement pattern for this time period to have been homogenous. Three site types comprise the settlement system: temporary hunting camps, impermanent base camps, and quarry sites. Subsistence reconstructions for this period are based solely on artifact function since no faunal assemblages or floral assemblages were known at the time Ford wrote his summary. Artifact analyses indicated deer hunting supplemented by some seasonal plant collecting and the hunting of smaller mammals and birds. Nuts were utilized when available, but fishing and plant processing tools were infrequent. Ford envisioned small hunting and gathering populations, presumably at a band level of sociopolitical integration, with marriage between groups. To him, this configuration was responsible for the widespread distribution of Early Archaic projectile point styles throughout the Northeast. Dragoo (1976:10-11) followed this scenario as well.

Funk (1977) advocates a more complex ecological approach to an interpretation of the Early Archaic adaptation in the Northeast. Funk (1977:25) described the food resources for the period from 8000 to 5500 B.C., a period characterized by a pine-oak environment for the Upper Susquehanna Valley (Rippeteau 1977:394; Funk 1977), as consisting of predominantly small mammals such as red fox, marten, and wolverine. Fish and other aquatic food would have been important food resources as well. Nuts would also have been utilized, but there were probably few other floral resources that would have been incorporated into the subsistence base.

The settlement pattern expected to be associated with such an adaptation would be characterized by thin, dispersed sites located in valley bottoms to exploit these resources. Upland nut-gathering sites might also have been present. Social groups would have been highly mobile, staying briefly at sites utilized in their seasonal round. Funk cautions that this model is applicable only to upstate New York and interior New England, but it should also hold true for the Lake Erie Basin in areas where the vegetational patterns were similar.

Cleland (1976), as mentioned earlier, considered the Early Archaic to be essentially a focal adaptation, presumably because of environmental conditions, although he does not specifically say so. However, in view of Funk's (1977) reconstruction, and compared with earlier Paleo-Indian adaptations, the Early Archaic is more diffuse than focal both with respect to hunting and fishing and also as to the use of floral resources, i.e., nuts.

Direct subsistence data for the Early Archaic in the Northeast are unfortunately absent, with the exception of a fish bone from the Shawnee-Minisink Site (McNett, McMillan, and Marshall 1977) on the Delaware River. Chapman (1977), however, has recovered acorn and hickory nut fragments from Early Archaic contexts in the Little Tennessee Valley. Because of the lack of direct data in this area, all statements concerning subsistence must be derived exclusively from technological, settlement, and paleoenvironmental data.

3.2.2.2.1 <u>The Natural Environment</u>. As discussed earlier, many of the early paleobotanical reconstructions are to be rejected in light of recent research (Forsyth 1973). Furthermore, Ogden (1977:30) stated that "the establishment of the deciduous forest in the Northeast occurred very rapidly in the period from 11,000 to about 9000 B.P. and represents an environment and presumably climatic events more dramatic than any that have occurred before or since." This seriously alters the pattern of human adaptation that had previously been hypothesized (Ford 1974; Dragoo 1976; Funk 1977; Stoltman 1978). A cautionary note was provided by Fitzhugh (1972:4-5) who correctly foresaw the problem of interpreting pollen profiles and making direct comparisons with contemporary habitats: "future ecological research in the Northeastern environments [are likely] to demonstrate even higher carrying capacities than those of the present boreal zone."

In the generalizations regarding the early Holocene concept of the "boreal," vegetative resources are considered of minimal importance, with the exception of nuts from the increasing appearance of oak through time. Griffin (1967), citing Yarnell's (1964) ethnohistoric study of Great Lakes plant resources, characterized the Early Archaic period for the entire eastern United States as having plant resources present, although he believed that the dependence on and knowledge of the native resources took a long time to develop, and that much of this development took place during the long Archaic period. This position basically followed that postulated by Caldwell (1958) for the development of the use of eastern U.S. forest resources.

Obviously then, most interpretations of Early Archaic adaptation in the Northeast are inaccurate. To resolve this situation, it is imperative to have a firm understanding of the paleoenvironmental characteristics of the early Holocene. Unfortunately, such a detailed environmental record is not available for the Lake Erie Basin during the early Archaic period, nor has the information from this period been synthesized. As a result, this study will provide an initial synthesis of existing published reports incorporating theoretical propositions absent in previous treatments of this period in northeastern archeology.

Two themes are prevalent in previous discussions of the Early Archaic in the Northeast. The first theme involves a theoretical position, the second a substantive one. At a theoretical level, archeologists have often assumed that the Early Archaic represented a transitional adaptation of a basic population from a boreal to a deciduous environment (Stoltman 1978). Thus, a readjustment to the new Holocene environment must have occurred. This was accomplished by a gradual increase in knowledge in the use of these new resources (Caldwell 1958; Griffin 1967); hence a time lag exists. This would account for the paucity of remains and the low population numbers. Subsequent population growth is seen as a result of a rise in knowledge or the efficiency of the use of the developing forest environment. This characterization can be argued on both theoretical and substantative grounds.

In many parts of the eastern United States, Early Archaic occupation was very dense (Chapman 1977; Coe 1964) and a gradual knowledge of the environment as a prerequisite to growth cannot be used as an explanatory mechanism for explaining increases in population. Ethnographically, all adaptations dependent on a hunting and gathering subsistence base indicate an extremely sophisticated and broad knowledge of environmental resources, even in adaptations characterized by low population size and density such as found in certain Great Basin groups (Steward 1938).

3.2.2.2.2 Site Distribution. Substantively speaking, if we expect that the Early Archaic adaptations in the Northeast were to a boreal forest biome while Late Archaic (particularly after 4000 B.C.) adaptations were to a deciduous forest environment, then we would expect to see striking differences in the general settlement patterns and adaptations between the two periods. However, such differences cannot be empirically demonstrated in those areas where archeologists have recognized or reported Early Archaic and Late Archaic materials.

3.2.2.2.2.1 Ohio. Murphy (1975) noted that Early Archaic components are well represented in the Hocking Valley in south central Ohio. Shane (1974a and b) also reported numerous Early Archaic components for the Lower Huron Valley area of north central Ohio. Furthermore, most of these components were found on multicomponent sites with later Archaic materials, thus confirming the basic similarity of settlement pattern and presumed adaptation. Brose (1977) also reported Early Archaic components from the U.S. Steel facility on the Lake Erie shore of Ashtabula County, Ohio and Erie County, Pennsylvania. Johnson, Richardson, and Bohnert (1979) reported numerous Early Archaic points from various locales in northwest Pennsylvania, many in the Lake Erie Basin. Bowen (1976) also noted numerous Early Archaic points in the Green River drainage of Seneca County, just south and adjacent to the survey area.

Thus, there is clearly a precedent for Early Archaic occupation in the Lake Erie Basin. Moreover, the paucity of recognized Early Archaic material in the northeast cannot be used as evidence of low carrying capacity and, hence, a boreal biome.

The present-day distribution of Early Archaic sites in the Lake Erie Basin was obviously affected by the lake level. During the Early Archaic period, the lake was well below its present level with the entire Western Basin being exposed. Furthermore, the northeastern portion of the Lake Erie shoreline, north of Cleveland, has been severely eroded in relatively modern times. As discussed earlier, the Western Basin of Lake Erie was the richest environmental area in the survey area, and an east to west gradient of occupation density reflecting this productivity is predicted.

3.2.2.2.2.2 New York and Pennsylvania. Cultural manifestations dating to the earliest post-Pleistocene are rare in New York and Pennsylvania; they occur primarily as isolated surface finds of diagnostic projectile points and in a limited number of site components such as Meadowcroft Rockshelter (Adovasio et al. 1977) and Sheep Rock Shelter (Michels and Smith 1967). An apparent occupation hiatus between late Paleo-Indian and the late Middle Archaic has been postulated on the grounds that a closed boreal forest during the early Holocene presented an economically unfavorable habitat to early hunter-gatherers of the Early Archaic and early Middle Archaic (Fitting 1968; Ritchie 1969). From recent interpretations of pollen sequences in western New York and Pennsylvania (Miller 1973; Walker and Hartman 1960) we are now quite certain that, by at least 7000 B.C., a pine-oak forest prevailed in the Allegheny Plateau (Johnson, Richardson, and Bohnert 1979; Calkin and Miller 1977) and probably somewhat earlier in the Erie Lowlands. Although these earliest forests no doubt did not have the productive potential of later deciduous hardwood forests, it is clear that during the Early Archaic the plateau and adjacent lowlands supported some nut-bearing trees, such as oak (up to 25 percent) as well as walnut and butternut, and, as indicated by remains at Hosterman's Pit, dated to 7,290 B.C. in the plateau of Pennsylvania, an essentially modern temperate forest fauna (Guilday 1967).

The postulated settlement-subsistence pattern for the Early and Middle Archaic in the Northeast is one involving a rather selective utilization of deer, several smaller animal species, particularly raccoon and turkey, and nuts by small, highly mobile groups that ranged over fairly large territories. The pattern is largely supported by the striking homogeneity of point styles over large portions of the East. The quantum increase in terminal Early Archaic points may reflect an influx of groups from the south, as forests in the Allegheny region supported increasingly greater proportions of oak, walnut, and hickory by the end of the seventh millenium B.C. (Miller 1973). Interestingly, point-distribution surveys from northwestern Pennsylvania, such as from Venango County, suggest that the upland valleys of the Allegheny drainage and plateau were being utilized during the Early Archaic, and that rock shelters on hill breaks or hill tops near to water were one important settlement type (Curtis 1969). It appears that upland areas like Venango County were more heavily used during this period than were the Lake Plains.

To the north, in western New York, evidence for the Early Archaic is very sparse although sporadic finds of bifurcate base points do occur (Ritchie and Funk 1973:337). The generally low densities of Early Archaic materials suggest limited use of this area by hunter-gatherers ranging from the more favorable areas to the south and east.

In light of this new understanding of early Holocene environmental conditions in the southern Lake Erie Basin, we must view the paucity of Early Archaic manifestations on the Lake Plain as resulting not only from low occupation density, but also from sampling error. Early Archaic lake levels were substantially lower than present-day ones, which raises the probability that early sites once situated near the shore and mouths of tributary streams have since been submerged and/or destroyed by higher water and by shoreline erosion.

3.2.2.2.3 <u>Sociocultural Organization</u>. Although there is no difference in Early Archaic projectile point styles within the entire Lake Erie Basin, it should not automatically be inferred that the adaptation was similar throughout the region in terms of ethnicity, language, social networks, or kinship patterns. Based on the present paleoenvironmental reconstruction for this period, we do see a similar basic environment for the entire Lake Erie Basin. However, this does not mean that there were no spatial differences in resources, quantitatively or qualitatively, between the various drainages or topographic areas throughout the study area.

There was a major difference in the type of faunal resources in the Lake Erie Basin during the Early Archaic period and those of the preceding period. Deer were the dominant faunal prey of the Early Archaic. Associated with this new subsistence item were the technology and settlement strategy to best exploit this new resource. Unlike the migratory caribou, the major subsistence item of the Paleo-Indian period, deer have a somewhat circumscribed home range. Although seasonal shifts in home range are still observed, deer are more homogeneously distributed throughout the forest. Human settlement probably shifted in response. Floral resources now became important in the subsistence base as well. These items were also distributed more homogeneously than in previous times. Thus a diffuse adaptation is seen. Assemblages now included the adze, grinding implements, and the atlatl and barbed projectile points, presumably for a stalking type of hunting. It is interesting to note that the introduction of the barbed projectile point in the Tehuacan Valley of Mexico occurred in the same phase in which deer became important in the subsistence base, the El Riego phase (6500-4900 B.C.), replacing horse and antelope of the earlier Ajuerado phase and the associated lanceolate projectile points (Flannery 1967). These barbed points would penetrate deeply into an animal and, if they did not hit a vital spot, would cause the animal to bleed so it could be trailed. Points with pronounced barbs would remain imbedded in the animal, causing it to eventually drop (Flannery cited in MacNeish 1967:304). Flannery also suggested that thin, weakly barbed points were associated with individual hunting, while thicker, strongly barbed points were utilized by groups of hunters. This technological shift suggests the introduction of the stalking type of hunting, presumably for deer, elk, and moose, instead of ambush hunting for migratory caribou utilizing lanceolate projectile points.

Northeastern archeologists have, without exception, noted that it was the relationship between the early Holocene environment and humans that is important in understanding the Early Archaic and all subsequent Archaic developments. What they fail to agree upon is the environment within which this adaptation occurred. Theoretically speaking, one could argue that denser population during a particular period or in a particular region is a consequence of higher productivity of wild resources and, therefore, a higher carrying capacity. The variables and factors that influence this productivity are climatic and geological-physiographic, and affect the resources primarily through vegetative composition and aquatic environments. Thus, by modeling the spatial distribution of the various forest types within the Lake Erie Basin for each period, the relationship between environmental and cultural processes can be investigated, with the goal of explaining the various features of the cultural phenomena empirically observed in the region. During the Archaic, the productivity and availability of game (both upland and aquatic) and floral resources utilized by humans can be viewed as significant variables affecting population size, density, and distribution as revealed archeologically in settlement pattern data. Local adaptations, therefore, must be explained in terms of human-environmental relationships rather than in stylistic characterizations and comparisons of material cultural inventories.

3.2.2.3 Middle Archaic Settlement-Subsistence Adaptations

The Middle Archaic period extends from 6000 to 4000 B.C. Although many patterns identified for the Early Archaic continued, differences in adaptation and regional development appeared during the Middle Archaic. These can be attributed to environmental variables--both spatial and temporal--although this correlation has not been demonstrated in the literature. From the data available, it appears that the deciduous forest had been established by 7000 B.C. and that minor climatic changes had taken place. Ogden (1977:30-31) noted that "minor but consistent changes in the proportion of hemlock, beech, hickory and elm pollen throughout northeastern North America reflect subtle but important differences in effective moisture and temperature." During this period, he reported that there was a maximum increase of hemlock in the coastal northeast and the formation of an ecotonal difference between eastern and western Ohio, with the maximum occurrence of hickory in the east and beech in the west (Ogden 1977:29). The lake was still 15 m below its present level, and carrying capacities for human adaptations were similar to the Early Archaic period.

The Middle Archaic period is a relatively well-documented archeological period in the eastern United States. Russel Cave, Eva, level 4 of Graham Cave, and Zone II of Modoc Rock Shelter can all be placed in this period (Fowler 1959:264). To this list can be added the Koster Site (Hovart 1972), the Neville Site (Dincauze 1976), the Doershuk and Gaston sites in North Carolina (Coe 1964), and the Ross Site in New York (Funk 1977). Yet, surprisingly, Middle Archaic occupations are missing from the stratigraphic sequences of many alluvial sediment sites in the Southeast, such as the St. Albans Site (Broyles 1966, 1971) in West Virginia.

Many archeologists (Ford 1974; Dragoo 1976) see an increase in population as a response to environmental stabilization during this period. This can be questioned because survey data are simply not adequate at this time to demonstrate a change in population size or density, either through the number of components, number of diagnostic projectile points, or shifts in settlement pattern.

More subsistence data are available for the Middle Archaic than for the Early Archaic. Asch, Ford, and Asch (1972:26) noted no change in Middle Archaic subsistence from 5000 to 2000 B.C., stating that only nuts were found in the floral assemblage recovered from Koster. Seeds were absent from the floral remains and are considered to be either not important in or absent from the diet. Chapman (1977:115-116) observed the same pattern in the Archaic sequence of the Little Tennessee River Valley. He observed few to no seeds in flotation samples from Middle Archaic sites, with acorn and hickory remains very common. More importantly, he noted that this situation existed for the Early Archaic occupation as well. He went on to say that the only difference between the Early Archaic and the Middle Archaic subsistence in the area was the addition of walnut during the Middle Archaic period. Asch, Ford, and Asch (1972:27) pointed out that walnuts require more processing time than do acorns and hickory nuts and that walnut trees are widely spaced. The utilization of these resources during the Middle Archaic and not the Early Archaic could possibly indicate utilization of a less desirable food resource as a result of population pressure, and a disruption of the previous subsistence scheduling.

There seems little reason, based on data presented to date, to make a distinction between Early and Middle Archaic periods from an adaptive point of view. Since no paleoenvironmental differences of major importance occurred, nor did a shift in the settlement-subsistence pattern occur, either quantitatively or qualitatively, there is little justification for such a division. Therefore, it is probably better to consider these two periods as being identical in terms of broad general adaptation to the region, including the Lake Erie Basin.

As noted earlier, developmental differences also existed within a region and were reflected in the variation in artifact styles during the period from 6000 to 4000 B.C. Some of these regional differences may not be correlated with environmental subdivisions. As Ogden (1977:29-31) noted, an ecotonal difference existed between eastern and western Ohio in 4000 B.C. This persisted through the postglacial climatic changes known as the Xeothermic Interval. In eastern Ohio, there appears to have been a maximum of beech pollen at the expense of hickory, while in western Ohio, there was a minimum of beech pollen. However, in spite of this demarcation of environment, there are no discernable differences in projectile point styles or settlement patterns for the two areas (Murphy 1975; Mayer-Oakes 1955; Dragoo 1959; Johnson, Richardson, Bohnert 1979; McKenzie 1967; Prufer and Sofsky 1965).

Two contemporary projectile point traditions are evident for the eastern United States from 5000 to 3500 B.C. These two traditions have mutually exclusive geographic distributions and an almost identical temporal range. One of these distributions is restricted to the Atlantic Coastal Plain and Piedmont; it has been referred to as the early Atlantic stemmed tradition by Fitzhugh (1972) and includes Stanley material. The other is the Piedmont Tradition (Witthoft 1959). This tradition is characterized by narrow, weakly shouldered, contracting stemmed projectile points typified by the Morrow Mountain point type of the North Carolina Piedmont sequence and by the Stark and Merrimack points from the Neville Site in central New Hampshire (Dincauze 1976). These contracting stemmed, lozenge-shaped points are minimally represented west of the Appalachians. For example, a few stray points are reported for the Lake Erie Basin, including two Morrow Mountain projectile points found during the survey of the U.S. Steel facility (Brose 1977:10-12). Johnson, Richardson, and Bohnert (1979) also recorded a single Morrow Mountain point in their survey of northwestern Pennsylvania, while 51 Big Sandy-Otter Creek types were found. No Morrow Mountain points are reported for the Hocking Valley, nor were any such points identified in the Upper Ohio Valley area (Mayer-Oakes 1955; Dragoo 1959).

In the Lake Erie Basin area and in the majority of the Midwest, it is the side-notched Big Sandy or Otter Creek projectile point type that characterizes the Middle Archaic period. Similar point styles are referred to as Osceola and Paddatz points in Wisconsin and Michigan (Fitting 1970) and as Goddard side-notched at the Koster site. Many of the phases incorporating this distinctive projectile point style have been radiocarbon dated.

It should once again be stressed that the Midwest, and the Lake Erie Basin in particular, is cross-cut by the same projectile point style, the side-notched point. These areas possessed different environmental types. Thus, the similarity of projectile point styles does not necessarily indicate a similarity in subsistence and settlement patterns. Instead, these cultural characteristics must be determined in their particular local environmental and adaptative setting.

3.2.2.3.1 The Natural Environment. Once again, as in the Early Archaic period, much of the potential habitat having a high resource potential in the Western Basin is currently submerged. Because of the ever-rising lake level, settlement patterns were constantly shifting. Therefore, some differences between the Early and Middle Archaic periods are to be expected, but these differences were caused by the spatial relocation of resources as a function of the lake's rise. This is an important point, because the existing site data do not adequately indicate the settlement system, since differences between the twc periods may be only a function of the shifting location of resources, with a concurrent relocation of sites in response to this shift. Furthermore, much of the original settlement pattern, irrespective of any shifts and for whatever reason these shifts occurred, is now submerged.

Therefore, settlement models must take into account changes resulting from lake level rises, as well as those due to demographic, subsistence, or other adaptational shifts. The east-west resource potential gradient for hunting and gathering adaptations still existed, with the Western Basin having the highest resource potential. Fitting (1970) implied this in his suggestion that if Early and Middle Archaic material were to be found in Michigan, it would be in Monroe County, which is immediately adjacent to the Western Basin of Lake Erie. No a priori acceptance of population growth, settlement-subsistence change, or sociocultural changes can be postulated between 8000 and 4000 B.C., although this has been suggested by many northeastern archeologists (Ford 1974; Dragoo 1976; Funk 1977).

3.2.2.3.2 Site Distribution. Information regarding site distributions over broad areas is somewhat better for the Middle Archaic and provides basic information on settlement patterns. This information is important for corroborating the settlement model suggested by Ford (1974).

3.2.2.3.2.1 Ohio. Brose (1977) identified a number of Middle Archaic components that provide settlement pattern data in his survey at the U.S. Steel plant in Ashtabula County and Erie County. For example, at Holdson sites 2, 3, and 4 there are three 15- or 20-m diameter clusters of 11, 15, and 10 circular ash and charcoal concentrations, each approximately 0.75 m in diameter. The clusters are separated from one another by a distance of 10 to 20 m. No postmolds, midden, or other structural evidence were encountered. The ash and charcoal concentrations were tested and found to be hearths. Flotation samples of hearth contents indicated charred hickory nut and acorn fragments as well as small seeds resembling chenopodium. No fauna were recovered. Three side-notched points and one bifurcate-based point were associated with the features, lithic cores and the debitage of non-local flint were also recovered from the surface immediately surrounding these features.

Brose interpreted these three sites to be specialized seasonal utilizations of the area for non-hunting economic activities. He suggested that these sites represented predominantly female activity base camps with little curatorial behavior. While one can question the notion of little curatorial behavior in view of a total of only four projectile points and a lack of ground stone tools, Brose is undoubtedly correct in his suggestion that these sites were seasonally occupied. Although data are limited, it is likely that small cooperative family units were the basic demographic unit utilizing the site, minimally during the fall as suggested by the nut fragments and possibly also in late summer as indicated by the charred seed.

Brose also identified another Middle Archaic occupation, the Terry Vinyard Site, in the U.S. Steel facility. Cultural material was encountered over an area measuring 50 by 70 m. Twelve circular charcoal and ash filled hearths were encountered. Flotation of these features revealed only small fragments of calcined bird and mammal bone. No artifacts were associated with these features except for the large central hearth where a single large side-notched Middle Archaic point was recovered. Sufficient charcoal was recovered from the features to provide a radiocarbon determination (still in progress when Brose's report was prepared). Brose wisely pointed out that it was impossible at that time to evaluate whether all of the features were contemporary, although he did note that there were three distinct spatial clusters of these features. Based on minimal data, it appeared that this site was somewhat larger than the Hodgen sites, and that it might represent a relatively more substantial occupation of perhaps a few extended families. Two postmolds were encountered by Brose just north of the central hearth area.

There was no indication of any non-egalitarian sociopolitical organization, nor of semipermanent settled life with population aggregates of more than 50 people. Therefore, the model proposed by Ford (1974) for this period (8000 to 4000 B.C.) appears to be accurate. Data from Brose's (1977) study suggest that there is some flexibility in site type and that the function, location, and seasonal use of the sites is variable. Brose's sites, which are all relatively small, seasonal, and represent highly nomadic lifestyles, probably were never occupied by more than 25 people at any one time.

3.2.2.3.2.2 New York and Pennsylvania. Culture patterns postulated for the Middle Archaic in the Northeast are essentially unchanged from those of the late Early Archaic (e.g., Ford 1974). Sites are equally rare and, as with the Early Archaic, comprise primarily isolated surface finds and a limited number of site components. The Atlantic Seaboard sites have produced evidence of at least a seasonal emphasis on aquatic resources including beaver, raccoon, migratory fowl, and shellfish in addition to deer and turkey (Ritchie and Funk 1973:337). In Pennsylvania, the Middle Archaic is less well represented. At Sheep Rock Shelter (Michels and Dutt 1968) occupational evidence for this period is light and consists of five early Laurentian points dating ca. 4000-3000 B.C. Preliminary reports from Meadowcroft also suggest only light occupation of lower Stratum IIb; where Stanley, Morrow Mountain, and Halifax points are dated 4720 B.C. and 3350 B.C. (Adovasio et al. 1977). Evidence for extensive use of aquatic resources, small game, or plants is absent from both shelters, as are indications of storage facilities. Such evidence, while limited, would appear to suggest that groups in the interior Northeast continued the highly mobile pattern of selective hunting-gathering throughout the Middle Archaic, in contrast with adjacent areas to the south where evidence from the Central River sites such as Koster (Asch, Ford, and Asch 1972) indicates a comparatively more intensive exploitative pattern involving fishing and plant gathering by larger and somewhat less nomadic groups. The meager numbers of Middle Archaic Big Sandy/Otter Creek points (Funk 1965) recovered in a recent survey of northwestern Pennsylvania appears to support this interpretation (Johnson, Richardson, and Bohnert 1979).

In Venango County, northwestern Pennsylvania, the occupation of hillbreak and hilltop rock shelters that were identified during the Early Archaic continues into the Middle Archaic. In addition, a few scattered surface finds of Archaic materials are reported on several river terraces along the Allegheny River or one of its major tributaries (Curtis 1969).

In southwestern New York, there are no published references to Middle Archaic materials. The apparent lag in the demographic filling in of the interior areas compared to the Central Riverine area and the Hudson Valley can probably be best understood in terms of ecological conditions. Pollen sequences from the western Allegheny Plateau (Miller 1973) indicate a gradual increase in deciduous elements through the Middle and Late Archaic, although the post-glacial maximum in terms of nut trees and deciduous forest fauna was not reached until terminal Late Archaic, ca. 1500 B.C. (Miller 1973). In contrast, oak-hickory forests were well established in the Riverine Midwest, perhaps as early as 5000 B.C. (Ford 1974). In light of these contrasting conditions it seems reasonable to expect that the larger river valleys to the south and along the Atlantic Seaboard absorbed the initial stages of Holocene population growth in the Northeast, leaving settlement-subsistence patterns in the interior areas little changed throughout Middle Archaic times.

3.2.2.4 Late Archaic Settlement-Subsistence Adaptations

The Late Archaic period dates from 4000 or 3500 B.C. to 1500 B.C. In the Northeast, this period is characterized by a series of dramatic cultural changes. A series of regional traditions are also evident and seem to correlate with various broad ecological zones. Regional traditions include the following: Lake Forest, Shield, Maritime, and Riverine (Ford 1974; Dragoo 1976). Two of these traditions are adjacent to the study area, but, as will be shown, the utility of these distinctive terms is still open to question. They have led to more confusion than order in furthering an understanding of the archeological phenomena of this time period.

3.2.2.4.1 <u>The Natural Environment</u>. A series of definite changes in subsistence, settlement, population, and sociopolitical organization characterized the Late Archaic in the Northeast. Concurrent with these changes was a series of climatic changes. Although not precisely dated, these traditions appear to have occurred contemporaneously. The deciduous forest was fully established, and the period from 4000 to 2000 B.C. is recorded as a "warm-dry maximum," known as the xerothermic interval in Ohio (Ogden 1977:29; Forsyth 1973). The most important aspect of this climatic shift is seen in the vegetational record. For the first time, pollen profiles show dramatic increases in the percentage of grasses and other herbaceous plants (Ogden 1977; Forsyth 1973). Carbone (1977:204) observed this phenomenon in his phytolith analysis in the Shenandoah Valley where, for the Late Middle to Late Archaic, he observed many more grasses in the phytolith spectra. This independently corroborates the xerophytic interval and its vegetational matrix as seen in Ohio.

The consequence of this climatic and vegetational shift is of major importance to the interpretation of Late Archaic subsistence and settlement patterns and to their associated sociopolitical organization. For the first time, Caldwell's notion of Primary Forest Efficiency is achieved. The closed canopy deciduous forest with little understory gave way to a more open forest with associated grasses in the understory. The warmer and drier environment probably allowed a new hunting technique not possible before this time--burn drives. These drives are recorded for the South Carolina and Georgia coast in the sixteenth and seventeenth centuries (Swanton 1946). Grasses in the understory facilitated extensive fires. By the same token, burning favored the immature successional phases of forest recolonization, especially shrubs and grasses. The consequences of this type of hunting had important implications for the subsistence scheduling that developed during this period.

Artificially induced fire favors grasses in the plant succession. These grasses and their seeds are available to both humans and herbivorous prey such as deer. The productivity of these food resources is higher than that available in a mature forest. Deer biomass would also relatively increase when compared with earlier periods. Thus, potentially higher population densities could be maintained than for earlier periods. This is empirically borne out in the archeological record. But, more importantly, a new class of food resources, the herbaceous plants and their seeds, became viable for human exploitation. Useful seeds colonized disturbed habitats and were quickly eliminated in the succession if the disturbance was not continued. Through a strategy of habitat disturbance, various seeds could be managed for efficient utilization on an energy-budget basis in the subsistence schedule. Two factors did not permit the incorporation of seeds into the subsistence regimes of earlier adaptations. The first of these was biological; that is, the seed-producing plants themselves were not present in the environment in any great numbers. The second, a cultural factor, is that a continued maintenance of disturbed habitats was necessary for continuous seed production.

These disturbed habitats need not necessarily be caused by fire. Struever (1968) suggested that the predictable annual flooding regime of major rivers has a scouring effect on their floodplains providing natural yearly disturbance of these areas for seed production. Regardless of the mechanism for the disturbance that maintains this production, it was no doubt present in the Lake Erie Basin during the Later Archaic period.

The seeds most important in the subsistence base of the Late Archaic included both native and tropical varieties. The native varieties included knotweed, smartweed (Polygonium spp.), lamb's quarters (Chenopodium album), sumpweed (Iva annua), and sunflower (Helianthus annuus) (Ford 1974; Struever and Vickery 1973). There is mounting evidence to suggest the last three items were domesticated at an early date (Struever and Vickery 1973; Yarnell 1978; Asch and Asch 1977). In addition to these native wild and domesticated seeds, tropical domesticated cultigens, including curcurbits such as squash and pumpkin, are found in archeological contexts in the southern Midwest at dates as early as 3000 B.C. The importance of these curcurbits as food items has been questioned by Struever and Vickery (1975) who argue that these resources were primarily used for containers rather than food. However, the seeds of these items are extremely high in protein (Watt and Merrill 1975) and should not be overlooked as a potential subsistence item.

3.2.2.4.2 Settlement Pattern. It is the addition of these seeds, both domesticated and wild, native and tropical, that caused a series of dramatic demographic and sociocultural changes in the archeology of the eastern United States at this time. A marked increase in population size occurred. Semi-sedentary habitation sites with permanent structures are recorded. Sites are more frequent in number, and settlement patterns and intersite variability suggest a relatively well-defined settlement system.

Winters (1969) has proposed a seasonal settlement system model for the Late Archaic Riverton phase occupation in the central Wabash Valley of Illinois. This cyclical settlement model is based on his analysis of seasonally sensitive faunal and floral resources recovered from a number of contemporary sites of this period in the Wabash Valley. He (1969:137) demonstrated four settlement types: winter settlements, transient camps occupied during the spring and fall, base camps occupied during the summer, and hunting camps utilized throughout the year. In addition to these four types, he suggested the possibility of two additional settlement types that are not visible due to lack of diagnostic artifacts. These are bivouacs and gathering camps. The settlements are two to three acres in extent; they have permanent houses with clay floors, numerous storage pits, and some burials. Transient camps are the same size but without houses and have only a few storage pits. Their emphasis is on hunting and hide preparation. Base camps are two acres in extent, with many projectile points, no houses, numerous clay platforms, and a few storage pits. Hunting camps are small areas characterized only by projectile points and knives. The substantial increase of cultural refuse, sedentism, and its implied greater population is seen in the Riverton phase. Winters guessed that a population of 100 might be representative for his settlement site type (1969:130). The fact that such a settlement system has been described for the Riverton phase does not imply that all areas of the Northeast developed settlement patterns along similar lines. This Midwest example does show that during this time period there was a general increase in population and a development of sedentism and seasonally distinctive settlement-subsistence patterns.

Concurrent with these developments was the rise of mortuary ceremonialism throughout the Northeast. These complexes are variously referred to as Red Ocher, Glacial Kame, Old Copper, and Point Peninsula (Dragoo 1963). Various attempts have been made to define and differentiate these mortuary complexes both spatially and artifactually (Cunningham 1948; Ritzenthaler and Quimby 1962; Fogel 1963). Although there are regional differences in the occurrences of some of these mortuary items, the sociopolitical and sociocultural importance of this ceremonialism is essentially the same. However, spatial variability of certain items might be important in differentiating trade and interaction networks between groups and also for the identification of status within groups.

The artifacts comprising these mortuary complexes include red ocher, bifacially chipped ceremonial "blades," turkey-tailed projectile points, copper beads, celts, awls, points, tubular marine shell beads, birdstones, galena, bar amulets, and shell gorgets. This last item, and particularly the sandal sole gorget, appears as the single trait distinguishing Red Ocher and Glacial Kame mortuary complexes (Fitting 1970). Cremation of the burials is also a feature of this mortuary pattern.

3.2.2.4.3 Sociocultural Changes. This mortuary ceremonialism is highly indicative of important sociocultural variables. Binford (1971) pointed out that differences in burial treatment and accompanying grave goods can be equated with status distinctions. Thus, for the first time in northeastern archeology, we see the emergence of status differentiation and an associated non-egalitarian sociopolitical level of integration recognizable in an archeological context.

There has been no thorough analysis of the status differentiation present in the mortuary behavior of the Late Archaic in the Lake Erie Basin. However, Binford (1963) noted status distinctions in burials in a limited sample of Late Archaic mortuary material from eastern Michigan. Winters (1968) demonstrated differential status in burials through the study of grave goods in Late Archaic sites on the Green and Ohio rivers in Kentucky. He identified ascribed statuses in these burials as evidenced by copper and shell artifacts associated with children. Although he did not directly associate this status differentiation with ranking, current thinking regarding mortuary practices indicates that this may indeed be the case. Tuck (1978b), although not providing specific data, suggested that the status differences represented by differential burial treatment and grave goods in the Port aux Choix cemetery on the Labrador coast is indicative of ascribed status and hence ranking. Binford (1972:388), however, noted that his analyses of Late Archaic mortuary practices in eastern Michigan did not suggest ascribed status, but instead that differential treatment was a function of age, sex, and the spatial displacement of kin as a result of exogamy. Although Binford's statement is at variance with Tuck's, it does not indicate that either is incorrect. The implication is that at this time in the Northeast there was a range of sociopolitical and sociocultural organization ranging from egalitarian to ranked levels of integration, with intermediate categories such as big-man type organization possibly represented by Binford's data (1963, 1972).

These more evolved sociopolitical levels of integration had not previously existed in the Northeast. The variability in the level of sociopolitical organization is predicated on the ecological heterogeneity now present in the northeastern United States. This characterization agrees with the model proposed by Ford (1974:394). He hypothesized a model for the Northeast in general for this time period. In his model he included status differentials, with a headman related to others in the community and to socially integrated villages. The headman functioned as an adjudicator of bride wealth. While Ford's model of big-man type sociopolitical integration is basically sound, it does not universally apply for all areas of the Northeast during the Late Archaic. A single structured model of this type does not provide for the differing levels of sociopolitical integration and polity size that obviously existed during the Late Archaic (Sahlins 1958). It is the differential productivity of the varying regions of the Northeast that may have affected the level of population and sociopolitical development for a specific area. Ford agrees that subsistence and technology became more heterogeneous at this time.

Thus, we can expect a wide spectrum of population characteristics, subsistence and settlement systems, and correlative sociopolitical organization for the Late Archaic. The Riverton example represents one level of sociopolitical integration in the Late Archaic, but a continuation of the same settlement pattern and sociopolitical system as seen in the earlier Archaic periods surely existed in many areas of the Northeast and was probably the most frequently observed type of adaptation.

3.2.2.4.4 Site Distribution. Although the Late Archaic is universally recognized throughout the Northeast, it is only minimally represented in the Lake Erie Basin. In the following section, the distribution of sites in Ohio, New York, and Pennsylvania will be discussed. Emphasis will also be given to site types including cemeteries.

3.2.2.4.4.1 Ohio. One Late Archaic through Early Woodland period cemetery dating from 2500 to 600 B.C., the Williams site in Woods County, OH, has been investigated in the Maumee River drainage (Stothers 1973, 1979a). This cemetery consists of 18 separate mass burials. The site can be characterized as a red ocher cremation cemetery containing numerous status items, including bannerstones, shell masks, and gorgets. Stothers (1973) considers this mortuary complex to be related to the coastal Northeast, spreading inland from that area along the St. Lawrence drainage across the Great Lakes and throughout the Ohio River Valley. This is the only reported mortuary site in the vicinity of the Ohio portion of the Lake Erie Basin.

The proposed hiatus in Late Archaic material in the Lake Erie Basin may well be a misrepresentation of the settlement and mortuary patterns that have been used to normatively categorize this period. An inspection of site files indicates that numerous points dating to the Late Archaic period are found in this area of Ohio. Brose and Essenpreis (1973) illustrated numerous Late Archaic projectile points from the Lake Erie Basin in Monroe County, Michigan.

The proposed hiatus for the Late Archaic in the Western Basin probably developed as a function of two phenomena. The first of these is the absence of elaborate burial sites and large semipermanent settlements. These features characterize this time period in the Northeast so their absence here may have prompted the notion that the Late Archaic did not exist in the Western Basin. This idea clearly does not take into consideration variability in settlement, subsistence, population, and sociopolitical organization, which we would expect to see in a heterogeneous environment with variable productivity.

The second factor responsible for this notion is the fact that the lake level has risen since this period, submerging many of the major river drainages flowing into the Western Basin at that time (Graves 1977), including the Maumee, Vermillion, Portage and Sandusky rivers, as well as the lake plain and basin proper. As a result, the settlement pattern was arbitrarily disrupted due to the steadily rising water level. It is known from other areas in the Northeast that Late Archaic adaptations are heavily oriented towards floodplains and river bottoms since these were the most productive areas in the region. Although other types of sites not in these topographic zones are known (cf. Winters 1969), the inundation of the river valleys adjacent to the Lake Erie Basin must have removed many of the larger settlement types from the archeological record. These are the more easily recognized type of archeological sites, including those that have come to typify the Late Archaic. Since, as Winters (1969) pointed out, Late Archaic settlement systems were diverse, with numerous types of sites, the obliteration of some of these types affects the identification of this larger system.

3.2.2.4.4.2 New York and Pennsylvania. Western and central New York provide some of the best information for Late Archaic adaptations in the interior Northeast. Work in central New York on Laurentian tradition (Brewerton) and Lamoka sites by Ritchie (1969) has disclosed a strong lakeside-riverine adaptation involving the use of large (2 to 3 acre) summer base camps located on shallow lakes presumably for fishing, as well as small seasonally occupied hinterland hunting-gathering camps. At the large Brewerton sites, Oberlander No. 1 and Robinson on Oneida Lake, hunting was found to be of primary importance although some fishing is also clearly indicated in the tool assemblage.

Lamoka sites, which are presently considered to generally antedate Brewerton phase sites clearly reflect a more intensive utilization of local resources that included a substantial amount of fishing as well as plant processing. Lamoka Lake in the Genesee Valley bore evidence of a relatively stable multi-season occupation, possibly in rectangular houses, by large bands estimated at some 150 to 200 people at some sites. Hunting, fishing, trapping, and acorn gathering appear to have been important economic activities (Ritchie and Funk 1973). In addition to the widespread occurrence of Brewerton and Lamoka materials, indications of the growing number of competing bands is evidenced in indications of warfare implying territorial conflicts. The large Lamoka base camps at Lamoka Lake and Geneva revealed human osteological remains indicating trauma from battle as well as signs of cannibalism (Ritchie 1969). Although few loci have been investigated, Brewerton and Lamoka materials occur frequently throughout the Erie Lowlands, particularly along Cattaraugus Creek and Buffalo Creek (Ritchie 1969; SUNY Site Files). There appears to have been a general preference for locating Late Archaic sites near shallow lakes, along rivers and large streams, and in the uplands near small streams and springs (Ritchie 1969; Ritchie and Funk 1973). Recent investigations at the Zawatzki site have provided good evidence for heavy utilization of nuts in the Upper Allegheny Valley by Brewerton phase groups as early as ca. 3680 B.C. (Calkin and Miller 1977:311).

Published reports for western Pennsylvania do not indicate the presence of large base camps as reported for Brewerton or Lamoka in New York. However, the abundance of Brewerton or related broad-stemmed points both from surface loci and stratified deposits clearly indicates a marked increase in Late Archaic occupations from earlier periods. Laurentian (Brewerton) materials are common throughout the upper Ohio Valley (Mayer-Oakes 1955b; Dragoo 1971). At Sheep Rock Shelter, intensive occupation is indicated in strata containing Brewerton and narrow-stemmed points dated to 2350-1855 B.C. (Michels and Smith 1967). Brewerton and Lamoka also appear at Meadowcroft Rockshelter, ca. 2870-1260 B.C. (Adovasio et al. 1977). Despite the abundant indications of reasonably heavy occupation of western Pennsylvania by Late Archaic times, little can be inferred about the subsistence or settlement strategies employed by these groups.

In Venango County, Pennsylvania, the number of sites having diagnostic Late Archaic materials, from excavated and surface-collected contexts, increases during the Late Archaic (Curtis 1969). Rock shelters continue to be occupied in addition to terraces along the Allegheny River, with the ratio of large terrace sites to small rock shelters almost 1:2 (Curtis 1969).

According to surveys by Johnson, Richardson, and Bohnert (1979) in Erie and Crawford counties, Brewerton points are found in both upland lake and stream contexts as well as in lowland river valleys and along the Lake Erie shoreline. Lamoka and related narrow-stemmed points (Vosburg, Normanskill, Vestal) occur in similar settings at a somewhat later time (Johnson, Richardson, and Bohnert 1979: Figure 7). In the absence of excavated remains, it can be said that extant Late Archaic manifestations from northwestern Pennsylvania do not contradict a trend toward a stronger adaptation to aquatic resources similar to that evident for Brewerton-Lamoka in New York.

Although the ecological basis for the explosive appearance of Late Archaic materials and the implied population increase is not well understood, there is a temporal correlation with the establishment of an oak-hickory forest. Resources including important mast foods (acorns, hickory, walnut, butternut, and beechnut) and associated fauna (deer, turkey, and others) may have reached a post-glacial maximum during the later part of the Late Archaic in western New York and Pennsylvania. In addition, higher stabilized water levels and water temperatures may have increased the availability of aquatic resources such as shellfish and anadromous fish in rivers and lakes.

3.2.2.4.4.3 Comparative Data: Saginaw Valley. Perhaps a better approximation of the Late Archaic adaptation in the now drowned Western Basin of the Lake Erie Basin can be achieved by utilizing the Saginaw Valley adaptation data as a model. Although the Saginaw Valley is not ecologically identical to the Western Basin, the differences are of minimal importance at this level of generalization. The important feature of the Late Archaic settlement-subsistence system in the Saginaw Valley of Michigan that makes it appropriate for comparative purposes and modeling is its focus toward marsh and lacustrine resources. This situation would also have existed in the now drowned Western Basin during the Late Archaic period. Thus, although the precise spatial dimensions for the Late Archaic adaptation in the Western Basin cannot be predicted, an understanding of the nature of this adaptation can be achieved. Fitting (1970) summarized the basic features of Saginaw Valley Late Archaic adaptations and this summary will be followed here.

The artifacts characteristic of the Late Archaic phase in the Saginaw Valley are the same as those found throughout the Lake Erie Basin. These are the narrow-stemmed points known as Dustin in Michigan, Ohio, and Illinois; as Lamoka in New York; and, more appropriately, as "narrow-stemmed point" in the Northeast as a whole (Funk 1976). Analyses of the artifactual and subsistence data from a number of Saginaw Valley sites has provided a basic settlement-subsistence system reconstruction for this environment. These sites include Schmidt, Hart, and Feeheley.

Analysis of the fauna from the Schmidt Site indicates five species of mammal (deer, dog, racoon, muskrat, and canid); nine bird species (hooded merganser, blue and/or green teal, baldpate, pintail, ruddy duck, wood duck, American coot, common mallard, and _Anas_ spp.); two species of turtle, (soft shell and snapping); and 11 species of fish (sturgeon, drum, walleye, large-mouth bass, bowfin, channel catfish, longnose gar, yellow perch, northern yellow bullhead, catfish, and bass). This site is interpreted as a camp whose occupants utilized the resources of a shallow weedy pond (fish and birds). It is interesting to note that the birds were migratory waterfowl, locally available from summer through fall, and that the deer, the main faunal subsistence item, was probably utilized during the winter. Deer accounts for more than 70 percent of the meat resources (Cleland 1966).

At the Hart Site, most of the faunal remains are fish with only a single species (drumfish) identified. No mammal bones larger than muskrat were identified. A single _Rubus_ seed (blackberry or raspberry) was also recovered. This site is interpreted by Wright and Morlan (1964) as a summer fishing station, a function also assigned to the Feeheley site (Cleland 1966). The Feeheley Site also functioned as an important burial site (Taggart 1967; Fitting 1970). Although not a single component site, it is restricted to the Archaic period, and the lithic assemblages are similar to those of the Schmidt and Hart sites. The site has been radiocarbon dated to 1980 ± 150 B.C.

However, the diagnostic projectile points from this site are Brewerton-like, suggesting a slightly earlier occupation than those sites containing Dustin points (cf. Funk 1976). The faunal assemblage from this site is almost identical to that of the Hart Site. Poor preservation limited most identifications to the order and genus levels. Only five species could be identified: freshwater drum, brown bullhead, yellow perch, muskrat, and an intrusive chipmunk. Some 61 percent of the sample was fish, 22 percent was mammal, 10 percent turtle, and 7 percent bird. No deer were recovered from this site. Cleland (1966) believes that the lack of a large number of species suggests that the inhabitants of the site were specializing on the resources of a microenvironment. He noted that all of the species were primarily found in shallow water shore areas (Cleland 1966:111-112). Yarnell (1964) identified 14 varieties of charcoal and plant remains from this site, including walnut, butternut, acorn, and a single grape seed.

Fitting (1970:76), following Cleland (1966), suggested that the Schmidt Site, because of its greater number of deer and bird, represented a summer through winter base camp, while the Hart and Feeheley sites represented short-term occupation sites utilized in the spring and summer. This conclusion was supported by Cleland (1966:116) and Taggart (1967) who pointed out that debris was much denser and continuous in deposition at the Schmidt Site while it was lenslike and intermittent at Feeheley and Hart. Taggart (1967) also noted that the Schmidt Site was protected from winter winds, which is not the case for the Feeheley Site.

These three sites provide the basis for both a model of adaptation and a specific settlement system. This system consists of a single base camp, probably utilized throughout most of the year, and a series of intermittently occupied, specialized fishing and trapping stations. Another settlement type should probably also be included in the system, one which has not been identified, but, based on data from southeastern Michigan (Brose and Essenpreis 1973), most surely exists in the Saginaw Valley as well. This site type is the intermittent, male activity hunting and butchering camp. It is characterized by numerous, very small components consisting of only a few projectile points, tools, and debitage associated with hunting and butchering. These sites were probably utilized for short times through the year.

3.2.2.4.5 Late Archaic Model for the Lake Erie Basin. Since the environment, physiography, and drainage conditions of the Late Archaic Western Basin were similar to those of the Saginaw Valley, it is possible to apply this model as well. However, precise spatial predictions from this settlement model are not possible. This lacustrine adaptation is strikingly different from that of the Riverton phase. The Western Basin Late Archaic adaptation is more limited in scope, with an intensive utilization and high reliance on aquatic resources. These lacustrine resources are very diverse and a specialized technological and scheduling system must have developed to maximize their exploitation (Cleland 1966:116). This adaptation probably continued for some time after the Late Archaic, forming a tradition distinctive from that found in the north central and northeastern Ohio areas.

This reasoning follows that of Stothers (1978b) and Fitting and Brose (1971) who noted that there was a basic hiatus in the cultural development in the Western Basin and that this area did not participate in the complex inter-regional interaction networks characteristic of the later Early and Middle

Woodland periods. For example, although the Williams Site has components that date to the Early Woodland, the ceremonial patterning is totally Late Archaic in context. This adaptation has been termed by Stothers (1973) as the Western Basin tradition, but this term has also been used to describe later agricultural adaptations in the Western Basin. For this reason, the non-agricultural portion of this tradition has been termed the Western Basin Lacustrine pattern.

It should be obvious that there is no Late Archaic hiatus in the Western Basin, nor, for that matter, in any portion of the Lake Erie Basin. Instead, a series of environmental and hydrological conditions modified the nature of the landscape, obliterating the actual settlement pattern and obscuring the settlement system. This can be illustrated by the example of the Williams Site, which is upriver from the Western Basin on the Maumee drainage in an environmentally less desirable location than the area at the mouth of the Maumee River. However, the Williams Site remains while other sites downstream have been drowned and covered with sediment. The Hind Site, located near Chanan, Ontario (Stothers, Pratt, and Shane 1979), is another such cemetery site, almost identical in its grave assemblage, and in an identical setting as the Williams Site. It might even have belonged to the same settlement system as Williams. Furthermore, Stothers (1975) noted that a number of small, Late Archaic components, possibly representing isolated nuclear family hunting stations, existed in the interior regions. This supports the existence of more than one site type for the Late Archaic period.

Shane (1977 letter to Pratt) noted that almost every bluff edge between the Milan and Esch sites on the west side of the Huron River in north central Ohio contains Archaic material, mostly Late Archaic. This situation is also seen in the survey Shane (1974a) conducted of the Erie Nuclear facility region immediately adjacent to the east. Here he recorded 26 components, all campsites. No villages were recorded in this, one of the few intensively surveyed areas in the north central Ohio portion of the basin. Shane pointed out that the topography in the vicinity of the Huron River Valley is highly dissected. This would have the effect of minimizing the impact of lake level rises on settlement patterns. This area is not as productive in terms of resource potential and types of resources when compared with the Western Basin area and this may account for the lack of villages or other large semipermanent habitation sites.

The subsistence pattern for north central Ohio, although not known archeologically, must nonetheless have been very different from that of the Western Basin. North central Ohio provides for a riverine rather than lacustrine mode of adaptation. Although several of the potential resources are similar for both areas (such as acorn, hickory, and deer), specialized emphasis on shallow-water and pond fauna, such as turtles, migratory water fowl, and fish, is not possible in riverine habitats. Floral resources, such as wild rice and marsh grass roots, shoots, and tubers would also be absent or of minimal importance in the riverine environments and in Late Archaic adaptations to these areas. It is maintained here that shallow-water lacustrine resources were less numerous, and hence less important, in Late Archaic subsistence systems the further east along the Lake Erie Basin one proceeds.

The precocious Late Archaic sociopolitical development exclusive to the shoreline regions did not develop until after 2000 B.C. (Fitting and Brose 1971). At this time, the generalized Brewerton complex or "Laurentian" Late

Archaic was replaced by the narrow-stemmed complexes (Funk 1976) that typify such northern phases as Riverton, Lamoka, Bare Island, Dustin, and the Tritterton phase at Koster. There were precocious sociopolitical developments to the south and in the coastal regions, but these seem to have had no correlates in the Laurentian complexes of the early Late Archaic.

In eastern Ohio, during the Late Archaic, Mayer-Oakes (1955b) identified a distinctive Late Archaic assemblage which he termed the Panhandle complex. This complex is characterized by a series of weakly shouldered, straight-stemmed or stemless lanceolate points known as Steubenville. These points appear to be restricted to the Upper Ohio drainage and to western Pennsylvania and New York (Johnson, Richardson, and Bohnert 1979). No such complexes have been identified for western Ohio, although there is a distinct possibility that such material might be confused with the earlier Plano material that it slightly resembles (cf. Prufer and Baby 1963).

3.2.2.5 Transitional Settlement-Subsistence Adaptation

In about 1500 B.C., and lasting to about 800 B.C., there appears in the piedmont of the middle Atlantic coastal plain yet another assemblage, comprised of steatite bowls and borad stemmed projectile points of the Perkiomen, Ashtabula, Susquehanna, and Laurel types. This complex of artifacts is equated with the Transitional Period by Witthoft (1953), indicating a transition between the Later Archaic and Early Woodland ceramic-bearing periods. This tradition is characterized by a riverine adaptation and is sometimes associated with crude, steatite tempered ceramics as well.

A few of the projectile points of this tradition, referred to as Ashtabula points in Ohio, are found in the Western Basin (Brose and Essenpreis 1973) but most of this material is restricted to northeastern Ohio and particularly the Upper Ohio Valley. However, the steatite reported from the Piedmont River Valley sites is not frequent west of the Appalachians.

Many of the developments characteristic of the Piedmont and Coastal Plain Transitional Period of the Northeast are absent in the Lake Erie Basin. Although the projectile points associated with the Transitional Period are present, the other diagnostic artifacts and the distinct settlement characteristics are not. It also appears that material remains indicative of this complex are restricted to the eastern portions of the basin. This tends to reinforce the circumscribed and specific nature of the lacustrine adaptation in the Western Basin, suggesting spatial, environmental, and cultural integrity for this adaptive pattern. It is probably accurate to consider the occurrence of Transitional material in the eastern area of the Lake Erie Basin as a temporal marker rather than a culturally distinct period.

3.2.2.5.1 Site Description. Transitional sites have been identified by the presence of diagnostic materials and are known throughout the three-state area. Materials include diagnostic projectile points as well as some steatite.

3.2.2.5.1.1. Ohio. Prufer and Sofsky (1965) noted the occurrence of transition material at the McKibben site in Crumball County on the Mahoning River, north of Princeton. Sixteen Ashtabula and 5 Perkiomen projectile points were recovered; no Panhandle complex material was found. McKenzie (1967) recorded Ashtabula points from Archaic sites in the lower Scioto River Valley. Shane (1971:160-161) recovered projectile points resembling Perkiomen and broad points from a midden strata in the Rais-Swartz Rockshelter in south central Ohio; this strata dates to 1560 ± 130 and 1540 ± 140 B.C. and has ceramics associated with it. This is the earliest dated ceramic material in Ohio and predates, by at least 1000 years, known ceramic material in the Lake Erie Basin.

Shane (1974a) identified 18 transitional components, all campsites, in the Erie Nuclear Power Plant area of north central Ohio. Unfortunately, he did not discuss the nature of the assemblages comprising the components. However, because the components predominantly occur with Late Archaic components, it is inferred that the Transitional, as manifest in this region, is a temporal period rather than a distinctive cultural complex characterized by a specific type of adaptation as originally conceived by Witthoft (1953).

3.2.2.5.1.2 New York and Pennsylvania. Transitional points in several variant but morphologically similar forms are found throughout much of the Northeast, in the Frost Island and Orient phases of New York (Ritchie 1965; Ritchie and Funk 1973), in the Atlantic phase of New England (Dincauze 1976) and in Pennsylvania (Kinsey 1972).

Despite the suggestion by Kinsey (1972) that "broad spear" points were used for fishing, there is little concrete evidence for their function. The consistent association of Susquehanna points with soapstone vessels along the lower Susquehanna River (Witthoft 1953; Kinsey 1972) and in the floodplain of the upper Ohio drainage (Mayer-Oaks 1955b) has led to the assumption that Transitional groups were heavily oriented to the exploitation of riverine resources (Kent, Smith, and McCann 1973; Johnson, Richardson, and Bohnert 1979). To date little evidence from faunal remains has been produced to confirm this assumption. Orient phase sites from eastern New York show a conspicuous absence of fishing related materials although shellfish are apparently abundant (Ritchie 1969:344; Ritchie and Funk 1973:346). Notched stones described as net weights are found in good numbers within Susquehanna Valley sites (Ritchie 1969:159). Evidence that Transitional period subsistence-settlement was significantly different from earlier Late Archaic adaptations in the same areas is thus very limited.

The most distinctive chacteristics of the period are as follows: 1) there is a wide distribution of similar point styles over a broad area, in contrast to the marked regionalism of the Late Archaic; 2) exotic lithic materials are used, predominantly rhyolite, which appears to have originated from a limited number of locations within southeastern and central Pennsylvania; and 3) the use of heavy soapstone vessels, also from limited sources in southern Pennsylvania and the Chesapeake area (Ritchie 1969:162; Witthoft 1959). These distinctive features have supported the proposition that the Transitional marked a time of fundamental alterations in travel and exchange patterns, which involved long distance transport, travel and trade along waterways, presumably by canoe (Ritchie 1969:162; Michels and Dutt 1968:74; Ritchie and Funk 1973).

If these interpretations are correct, they also suggest important sociopolitical changes away from the localized territorial band organization of the Late Archaic (e.g., Ford 1974).

Existing settlement data from central New York indicate a pattern of small seasonal camps located both along large waterways and in upland locations. There are fewer indications of the existence of large base camps like those of the Late Archaic in the same area. Transitional materials appear to be quite scarce in the southwestern portion of the state (Ritchie 1969; Ritchie and Funk 1973).

In Pennsylvania, Transitional materials are most abundant in the lower Susquehanna, Lehigh, and upper Delaware valleys (Witthoft 1953; Kinsey 1972). In western Pennsylvania, however, Transitional materials are less frequent than those of the preceding Late Archaic. Broad spear points occur in the absence of steatite at Meadowcroft (Adovasio et al. 1977). Dragoo identified a possible Transitional living surface beneath Chambers Mound in Lawrence County (Zakucia 1961). And recent surveys in Erie County (Johnson, Richardson, and Bohnert 1979) indicate a clear reduction in materials from this phase compared to earlier Late Archaic materials although there are also indications of distribution between the Plateau and Lowlands. In the former area, Susquehanna points predominate, while the related Ashtabula point dominates in the Lake Plain and is restricted to this zone.

In Venango County, northwestern Pennsylvania, diagnostic projectile points and steatite materials, including vessel shards, cubes of raw steatite, and unidentifiable fragments are represented in local artifact collections, (Curtis 1969). These materials were found at both rock shelters and riverine terraces (Curtis 1969). Although the total number of sites appears to decrease slightly from the Late Archaic, the ratio of riverine to rock shelter sites is closer to 1:2.5 (Curtis 1969).

3.2.3 Woodland Period

This section will focus upon the Woodland Period, which is generally associated with changes in material culture and technology such as new projectile point styles, the widespread use of ceramics, the appearance of the bow and arrow, and increased dependence on maize horticulture. Non-material changes in the settlement and subsistence strategies of the local populations associated with increases in population sizes and density and more complex sociocultural organization are also associated with this period. The material and non-material changes identified for the general northeastern region had subregional variations in both time and space. These variations are measured as adaptations to particular environmental settings given certain technologies. Three temporary major subdivisions have been identified within the Woodland Period: Early, Middle, and Late. The following discussions are organized into subsections corresponding to these temporal subdivisions. Spatial variability will also be considered within each of the subsections.

3.2.3.1 Early Woodland Settlement-Subsistence Adaptations

The Early Woodland Period extended throughout the Northeast from 1000 to 500 B.C. This period is associated with the introduction of two technological items into the archeological assemblage: the bow and arrow and ceramics.

Previously this new adaptation had also been associated with the initial appearance of agriculture, but it has been proven that this trait was present in the Late Archaic and, as will be shown shortly, was only minimally incorporated into the subsistence base. Also associated with this period is the appearance of burial mounds; these mortuary phenomena are usually referred to as Adena and have their "heartland" in the central Ohio area.

In the Lake Erie Basin very little change occurred between the Late Archaic and the Early Woodland periods, at least from an adaptive point of view. Agriculture was present in the Late Archaic as was mortuary elaboration and ceremonialism with the exception of mounds. It was the appearance of ceramics that differentiated these two periods.

One of the most perplexing aspects of Early Woodland archeological research is that most investigation has focused on mortuary sites, with a lack of information regarding local settlement patterns and adaptations. Many comparative analyses of mortuary traits have been performed and demonstrate the commonalities of this mortuary complex in several regions.

3.2.3.1.1 The Natural Environment. Graves (1977) assembled the pollen sequences for the last 4000 years from three cores, all of which are located within 150 mi. of the Western Basin. From the Late Archaic through the Early and Middle Woodland periods there was a warming and drying trend. Ogden (1966) also noted a continuous increase in non-arboreal pollen, which might imply that large populations and the origin of settled villages did not occur in northcentral Ohio until the forest environments were at their maximum natural resource potential. However, the palynological data are not specific enough for a precise correlation.

3.2.3.1.2 Site Distributions. Early Woodland sites are recognized in the three-state area. Within these states there is regionalism in the cultural patterns of different areas. In general, social groups in the Ohio area were less complex in their organization, and the material remains found there reflect this lack of complexity when compared to other areas that have mounds, exotic trade items, etc.

3.2.3.1.2.1 Ohio. At present, there is no way of evaluating the occurrence of Early Woodland villages in the northcentral Ohio area as a function of increased dissection, higher relief, and more developed drainage characteristics. However, no burial mounds have been reported for the Leimbach Phase in the Huron Valley or for northcentral Ohio in general. Once again, this could reflect a displaced and disrupted settlement pattern due to lake-level rise, with the mound sites now being buried. Alternatively, it could indicate that this region was not of sufficient productivity at the time for the development of more complex forms of sociopolitical organization, a correlate that has been shown to exist (Sahlins 1958). Because semipermanent villages with fortifications are known, it is doubted that the burial mounds are absent simply as a function of drowning due to lake-level rise. It seems more appropriate to suggest that the productivity level in this area was not yet high enough to support a population size and density requiring a sociopolitical organization characteristic of the big-man or ranked variety.

We do not, however, suggest that early woodland material is entirely lacking from the Western Basin. Stothers (1974, 1975) identified a number of small Late Archaic and Early Woodland components in the region. He interpreted these sites as part of a settlement system composed of transitory bands of people living in small encampments of dispersed family groups.

3.2.3.1.2.1.1 Leimbach Phase. Shane (1967a and b) delineated a regional expression of Adena that he termed the Leimbach Phase. He viewed this as a local expression of an early phase of a generalized Scioto tradition found throughout central and eastern Ohio during the Early and Middle Woodland periods. Fitting and Brose (1971) objected to the use of the Scioto tradition because of its all-encompassing geographic extent, a position we share. Shane (1967a) saw no difference between Leimbach and Adena phase material as defined from mortuary analysis. No further regional variation for this phase is recognized in the archeological literature; thus, this phase can be extended to the Pennsylvania border. There is an absence of Leimbach Phase material in the Western Basin; the significance of this will be discussed later.

For the northcentral Ohio region, the Leimbach Phase appears to be best known archeologically in the Huron and Vermillion river valleys. Here the Leimbach Phase dates to the period extending from 500 to 100 B.C. (Prufer and Shane 1976). Artifactually, this phase is identified by a series of weakly shouldered contracting stemmed projectile points including Cressup, Adena Stemmed, and Robbins, the latter type being found in mortuary contexts. Ceramics for this phase consist of crude, thick grit-tempered globular pots, flower-pot or barrel-shaped with semi-conoidal or flat bases and a variety of lugs. These vessels are usually undecorated (Fitting and Brose 1971; Prufer and Shane 1976). These ceramics are ubiquitous in the Northeast and are referred to as Adena Plain or Fayette Thick. These, plus two local variants, Leimbach Thick and Leimbach Cordmarked, occur throughout northcentral and northeastern Ohio (Shane 1967a). Research at a number of Leimbach Phase sites, including Leimbach, Seaman's Fort, Mixter, and North Fairfield (Shane 1967a; Prufer and Shane 1976) and the nearby Griddle Road (Brose 1971) provided a body of data from which to interpret the settlement and subsistence pattern of an Early Woodland local adaptation in the Lake Erie Basin. We maintain that this adaptation is characteristic of the Huron River Valley and other similar-sized rivers in the northcentral Ohio region.

Floral analysis from the Leimbach and Seaman's Fort sites have resulted in the following specimens: squash rind fragments from four features, 25 blackberry or raspberry seeds from five features, 12 Chenopodium seeds, summac, strawberry, poke, cleavers, grape, and ragweed. Considerable quantities of hickory, walnut, and butternut shell fragments were included in the assemblages with traces of acorn and hazelnut. Faunal analysis from the Leimbach and Heckleman sites indicate that mammals were the most frequent bone elements encountered, with birds and fish represented as well. A partially completed analysis of the faunal assemblage from the Seaman's Fort Site provides a more representative collection; preservation is much better at this site. The assemblage contains large quantities of deer remains, with seasonal data for two occupations, mid-summer and December, as revealed by antler growth (Prufer and Shane 1976).

A tentative settlement typology has been established for the Leimbach phases in the northcentral Ohio region (Prufer and Shane 1976). This typology is at present composed of two site types: 1) a semi-permanent village with associated earthen walls, ditches, and palisades and 2) small open-air hunting stations. The former type is known to have been occupied from summer through fall. One of the distinctive features of these open-air sites is a lack of ceramics. These sites are interpreted as functioning as hunting and butchering stations visited temporarily and sporadically, probably by small groups of males (Prufer and Shane 1976; Brose 1971). This typology, as proposed, is not complete; other site types might exist as suggested by the Mohawk Park Rock Shelter Site, which contained Leimbach Phase ceramics although it was obviously neither a semi-permanent village nor an open-air hunting station.

Shane (1974a) provided further intensive survey data for a five-mile radius encircling the Erie Nuclear Power facility. This area includes portions of the Huron River Valley and the Berlin Heights Beach Ridge. His survey recorded 22 Early Woodland occupational components; one of which was a single-component village. The remaining sites contained material from earlier phases, particularly Late Archaic. This tends to reinforce the position presented earlier, that this adaptation was similar to the Late Archaic period. However, one major difference between these two periods should be pointed out. Subsequent to 500 B.C., no Late Archaic villages or large semi-permanent sites were to be found in the northcentral or northeast Ohio region. It is suggested that if such sites existed at that time they would have been located close to the mouths of the river systems, which are now drowned. However, the absence of large villages during the Late Archaic may also reflect other sets of circumstances.

As mentioned earlier, for the Late Archaic Period, the notion of an occupational hiatus in the Western Basin during the time span from 2000 to 100 B.C. appears in the literature with an apparent lack of any Leimbach Phase material. Brose and Essenpreis (1973) noted a total absence of diagnostic Early Woodland cultural material from Monroe County, Michigan, which is adjacent to the Western Basin of Lake Erie. The same phenomenon is seen for the Ohio portion of the Western Basin (Fitting and Brose 1971; Stothers, Pratt, and Shane 1979).

3.2.3.1.2.1.2 Sociocultural Organization and Settlement Pattern. The social organization and settlement pattern associated with the site distribution that has been characterized for the Ohio area was similar to the profile of the Late Archaic. Sites were probably composed of dispersed family groupings. These camps were located in the interior regions during the late fall through early spring and at the lacustrine locations during the late spring, summer, and early fall to exploit aquatic flora and fauna (Stothers 1974:8). While this is somewhat similar to the model presented here, it seems more reasonable, in light of the displaced shoreline and former aquatic habitats that would have been present in the Western Basin during the Late Archaic and Early Woodland, that these settlements represent hunting camps and not winter base camps. These base camps were probably located in the drowned areas of the Western Basin or are now deeply buried under sediment (Stothers, Pratt, and Shane 1979).

It is therefore suggested that the Early Woodland settlement pattern in the Western Basin is identical in all respects to that of the Late Archaic. Because of this, Leimbach Phase material and adaptations that produced it should not occur in the Western Basin. It seems that, for ecological and adaptive reasons, the Western Basin represents a distinctive cultural region in both Late Archaic and Early Woodland periods, differing markedly from that of northcentral and northeastern Ohio. The primary difference, as discussed in the section on the Late Archaic Saginaw Bay model, is that the Western Basin adaptation was made for shallow-water marsh/lacustrine environments which were not present in the northcentral and northeastern regions of Ohio where floodplain environments were dominant. The distinctive and circumscribed nature of these two regions resulted in two distinct cultural historical developments.

The distinctive cultural pattern that developed in the Western Basin has been referred to as the Western Basin Tradition (Stothers 1975). Stothers extended this tradition into the Late Woodland Period, to A.D. 1200. It is suggested here that the earlier portion of the tradition, i.e., 2000 to 100 B.C. and possibly to A.D. 500, can be distinguished from the later, maize-producing horticultural adaptations found in the area after A.D. 500. Such an adaptation should be called the Early Western Basin Lacustrine adaptation. This usage suggests a similar underlying adaptation throughout the time span, with similar settlement patterns, subsistence patterns, and ethnic or cultural relatedness, closely parallelling the adaptation seen in the Saginaw Bay area. Although artifactual data and mortuary behavior are not definitive variables of the adaptation, there does seem to be some correlation of these characteristics with the spatial boundaries of the Western Basin even at an early date. For example, the mortuary ceremonialism observed in the Western Basin during the Late Archaic and Early Woodland periods is absent from the eastern regions of the basin, and Early Woodland material appears to be completely absent from the Western Basin. Both of these distinctions could, however, be due to inundation resulting from the rising lake levels that obscured the settlement pattern.

Published information regarding Early Woodland occupations in the northeastern portion of the Ohio Lake Erie Basin is minimal. Brose (1977) identified a single Early Woodland component in his survey of the U.S. Steel facility in Ashtabula County, Ohio, and Erie County, Pennsylvania. Surface investigations and testing at the Elmwood Road Site yielded upper Mercer flint debitage, Adena and Robbins projectile points, a single Fayette Thick Early Woodland potsherd, and burned animal bone. No in situ cultural material, deposits, or features were encountered because the area had previously been destroyed by agricultural activity. Brose (1977) characterized all Early Woodland components in the Ashtabula area survey region as representing short-term campsites that functioned as seasonal resource areas exploited by small groups. He also stated that other Early Woodland sites are known in this section of northern Ohio, but did not characterize their settlement function or type.

We maintain that the majority, if not all of the Early Woodland adaptations in the northeastern Ohio portion of the Lake Erie Basin consisted of small groups with seasonally varying compositions; these groups subsisted on hunted and gathered foodstuffs not unlike their predecessors in the Middle and Late Archaic periods. Semi-permanent villages with sustaining seasonal exploitation sites, characteristic of the northcentral Ohio area, are absent. The resource potential of the drainages and the soils that dissect this portion of the Lake Erie Basin is not as substantial as that in areas to the west, particularly in the Huron Valley. This characterization holds for all periods discussed so far, with the exception of the Paleo-Indian Period. Early Woodland semi-permanent villages in the Lake Erie Basin, if they are to be expected at all, would only be located in the floodplains of the largest rivers dissecting the basin, such as the Cuyahoga, Chagrin, Grand, and Ashtabula rivers.

Only one site reported in the literature even vaguely fits the description of a semi-permanent village component. Murphy (1971b) recovered a few Adena projectile points from the Lyman Site along the Grand River. Associated with this site was an earthwork that dated to 2090 ± 150 B.C. (Murphy 1971b:21). But the context of this date is unknown. This is particularly problematic since a later Whittlesey component is also found at this site. Furthermore, no early Woodland ceramics were recovered from the investigation. This tends to suggest that charcoal from an earlier occupation was incorporated into the earthwork during its construction at a much later date.

From this discussion, it can be concluded that the basic social unit was the single small kin group. Sites consist of flexible seasonally shifting villages and campsites in a wide range of microenvironments. This is the best approximation of the settlement model for the northeastern Ohio region of the Lake Erie Basin during the Early Woodland Period. Although other areas of the Basin are less well known, this same model may apply to some of those areas as well.

3.2.3.1.2.2 New York and Pennsylvania. This period is differentiated from terminal Archaic or Transitional phases by the appearance of new additions to the artifactual inventory, including smoking pipes of the tubular varieties, birdstones, boatstones, bar amulets, and copper ornaments (Ritchie 1969). These items are often found within the context of mounds or burial tumuli, implying important new developments in mortuary ceremonialism. Ceramics become important and completely replace earlier steatite vessels. Although once considered a "horizon marker" for the Woodland period (Sears 1948:124), there is some evidence that true pottery was in use during Transitional times. Steatite-tempered ceramics have been recovered from Susquehanna components in Pennsylvania (McCann 1962:53-55; Witthoft 1953:12) and has a scattered occurrence in New York (Ritchie 1969). Vinnette 1, a moderately thick grit-tempered plain ware, which becomes the dominant ceramic type in Early Woodland New York, also has a restricted occurrence in earlier components at the Wilson Site in Pennsylvania (McCann 1962) and within the Frost Island component at the O'Neil Site in New York dated at 1250 B.C. (Ritchie 1969).

Diagnostic lithics of this period include a variety of broad, flat-stemmed points: Forest Notched, Meadowood, Adena stemmed, and Rossville (Ritchie 1969; Granger 1978; Johnson, Richardson, and Bohnert 1979). Also present are large preforms called "cache blades" (Mayer-Oakes 1955b).

Marked contrasts are seen in cultural manifestations thought to represent this period in Pennsylvania and New York. While the ecological basis of this variability is not yet understood, it is most clearly seen when contrasting western Pennsylvania with its strong formal influences of burial ceremonialism from Adena in Ohio and from the Meadowood culture of western New York.

Meadowood constitutes the earliest period of aboriginal occupation in western New York for which systematically derived information on settlement patterns exists. Recent work by Granger (1978) on 26 Meadowood components in the Niagara Frontier centered in Erie County identified a pattern comprising 1) habitation sites associated with perpendicular ridges approximately 600 ft above streams or shallow lakes, or parallel ridges above deep lakes or major rivers and 2) burial sites, at somewhat lower elevations on parallel ridges or terraces near wide, large streams. Based upon artifactual, structural, and limited faunal data, Granger reconstructed the following settlement-subsistence system for Niagara Frontier Meadowood culture. Two or possibly three local band territories of approximately 500 $mi.^2$ each probably existed. Within these, groups exploited riverine-lacustrine and upland habitats through a system of seasonal large base camps with perhaps 150 people and smaller task camps of only 15 to 35 people. Base camps were probably occupied from autumn to early spring at which time hunting, fishing, and nut-gathering occurred. Associated extractive camps have been identified on small sand knolls near marshes and along the river benches.

Meadowood habitation components are noted in similar locations throughout New York (Ritchie 1969; Ritchie and Funk 1973). Sizes vary; most are less than one quarter acre, although some cover one acre (Ritchie and Funk 1973:347). Despite Ritchie's and Funk's (1973) supposition of a heavy riverine-lacustrine economic focus during Meadowood times, the prevalence of terrestrial fauna and scarcity of fish remains in sites and the occurrence of mullers, milling stones, and pits with charred acorns, nuts, and grape seeds suggest an exploitation pattern little different from that of the Late Archaic. However, a spatially circumscribed pattern of exploitation involving shorter distance movement between base camps and ancillary "back country" camps may now occur in the Early Woodland (Ritchie and Funk 1973:348). Granger (1978) suggested a strategy of minor seasonal location adjustments within a 10-mile radius catchment area of a base camp.

Mortuary practices were also distinct in the apparent use of cemeteries or "mortuary activity sites" that were usually separated from habitations. Sites were perhaps located in neutral and convenient areas for use by lineage groups of kin-based corporate groups from adjacent local bands (Granger 1978).

Extensive trade in exotic items continued as in the Late Archaic, especially involving Meadowood cache blades of Onondaga chert. The considerable quantity and quality of mortuary offerings and their occurrence in a small percentage of cemetery graves is suggestive of the further development of positions of prestige and influence along lines initiated in the Late Archaic (Ritchie and Funk 1973:349).

Although Meadowood points and Vinette 1 or associated interior-exterior cord-marked pottery are reported scattered throughout Pennsylvania, there is little evidence of the associated settlement pattern west of the Allegheny Front in central Pennsylvania (Kent, Smith, and McCann 1973). In the upper

Ohio drainage, strong relations with Adena are seen in the prevalence of Adena-stemmed points, Half-Moon and Fayette Thick pottery, tubular clay and stone pipes, and probably burial mounds (Mayer-Oakes 1955b). The eastern influence of "dispersal" of Adena (Ritchie and Dragoo 1960) has been assumed to be reflected in a number of burial mounds as far north as the confluence of the Monongahela and Allegheny rivers near Pittsburgh associated with traits comparable to Adena at Moundsville, Ohio, i.e., blocked-end tubular pipes, gorgets, and ceramics. Similar Adena traits are also present, although not in association with mounds, in the Beaver and Allegheny valleys. Mounds are usually found in close proximity to the large watercourses in the Ohio drainage. In Erie County, Johnson, Richardson, and Bohnert (1979) reported Adena and Meadowood points in fair abundance, as well as Lagoon-Rossville, Forest-Notched, and Orient types in lesser quantities.

Unlike western New York, Early Woodland habitation sites are not well documented in western Pennsylvania; therefore, little evidence for reconstructing settlement or subsistence patterns is available. In view of the fact that Adena habitation occurs along the Ohio River in northeastern Ohio and that these are often covered by thick layers of river silt, a similar location would be expected for western Pennsylvania.

In Venango County, northwestern Pennsylvania, Meadowood points were identified in surface and excavated collections, and other projectile points were assigned to this period although they did not completely conform to the literature on Upper Ohio Valley styles (Curtis 1969). These unusual points were similar to southern types in general outline but differed in that they were thicker and cruder in manufacture. Early Woodland ceramic types were not observed in the artifactual materials studied (Curtis 1969). The number of sites assigned to this period more than doubled the number assigned to the Transitional Period, and sites were now present in more tributary drainages of the Allegheny River. More than half of the Venango County sites were rock shelters and, with the exception of one hilltop site, the other half were located on terraces.

While the northeastern influence of burial ceremonialism of Adena appears to have extended little beyond western Pennsylvania, the presence of Adena-like objects do appear in fair abundance within the Middlesex Burial complex of central New York. The presence in burial contexts of blocked-end tubular pipes; birdstones; gorgets; cache blades; boatstones (sometimes of copper); bar amulets; copper celts, awls, and beads; and shell beads of several types from central and eastern New York appears to represent an as yet undefined relationship with Adena to the southwest (Ritchie 1969).

The accepted time span for Early Woodland is ca. 1000 to 500 B.C. (Witthoft 1965), based on radiocarbon determinations from New York (from 999 to 563 B.C.) (Ritchie 1969) and a single 850 B.C. date from the Williams Mound in Warren County, Pennsylvania (Kent, Smith, and McCann 1971).

3.2.3.2 Middle Woodland Settlement-Subsistence Adaptations

In the northeastern United States, the Middle Woodland Period extends from 500 B.C. to A.D. 500. This period is recognized by characteristic artifacts and mortuary patterns. Similarities in artifact types, mortuary items, and burial practices cross-cut regions and local cultural complexes. Trade and exchange of exotic goods, raw materials, and mortuary items is known as the Hopewellian Interaction Sphere (Caldwell and Hall 1964). Not all local Middle Woodland social groups participated in this system of exchange and ceremonialism. The most conspicuous of the groups that did participate were situated on the lower Scioto, the lower Ohio, and the Illinois rivers, and in westcentral Michigan and western New York (Griffin 1967).

During the Middle Woodland there was no difference in the basic form of adaptation, either in subsistence or in settlement patterns, when compared to the Early Woodland. The regional and adaptive differentiation identified earlier between the Western Basin and northcentral and northeastern Ohio is clearly recognized and defined in the literature (Stothers, Pratt, and Shane 1979). The Middle Woodland occupation in the Western Basin is referred to as the Western Basin Woodland. In northcentral Ohio, the occupation is referred to as the Esch Phase. With the exception of a single burial site, the West Springfield Cemetery in Pennsylvania, and a single Middle Woodland component, the Roddy Site at the U.S. Steel facility in Ashtabula County, the Middle Woodland occupation is almost nonexistent in the northeastern Ohio area (Brose 1977). Brose, Werner, and Wolynec (1977) commented on Middle Woodland components in their predictive model of site location for Ashtabula, Erie, and Crawford counties, but much work in this area is still ongoing. The reason for the apparent lack of occupation in northeastern Ohio will be discussed later.

3.2.3.2.1 The Natural Environment. The climate and environment during this period was similar to that of the Early Woodland Period and was characterized by Graves (1977) as warm and dry with an oak-hickory maximum representing the forest composition. The Lake Erie shoreline was between 2 and 3 m below its present level and had not yet penetrated into Maumee Bay. This is not to suggest that there were not small fluctuations in the environment at that time but simply that perturbations of this scale cannot be specifically determined, given the level of specificity attainable in the palynological data.

3.2.3.2.2 Site Distribution. In general, more information is available on the study area in Ohio, New York, and Pennsylvania for the Middle Woodland than for the Early Woodland. Ceramics were by this time frequent at sites, providing additional information on temporal regionalism and cultural affiliation that can be combined with the lithic data.

3.2.3.2.2.1 Ohio. Ceramic types can be used to identify Middle Woodland sites in the Western Basin. These ceramics are distinctive in form and can be differentiated from those in other areas in the lower Great Lakes. Western Basin ceramics are tempered with crushed quartz, limestone, and sand that is medium coarse in grade. Body sherds are roughly cord-marked and without other decoration; no rocker stamping is seen on the body. Vessels have round or subconical bases and flattened, splayed, wedge-shaped lips. Decorations on the lips are chronologically diagnostic. Early varieties of ceramics, as identified at the Gladieux Site, are dated within the first century B.C. They exhibit dentate stamped motifs on the rims, which are often castellated, and show rectilinear zoned motifs on the neck area. This zoning consists primarily of opposed triangles and plats primarily applied by dentate stamping or stab and drag linear punctation. This earlier ceramic variety occurs with interior-exterior cord-marked vessels, thought to be a holdover from the Early Woodland. Incising occurs, as do cord-wrapped stick impressions, near the end of the period.

An entirely different ceramic assemblage is seen in the northcentral Ohio region for the Middle Woodland. These ceramics are similar to those found in the Middle Woodland Scioto Tradition, including McGraw cord-marked, Chillicothe rocker-stamped, and Chillicothe brushed. These southern types are found as a minority in association with the local Mixter dentate stamped and Wayne cord-marked cermamic types. The latter two types are thought to be temporally distinctive of the late Middle Woodland (Shane 1967b; Prufer and Shane 1976). The distribution of Mixter dentate ceramics extends as far east as the Cuyahoga River. Except for the few southern ceramic types, Middle Woodland ceramics of the Esch Phase are devoid of decoration (Prufer and Shane 1976).

Lithic styles also vary between the Western Basin and northcentral Ohio. In the Western Basin, the projectile point styles represent a continuation from the earlier periods, with Jack's Reef Corner notched points appearing by A.D. 300 to 400 and a few Madison or Levanna points appearing during the end of the period. Lithic resources are primarily local and include Ten Mile Creek, Delavar, Columbus, and Dunbar flints found in the underlying glacial till. A few Flint Ridge and upper Mercer flint varieties occur, but these are infrequent (Stothers, Pratt, and Shane 1979).

The lithic assemblage of the Esch Phase of northcentral Ohio is quite distinctive compared to that of the Western Basin area. Projectile points are of side- and corner-notched varieties, but are produced from Flint Ridge flint. Unifacial Hopewellian blades and prismatic blades are known, a pattern distinctive from that of the Western Basin.

Settlement and subsistence patterns are also quite different for these two areas. Five well-documented Middle Woodland sites are known in the Western Basin: Indian Island #4, North Bass Mound Site, Waterworks Mound Site, Dodge Site and Gladieux Site (Stothers, Pratt, and Shane 1979). Information from these sites has been incorporated and developed into a settlement-subsistence model for the Western Basin.

Stothers, Pratt, and Shane (1979) suggested a "bipolar settlement" pattern, with year round occupation at a base camp with a series of supporting satellite extraction stations for processing varying resources. The Dodge Site is representative of this base-camp settlement type. It covers approximately one hectare of an unplowed river terrace that lies above the normal floodplain of the Maumee River. Hamalainen (1975, cited in Stothers, Pratt, and Shane 1979) noted that the site is optimally located for the collection of spring and fall migratory birds and other riverine resources. Deer are the most important subsistence item with migratory fish second in importance. The site is located near the Oak Savannah area. The year-round occupation at this site is suggested by deep midden deposits, refuse pits, multiple burial pits, and a shifting of the occupation area along the terrace. There is no statement regarding the occurrence of postmolds, structures, palisades, or other similar features.

The Indian Island #4 Site, just offshore, is an example of a satellite fishing station (Stothers, Pratt, and Shane 1979). Few lithic remains, no burials, and a large amount of fish refuse suggest a short-term occupation and specialized site function. Maize has also been recovered from both Middle Woodland occupational components of this site (Stothers and Yarnell 1977). Also associated with the settlement model are a series of upland ceramic and aceramic hunting stations (Stothers, Pratt, and Shane 1979).

This model is identical to that found in the Saginaw Bay area during the Late Archaic that was applied to the Western Basin area. This pattern is finally visible in the Lake Erie Basin because the lake level rose enough to drown much of the Maumee Valley. This resulted in a shifting of the settlement pattern to higher terrain, in this case to non-flood plain elevations. Besides being optimally located in terms of resource potential, this location provided better shelter from potentially damaging winter storms.

The settlement-subsistence model outlined here is considered to be characteristic of the Late Middle Woodland (Stothers, Pratt, and Shane 1979). In the earlier portion of the Middle Woodland, a slightly different settlement pattern, one similar to that seen for contemporary Ojibwa and Cree, probably existed. Instead of permanent, year-round base camps with specialized procurement stations, this settlement model involves the coalescence of band segments into late spring-summer-early fall sites. The emphasis was on exploiting riverine and lacustrine resources at one settlement type, and the fragmentation of the band segments that disperse into smaller stream valley and interior areas for nut gathering and deer hunting at a second site type. These winter sites were probably composed of small extended or nuclear family groupings and were probably similar in size to the satellite hunting stations of the proposed late Middle Woodland settlement model (Stothers, Pratt, and Shane 1979).

The settlement-subsistence pattern for the Midddle Woodland occupation in the northcentral Ohio region is surprisingly similar to that of the Early Woodland Period in total number of occupational components, site types, and subsistence characteristics, although there is a decrease in the number of known villages (from five to two). The primary criteria distinguishing the Early Woodland adaptation from that of the Middle Woodland are diagnostic artifacts, specific mortuary characteristics, and the absence of fortifications or defensive earthwork in the latter period.

Two villages, Esch and Hecklemen, have been identified for the Esch Phase (Stothers, Pratt, and Shane 1979). The former site is also associated with two burial mounds. A mound used to be associated with the Heckleman Site but was removed for farming purposes some 50 years ago. A radiocarbon date of A.D. 470 ± 105 was obtained from a pit at Heckleman, and this site is considered to be roughly contemporaneous with Esch (Prufer and Shane 1976). No excavations have been conducted at the Esch habitation site although surface investigations after plowing indicate the existence of subsurface features. Excavations at Heckleman have revealed at least 13 Esch Phase features (Stothers, Pratt, and Shane 1979). There is no mention of postmolds, structures, or settlement plans for either site.

Faunal remains recovered from Esch are well preserved and abundant. These include deer, racoon, cottontail, ducks, freshwater drum, and other fish. Burned human bone is noted from the faunal assemblage as well (Stothers, Pratt, and Shane 1979). There is no information about floral remains. The faunal material excavated from the Hecklemen Middle Woodland component are not as well preserved. Species include deer, raccoon, squirrel, and turkey. Seasonal data derived from antlers and teeth suggest at least a summer occupation. Analysis of the floral samples has not yet been completed, but no cultigens were initially identified.

Regionally, there appears to be a decrease in the number of villages. The Middle Woodland components at sites such as Heckleman and Esch lack defensive earthworks and fortifications. It appears, then, that no Middle Woodland villages are known outside of the Huron River Valley area. In the Huron River Valley and adjacent regions, nineteen Middle Woodland campsites have been located (Shane 1974b), only three less than for the Early Woodland Period. To these types of components should be added the Middle Woodland occupations of the Mixter and Taylor sites.

Shane (1967b:170) originally thought that the Middle Woodland occupation at Mixter dated later than the appearance of Hopewellian material in the area, representing a transition into early Late Woodland. However, Wayne cord-marked, the local Hopewellian or Middle Woodland ceramic variety, is thought to predate the Hopewell expression in this area, in the absence of southern Hopewell materials.

An interesting phenomenon at this time is the decrease in Middle Woodland occupation east of the Huron River, a pattern also reflected in northeastern Ohio. This might suggest differential environmental change and deterioration to such an extent that sedentary or semi-sedentary settlement was not possible in areas outside of the Huron Valley.

The decrease in village components in the eastern drainages of the north-central Ohio area could be interpreted as indicative of the beginning of a cooling and moistening climatic regime impacting this area. The result of this climatic shift was a reduction in overall productivity for areas outside the Huron Valley.

The late Middle Woodland model is typical of the most productive environments in the Western Basin, while the one for the Late Archaic-early Middle Woodland periods is typical of the less productive regions. It is suggested, however, that the base-camp satellite model is more appropriate for the Maumee Bay-Maumee River mouth area since this would have been the most productive area of the Western Basin when the lake level was at its contemporary position.

3.2.3.2.2.1.1 Burial Mounds. A series of burial sites and small sites of this time period are known for the islands in the Western Basin; one burial mound, the Waterworks Mound, is located near the mouth of the Maumee River on the southeast shore of Lake Erie (Stothers, Pratt, and Shane 1979; Pratt 1977). Five of these sites, the Waterw Mound, the Whittlesey Mound, the North Bass Island Mound, the Grand Rapids . urial Mound, and the Pelee Island Mound are Middle Woodland burial mounds (Prahl, Brose, and Stothers 1976).

The Whittlesey, North Bass Island, and Waterworks mounds are the best documented ceremonial manifestations of this period in the Western Basin area. In the North Bass Island Mound, several individuals were interred within a cedar-log crypt. At the Whittlesey Mound, a crypt of encircling limestone slabs contains a series of burials. At the Waterworks Mound, primary extended and secondary interments were scattered throughout the mounds. Ceramics, projectile points, and pipe fragments were the associated grave goods (Prahl, Brose, and Stothers 1976).

As is obvious from the existing archeological literature, the settlement patterns of the Western Basin Middle Woodland Period are obscure. It is curious to note that five burial mounds are located either close to the shore or on the outer islands of the Western Basin. The problem of evidence for supporting populations remains. The Maumee River settlement system could not have been responsible for these mounds, since the site survey in this area has been reported as being quite intensive (Prahl, Brose, and Stothers 1976; Stothers, Pratt, and Shane 1979). The answer must be that these habitation sites were drowned, eroded, or covered by sediment. Mortuary patterning for this period is much more visible than for the Late Archaic or Early Woodland periods. This is because the lake level was higher during this time than it had been during the previous periods, and more of the settlement pattern has been preserved. Coupled with this might be a cultural preference for mortuary site placement at higher elevations. Sedentary or semi-sedentary villages probably existed in this area and the settlement model presented by Stothers, Pratt, and Shane (1979) for the late Middle Woodland is probably applicable to the contemporaneous Western Basin, i.e., that area not flooded during this period.

Evidence for mortuary ceremonials in northcentral Ohio comes exclusively from the larger of the two Esch Mounds excavated by Greenman (1930, 1937a). This mound was composed of sand and had dimensions of 50 m in diameter and 6 m in height. Extended burials and cremations were placed on the mound floor and in subfloor graves. One burial might have been within a simple log tomb (Stothers, Pratt, and Shane 1979). Most of the ceramics from the mound are Wayne cord-marked and McGraw cord-marked. Also included is a single Chillicothe Rocker-stamped beaker illustrated in Greenman (1937a: Fig. 19). Lithics from the mound include corner-notched projectile points and unifacial prismatic blades manufactured from Flint Ridge flint, a platform pipe, and an alligator effigy pipe, as well as a small piece of obsidian.

3.2.3.2.2.1.2 Sociocultural Organization and Settlement Pattern. Surprisingly, the sociopolitical organization of this Middle Woodland adaptation in the Western Basin may not have been as advanced as that of the Late Archaic-Early Woodland mortuary patterning as seen at the Williams Site. On the basis of brief descriptions of these Middle Woodland burial mounds, there appear to be no burial treatment or grave good assemblages indicative of ascribed status.

In northcentral Ohio, the burial practices represented by the mortuary ceremonialism analysed to date do not presently allow a differentiation between ascribed and achieved status through differential grave lots and burial treatment. However, as mentioned earlier, what is known of mortuary behavior is suggestive of non-egalitarian sociopolitical organization and of a big-man or ranked social system. This contention is based on the clear affinity of the mortuary patterning with that found in the lower Scioto area of southcentral Ohio. This clearly suggests active participation in the Hopewellian interaction sphere, with trade of such exotic items as obsidian, ceramics, and lithic resources for use in a mortuary as opposed to secular context. While such behavior is totally consonant with achieved status, the considerable size of the Esch mound and its required labor input suggests a gross utilization of energy and energy differentiation in the society characteristic of more complex sociopolitical systems, i.e., ranked societies. Ascribed status has been shown to exist in the mortuary behavior of the Middle Woodland occupation of the Lower Illinois Valley (Buikstra 1976). Although many of the characteristics of the mortuary patterning of these two areas are similar and both participated in the Hopewellian Interaction Sphere, one cannot be sure of the ranked nature of Esch Phase social organization without a more thorough analysis of the mortuary material.

As suggested by Prufer and Shane (1976); Prahl, Brose, and Stothers (1976); and Stothers, Pratt, and Shane (1979); two distinct cultural traditions were developing during the Middle Woodland--one involving the Western Basin and one centered in northcentral Ohio. These traditions were distinctive in terms of their adaptations, material culture, and probably ethnicity. Furthermore, there was no interaction between these distinct traditions. Interactions such as exchange and trade are seen between the northcentral Ohio area and southern Ohio; Western Basin influences were to the north. As noted earlier, this developmental trend was seen earlier in an adaptational but not a material sense.

Distinctive internal developments also appeared during this period. In the Western Basin, Middle Woodland occupational components of all types were more numerous than in the preceding period, and five mortuary sites have been noted. However, in the northcentral Ohio region, there was a slight decrease in the overall number of occupational components, and an important decrease in the number of villages. This is slight for the Huron River Valley but acute for the east, where no villages or mortuary sites exist, except the one mentioned by Brose in Pennsylvania and several unspecified locations in northeastern Ohio (Brose 1977).

The expansion of the Western Basin Middle Woodland population is seen as being the result of the rising lake levels and the fact that more recent sedimentary history preserved more of the settlement pattern of the area compared with earlier phases. In the northcentral and northeastern areas, however, this factor cannot be invoked because fewer components, particularly villages, are known. As was shown, there was an actual reduction of carrying capacity caused by suppressed productivity of the environment due to a climatic shift toward a cooler and moister regime known to have occurred by A.D. 500, and possibly by A.D. 400. (Graves 1977:76).

The shift to this cooler and moister regime did not have the drastic impact on the Huron Valley settlement-subsistence system that it did on the systems to the east. This was because of the inherently greater productivity of the environment of this area. There are two reasons why a similar drop did not occur in the Western Basin. First, the sedimentation and lake level affected the visibility of earlier settlement patterns much more severely than that of the Middle Woodland pattern. Second, and more importantly, the adaptations in the Western Basin are distinctively different from those found in north-central Ohio due to their lacustrine orientation. It appears that the environmental shift in this region either occurred later or had a different, less drastic, effect on the subsistence base of groups living there.

Although maize was found in a Middle Woodland context at the Indian Island #4 Site, dated at A.D. 540 ± 95, it is doubtful that its occurrence in this area gave an adaptive advantage in the face of the environmental shift when compared with areas to the east. It was not until after A.D. 500 that maize became important. During the Middle Woodland, we are still dealing primarily with natural resource procurement systems, i.e., primary forest efficiency. This changed shortly after this period.

3.2.3.2.2.2 New York and Pennsylvania. The geographic diversity of cultural patterns apparent within New York and Pennsylvania during the Early Woodland became even more marked during the Middle Woodland, resulting in a rather complex and often confusing regional picture. Western Pennsylvania was characterized by manifestations of burial ceremonialism related to Hopewell developments in Ohio in the form of mounds or tumuli, while very little is known of settlement or subsistence. The New York sequence, on the other hand, was much more complete in this regard, although evidence comes primarily from central New York rather than from the Erie Lowland where earlier Meadowood materials were abundant.

The earliest phase in New York is Canoe Point (Early Point Peninsula tradition), which is poorly represented by several small components within multicomponent sites; i.e., Vinnette, Wickham, and O'Neil. Diagnostic artifacts include thick, crude, side-notched and stemmed points; and dentate-stamped, pseudo-scallop shell, rocker-stamped, and corded Vinette 2 pottery. Despite the fact that Ritchie (1969) and others (Ritchie and Funk 1973) assumed that Canoe Point was an adaptation to riverine-lacustrine exploitation that included heavy fishing, shell gathering, and even rice harvesting, there is virtually no evidence for this except within the "core area" of southeastern Ontario. There is little evidence south of Lake Erie suggesting that Canoe Point subsistence-settlement was substantially different from Meadowood.

The following phase, Squakie Hill, was characterized by the presence of burial tumuli with associated cult objects thought to reflect Hopewellian inspiration (Ritchie and Funk 1973). Small earthen burial mounds have long been recognized in western and central New York (e.g., Squier 1851) as has been their apparent affiliation with the "Mound Builder" cultures of the Ohio Valley (Parker 1922:83-93). To date, all evidence of the phase has come from mound explorations. While scattered finds of diagnostic cult items have occurred within multicomponent sites, no certain habitations have been located (Ritchie 1969). A review of mound locations (Ritchie 1969:219-222; Parker 1922) in New York indicates a preference for raised topographic situations such as plateaus, promontories, or high slopes, almost always above a river or large stream. Mounds are frequent in the Lake Plain and occur along Buffalo, Cattaraugus, Canadawa, and Chautauqua creeks (Parker 1922; SUNY Site Files). A summary of burial items from excavated mounds and isolated finds would include cache blades, copper, platform pipes of Ohio firestone, copper ear ornaments, as well as notched and stemmed points of Flint-Ridge chalcedony (Snyders and Gibson points) (Ritchie 1969).

In the absence of habitation data, few concrete statements are possible concerning the wider ecological implications of burial ceremonialism in New York at this time. It is unlikely that mound burials reflected the imposition of a religious cult in the hands of religious specialists from the Hopewell centers over indigenous Point Peninsula groups. Yet the lack of evidence for cultigens or sedentary village economics makes it difficult to envision the existence of an incipient ranked, magico-religious hierarchy in western New York similar to that implied for the Ohio Valley. As suggested by Ritchie and Funk (1973), sites like Squakie Hill probably reflect a less sophisticated burial cult centered around a glorified shaman figure, yet within the sphere of formal influences from Hopewell centers. The predominance of mounds in the western lowland areas may in fact reflect the somewhat greater productive potential of these areas during the Woodland Period. This may have supported ranked nature of Esch Phase social organization without a more thorough analysis of the mortuary material.

As suggested by Prufer and Shane (1976); Prahl, Brose, and Stothers (1976); and Stothers, Pratt, and Shane (1979); two distinct cultural traditions were developing during the Middle Woodland--one involving the Western Basin and one centered in northcentral Ohio. These traditions were distinctive in terms of their adaptations, material culture, and probably ethnicity. Furthermore, there was no interaction between these distinct traditions. Interactions such as exchange and trade are seen between the northcentral Ohio area and southern Ohio; Western Basin influences were to the north. As noted earlier, this developmental trend was seen earlier in an adaptational but not a material sense.

Distinctive internal developments also appeared during this period. In the Western Basin, Middle Woodland occupational components of all types were more numerous than in the preceding period, and five mortuary sites have been noted. However, in the northcentral Ohio region, there was a slight decrease in the overall number of occupational components, and an important decrease in the number of villages. This is slight for the Huron River Valley but acute for the east, where no villages or mortuary sites exist, except the one mentioned by Brose in Pennsylvania and several unspecified locations in northeastern Ohio (Brose 1977).

The expansion of the Western Basin Middle Woodland population is seen as being the result of the rising lake levels and the fact that more recent sedimentary history preserved more of the settlement pattern of the area compared with earlier phases. In the northcentral and northeastern areas, however, this factor cannot be invoked because fewer components, particularly villages, are known. As was shown, there was an actual reduction of carrying capacity caused by suppressed productivity of the environment due to a climatic shift toward a cooler and moister regime known to have occurred by A.D. 500, and possibly by A.D. 400. (Graves 1977:76).

The shift to this cooler and moister regime did not have the drastic impact on the Huron Valley settlement-subsistence system that it did on the systems to the east. This was because of the inherently greater productivity of the environment of this area. There are two reasons why a similar drop did not occur in the Western Basin. First, the sedimentation and lake level affected the visibility of earlier settlement patterns much more severely than that of the Middle Woodland pattern. Second, and more importantly, the adaptations in the Western Basin are distinctively different from those found in north-central Ohio due to their lacustrine orientation. It appears that the environmental shift in this region either occurred later or had a different, less drastic, effect on the subsistence base of groups living there.

Although maize was found in a Middle Woodland context at the Indian Island #4 Site, dated at A.D. 540 ± 95, it is doubtful that its occurrence in this area gave an adaptive advantage in the face of the environmental shift when compared with areas to the east. It was not until after A.D. 500 that maize became important. During the Middle Woodland, we are still dealing primarily with natural resource procurement systems, i.e., primary forest efficiency. This changed shortly after this period.

3.2.3.2.2.2 New York and Pennsylvania. The geographic diversity of cultural patterns apparent within New York and Pennsylvania during the Early Woodland became even more marked during the Middle Woodland, resulting in a rather complex and often confusing regional picture. Western Pennsylvania was characterized by manifestations of burial ceremonialism related to Hopewell developments in Ohio in the form of mounds or tumuli,.while very little is known of settlement or subsistence. The New York sequence, on the other hand, was much more complete in this regard, although evidence comes primarily from central New York rather than from the Erie Lowland where earlier Meadowood materials were abundant.

The earliest phase in New York is Canoe Point (Early Point Peninsula tradition), which is poorly represented by several small components within multicomponent sites; i.e., Vinnette, Wickham, and O'Neil. Diagnostic artifacts include thick, crude, side-notched and stemmed points; and dentate-stamped, pseudo-scallop shell, rocker-stamped, and corded Vinette 2 pottery. Despite the fact that Ritchie (1969) and others (Ritchie and Funk 1973) assumed that Canoe Point was an adaptation to riverine-lacustrine exploitation that included heavy fishing, shell gathering, and even rice harvesting, there is virtually no evidence for this except within the "core area" of southeastern Ontario. There is little evidence south of Lake Erie suggesting that Canoe Point subsistence-settlement was substantially different from Meadowood.

The following phase, Squakie Hill, was characterized by the presence of burial tumuli with associated cult objects thought to reflect Hopewellian inspiration (Ritchie and Funk 1973). Small earthen burial mounds have long been recognized in western and central New York (e.g., Squier 1851) as has been their apparent affiliation with the "Mound Builder" cultures of the Ohio Valley (Parker 1922:83-93). To date, all evidence of the phase has come from mound explorations. While scattered finds of diagnostic cult items have occurred within multicomponent sites, no certain habitations have been located (Ritchie 1969). A review of mound locations (Ritchie 1969:219-222; Parker 1922) in New York indicates a preference for raised topographic situations such as plateaus, promontories, or high slopes, almost always above a river or large stream. Mounds are frequent in the Lake Plain and occur along Buffalo, Cattaraugus, Canadawa, and Chautauqua creeks (Parker 1922; SUNY Site Files). A summary of burial items from excavated mounds and isolated finds would include cache blades, copper, platform pipes of Ohio firestone, copper ear ornaments, as well as notched and stemmed points of Flint-Ridge chalcedony (Snyders and Gibson points) (Ritchie 1969).

In the absence of habitation data, few concrete statements are possible concerning the wider ecological implications of burial ceremonialism in New York at this time. It is unlikely that mound burials reflected the imposition of a religious cult in the hands of religious specialists from the Hopewell centers over indigenous Point Peninsula groups. Yet the lack of evidence for cultigens or sedentary village economics makes it difficult to envision the existence of an incipient ranked, magico-religious hierarchy in western New York similar to that implied for the Ohio Valley. As suggested by Ritchie and Funk (1973), sites like Squakie Hill probably reflect a less sophisticated burial cult centered around a glorified shaman figure, yet within the sphere of formal influences from Hopewell centers. The predominance of mounds in the western lowland areas may in fact reflect the somewhat greater productive potential of these areas during the Woodland Period. This may have supported larger, although as yet undocumented, communities based upon intensive utilization of the beech-maple forests and riverine-lacustrine habitats of the lowlands.

The next phases in New York were Kipp Island and Hunter's Home. During these phases, burial ceremonialism appears to have been simplified from that of earlier Meadowwood groups. Kipp Island components, characterized by Jacks Reef pentagonal and corner-notched points, triangular points, cord-marked and dentate pottery, polished stone pendants, and elbow platform pipes, are found within multicomponent and single-component habitation sites as well as in burial cemeteries. Large, possibly year-round base camps and summer fishing camps have been located on Kipp Island, a glacial drumlin in Montezuma Marsh, Seneca County. The site is some 3/4 acres in extent and contains evidence of circular houses and storage pits. Faunal remains clearly indicate a heavy fishing and shellfish-gathering focus in addition to hunting, trapping, and gathering of a variety of aquatic riverine fauna. Also indicated is the gathering of goosefoot, hickory, and butternut. The Felix and Jack's Reef sites indicate a similar pattern of local intensification in exploitation. As during the Meadowood phase, burials took place in separate cemeteries some distance from habitations, although large multiple burials were absent, and single flesh inhumations were the norm. Hopewellian items frequently appear in burials, although cache blades are of the crude, thick "quarry blank" variety, and there is a prevalence of partially modified bones and antler not common in earlier periods (Ritchie 1969).

The terminal Middle Woodland Hunter's Home phase of central and western New York appears to reflect the apex of the broad-spectrum pattern of intensive exploitation of locally occurring resources. A number of sites are reported from the Niagara Frontier adjacent to the Niagara River. These appear to have been fishing stations, as evidenced by faunal remains and site locations. The principal sites occur on the river terrace (Martin), a small stream terrace on Grand Island (Burnt Ship), and on the portage path above Niagara Falls (Portage). Two camps located on the terrace (Surma and Orchid) may have related ossuaries. Diagnostic points included Jack's Reef and Levanna types; pottery was Vinette 1 (White 1976). There are presently no published Hunter's Home phase sites from southwestern New York. The bulk of information on settlement and subsistence comes from the central part of the state where materials occur both within a multicomponent context, i.e., Kipp Island #4 in Montezuma Marsh and Hunter's Home located on a level sand terrace on the same marsh, and within large single-component occupations such as the White Site, located at the confluence of the Unadilla and Chenango rivers (Ritchie 1969:258-262). The White Site is unique for its location on a high ridge dividing the Unadilla and Chenango rivers. The site covers about 3/4 acres and apparently held several small oblong houses. Although no cultigens or other vegetable remains were recovered, the similarity in site size, the implied intensity and stability of settlement, and the location of the site are similar to later Owasco villages where horticulture was practiced. This may signify the incipient stages of agriculture during this phase (Ritchie and Funk 1973). Hunter's Home phase sites from the Mohawk and Hudson valleys, i.e., Turnbull and Black Rock, show clear evidence of heavy fishing and harvesting of wild plants, but no cultivation. Hunter's Home sites average about 1/2 acre and, like earlier sites, are usually situated along rivers or large streams. Ritchie and Funk (1973) designated this pattern as semi-permanent sedentary after Beardsley et al. (1956).

The further simplification of burial customs represented by only sporadic grave offerings has been suggested to reflect the possible breakdown of individual headman-shaman prestige positions and the greater influence of descent (perhaps corporately organized) groups related to incipient agricultural economies (Ritchie and Funk 1973). Alterations in site-location preferences and the appearance of oblong houses would seem to support this interpretation.

In western Pennsylvania, the Middle Woodland is known from the numerous burial mounds, surface collections and rock shelters long reported for the Upper Ohio and Allegheny River valleys. Burial tumuli do not seem to have occurred in the Lake Plain of Erie County (Mayer-Oakes 1955b; Kent, Smith, and McCann 1971; Curtis 1969; Johnson, Richardson, and Bohnert 1979). Based on ceramics and mound construction, two "culture areas" have been defined for the area (Johnson 1976; Johnson, Richardson, and Bohnert 1979). In the Upper Ohio Valley, mounds were of large stone slab construction and are associated with only modest amounts of Hopewellian cult items. The prevalent ceramic was a limestone-tempered, cord-marked ware referred to as Watson ware. Mound construction followed a pattern similar to earlier Adena tumuli, the only differences being that Middle Woodland locations were along lower river terraces rather than hilltops. Dragoo (1956) thought that this shift was an indication of the establishment of agricultural village life although no evidence of such villages has been disclosed for western Pennsylvania.

More mounds in western Pennsylvania occur in the second "culture area," in the Beaver and Upper Allegheny valleys north of Pittsburgh in Warren County, where two mound clusters, the Sugar Run group and Irvine group, have been investigated. Mounds in this area occur on the floodplain of larger waterways, are generally larger in size, and ordinarily of earth-filled construction with stone slab retaining walls, stone slab-lined cists, and covered burial pits (Johnson, Richardson, and Bohnert 1979:75). Associated ceramics are grit- rather than limestone-tempered and fabric impressed, and are called Mahoning ware (Mayer-Oakes 1955a). There is a relative abundance of exotic Hopewellian materials associated with these mounds and as scattered finds. These include platform-pipes, mica, freshwater pearls, copper ornaments, cache blades, and lamellar knives of Flint Ridge chalcedony; gorgets; pendants; and Raccoon, Jack's Reef, and Levanna projectile points. In formal aspects, these manifestations are comparable to Squakie Hill of New York during the same period (Johnson 1976; Johnson, Richardson, and Bohnert 1979).

In Venango County and southern Crawford County, Middle Woodland ceramics and projectile points are represented in local collections from rock shelters, river terraces, and uplands (Curtis 1969). Collections of materials that were studied also contained some exotic items attributed to this period, including Flint Ridge materials, flint excentrics, platform pipes, and a small obsidian knife from a floodplain surface collection which was dated to A.D. 178 ± 126 (PSU 53-5615) by obsidian hydration (Curtis 1969). In addition, a special resource site (for the extensive collection of petroleum) may have come into use during this period (Curtis 1971). Rock shelters and a few hilltop sites continue to be occupied in the same Allegheny tributaries as in the earlier periods although more terrace sites are now represented in additional drainages. The most extensive Middle Woodland collections are reported from the hilltops and flats along Sugar Creek Valley in the French Creek watershed where there was little occupation reported during previous periods (Curtis 1969).

Johnson and co-workers thought that this areal dichotomy, which seemed to persist into late Woodland times, roughly followed the terminal Wisconsin morraines along the western edge of the plateau and thus may have had its ecological basis in the effects of natural environmental zonation on cultural patterning. The interface between the northern hardwoods and mixed mesophytic forest of the Allegheny Plateau and the beech-maple forest of the Erie Lowlands may have formed a "longitudinal cultural frontier" (Fitting 1971) along which formal ties were maintained from the southcentral Ohio valley Hopewell centers along the Allegheny Valley of Pennsylvania to the Genessee Valley of New York (Squakie Hill) (Johnson, Richardson, and Bohnert 1979:76).

The distribution of temporally diagnostic projectile point types in northwestern Pennsylvania may reflect some as yet unclear settlement changes during the period. On the plain, lithics were generally rare, particularly those considered to represent early Middle Woodland Snyders, Gibsons, and Steubenville-stemmed points. Fox Creek points, dating to the middle of the period in the Hudson Valley (Funk 1976) are apparently not found in the plain but do occur in the French Creek drainage. The later Jack's Reef, Raccoon, and Levanna types are relatively more abundant throughout, although they are particularly abundant in the French Creek floodplain; this may suggest a tendency during terminal Middle Woodland toward population concentrations in select locations rather than an overall population increase in northwestern Pennsylvania (Johnson, Richardson, and Bohnert 1979:74); this pattern is not unlike that found in the Kipp Island and Hunter's Home phases of New York. Habitations, presumably contemporaneous with Hunter's Home, have apparently been located within the upper and middle Allegheny-Cornplanter No. 1, Steamburge II, Vannata No. 1, and Hoags Flats No. 2; these may represent clusters of small fishing hamlets comprising 2 or 3 houses (Johnson, Richardson, and Bohnert 1979).

The abrupt decline of the Hopewellian interaction sphere toward the later part of the Middle Woodland has been attributed to climatic deterioration within the Ohio Valley that may have undermined the stability of Hopewellian economics and hence cultural complexity and influence. Recent interpretations of pollen profiles from New York and Pennsylvania have brought this thesis under question (Johnson, Richardson, and Bohnert 1979; Ford 1974). Ford suggested that the introduction of the bow and arrow, probably represented by Levanna, may have allowed communities previously dependent upon Hopewellian trade networks to establish economic independence at the local level, thus dissolving the Hopewellian sphere of influence. As noted, no evidence for Middle Woodland village agriculture exists for western Pennsylvania or New York, although the remains of Zea in Stratum IV at Meadowcroft Rockshelter, dating to 340-375 B.C., leaves little doubt that corn was available in the Upper Ohio Valley of western Pennsylvania during the Middle Woodland (Adovasio et al. 1977).

3.2.3.3 Early Late Woodland Settlement-Subsistence Adaptations

From A.D. 500 to 1000, a major cultural shift occurred throughout the Lake Erie Basin. There was a reorientation in the subsistence and settlement patterns in response to changing climatic conditions. Maize horticulture, based on the more productive genetic strains, was introduced (Stothers and Yarnell 1977). Presumably associated with this subsistence and settlement change was a shift in social organization.

3.2.3.3.1 The Natural Environment. Stothers and Yarnell (1977) presented a model of Hopewellian decline following the paleoclimatic regime proposed by Bryson and Wendland (1967). They contended that at about A.D. 350 to 400 there was a warming period, i.e., the Scandic Episode. This warming trend shifted the northern edge of the biotic zone in which maize agriculture could be practiced in the Lake Erie Basin. They believed that maize came into this region from the south through the Hopewellian Interaction Sphere. At the same time, genetic strains of more reliable and more productive maize were available, making maize a viable subsistence staple. It is this combination of a northward shift of the warm climate and the introduction of advanced races of maize that eroded the Hopewellian Interaction Sphere by causing the institutionalized inter-regional trade network to collapse.

They also contended that this position countered that proposed by Griffin (1960). Griffin postulated a minor cooling trend during the later portion of the Hopewell Period, which affected the existing agricultural production. This, to him, resulted in the shift from Hopewell to early Late Woodland. Brown (1977:171-172) viewed Griffin's contention as incomplete, that is, as trying to explain events without explicitly linking climate changes to settlement-subsistence changes and ultimately to sociopolitical changes. To Brown, it was not clear how a climate change in general would impact a broad-spectrum resource base.

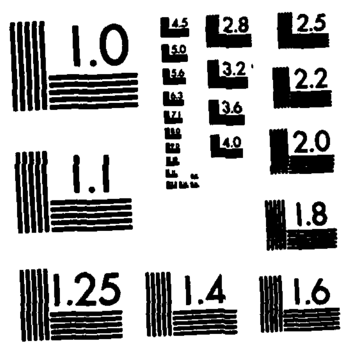
Ford (1974) did not consider climate change as being important in the disruption of the Hopewellian Interaction Sphere and subsistence-settlement patterns at the end of the Middle Woodland. Instead, he thought that the replacement of the atlatl with the bow and arrow was partly responsible for this decline. This was because the bow and arrow was more efficient for hunting and would disrupt trade routes. It is inferred that Ford did not like climatic change models for reasons similar to Brown's. In spite of these contentions, a model that explicitly shows how environmental shifts in the Lake Erie Basin area created a shift in adaptation by necessitating changes in settlement patterns and sociopolitical organization will be presented.

At approximately A.D. 500, a moister and cooler climate was recorded in the vicinity of Lake Erie. In the western part, this climatic shift resulted in a rise in beech and maple pollen at the expense of the oak and hickory pollen shown to be maximally represented in the pollen strata of the earlier Middle Woodland Period. As discussed for the Middle Woodland, acorns and, particularly, hickory nuts were important subsistence items in this adaptation. During the Early and Middle Woodland periods, oak and hickory were also at their maximum pollen percentages, indicative of a warm and dry climate. These conditions allowed a very high carrying capacity and substantial population size. The shifting climate in A.D. 500 and the appearance of more beech-maple in local forests would have disrupted foraging strategies that emphasized exploitation of the highly productive hickory and oak. This lowering of the overall productivity of a forest area affected the already existing large, semi-sedentary or sedentary populations, causing them to shift their subsistence emphasis to other food items (such as maize) to replace the lowered percentages of acorns and hickory nuts now available.

This process of shifting the economic emphasis to maize was a slow one. As noted earlier, there appears to be archeological evidence of reduced carrying capacity as seen in population decreases in northern Ohio, east of the

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981

UNCLASSIFIED F/G 5/1 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Huron River drainage. Initial maize production could not be expected to have provided a one-to-one substitute for acorns and hickory nuts. Decreases in population in the area, or at least a realignment of existing population and settlement patterns, must be expected to have taken place. It is probable that both situations occurred. It is possible that there was also a negative climatological impact on wild and/or domesticated native seed resources associated with the oak-hickory forest. There is, however, no palynological or ethnobotanical evidence to bear out this speculation.

3.2.3.3.2 Site Distribution. Gradual changes in the cultural characteristics of the prehistoric inhabitants occurred during the early part of the Late Woodland Period. Environmental changes combined with demographic increases were reflected in the settlement-subsistence adaptations to specific regions. These adaptations established trends that were later manifested in the behavior of ethnohistoric groups that controlled various subareas.

3.2.3.3.2.1 Ohio. Associated with the climatological shift that occurred during this period were reductions and redeployment of population and, as a result, a change in sociopolitical organization. This was reflected in the breakdown of the Hopewellian Interaction Sphere throughout most of the Northeast and Midwest. This does not imply that all areas witnessed a decline in sociopolitical complexity. In Wisconsin, for example, the same basic mortuary ceremonialism, settlement, and subsistence patterns continued unchanged for hundreds of years after the disappearance of the Hopewellian Interaction Sphere to the south (Ford 1974:403). Stability in the level of sociopolitical organization in this area might, in part, have been a result of the absence of environmental fluctuation when compared to the environmental changes described for the Lake Erie area, and also of the inability to produce maize this far north.

From about A.D. 500 to 800-1000, no burial mounds or villages are reported for the Ohio area of the Lake Erie Basin. This period of post-Hopewellian decline is referred to as the early Late Woodland Period (Griffin 1967:187). The earlier portion, from A.D. 500 to 800, is very poorly understood archeologically. Fitting (1965a), in his original formulation of the Late Woodland sequence of southeast Michigan, saw a continuation of the basic Middle Woodland Wayne tradition until approximately A.D. 800 to 900, when the Younge tradition emerged with its earliest Riviere au Vase Phase (ca. A.D. 800 or 900 to 1000). Others (Stothers 1973, 1975; Stothers, Pratt, and Shane 1979; Prahl, Brose, and Stothers 1976; and Stothers and Yarnell 1977), however, saw these phases as possibly distinct cultural complexes that may have been contemporaneous. Thus, three contemporaneous manifestations have been identified in the literature for the Ohio area: the Riviera au Vase Phase, the Wayne tradition, and the Western Basin complex.

The best evidence of occupation in the Western Basin between A.D. 500 and 800 or 900 comes from Gard and Indian islands at the mouth of the Ottawa River, Maumee Bay, Michigan (Stothers and Yarnell 1977). During the time under discussion, these islands were dunes still connected to the land. Not until 1400 were they surrounded by water and cut off from the land (Graves 1977). Occupational components at these sites have been placed in the Riviere au Vase Phase (Stothers and Yarnell 1977:210); they include the following: Indian Island #3 and #5 and Gard Island #2 and #3 (Stothers and Yarnell 1977:210-212). These components have been dated with a series of seven radiocarbon dates that gave a range in occupation from 530 to 1140 (Stothers and Yarnell 1977). Another site, Indian Island #4, is considered transitional between the late Middle Woodland and the early Late Woodland periods, with accepted radiocarbon dates of A.D. 540 ± 90 and 590 ± 55 (Stothers and Yarnell 1977). One of these components, Gard Island #2, is associated with a cemetery containing 37 individuals (Stothers and Yarnell 1977). A single Riviere au Vase Phase site, the MacNichol Site, 33 Wo 10, is reported for the Ohio region of the Lake Erie Basin. This site, which is situated on the Maumee River drainage, was dated at A.D. 740 ± 80 and assigned to the Younge tradition.

Stothers and Yarnell (1977:222-226) characterized the settlement-subsistence system of the Riviere au Vase phase as being composed of two settlement types: a late fall to early spring encampment found inland for winter hunting (very small, with little cultural material) and a late spring to early fall larger settlement (composed of coalesced band segments located in riverine/lacustrine environments such as bottomlands, mudflats, and swamp and marshlands). The subsistence activities at these latter sites would have been composed of fishing, fowling, gathering of marsh plants, and planting and cultivating small maize gardens. Maize kernels were found at all sites, and one grape seed and one polygonium seed along with abundant fish remains were recovered from Gard Island #3 (Stothers and Yarnell 1977:212-213). As can be seen, this is the same subsistence-settlement model proposed for the late Middle Woodland in the Western Basin (Stothers, Pratt, and Shane 1978).

Stothers and Yarnell (1977) maintained that these island sites could not have been utilized on a year-round basis because access to the islands was physically impaired due to the harsh winter environment, spring flooding, and ice jams. Graves (1977), however, pointed out that, during this time period, these islands were still part of the mainland, not yet having been surrounded by water.

We concur with the opinion that the shift to an increased reliance on maize did not cause an abrupt shift in settlement-demographic patterns in this period (Stothers and Yarnell 1977). Summer extraction sites were also suitable for maize production, consequently no abrupt shift in settlement location or patterns would have been necessary if the economic dependence of maize production was increased very gradually. At first, maize may have been produced on a small scale and viewed as an additional seasonal resource to be combined with other plant resources being gathered in the area.

The Western Basin complex (Stothers 1973) is stylistically related to the contemporaneous Princess Point complex in southwestern Ontario. A single site, the Sissung Site, located along Stoney Creek one half mile inland from Lake Erie in Monroe county, Michigan, forms the basis for defining the Western Basin complex. This site is dated to A.D. 700 ± 120 (Stothers 1973; Stothers and Yarnell 1977). Stothers and Yarnell (1977) suggested that this site was more lacustrine and littoral in orientation than the previously discussed Riviere au Vase Phase sites. Floral elements recovered were carbonized maize kernels, hickory-nut fragments, and wood charcoal. Stothers and Yarnell pointed out that not enough cultural material was recovered from this site to clearly understand its contextual position. For this reason, there appears to be little reason to make a major cultural distinction between this site and those assigned to the Riviere au Vase Phase from an adaptational point of view. The utilization of a distinctive separate terminological category, Western Basin complex, for a single, poorly known site is unwarranted; the site should probably be included in the Riviere au Vase Phase.

Another early Late Woodland manifestation in the Western Basin area is referred to as the Wayne tradition (Prahl, Brose, and Stothers 1976:262-263). This manifestation represents a continuation of the local non-Hopewellian Middle Woodland tradition (Fitting 1970; Prahl, Brose, and Stothers 1976). The ceramics characterizing this manifestation appear to be typical of those that characterize the Late Woodland occupations in central and/or western Michigan; this material is not considered to be historically related to nor to represent an antecedent to the later Younge tradition (Prahl, Brose and Stothers 1976). Wayne cord-marked ceramics do, however, characterize the Esch phase in northcentral Ohio and are probably ancestral to later early Late Woodland material in that area.

Wayne tradition sites usually are found 10 to 20 mi inland from the western shore of Lake Erie, in the Toledo area (Prahl, Brose, and Stothers 1976). Such sites are often located on the small tributaries of larger eastward flowing rivers that empty into the lake . The Curf Site, which is the best-known example of this complex, has been dated to A.D. 830 ± 120 (Prahl, Brose, and Stothers 1976). The ceramics characteristic of the site include Wayne cord-marked and fabric-impressed, Wayne-smoothed, and Macomb interrupted linear. The site function is interpreted as a fall through winter campsite; the evidence for seasonality consists of deer antlers and hickory and walnut fragments. To date, no summer settlement types have been identified for this tradition.

Surprisingly, little early Late Woodland material has been found along the southern shore of the Western Basin (from the mouth of the Maumee River east to the Toussaint River) (Pratt 1977, 1979b). A single site, the Pauleson Site, located in Maumee Bay State Park, has a Late Woodland component; but this site is only known from a collection (Pratt 1979b). A recent inspection of the site failed to reveal any specific settlement or subsistence information (Pratt 1979b). Pratt noted that erosion of the shoreline in Maumee Bay State Park has been severe and that the contextual and spatial integrity of many of the area's sites have been destroyed or submerged.

East of the Toussaint River, there might be cultural material assignable to this initial segment of the early Late Woodland Period, as represented by the Libben Phase material reported to be scattered throughout the Black Swamp and Sandusky Bay area (Prufer and Shane 1976; Bowen 1978). However, the preliminary description of ceramics and settlement pattern clearly indicates that this phase is more typical of the time period from 800 to 1000, as suggested by Prufer and Shane.

In northcentral Ohio, only one feature at the Leimbach Site can be assigned to this earlier portion of the early Late Woodland, circa A.D. 500 to 800 (Prufer and Shane 1976). This feature was radiocarbon dated at A.D. 575 ± 180 and included two rimsherds from two different vessels of the type Vase Tool Impressed. It appears that there is a continuity of ceramic types from the preceding Esch Phase into this A.D. 500 to 800 period. Hickory-nut shell fragments, three Chenopodium seeds, and maize kernels have been identified in flotation samples from this feature (Prufer and Shane 1976:294).

In northeastern Ohio, the period from A.D. 600 to 900 is termed the Hale Phase (Brose 1978c:89-90). This transitional Middle to Late Woodland Period has a settlement system composed of summer multifamily horticultural villages located along alluvial floodplains in mixed mesophytic forests. Spring or fall fishing and bird collecting site types exist and are situated along the lakeshore at river mouths, while winter hunting camp sites are situated in upland rock shelters or adjacent to springs. There appears to have been no difference in population size and composition between summer, fall, and spring settlements, but smaller family segments were characteristic at winter sites (Brose 1978c). The Jonothans Farm Site represents a summer village settlement type; the Boston Ledges Site represents a winter campsite type (Brose 1978c:101-102).

The Boston Ledges Site has been excavated and the results published (Brose and Scarry 1976). The site actually consists of two spatially distinct shelters referred to as A and B. Limited excavations were conducted in shelter A, much of the site having been previously excavated or disturbed; more extensive excavations were conducted in shelter B. The ceramics from the upper strata of shelter A and all those recovered from shelter B represent a distinct temporal marker for this time period for northeastern Ohio. These ceramics are characteristically heavily grit-tempered and have globular forms with outcurved rims and subconical bases. They are also decorated with S_{z}^{z} twisted cord impressions (usually applied vertically) and with outward beveled, flat lips decorated with a separate Z_{s}^{s} twisted cord (Brose and Scarry 1976:184-185). These ceramics have been referred to as Cuyahoga cord-marked (Brose 1977:99) and have their closest affinity with Jack's Reef and Kipp Island Phase ceramics (Brose and Scarry 1976:185). Although this site has not been radiocarbon dated, similar ceramic material from the Lake County Dude Ranch has been dated to A.D. 780 ± 65 (Brose and Scarry 1976:185).

Faunal remains from the site indicate a hunting economic focus. Six deer and four wapiti have been recovered from shelter B, while one deer, one wapiti, one raccoon, and two turkeys are minimally represented in the assemblage from shelter A. No shell or fish remains were encountered (Brose and Scarry 1976). There is a major discrepancy regarding site seaonality as presented by Brose in his Hale Phase classification of the site as a winter camp (Brose 1978c:102) and that was indicated by the faunal assemblage. Brose and Scarry (1976:186) stated that shelter A was occupied throughout the year, while shelter B was occupied from late summer to fall, on the basis of cervid tooth eruption and wear. This is in direct opposition to Brose's later classification of the Boston Ledges shelter as a winter campsite (Brose 1978c:102).

Brose and Scarry (1976:201-203) did, however, provide a more thorough analysis of the settlement and sociopolitical components of the Boston Ledges shelter and the Cuyahoga River drainage for this time period. On the basis of artifact patterning analyses and an activity set analysis integrated with demographic theory, they suggested a total population at the site of between 14 and 21 individuals, consisting of two nuclear families integrated into an extended household. They proposed that other such campsites existed in the ravine and stream areas nearby and that the complementary maize-producing sites situated in the alluvial valleys had populations ranging from 25 to 70 individuals. This settlement model differs somewhat from that proposed earlier by Brose for this period and is strikingly similar in social organization and demographic characteristics to that presented by Stothers and Yarnell (1977) for the contemporary Riviere au Vase Phase in the Western Basin area.

By about A.D. 800 or 900, the early Late Woodland Period is much better known archeologically. In the Western Basin area, there was a return to permanent village life. This period began what is known in the Western Basin area as the Younge tradition (Fitting 1965a; Stothers, Pratt, and Shane 1979; Prahl, Brose, and Stothers 1976). Artifactually, this tradition was not confined to the Western Basin; ceramics and lithics for both the Western Basin and the northcentral Ohio region were very similar. This similarity was apparently not shared with northeastern Ohio, although, as Prufer and Shane (1976) pointed out, this period has been poorly described for that area. Furthermore, there was little similarity in ceramics or projectile points with areas to the south. Late Woodland Scioto tradition ceramics, such as the Peters cord-marked and Peters plain types, are missing in northcentral Ohio. These areas of Ohio shared their ceramic assemblages with contemporary sites on the Michigan shore of Lake Erie and, in fact, most of the type, tradition, and phase terms utilized to describe the southeastern Michigan material also apply to the Ohio early Late Woodland manifestations extending east along the lakeshore to the Black River (Fitting 1965a, 1970; Prahl, Brose, and Stothers 1976).

Contemporary archeological material in the Point Pelee Peninsula of the northern shore of the Lake Erie Basin are generally not of the Younge tradition. They tend instead to develop out of the later phase of the Western Basin complex (Prahl, Brose, and Stot' :s 1976:266), which, as previously stated, was not found in the Ohio porti.. of the Western Basin. Instead, the contemporary Wayne tradition material is found (Prahl, Brose, and Stothers 1976).

Two phases exist for the Western Basin area; the Riviere au Vase and the Libben. Only geography distinguishes these phases during this time period. For convenience, all archeological material in Ohio dating to this period will be placed in the Libben Phase, while that from southeastern Michigan will be referred to as Riviere au Vase. Although this might seem an arbitrary division, it is justified for several reasons: 1) There are no cultural differences, i.e., artifacts, between the Libben and the Riviere au Vase phases. The application of two distinct terms for adjacent areas might otherwise imply cultural or adaptational differences. 2) The sole use of the Libben Phase in this area removes any objection concerning Wayne ceramics as possible historical antecedents. 3) The type site for this phase is also the best-known component for the Western Basin and the northcentral Ohio region; thus, using it as a general (not to be mistaken for normative) description of the adaptation is more precise. 4) This negates the need to discuss components from southeastern Michigan, which might not necessarily provide applicable models for understanding adaptive patterns in the Ohio portion of the Western Basin.

The Lake Erie shoreline, from the mouth of the Maumee River to an unspecified point east of Maumee Bay, was supposedly not suitable for any kind of permanent occupation (Prahl, Brose, and Stothers 1976). Only temporary seasonal fishing and fowling sites have been found in this area. Occupational components in this area include the Doctor's Site and the Morin Site, the latter dated at A.D. 1070 ± 100. An interesting feature of these sites is that their ceramics show similarities to the Ontario Glen Meyer tradition. This may be attributable to geographic proximity, resulting in some intermixing of ceramic types at all time levels rather than actual population movement (Prahl, Brose, and Stothers 1976:266). A similar situation is seen at the Libben Site where ceramics show affinity to the Kipp Island and Hunter's Home phases in New York but not to northeast Ohio ceramics of the same time period (Prufer and Shane 1976:301).

In addition to the pseudo-shoreline sites, a number of riverine sites have been reported for this phase. These include the Indian Hills and Hospital sites. Only the former is known in any detail (Prahl, Brose, and Stothers 1976). The early Late Woodland component of the Indian Hill Site has been dated at both A.D. 710 ± 120 and 890 ± 130. No information regarding economic base, site size, seasonality, or other characteristics (other than ceramics) have been provided for these sites.

Located on the Portage River, but still within the Western Basin area, is the Libben Site (Prufer and Shane 1976). Comprehensive and intensive excavation has been conducted at this site, not all of the results of which have been published. The radiocarbon dates indicate an eighth to tenth century occupation (Prufer and Shane 1976). The site consists of a village and an associated cemetery situated on a sandy knoll on the north bank of the Portage River. The village area, as defined by excavation, was approximately 0.8 acres (0.3 hectares) and was composed of an unspecified number of circular houses some 25 ft in diameter. The village was surrounded by a stockade extending in a "C" from the river bank. This stockade appears to have been rebuilt at least three times. The exact original size of the site is unknown since much of it has eroded into the river; the village was also encroached on by the cemetery to the west (Prufer and Shane 1976).

More than 1500 burials were recovered from this cemetery, and an intensive demographic analysis of the skeletal materials has been published (Lovejoy et al. 1977). Burials were, for the most part, articulated primary extended interments of the single, double, and multiple types. These numbered 1327 (Lovejoy et al. 1977; Prufer and Shane 1976). The remaining burials include cremations, bundle burials, and flexed burials. Many of the burials were accompanied by extensive grave goods. Burial offerings included ceramic vessels, conch columella pendants, marginella beads, necklaces of shell disk beads, and clay elbow pipes. The ceramics were locally produced. No analysis of the burial goods has yet been published to suggest whether there was ascribed or achieved status patterning. However, on the basis of extensive burial offerings and the exotic nature of some of these materials, some sort of minimal status differentiation indicative of non-egalitarian sociopolitical integration is suggested.

An analysis of the life table prepared from the 1327 primary interments indicated a life expectancy (at birth) of about 20 years for the population, with a mean family size of 3.8 indicative of a "robust, successful population" (Lovejoy et al. 1977:292). Bender (1979:194) calculated a mortality rate of 5.0 from the Libben life table published by Lovejoy et al. (1977). Such a rate indicates that five deaths occurred per year, assuming the population was stable and stationary. This mortality rate gives a population figure for the site of between 88 and 110 people, depending upon whether the site was occupied for 250 or 300 years (Bender 1979:194). This calculation was based on the 1327 articulated skeletons utilized in the original life table. If the 1500 skeletal deaths are utilized (the number actually recovered from the site), the range of populaion size shifts upward to between 100 and 120. These figures might, however, be inaccurate if one or more of the following conditions exist. 1) The burials that have been recovered are not representative of the demographic characteristics of the local population. 2) More burials remain to be recovered. 3) The duration of site occupation differed from that suggested.

A detailed pathological analysis of the Libben skeletal series has not yet been published. Prufer and Shane (1976:296) reported that many burials were severely pathological and that 48 showed trepanation. Some had cut marks and perforated long bones. Lovejoy et al. (1977:292) noted that there was elevated adult male mortality and suggested high levels of warfare as a possible cause. Violent death was frequent among males and a number of "trophy" skulls were recovered. These skeletal data, coupled with the defensive nature of the site, clearly indicate the presence of warfare.

Few Libben Phase sites are found on the shoreline of Lake Erie from the mouth of the Maumee River to east of Maumee Bay. Prahl, Brose, and Stothers (1976) reported that seasonal camps were identified there for this phase, and they appear to have functioned as fishing and pooling sites. However, no large permanent settlements have been identified.

A considerable range of subsistence items has been recovered from the Libben Site. The faunal assemblage consists of more than 300,000 elements representing 25 species of mammals, 11 species of fish, and 28 species of birds (Romain 1979b:42). Fish were by far the most important faunal resource, accounting for 78.3 percent of the usable meat, broken down by species as follows: freshwater drum, 37 percent of the usable meat; walleye, 13 percent; and catfish and bullhead, 13 percent; the rest consisted of bass, pike, and sucker. The percentages reflect the laboratory analysis of recovered faunal remains and not necessarily the exact amount of fauna consumed.

Mammals accounted for only 20.2 percent of the total usable meat, with deer accounting for 63 percent of this total. Other mammals that were utilized included muskrat, black bear, and raccoon. Birds provided only 1.4 percent of the usable meat and were, for the most part, migratory waterfowl.

The faunal assemblage clearly indicates an emphasis on fishing and trapping (Prufer and Shane 1976; Lovejoy et al. 1977). Although deer might seem highly represented, there is clearly a high incidence of low meat-yielding animals such as muskrat, raccoon, and squirrel. Romain (1979b:43) suggested that these might have been trapped for pelts, a necessary resource in the Northeast (Gramly 1977, Webster 1979). The observation that mammal trapping was more intensive than was stalking might also be reflected in the very low incidence of lithics reported for the site (Prufer and Shane 1976). Romain (1979b:43) further noted that the uniform size of fish species in the faunal assemblage is indicative of net fishing. The recovery of antlered and antlerless deer indicates that the site was occupied throughout the year; this is also inferred from the fish remains. Specific seasonal evidence was not supplied (Romain 1979b).

Floral remains recovered from the flotation of features indicate the charred remains of 10 genera including hickory nuts, acorn fragments, maize, hackberry, raspberry, and dock seeds (Romain 1979b:42). Prufer and Shane (1976:299) also reported wild rice, but this was not reported by Romain (1979b). Lovejoy et al. (1977:293, note 5) noted that wild rice husks were not found in flotation, although they presumed that rice was utilized but missing in the samples because of the fragile nature of the husks. The floral assemblage clearly indicates a very diversified or "diffuse" (Cleland 1976) subsistence base, and it is clear that maize had not yet become the dominant vegetable. These floral data, however, cannot be used for direct comparison to determine the frequency or intensity of utilization of the various floral items in the subsistence base. This is because acorn and hickory-nut fragments are nonconsumable waste, whereas maize and wild rice are directly consumable and would not be recovered unless accidentally deposited. Therefore, it is probable that maize was much more important than is currently indicated in the Libben subsistence remains (cf. Romain 1979:42; Lovejoy et al. 1977:291; Prufer and Shane 1976).

Prufer and Shane (1976:295,299) indicated that numerous sites of this period are found on sandy knolls in the Black Swamp area west of Sandusky Bay, although none of these have been reported or described in detail. They also reported the existence of Libben Phase components in the Huron and Vermillion drainages in northcentral Ohio. However, we suggest, on purely environmental grounds, that the adaptation in the Huron and Vermillion drainages would differ markedly from that of the Libben Site in the Western Basin.

Little other information on settlement systems for the Libben Phase exists. It is therefore assumed that the permanent village is the only type of site in this adaptation and that all other extractive economic activities had ephemeral loci not readily detectable archeologically. These would include trapping, fishing, and hunting stations, and perhaps even agricultural plots or gardens. However, it should be noted that this model is clearly limited in regard to data pertaining to this phase. It should also be noted that this model is applicable only to the Western Basin, and that the adaptation in the northcentral Ohio region for this time period is completely unknown.

Only a single Libben Phase occupational component is known for the northcentral Ohio region. This component is interpreted as a small hunting encampment, suggesting that the settlement pattern, as currently understood, was different for this area.

In the northeastern Ohio region, the period from A.D. 900 to 1150 of the early Late Woodland is referred to as the Riverview Phase (Brose 1978b:90). According to Brose, the settlement-subsistence system for this phase was made up of three site types: horticultural villages (primarily occupied from spring through fall), mid-summer campsites, and mid-winter campsites. Both of these latter types are nearly as large as the villages, with the former serving as fishing stations and the latter as hunting camps. The horticultural villages are located in alluvial bottomlands; the Kurtz Site is an example of this site type (Brose 1978c:103). Mid-summer camps are found in lacustrine locations. Mid-winter hunting camps are located in the uplands; the Avon Plant area is an example of this site type (Brose 1978c:104).

One difference between this settlement-subsistence model and that proposed by Brose for the Hale Phase is the absence of the spring and fall fishing/fowling camp. This is replaced by the longer occupation at the summer horticultural village and can be interpreted as indicative of a shift to more intensive maize-curcurbit production (Brose 1978c:90). Another difference is the addition of the mid-summer fishing stations that were not noted in the earlier Hale Phase model.

The proposed settlement-subsistence models were constructed from limited amounts of data and have not been tested against more complete archeological field data. However, the models, as presented, represent the available published information about this period of occupation in northeastern Ohio.

Three distinctive settlement-subsistence systems have been recognized for the early Late Woodland in Ohio. In the Western Basin, the settlement-subsistence system was characterized by an adaptation that intensively utilized a broad range of lacustrine and swamp resources, both plant and animal, as well as maize horticulture. This adaptation consisted of permanent villages of about 100 to 120 individuals. The villages were fortified, suggesting endemic warfare. They were situated on well-drained sandy knolls and appear to have been associated with cemeteries. Rich grave furniture suggests non-egalitarian sociopolitical organization of an unknown nature. This particular phase is known as the Libben Phase.

This pattern is not seen in the northcentral Ohio area, and the occupation in this area is poorly known. The single reported component suggests a hunting-gathering, highly nomadic settlement pattern characteristic of the Middle Woodland Period in the adjoining northeast Ohio area. It might be, however, that the supporting agricultural villages were located in lacustrine settings and have now been eroded and destroyed because of rising lake levels and erosion. Maize has been recovered from the early Late Woodland component of the Leimbach Site (Prufer and Shane 1976:294). Nevertheless, no early Late Woodland sites are reported in the Erie nuclear survey area (Shane 1974a); thus the nature of the adaptation remains in question.

Settlement-subsistence system models have only been sketchily presented for the northeast Ohio area (Brose and Scarry 1976; Brose 1978b). This, however, does not invalidate the general patterns and trends proposed for the area. An increase in population, an increase in sedentism, and an increased reliance on maize are all assumed for this area. This increase in population in light of the degrading environment must be related to increased maize production.

The basic settlement model suggested by Brose and Scarry (1976), horticultural villages consisting of 25 to 70 people occupied during the spring through fall with various seasonal campsites and extractive sites with fewer than 25 individuals, appears reasonable in the absence of more comprehensive data. This pattern is very similar to that discussed for the Riviere au Vase Phase of southeastern Michigan, but it is probable that the lacustrine summer villages have been eroded away in this area. Lack of evidence of warfare in this area also suggests a more nomadic settlement system and a smaller population base than was seen in the Western Basin as well as a less complex level of sociopolitical integration.

3.2.3.3.2.2 New York and Pennsylvania. The designation of an early Late Woodland Period between A.D. 500 and 1000 is not consistent in the sequences that have been constructed and published in the literature for the Lake Erie Basin. While the Ohio sequence contains several geographically distinct phases, no comparable sequences of tradition have been clearly identified for the western New York and northwestern Pennsylvania areas.

On one hand, lack of recognition of early Late Woodland phases during this 500 year span may reflect the lack of data available in the New York and Pennsylvania regions. On the other hand, it is also possible that a predominantly Middle Woodland lifestyle continued in these areas until A.D. 900-1000. At that time, cultural and material patterns changed enough to be archeologically recognized. More excavated deposits with absolute dates and associated diagnostic materials will be necessary to characterize the cultural affiliations of New York and Pennsylvania societies during this time.

3.2.3.4 Terminal Late Woodland

This period, which began at about A.D. 1000 and lasted until historic contact in the Lake Erie Basin, is characterized by a shift in the intensity and reliance on maize horticulture (Brose 1978b; Prufer and Shane 1976; Prahl, Brose, and Stothers 1976). Population gradually increased and more permanent settlements began to appear. Settlements included a variety of fortifications and were more frequently established in strategic locations. Distinctive cultural patterns began to appear within geographic areas that are known to have been part of the recognized territories later associated with ethnohistoric groups.

3.2.3.4.1 The Natural Environment. The climate during this time was a continuation of the earlier moist cool trend that initially appeared about A.D. 500 (Graves 1977). In approximately 1350, a warm and dry period took hold in the Western Basin area (Graves 1977:79). It is not surprising that maize-based agriculture reached its apogee at this time. It is also interesting that early increases in population size were not necessarily associated with fortified villages (Brose 1978b:580); thus, agricultural intensification and pressure on resources was apparently not yet critical. It appears that population increase was a result of increased maize production brought about by better climatological conditions for growing maize, both in terms of minimizing risk and increasing productivity. After 1500, however, with the appearance of large, extensively fortified settlements, this situations changed.

3.2.3.4.2 Site Distribution. The descriptive data available for the three-state study area surrounding the lake are discussed in the following sections. By 1200, two very distinct cultural traditions existed for the Lake Erie Basin. The Younge tradition (Prahl, Brose, and Stothers 1976) is found in the Western Basin and in northcentral Ohio; the Whittlesey Focus is restricted to the northeastern Ohio region.

3.2.3.4.2.1 Younge Tradition. Since the original designation of the Wolf Phase (Fitting 1965a), a proliferation of phase names has been utilized to describe Younge tradition material in the Western Basin and in northcentral Ohio. These include the Eiden Phase (Bowen 1978:12), Peterson Phase (Stothers 1978b), and Mixter tradition (Brose 1978a). The Eiden Phase refers to Mixter tool-impressed ceramics dating from 1300 to 1425 (Bowen 1978:12). Brose (1978a:570-571, Fig. 2c) geographically differentiates the Mixter tradition from the Wolf tradition. The Mixter contains four kinds of occupational components: Libben, Mixter, Heckleman, and Eiden. Brose did not provide the criteria according to which these divisions were made. The Wolf Phase, in its current usage, is an extremely broad geographical and temporal taxonomic unit defined on the basis of a single diagnostic artifact, Parker-festooned ceramics (Prahl, Brose, and Stothers 1976:281). Therefore, we think that more specific geographical/regional phases are more appropriate for later Younge tradition manifestations.

Two such phase names appear to meet these criteria: the Peterson Phase and the Eiden Phase. As used in this report, the term Peterson Phase will refer to all Younge tradition manifestations in the Western Basin previously assigned to the Wolf Phase and dating past 1200. This phase represents a continuation of the maize-lacustrine-swamp-marsh economic focus seen earlier at the Libben Site. Eiden Phase will refer to the post-1200 adaptation found in the northcentral Ohio region east of Sandusky Bay and west of the Black River. This adaptation is primarily a floodplain horticulture and riverine-bluff or beach ridge economic focus. Eiden Phase components lack the extensive use of swamp, marsh, and lacustrine resources characteristic of the Western Basin area. More precise chronological phases for the Younge tradition in Ohio are apparently not yet possible. From an artifactual point of view, there is no difference between the two phases, suggesting similar cultural affiliation.

In spite of the value of using a single-phase distinction to refer to Younge tradition material in the Western Basin, such nomenclature is not currently accepted by all archeologists. Stothers (1978a) thought of the Wolf Phase as being an intrusion of Upper Mississippian people into the Western Basin with the withdrawal of earlier Younge tradition (i.e., Springwell Phase) people in southwestern Ontario, merging with Iroquois groups there. According to Stothers, this intrusion is evident in the defensive details and/or earthworks at many Western Basin sites. Prahl, Brose, and Stothers (1976:270) listed five sites within the Western Basin that were originally assigned to the Wolf Phase. Three of these, the Point Place Site and two earth enclosures on Kelleys Island, are within the Ohio portion of the Western Basin. The Point Place Site is actually in Monroe County, Michigan, but almost on the state line. This site appears to have a Peterson Phase component in the upper level as evidenced by Springwell net-impressed, Parker-festooned, Monroe net-impressed, and Parker dentate ceramics. The occurrence of both Parker-festooned and Springwell net-impressed ceramics at the mouth of the Maumee River somewhat negates Stothers's hypothesized Upper Mississippian invasion and withdrawal of Springwell Phase occupation into Ontario. The site has been severly disturbed by the urban expansion of Toledo and no additional information on it exists.

The Kelleys Island sites consist of two large earth enclosures on the south shore of the island. Each is between 5 and 10 acres in extent, based on mapping by Eastman in the 1800s (Prahl, Brose, and Stothers 1976:271). Salvage collections from the site by Prahl include Macomb-linear and Parker-festooned ceramics. Little evidence of the earthen enclosures existed when Prahl made his ceramic surface collection in 1969.

Additional components of the Peterson Phase include the Peterson Site, a very large village site and cemetery located on the Portage River (Prufer and Shane 1976:302-303); the Pearson Village Site on Green Creek, about 3.5 mi. upstream from Sandusky Bay (Bowen 1978:12); and the Hudson Village Site (Bowen 1979:34). These sites are known only from surface collections, and no specific information regarding settlement or subsistence patterns is known. It is therefore suggested that the Libben Phase settlement-subsistence model for the Western Basin be utilized for the Peterson Phase as well. Cultural continuity between this phase and the earlier Libben Phase is strongly suggested by the evidence (Prufer and Shane 1976).

As expected, there appear to be fewer Peterson Phase components than Libben Phase components in the Western Basin. This is the result of two processes: one ecological and the other geomorphological. As the lake level increased, the lands in the Western Basin became swampier and the water table inundated more arable land and potential settlement areas. Compounding this process was the effect of high energy beaches, which scoured and destroyed more and more sites as the lake level encroached further landward. Therefore, although better strains of corn and more suitable climatic conditions were available at this time, the topography and drainage were altered; more and more areas of potential habitation and agriculture were removed from use. Thus, there was an apparent decrease in population through time in this area. It might be that the abandonment of the Western Basin by Younge tradition occupants was not a function of an intrusion of Upper Mississippian groups as proposed by Stothers, but was, instead, an abandonment or reduction in group size as a result of an intrusion of the lake onto the southern shore of the Western Basin.

Younge tradition occupation in the northcentral Ohio region, referred to here as the Eiden Phase, is much better known archeologically for the period after 1300. Numerous sites have been reported for this phase. Three of these, Burrill Fort, White Fort on the Black River, and the National Tube Company Site--were initially recorded by Greenman (1935) in his brief survey of northern Ohio sites. All three sites are located in the Black River drainage and two of them are *fortified hilltop sites*. Even the exception, the National Tube Company Site, might at one time have had a palisade. To this list of Black River drainage sites can be added the Eiden Site, made up of a village and cemetery (McKenzie and Blank 1976; McKenzie et al. 1972). An Eiden Phase component at the Heckleman Site on the Huron River has been dated at 1495 ± 95; the Leimbach Site on the same drainage also contains an Eiden Phase occupation (Prufer and Shane 1976). The Mixter Site (Shane 1967b) also contains an Eiden Phase component. With the possible exception of Mixter, whose Late Woodland occupational component was originally classified as a campsite (Shane 1967b), all of these sites are villages. In a later publication, Mixter was referred to as a village (Shane 1974a).

In addition to these sites, Shane (1974a) recorded eight other Late Woodland sites in the vicinity of the Erie Nuclear Plant. Three of these are villages that have cemeteries associated with them; five are Late Woodland campsites, two of which have cemeteries associated with them. Shane also listed a fortified village of indeterminate cultural affiliation.

One major difference between the settlement pattern observed in the northcentral Ohio Eiden Phase and that of the Peterson Phase is the occurrence of the camp in addition to the village and cemetery. Unfortunately Shane (1974b), who identified the campsite type, has not defined its characteristics, nor have any of these campsites been excavated adequately enough to reveal their function.

As mentioned earlier, the Eiden Site, the best excavated site from the Eiden Phase, represents the only intensively excavated and published site of this phase. A number of archeological and physical anthropological reports have been presented for this phase (McKenzie, et al. 1972; McKenzie and Blank 1976; Lallo and Blank 1977; Lallo 1979a and b). More importantly, detailed paleodemographic and paleopathological analyses have been performed on the burial population of the site. McKenzie and Blank (1976:326-327) considered this site to be made up of a single occupational component, based on the homogeneity of burial patterning. They suggested that a population of from 100 to 200 people occupied the site for a period of 50 years and concluded, on the basis of faunal age of death, that the site was occupied year-round. A radiocarbon date of 1490 ± 55 was recovered from the site (McKenzie et al. 1972:40). The ceramics are primarily of the Younge tradition. Bone and lithic assemblages are similar to other Late Woodland occupations in north-central Ohio, but a diverse and exotic shell industry was noted. Many of these shell artifacts, including margenella beads, conch columella beads, and shell pendants (including a weeping eye pendant), were found in burial offerings (McKenzie et al. 1972). Surprisingly, the shell industry at this site was much more pronounced than that at the Mixter Site, the only other excavated Eiden Phase site.

Although faunal remains were recovered from Eiden, these must be interpreted with caution since their frequency is highly biased due to uncertain deposition, preservation, and techniques for recovery. Mammals, particularly deer, elk, and raccoon, accounted for 89.56 percent of the meat. Sixteen other species, including oppossum, woodchuck, beaver, muskrat, squirrel, marten, fisher, river otter, mountain lion, weasel, skunk, wolf, dog, bobcat, grey fox, and black bear were noted (McKenzie et al. 1972:36).

Fish were the next most frequent class, with seven species yielding 8.5 percent of the total vertebrate meat. Drum was most frequent at 6.11 percent, with catfish, redhorse, sturgeon, pike, walleye, and perch making up the remainder. Reptiles accounted for only 0.56 percent of usable meat and were represented by three species of turtle. Birds were represented by six species comprising 1.29 percent of the fauna, with turkey most prevalent. Loon, Canadian goose, snow/blue goose, baldpate, and passenger pigeon were each represented by a single example.

Faunal utilization at the Eiden Site is distinct from that of Libben, where more than 78 percent of the faunal meat consisted of fish; at Eiden it consisted mainly of mammals. At Libben, 63 percent of the mammal meat was deer; at Eiden the majority of meat was more evenly divided between elk and deer at 32.68 percent and 29.88 percent, respectively. Thus, there was a distinctive and differential faunal pattern at Eiden. The greater importance of elk in the Eiden faunal assemblage may be the reason for the slightly differing settlement patterns between the two areas, campsites being a recognized settlement type associated with greater emphasis on the hunting of mammals.

Although floral remains were not recovered from Eiden, it is inferred that the pattern of floral resource utilization would be similar to that of Libben, with perhaps a higher reliance on maize. Dental attrition in the Eiden population is described as extreme (McKenzie and Blank 1976:320) and might be taken as evidence of the high reliance on floral meal processed by stone grinding.

The burial population from Eiden provides an extensive data base with which to assess the health and nutritional status of the Eiden population. A total of 235 burials were uncovered and, of these, 122 were available for study (McKenzie and Blank 1976:31-7). By comparison, Lallo (1979a:49) used 146 individuals from Libben in the life table from Eiden. Since the burial sample from Eiden is not as complete nor as representative as that from Libben, the two are not directly comparable. At face value, the Eiden population appears to have had a slightly greater life expectancy at birth, 26.8 years compared to 19.9 at Libben. Lallo and Blank (1977:60) reported that 16.4 percent (20) of the sample of 122 skeletons at Eiden displayed some form of porotic hyperostosis indicative of a nutritional disorder; 51.6 percent (16) of the subadults manifested porotic hyperostosis. At Libben, 55.6 percent of the subadults manifested porotic hyperostosis. Thus, it appears that patterns of mortality and health were similar between these two adaptations. The artifactual similarities reported by archeologists between the Western Basin and northcentral Ohio can therefore be extended to include demographic and pathological similarities. However, the form of adaptation in terms of subsistence and settlement patterns is slightly different as can be expected because of the different environmental and physiographic settings.

Based on available data, the most reasonable settlement-subsistence system that can be proposed for the Eiden Phase is one of permanent, fortified village settlements of from 100 to 200 people, usually with an associated cemetery, and a maize-deer-elk food base with minor utilization of fish. Elk-deer hunting/butchering campsites of more than ephemeral occupation, indicate the greater reliance on mammal resources in this phase. The increased reliance on elk and deer resulted in satellite settlements of more than an ephemeral nature situated in the surrounding forests. These might also have been used for wild-nut gathering concurrent with the hunting activities. The kinship structure and composition of such sites is not yet discernible. On purely ecological grounds, these postulated hunting and butchering campsites would have been most frequently occupied in late fall and early winter; they would have been situated in nut-bearing grove where game might congregate.

3.2.3.4.2.2 Whittlesey Tradition. The terminal Late Woodland occupation in northeastern Ohio is referred to as Whittlesey (Brose 1967, 1978b) and has been the subject of extensive archeological research since the mid-nineteenth century (Squier and Davis 1848; Whittlesey 1871; Greenman 1937a and b; Morgan and Ellis 1943). Brose (1978b) delineated three temporally distinct phases for this period. The earliest is the Fairport Phase dating from 1150 to 1350. This is followed by the Greenwood Phase, 1350-1500, and the South Park Phase, 1500-1650. This tripartite phasing was based on archeological investigations at the South Park Site, which yielded three chronologically distinct components, each with its own characteristic material and settlement configurations. The basic chronological phasing of the Whittlesey Focus was based on ceramic seriation at four sites in northeastern Ohio (Fitting 1966). Brose (1973) refined this seriation with archeological excavations of the multicomponent Southpark Site, where spatially discrete components of differing ceramic complexes were radiocarbon dated, thus allowing independent confirmation of Fitting's original ceramic seriation. The current phasing and its chronology is based on a stratified sampling survey of northeastern Ohio (Brose 1976b) together with more intensive testing and excavation of sites recorded by the survey.

One unfortunate and unavoidable problem hindering precise knowledge of the settlement pattern and system for each of the three phases is the paucity of dated components. Many of the smaller sites have small ceramic assemblages, inadequate for precise dating via seriation. A further complication to settlement system dating is that the literature seems to assume that the ceramic variability from site to site is primarily a function of temporal, not functional differences. At present, the ceramic seriation from South Park is assumed to be applicable to all of northeastern Ohio. We do not wish to suggest that this is an inappropriate operating assumption. However, because of the problems inherent in using seriation for adequate phasing, future work must focus on securing radiocarbon samples.

A number of interesting models dealing with the Whittlesey tradition can be found in the literature. Some aspects of the models discussed will be different from those that are most current. The existing models are not necessarily incorrect, but the level of generality required by this study demands a broader perspective than is sometimes provided.

The Fairport Phase (1150-1350) is the earliest of the Whittlesey tradition phases (Brose 1977, 1978a and b); it was initially defined on the basis of archeological research at South Park. Brose (1973) isolated an early component dating from between 1000 and 1250. Its ceramics were a mixture of types dating to similar time periods in southeastern Michigan, northeastern Ohio, southern Ontario, and southwestern Pennsylvania. Fairport plain was the most frequent type; Vase tool-impressed, Peters cord-marked, Reeve horizontal, Mixter dentate, and Wayne punctate types were also present. Most of the lithic assemblage consisted of Levanna materials. Bone fishhooks and bone beads were found as well.

This occupational component is characterized by a discontinuous midden with associated oval structures 30 ft by 17 ft on the average. These structures have no consistent orientation or domestic features that would be indicative of long-term occupation. Tightly clustered areas of domestic occupation are, however, present (Brose 1973:28). Floral and faunal remains indicate late spring to early autumn economic activity indicative of a diffuse hunting and gathering economy supplemented with some maize agriculture.

Brose suggested a community composed of from 10 to 15 nuclear families. There is some evidence, as revealed in attribute clustering of ceramics and lithics, that family units were related through the male line. No mention was made of fortifications; these are therefore assumed to be absent.

The Walnut Tree Site represents another archeologically investigated Fairport Phase occupation (Pratt 1979c:24). This site, unlike South Park, seems to represent a winter hunting camp. No bone was preserved at the site, but charred maize kernels were recovered suggesting possible storage for winter use. Cultural features and postmold patterns suggesting at least two circular oval dwelling areas were uncovered. Pratt (1979c:29) suggested a residential unit consisting of a small number of family units occupying the site on a seasonal basis over a long period of time. Ceramics were only minimally present at the site.

The Lillback Site represents another Fairport Phase component. No features or structures were recorded in the excavations, nor were faunal remains preserved. Lange (1979:25) interpreted the site as representing a winter campsite that was back from the lakeshore and occupied by transient hunters. He also believes that this site might be related systematically to the nearby Fairport Site.

Brose (1976c:39), after reanalyzing Morgan's and Ellis's report (1943) of the excavation at Fairport Harbor, identified a Fairport Phase occupation there. He classified this early component as a spring fishing village with some indication of fall hunting. He suggested that the occupation was extensive rather than intensive. Murphy (1971a) also excavated at the site and noted completely mixed stratigraphy as evidenced by European ceramics and nails distributed uniformly throughout the excavation. This, coupled with lack of radiocarbon dating, makes it difficult to date the site precisely except by seriation with other sites. Murphy (1971a:42) suggested a date of about 1300. On the basis of subsequent excavations at South Park (1973) and its radiocarbon-dated ceramic sequence, Brose suggested an early date for this site as well. It appears that this site was not primarily a fishing village, although fishing would have been a major activity. Instead, the site might best be classified as a summer village with an intensive occupation.

A similar situation exists for the Conneaut Fort Site, which has been designated as a winter camp (Brose 1978c:100). The artifactual and faunal assemblages indicate a more permanent occupation. This is clearly evidenced by the reported leopard frog and bullfrog remains (Brose et al. 1976), clearly not winter items since these frogs hibernate. The large number of features, particularly storage pits; the broad range of artifact types, including ground stone vegetable processing tools; the earthen fortification; and the 1.9-acre size would support the belief that this was a more permanent site. A radiocarbon date of 1330 ± 120 (Brose et al. 1974b:42) indicates that the site is intermediate between the Fairport Phase and the subsequent Greenwood Phase. Although the high preponderance of Fairport ceramics would argue for a Fairport Phase designation, the fortification argues for a Greenwood Phase occupation.

The sites discussed are largely responsible for our understanding of the Fairport Phase. These along with other occupational components have resulted in the construction of a settlement-subsistence pattern for the period. Brose (1978b) presented a settlement system composed of three settlement types. The first is a spring through late summer horticultural village situated along the lake plain and on floodplains of secondary drainages. These sites were unfortified, and have oval structures. Agriculture, although practiced, was of only slight importance. A second settlement type consists of spring and fall fishing and fowling stations. Depending on local conditions, these may be small villages, large campsites, or small fishing-fowling stations. A third type is the winter hunting camp composed of nuclear or extended families in the interior or on ridges adjoining the lake plain.

The Fairport Phase settlement pattern is identical to that proposed for the Riverview Phase. The major distinction, as suggested by Brose, is the gradual increase in the importance of agriculture. Because of the similarity between these two phases in terms of settlement patterns, from an adaptive standpoint, this phase will be treated as indistinguishable from earlier adaptations. This may turn out to be either incorrect or undesirable, but, based on the information at hand and for the purpose of this study, this usage will be followed.

At the end of the Fairport Phase, i.e., 1300-1350, there was a striking change in the settlement, subsistence, and ecological setting of the Whittlesey occupation of northeastern Ohio. These cultural changes might best be understood in their environmental context. In about 1300-1350, there was a change in climatological conditions from a cooler and drier climate (1000-1300) to a warmer and moister environment. Evidence for this shift is based primarily on pollen profiles (Brose 1977). Both of these climatological characteristics are conducive to the increased production of maize. This shift in climatic factors and the ever improving genetic strains of maize (Stothers and Yarnell) resulted in a greater reliance on maize as risks diminished and yields increased. This greater reliance on maize in the subsistence base of the Greenwood Phase occupation of northeastern Ohio had important consequences for its social organization and settlement patterns.

The greater reliance on maize production resulted in a larger potential carrying capacity and, hence, in a larger population (Pratt 1979c). As a result, there was a shift from a relative diffused economy to a more focal one. Areas with large expanses of high quality agricultural soils became very important in the choice of settlement location and it is likely that control of this critical and limited resource necessitated permanent year-round occupation. That competition between neighboring polities existed can be clearly seen in defensive features such as palisades and earthworks that characterize the village sites of this phase.

In the preceding Fairport Phase, not all of the prime agricultural land was occupied because maize production was only one component of the subsistence system. During the Greenwood Phase, however, maize became a dominant resource. Brose (1970:20-21) noted that, in addition to the increased emphasis on maize production, beans are found in northeastern Ohio for the first time.

Once again, South Park contains the most thoroughly investigated and reported Greenwood Phase component for the area. This component is characterized by small, discontinuous midden areas with postmold patterns indicating subrectangular structures of from 30 to 35 ft wide by 15 to 17 ft long, oriented east to west (Brose 1973:31). At least nine of these structures were uncovered (Brose 1977:20). There is some evidence for wall trenches and wattle-and-daub construction. Multiple interior hearths were recorded, as were scattered interior and exterior bell-shaped pits. The structures are closely clustered, but there is no evidence of fortification (Brose 1973:31).

Eleven ceramic types were associated with the component, and Brose suggested strong southern influences (1973:32). Fairport filleted is the most common ceramic type, representing 20 percent of the minimum number of vessels, with other types also present. Lithic projectile point frequencies are 60 percent Madison-like, 23 percent Levanna-like, and 17 percent Jacks Reef corner-notched (Brose 1973:32). Bone tools are similar to those of the Fairport Phase. One engraved slate celt with a southern cult motif was also recovered.

The floral and faunal analysis of this occupational component indicated (Brose 1973:31-32) that there was a spring through late summer use with an economy based on maize-beans-squash agriculture supplemented by the hunting of white-tailed deer. A community size of 10 domestic units is suggested, some of which consisted of extended families. Residence and descent patterns are not clearly discernible from attribute clusters or from the spatial distribution patterning of lithics or ceramics.

The Siebert Site, situated on a bluff overlooking the east bank of the Cuyahoga River some 25 miles upriver from Lake Erie, is another Greenwood Phase agricultural village (Pratt and Brose 1976). The ceramics from the site include Tuttle Hill notched, Reeve horizontal, and Fairport Harbor plain. Very few faunal remains were recovered from this site, a situation not accounted for by poor preservation since bone tools were numerous. One deer quarter, butchered at another site, was recovered. The limited excavation of this site (eighteen 5 x 5 ft tests) revealed only five features and no structures or palisades. Site size is not specifically stated, but most cultural material was concentrated in an area 175 ft by 275 ft with test pits outside this area showing only limited amounts of cultural material (Pratt and Brose 1976:7).

The Conneaut Fort Site Brose et al. 1976) represents another classic example of an early Greenwood Phase fortified village. This site has been radiocarbon dated to 1330 ± 120 (Brose et al. 1976:42) and 1340 ± 60 (Brose 1977:108). This site, originally visited by Squier and Davis (1848) and later by Williams (1878), is a hilltop site with earthen enclosures some 1.9 acres in extent (Brose et al. 1976:34). Based on the distribution of ceramics, it is considered to be a single-component site (Brose et al. 1976). The ceramics are more homogeneous than those of other Greenwood Phase components. The high proportion of Fairport filleted and the clear Greenwood Phase dating of the assemblage suggest that Fairport plain ceramics might not be a Fairport Phase temporal marker for all areas within northeastern Ohio. It appears that the frequency of Fairport plain ceramics is correlated more with an easterly location. There is a clear linear increase in the frequency of Fairport plain ceramics from west to east, apparently at the expense of other ceramic styles such as *Tuttle Hill notched*. Clearly, one of the research emphases for future work in this area will be the developing of localized (i.e., watershed or other spatially discrete unit) ceramic sequences by tight radiocarbon dates so that more precise seriation can be developed for local areas for the dating of surface material. For phasing purposes, radiocarbon dating, in conjunction with settlement configuration, will take precedence over ceramic seriation in this report.

Although numerous postmolds were recovered, no distinct patterns were seen; this was perhaps due to the limited amount of excavated area (just over 2 percent). However, curvilinear postmold patterns are suggested. Brose et al. (1976) considered this site to be a winter-occupation one on the basis of the occurrence of a single nine-month-old deer. Seasonal occupation is also suggested by butternut, hickory, and walnut fragments as well as by corncob fragments found in pits indicative of winter storage. A population of from 35 to 60 individuals in five to eight social units composed of extended families is suggested. Three burials--an adult male, an adult female, and a 12- to 13-year-old--were also recovered from the site. The female and the subadult displayed osteoporosis.

Mammals, particularly deer and elk, were the most important class of fauna in the diet; they accounted for 97.2 percent of the faunal meat. A few reptiles were represented by the remains of snapping turtle, leopard frog, and bullfrog; birds were represented by turkey, snow goose, scaup, merganser, upland plover, and dove. Fish remains include whitefish, sturgeon, northern pike, channel catfish, and sucker. The faunal assemblage indicates a very focused exploitation of mammals, particularly deer and elk. This seems consistent with an emphasis on maize production although Brose et al. (1976:72) characterized the occupation as having a diffuse economy.

The Conneaut Fort Site is interpreted somewhat differently in this report than in the literature. The population estimates for a site of some 2 acres seem too low; a population of from 100 to 200 seems a more reasonable estimate. The site appears to have been occupied year-round rather than solely in the winter. The single nine-month-old deer does indeed represent a winter occupation, but the leopard frog and bullfrog, both hibernating species, clearly indicate a warmweather occupation, as do the scaup, snow goose, and merganser. It is clear that the butternuts, walnuts, and hickories are indicative of fall and winter occupation, but the corn cob seems to be suggestive of greater permanence and year-round utilization. This is based on the assumption that corn would be removed from the cob at the summer village for ease in transportation and handling before being transferred and stored at winter camps. Also, the defensive posture of the site, as suggested by the earthwork, suggests more permanence than is suggested in the site report. On this basis, the function of this site is interpreted as being a permanent, year-round, fortified agricultural village.

The Eastwall Site, located at the mouth of Conneaut Creek, is interpreted as being another permanent agricultural village site. Brose (1977:20-21) interpreted this site as a fall-spring village. However, its very large size (5 acres) and numerous postmolds along with extensive midden deposits indicate another permanent village. Although only the result of limited testing has been published to date, the basic subsistence economy of the site is known. Fish were the most abundant faunal remains, with late summer and fall-spawning fish such as sturgeon and drum being the most frequent (Brose 1977:126). Maize and beans, charred seeds, nutshell fragments, and fish scales have been recovered in flotation samples. Brose (1977:108) stated that this site was contemporaneous with Eastwall; there is no reason to suggest otherwise.

The Ahlstrom Site, dated at 1450 ± 55, is also interpreted as a summer agricultural village (Brose 1978b). Further into the interior, the Greenwood Village Site has been classified as a small agricultural village of this time period. Tuttle Hill may also contain another small agricultural village.

Temporary seasonal campsites are also clearly a part of the Greenwood Phase settlement system, the Hillside Roads Site represents the most comprehensively excavated campsite of this phase. This site is dated to around 1400 based on a seriation of its ceramics (Brose 1976b:28-31). The site is thought to have been seasonally reoccupied by two or three families during the late winter to early spring, with an economic focus on the hunting of deer and elk. Analyses of lithic and faunal remains from the site indicate that fish, turkey, beaver, and raccoon were also taken. No floral remains were recovered. At least two separate occupations were recorded at the site on the basis of the occurrence of overlapping structures. The structures suggest an occupation of from 40 to 50 years, although postmold patterns did not indiate the shapes and patterns of the structures (Brose 1976b). Other campsite components assignable to this phase include Bennett (Brose 1977); Andrews School, a component that also contains circular postmold patterns (Brose 1977; Pratt and Brose 1975); Carey Hill (Brose 1976b); and Rogers #1 and #2 (Brose 1977).

Brose (1977:20-22) constructed a settlement model for the Middle Whittlesey Period Greenwood Phase. This model consists of three primary types of sites: 1) small spring-fall horticultural villages, 2) small seasonal economic campsites, and 3) winter-spring campsites that can be subdivided into upland deer and elk hunting camps and lakeshore and alluvial fishing camps. Brose placed many of the sites discussed into various of these categories providing an excellent hypothetical and theoretical base upon which to further test, refine, and elaborate the settlement system. Although we do not reject the settlement model proposed by Brose as unsound or inaccurate, we do think that it is too precise and critically demanding for use with the data at our disposal. Therefore, we modified this settlement pattern to be more compatible with our purposes and data. We have chosen in its place a settlement model consisting of permanent agricultural villages occupied year round, usually in fortified positions and adjacent to large areas of high quality soil. Associated with these are campsites with smaller populations, which were used sporadically and seasonally. These sites are associated with both specialized and general resource procurement, with lacustrine and riverine emphasis on fish, and with interior emphasis on deer and elk hunting supplemented by nut gathering. Villages were not seasonally abandoned, but, instead, small groups left intermittently to camp at areas outside the village to procure resources, returning to the village when they were finished. Evidence for this is obviously limited, but the unusually dense middens; the intensive use of defensive sites, and the lack of evidence for seasonal abandonment of sites and sequential discrete occupations, support this position. It is obvious that campsites associated with lacustrine/riverine environments were foci of resource procurement of related biota, as were the interior upland campsites, but determining seasonality in the absence of excavated data and faunal and lithic analyses is not possible. The use of surface collected data is, therefore, limited. The most probable season of use can, however, be hypothesized from location alone. A conjectured fall-spring deer-elk hunting focus in the interior, and a spring-fall fishing focus seems justified. This is somewhat similar to the seasonality of the Fairport Phase settlement model, the major difference being the addition of the permanent year-round agricultural village as the focus of the population's residence. With an increased emphasis on maize and stored food, there was probably less emphasis on utilization of extractive sites for extended periods of hunting and fishing. There may possibly have been a shift to "male only" activities away from the village, although supplemental nut gathering would probably have been a male or female task. This interpretation is also favored by the defensive position of village, suggesting restricted population movements.

The final period of Whittlesey occupation in northeastern Ohio is known as the South Park Phase of which the Southpark Site is the best known component (Brose 1976a). This period, which lasted from around 1500 to 1650, constituted the last era of aboriginal occupation in northeastern Ohio.

Climatologically, there was no apparent difference between this time period and the preceding one. But the lake level continued to rise gradually. This has the same implications for settlement-pattern visibility as discussed before; erosion of the lakeshore and drowning of floodplain soils, which may account for Brose's (1973:39,44; 1977) observation that no major villages existed on the coastal plain during this period. This period's settlement pattern is the best preserved since the deteriorating and modifying effects of lake-level rise were less severe during this time than in previous eras. Brose (1978b:93) noted that there is some evidence for internal demographic stress during this period, especially toward its end.

The ceramics characterizing the South Park occupation consist of the following frequencies: Tuttle Hill notched, 41 percent; Fairport filleted, 13 percent; Reeve opposed, 13 percent; and plain cord-marked, 2 percent. Other types such as Parker festooned, Anderson incised, Seed incised, Madisonville grooved paddle, and Lawson incised were also present (Brose 1973:34; 1976:38).

The final occupation at South Park, dated from 1549 to 1640, is characterized by a settlement consisting of a number of "longhouses", 20 ft by 60 ft in dimension with the long axis oriented in a north-south direction (Brose 1973:32-35). The settlement is fortified, and the longhouses have central interior hearths. Analyses of attribute clusters and the spatial distribution of ceramics and lithics clearly indicate, for the first time in the archeological sequence, uxorilocal residence with strong suggestions of matrilineality (Brose 1973:32). Brose interpreted the site as a community composed of 10 to 12 extended matrilocal residence units, each of which was composed of three or four nuclear families, with a total site population of from 150 to 250. Only one other South Park Phase component, the Tuttle Hill Site, has been investigated (Greenman 1935b; Fitting 1966) and it appears to have been similar in configuration to the Southpark component.

These agricultural village sites, which are located at uniform intervals upon isolated promontories of steeply dissected bluffs along major river valleys, were highly fortified (Brose 1977:33). Other agricultural villages reported for the area include Boice Fort (Brose 1978b:580) and Anthony Ridge (Brose 1977:24). In addition to these permanent, year-round agricultural villages, Brose (1976a) identified two other site types: 1) small, special-purpose campsites located either in close proximity to the agricultural village or in an aquatic context and 2) elk-deer hunting/butchering stations. The campsites, which may have had wigwam structures and fortifications, are characterized by low artifact density. The stations are small sites, often fortified, located in the interfluvial plateau several miles inland. Two components of the former type have been identified in the literature: Fairport Harbor and Lyman (Brose 1976c:40), as well as two of the latter, Greenwood (Brose 1976c:40) and Ambler Metro Park #2 (Brose 1978c:110).

With one very important difference, the South Park Phase model is similar to the model proposed for the Greenwood Phase. This is the very dense, nucleated occupation of the permanent villages primarily as a function of the development of longhouses. Also, as mentioned earlier, there was a decrease in the number of these large villages in the South Park Phase compared to the earlier Greenwood Phase. This decrease was probably a function of village fusion or aggregation, a product of internal cultural features. These might have included warfare, changing social organization (i.e., matrilineality), and the requirements of the mating system, which would favor close association of exogamous clans or lineages in the same village.

It is clear that warfare was in some way involved with the aggregation process, since many of the villages are situated on high promontories, and had access to high quality agricultural soils. Where there does seem to have been a population decline from the previous period, this may have been more a function of the agglomerative process than an actual population decrease. However, the absence of any European trade goods at northeastern Ohio Whittlesey sites clearly suggests, as Brose indicated (1978c:93), an actual population decline by 1650. The appearance of longhouses and tightly packed, fortified villages with matrilocal and probably matrilineal exogamous clans would seem to suggest stress on resources from both external (warfare and competition) and internal sources (population pressure). These pressures eventually led to the collapse of a viable adaptation in this area and to population dispersal to other areas. The situation might have been aggravated by deteriorating environmental conditions as the environment changed from a warmer-moister regime to a cooler one, applying critical stress to an already delicately balanced adaptation. One of the objectives of future research in this area should be the investigation of this phenomenon.

The level of sociopolitical organization during this period is poorly known since mortuary information is almost totally lacking for this adaptation. The ethnohistoric baseline can, however, be used as a guide to understanding the level of sociopolitical integration. Contemporary Iroquois societies located to the east were not ranked, even in their highest level of political centralization stimulated by European contact (Tuck 1971). It is assumed that ranking was also absent in this adaptation; this assumption is based on the wide geographic dispersion of contemporary sites and the lack of archeological evidence for intervillage coordination, e.g., ossuaries like those found at sites of Huron and Iroquoian confederacies.

The endemic nature of warfare in the adaptation would clearly seem to have favored some sort of organized centralization of a non-ranked type. A successful warrior, one who could organize effective raids and successfully defend a settlement through direction of cooperative activities, would have achieved a higher status and some degree of central authority. Such a position might well have been a temporary one, hence formal ranking would have been absent.

3.2.3.4.2.3 New York and Pennsylvania. The Late Woodland horizon appears to be arbitrarily set at ca. A.D. 1000 in New York and Pennsylvania (Mayer-Oakes 1955b; Ritchie 1969) and is differentiated from Middle Woodland on the basis of artifactual traits rather than implied economic or sociopolitical criteria. Pottery became diversified through an elaboration of decorative techniques. Projectile points, on the other hand, remained largely undifferentiated within the general Madison type--a small triangular arrowhead (point).

Settlement-subsistence trends begun in terminal Middle Woodland times continued. The great number of sites as well as an increase in their size denotes a virtual explosion of population over earlier periods (Funk and Rippeteau 1976). By 1100, corn agriculture appears to have been well established (Ritchie 1969). Although corn may have been used as early as terminal Early Woodland in the southern areas of southwestern Pennsylvania (Adovasio et al. 1977), its florescence into the northern upland areas of the plateau seems to be correlated with the appearance of the hardier northern flint variety, which requires a minimum of only 120 days to mature (Yarnell 1964). Changes in settlement are seen in some areas in a trend toward larger, more nucleated and more permanently settled villages located near prime agricultural lands. A trend toward more frequent and more substantial village palisading, along with a tendency to position sites on highly defensible locations, often well removed from major navigable waterways, is a clear indication of the increasingly tense atmosphere associated with internecine warfare. House forms continued to elongate, reaching lengths of more than 350 ft in New York by the prehistoric Iroquois Chance Phase (Ritchie and Funk 1973:362). Longhouses probably reflected an increase in matrilocality and matrilineality arising from shifts in economic scheduling associated with a settled agricultural life involving increasingly longer periods of male absence for hunting, trading, and raiding and the increased importance of female based corporately organized village economics (Tuck 1971; Trigger 1978; Hayden 1977). Local style homogeneity of Iroquois village ceramics would appear to support this interpretation (Whallon 1968).

Although this developmental sequence is most clearly documented in the Owasco-Iroquois continuum in central and eastern New York (Ritchie 1969; Ritchie and Funk 1973; Funk 1978), sufficient data now exists from western New York and Pennsylvania to allow a review of such developments as they occurred in the southern Lake Erie Basin. Much of the work carried out in this region focused on the identification and tracing of settlement histories thought to represent populations ancestral to the historic Erie (White 1963; 1978a). The lack of historically documented village locations of the Erie tribe has made the "direct historical approach" (Steward 1942) that is so useful in tracing precontact village locations of the five New York Iroquois tribes (Funk 1978; Ritchie and Funk 1973) of little use in the southern Lake Basin. From early maps by Sanson, the general location of the Erie, ca. 1650, along the southern Lake Erie Basin is fairly certain. On the basis of this assumption, White (1978a) presented evidence from a number of contact period sites containing trade materials believed to represent at least four movement sequences of proto-Erie villages. Two are in the Niagara Frontier, one is along Cattaraugus Creek Valley, and one or more are in southwestern New York and northwestern Pennsylvania, at Ripley and Erie.

Village removal or "village movement" has been used widely as an organizing principle in New York Late Woodland research. It has been assumed that, analagous to the historic Huron, prehistoric groups maintained permanent villages, moving them at frequent intervals (every two decades) as local conditions suitable for agriculture deteriorated with use. White (1963), however, questioned the validity of this semi-permanent pattern prior to A.D. 1500 and suggested a semi-sedentary, seasonal movement model for earlier Late Woodland villages in the Niagara Frontier. Within the Lake Plain and the adjacent Allegheny foothills of Erie and Niagara counties, New York, a sequence of sites near Oakfield-Ganshaw, Woeller, Oakfield Fort, and NOK are thought to represent a succession of summer farming villages. All are embanked, suggesting substantial palisading. All are from 3 to 5 acres in area and, in the case of Oakfield Fort, contain three longhouses (some 85 x 23 ft). Bone from the Oakfield Site appears to reflect a spring or summer pattern in which small mammals, bird, and fish were heavily exploited and deer were of less importance (White 1963). Such warm weather farming settlements are thought to have been abandoned during the winter when family groups moved to hunting camps--a pattern apparently characteristic of the Delaware (Newcombe 1956:22). These winter hunting camps have not, however, been identified with certainty in the Frontier area. A second series of sites, dating to sometime before 1550, appear to represent a consolidation of some six villages north of Ellicott Creek, and their subsequent removal southward into and beyond Buffalo Creek. The sequence was recognized as early as the 1850s by Squier (1851) although only a few sites have since been relocated with precision. The sites are smaller, 1 to 2 acres, and probably held, as at the Henry Long Site, a single longhouse some 50 ft in length. All were palisaded and embanked. White

(1963) thought that this series represented the commencement of permanent year-round occupations characteristic of historic Iroquois. Ossuary burial sites also appear; these were located away from or perhaps between villages (White 1978a). From about 1540, the sequence of removal and consolidation continued, ending with two villages, the proto-historic Erie sites of Bead Hill, near Hamburg, and Klises, near East Aurora, by ca. 1640. All the sites in this sequence were located near large streams or rivers and were normally situated at some natural break in the terrain, such as on a sheer cliff at Simon or on a low creek bank at Klises, suggesting defensive considerations in their placement. White (1978), believed that the parallel village movements from 1540 to 1640 represented an alliance of villages constituting the easternmost tribe of the Erie.

In the lower plain of New York and Pennsylvania, the early Late Woodland period, ca. A.D. 1000 to 1300, referred to as the Allegheny Phase (Schock 1974), is not well represented. Several small sites, such as Peacock at the mouth of Chautauqua Creek, Griswold at the mouth of Conneaut Creek (Ohio), and East Wall at the mouth of Walnut Creek, may represent fishing stations used seasonally by semi-sedentary horticulturalists (Johnson, Richardson, and Bohnert 1979). However, no farming villages have yet been identified on the lakeshore, suggesting that such villages were located inland. A possible candidate is the Westfield Site, located on Chautauqua Creek some 1.5 mi. from the lake on glacial lake beachstrand deposits (Guthe 1958; Johnson, Richardson, and Bohnert 1979:79).

Allegheny Phase sites are more numerous in the Allegheny Valley of the plateau. Recent work on the Allegheny Reservoir project by Carnegie Museum and the State University of New York has identified a large number of small, compact palisaded villages situated on the floodplain on good agricultural soils and, presumably, near choice fishing locations (Dragoo 1977). The small composite samples of food remains available from these sites suggest a broad-spectrum exploitation centered around corn farming and fishing. The extensively examined Kinzua Site, dating ca. A.D. 1200, contained three oblong houses (50 x 20 ft), a central stucture (30-ft diameter), as well as several smaller round houses (15-ft diameter). A distinctive semi-subterranean storage structure known as a "turtle pit" occurs as a diagnostic feature on many of these early sites (Dragoo 1977). Other diagnostics include Levanna points and Owascoid or proto-Iroquoian ceramics (Glenn Meyer, Middleport, and Chautauqua wares). Grit tempering predominates; some collared vessels occur; and decorations include cord impression, some castellations, and incising (Dragoo 1977; Schock 1974).

Around 1300, in the plain and adjacent plateau, villages were larger and more substantially palisaded; most are recognized as "earth circles" often occurring in extremely defensible positions. Early travelers and researchers noted dozens of such earthrings throughout southwestern New York and northwestern Pennsylvania. Many of these sites have never been located again, and only a few have been systematically examined.

Narrow-collared, incised, shell-tempered pottery and small triangular Madison arrow points were in widespread use by this time. Schock's (1974; 1976) recent work on sites of this period (the Chautauqua Phase, ca. 1300 to 1525) focused on four possible village relocation sequences in southwestern New York: one along Cattaraugus Creek from Gowanda to Lake Erie, a second on

Clear Creek near Ellington, a third on Cassadaga Creek near Gerry and Sinclairville, and a fourth in central Chautauqua County at the headwaters of the Allegheny River. The Cattaraugus Creek group in the lake plain is of particular interest. A large number of village sites were recorded along the banks of this large stream by early investigators (Parker 1922a; Harrington 1922a) as "earth rings". Since the area is within the Cattaraugus Indian Reservation, archeological investigations have not been possible since the early part of the century and only four villages have been located. These include Silverheels (prehistoric component) (Harrington 1922b), Double Wall Fort, High Banks, and Burning Springs (Parker 1922b:162-170). A fifth village related to this sequence may be the Sheridan Earthworks (Squier 1851:81-82) located above Beaver Creek in the lake plain to the south (Schock 1976). While Cattaraugus sites are situated on the floodplain or terrace, most other villages of the phase within New York command high defensible positions, usually overlooking large stream valleys. For instance, the Lawrence, Rhinehart, Ellington, Ward Benedict, and J. Falcone sites are all situated from 90 to 150 ft above the Clear and Cassadaga creek floodplains (Schock 1976). As Schock (1974) and others pointed out, no villages of this period have been positively identified on the Lake Erie shore, and the distribution of known loci across the plain is inland from about 2 to 4 km, on and above the Whittlesey beachstrand gravel deposits. In view of the implied importance of defensible village structures and locations, an avoidance of the easily accessible and presumably easily attacked shoreline would seem logical strategically. The pattern may be more apparent than actual, however. Earthring fortifications were widely recorded by early observers (Cheney 1860; Edson 1875; Larkin 1880; Thomas 1894; Turner 1850). Parker noted that "all along the shore of Lake Erie from the state [Pennsylvania] line to Cattaraugus Creek are scattered remains of camps and villages " (Parker cited in Doty 1925:263). Few of these have been relocated. A similar observation by the Reverend Samuel Kirkland, a nineteenth century traveler reads:

> On the south side of Lake Erie, are a series of old fortifications, from Cattaraugus Creek to the Pennsylvania line, a distance of fifty miles. Some are two to four miles apart, others half a mile only. The walls or breastworks are of earth, and are generally on grounds where there are appearances of creeks having flowed into the lake, or where there was a bay (Turner 1850:38).

The apparent contradiction between historic and recent survey records of site locations may be the product of lakeshore erosion and the resulting submergence or destruction of sites once occupying stream deltas in the plain. There is good evidence for considerable encroachment by the lake over the past century. Parker (1907:478) remarked on the effects of lake encroachment on the historic Ripley Site. Recession-rate estimates based upon the analysis of historic photographs as early as 1875 (Carter 1977), showed that the lakeshore has been eroding away at a rate of from 1 to 3 ft per year along most of the Pennsylvania and New York shoreline.

In northwestern Pennsylvania, pre-1525 village sites are numerous in the upper Allegheny and French creek valleys, while only scattered finds of diagnostic items appear in the plain. A settlement pattern of large horticultural villages along the French Creek and upper Allegheny River floodplains has been identified. These villages include Onoville, McFate, and Wilson Shutes, and possibly associated hilltop villages with earthrings, often near marshes (Johnson, Richardson, and Bohnert 1979). Although few of the highland earthrings have been investigated, the floodplain villages like Onoville Bridge appear to be large, ca. 200 ft in diameter, stockaded, and containing several longhouses up to 100 ft long, as well as smaller circular dwellings. The distinctive "turtle pits" found at earlier Allegheny Phase villages do not occur (Dragoo 1977).

The Late Woodland Period in Venango County, northwestern Pennsylvania, is fairly well understood. Thirty-five rock shelters, 9 open-air terrace sites, and 3 hilltop sites have been recorded (Curtis 1969). During the first half of this period, a semi-nomadic settlement-subsistence system was evident where local band-like societies appeared to be culturally marginal to northern and southern traditions (Curtis 1971). Cultural marginality was manifested in: 1) material remains such as ceramics which have diagnostic traits of the northern and southern traditions in the same artifact; 2) less complex socio-cultural patterns, and 3) lack of evidence indicating an increased dependence on maize horticulture.

During the latter half of this period, populations congregated in at least one large fortified site and may have continued to use a few rock shelters (Curtis 1980). The fortified site is located along the Allegheny River and is enclosed by a ditch some 10 to 15 ft across and 6 to 8 ft deep in some areas. The ditch circles an area of about 1350 x 300 ft and is broken by a 40-ft earthen causeway (Curtis 1971). The embankment surrounding the ditch is riprapped with cobbles in some areas and contains evidence of a brush wall. One longhouse (22 x 40 ft) with semicircular storage rooms was excavated, and tests revealed that several more longhouses are present within the enclosure. A radiocarbon date from the embankment places the sites in the mid-seventeenth century (Curtis 1980).

On the basis of comparable radiocarbon dates, this site may have been part of a polity that was exploiting a major petroleum resource in Crawford County. Today, hundreds of oil collection pits remain, many of which contain preserved log-collection corrals, and historic accounts report that thousands of such pits were present in the nineteenth century (Curtis 1980). Based on the effort expended in the exploitation of petroleum, it may have been a resource that had more than casual importance during this period. Interest in petroleum may also have extended to other communities in the Lake Erie Basin (Curtis 1980).

By about 1550, most of the plateau appears to have been abandoned. The latest sites, such as Wintergreen Gorge, Graham, and Old Nut, are situated on the western periphery of the plateau, along the Portage Escarpment. McFate-incised, shell-tempered, simple-stamped ceramic wares occur on these sites as well as in the plain (Johnson, Richardson, and Bohnert 1979). The implied movement toward the Erie Lowlands seems to correlate well with Baerreis's and Bryson's (1965) neo-Boreal climatic period and the onset of cooler moister conditions. It is possible that many locations previously marginal for farming became prohibitively so during the neo-Boreal, forcing communities to move to the lower, milder conditions along the lakeshore. This is not contradicted by the limited occurrence of early historic sites in the region, of which three occur in the lake plain (East 28th Street, Ripley, Highbanks-Silverheels) and one in French Creek (Grave/O'Conner). Whether these sites represent a coalescence of former plateau groups is unclear, as is the relationship of these sites to one another (Johnson, Richardson, and Bohnert 1979). Highbanks-

Silverheels is probably the latest village in the Cattaraugus-Erie relocation sequence (White 1978a; Schock 1976); it appears to be contemporary with the contact period Klies Site in the Niagara Frontier. The proto-historic Erie site of East 28th Steet (Cadzow 1935a; Carpenter, Pfirman, and Schoff 1949) and Ripley (Parker 1907) may represent a single community sequence. On the basis of an examination of glass trade beads, Johnson (1979:79) would place Ripley a decade earlier (1625) than East 28th Street (1635). The Crowe/O'Conner Site contained an Erie/Seneca pipe dating ca. 1610 to 1645 (Johnson, Richardson, and Bohnert 1979:96).

3.3 SETTLEMENT MODES
(Randolph J. Widmer and Gary S. Webster)

Because the data on prehistoric cultural resources of the study area are so extensive and complex, they must be used in such a way as to make the prediction and interpretation of unknown sites feasible. Therefore, one aspect of the prehistoric societies described in Section 3.2 will be selected for further study--the settlement system. By identifying the types and distributions of sites at one point in time for one specific area, something can be said about the types and locations of sites that may be found in nearby and similar areas.

3.3.1 Constructing Descriptive Modes

A settlement system approach need not be deductively based, but may be generated by a purely inductive strategy. In this report, a combination of both inductive and deductive approaches will be utilized. The most viable means of generating general statements about the settlement system or series of settlement systems of an area is through the construction of a model. In a settlement system model, the archeological (cultural) remains are seen as loci of behavior utilized by human populations interacting with a series of environmental and ecological variables in order to survive. Studying the relationships and interactions between humans and their environment is the method of cultural ecology. Interactions that occur, i.e., adaptations, are made possible through a series of technological, social, political, and ideological components. Each of these components can be seen archeologically, to varying degrees and in varying proportions, in the patterning of material remains on the landscape. Thus, the patterning of material culture in an ecological setting helps the archeologist reconstruct the nature of the adaptation and allows him or her to develop a series of generalizations applicable for predicting both the location and type of prehistoric occupations in an area.

We think that cultural ecology is the most powerful theoretical and methodological paradigm for the interpretation and prediction of archeological resources. By knowing the ecological characteristics of a region, one can understand the kinds of resources used by people as well as their distribution on the landscape, their seasonal availability, their relative proportions, and their interrelationship in a dynamic ecosystem. This information can lead to the construction of models that characterize the most probable ways in which human groups interacted with such an environment. Such models often assume that human populations efficiently or "economically" utilized the resources available to them. Any probablistic statement concerning the location of archeological resources in fact assumes that certain areas were favored over others; that some sort of choice or preferential utilization was in operation.

If choices were not efficient or economical, the cultural groups making these choices would not continue as they were on a long-term basis and from an evolutionary perspective. Hence, adaptation implies prediction.

Once a given technology and subsistence base is determined for an archeological culture, a dynamic model for the utilization of the environment can be postulated on the basis of the spatial location of the resources most important to that adaptation. The evaluation of archeological material in an adaptive ecological settting provides a powerful means for interpreting the probabilities for location and site type, even if little is known about the contents of the site itself.

It is recognized that a cultural-ecological approach cannot account for all of the variability in the archeological remains in the survey area. Even if our ecological and archeological data base were superior, it is certain that some residuals of occupation would not be accounted for by such an approach to settlement modeling. This does not, however, mean that sites that are not clearly part of a settlement system cannot or should not be explained. Instead, it simply means that some phenomena cannot be explained through a cultural-ecological paradigm, and we acknowledge the importance of developing other theoretical and epistemological approaches for explaining such data.

A series of settlement modes will be presented (see Figure 3.0). We believe that these characterize the prehistoric adaptations identified in the survey area throughout the time that the area was believed to have been occupied. These descriptive modes were generated from the literature reviewed in the Section 3.2; they will be evaluated later against the site-file data available for discrete regions in the study area. Because a cultural-ecological paradigm, rather than a cultural-historical paradigm, was chosen for the explanation and prediction of archeological phenomena, the settlement modes presented in this report are of adaptive significance and embrace several distinct cultural units. This is due to the fact that, while spatial or temporal distinctions between archeological entities might often be recognized on the basis of differences in the style of their material remains, there may not be any real differences in the nature of their adaptations. Thus, similar adaptations may exist in spite of dissimilar material culture. This does not suggest that such distinctions are not important, particularly if they allow us to more tightly define the temporal and spatial context of the adaptation. From a cultural-ecological perspective, however, similar adaptive strategies should have similar settlement system forms.

To ensure that the settlement modes presented are not confused with the cultural-historical phases that exist for the area, numbers have been used to categorize these settlement system modes. Only published archeological material was used to generate the settlement modes. This was done so that the site-file data might be utilized as a further check or crude test of the settlement modes presented (see Section 3.2). The only exception is the Paleo-Indian era, for which the paucity of data in the literature necessitated the use of site-file information for the synthesis in the preceding section. Many of the settlement modes described are identical to those currently in use by researchers in New York, Pennsylvania, and Ohio. However, some modifications have been made. These modes are the most practical for interpreting and predicting archeological patterns in the survey area given the data available. The modes are tailored to the general needs of this project and should be evaluated in this context.

MODE IV

Settlement.

Semi-permanent, year-round occupation in base camps containing 25 to 50 individuals. Temporal variability in size due to individual and extended family units shifting to spring-summer fishing stations, and males to hunting stations.

Site Types

1. Semi-permanent base camps: Occupied year-round by 25 to 50 individuals. Shifting group membership. Shallow-lake resource orientation found in climatically protected locations. Extreme economic diversification. Settlements still probably exogamous.

2. Spring-summer fishing camps: Occupied by nuclear or extended family units (4 to 25 people) from base camp on a seasonal basis. Shifting group membership. Specialized, intensive exploitation of marsh/lacustrine resources.

3. Hunting/butchering sites: Dispersed, interior hunting/butchering sites. Utilized throughout the year by male members of the semi-permanent base camp.

4. Burial Sites: Associated with Site Types 1 and 2.

MODE V

Settlement

Population aggregation into fortified villages possibly occupied year round. Female resource procurement nearby. Male hunting/ butchering further to interior. Possible winter camps in interior.

Site Types

1. Semi-permanent fortified villages: Summer-fall and possibly year-round occupation. Extensive range of subsistence items, primarily riverine/alluvial valley resources. Population of from 50 to 60 individuals, perhaps more. Site is exogamous.

2. Hunting/butchering sites: Male activity, open-air sites. No ceramics. Very ephemeral occupation.

3. Interior rock shelter sites: Possible winter occupation in interior by nuclear or extended families. Might merely be male-female extraction sites. Associated with ceramics.

MODE VI

Settlement

Similar to that of Mode V with the deletion of fortifications and the addition of burial mounds associated with the permanent village (Site Type 1).

Site Types

1. Permanent Village: Year round bluff-top village adjacent to river floodplain. No fortification. Population of from 60 to 100 individuals. Extensive resources based on riverine/alluvial valley exploitation. Exogamous villages.

2. Hunting/butchering camps: Temporary hunting and butchering stations located on bluff tops and along interior ravines and streams. No permanent habitation. Possible extractive functions on seasonal basis only.

3. Burial mounds: Burial mounds contain exotic Hopewell trade goods indicative of intrasocietal status differentiation.

MODE VII

Settlement

This system involved the use of a series of small seasonal camps by microband or extended-family units numbering no more than 25 individuals within a fairly well-defined territory such as a river basin. During some seasons, primarily the summer, macrobands of perhaps 75 to 125 people coalesced at large base camps located in favorable fishing areas. The pattern was called recurrent settlement by White (1963). Similar patterns are ethnographically described for boreal forest groups such as the Cree-Ojibwa (Rogers 1969) and Nipissing (Day 1978). By analogy, it is suggested that such groups in the southern Lake Erie Basin were organized along patrilineal-patrilocal lines.

This mode is distinguished from Mode IV by its higher relative mobility the year round. The rich lacustrine environment afforded in the Western Basin (Zone 1), which permitted significant permanence to base camp locations, is not found in Zones 4 and 5. The differences between Mode VII and Mode III are more subtle, largely stemming from the presumed nutritional advantages of more efficient extraction and scheduling procedures (primary forest efficiency) used by Late Archaic-Middle Woodland populations in Zones 4 and 5 over those used during earlier periods.

Site Types

1. Base Camps: Large (up to 5 acres), often having thick stratified middens indicating heavy recurrent use over long periods. Bone and other food refuse may be abundant as may storage pits of various sizes. Structural features are often present, usually indicating round or rectangular house forms.

2. Seasonal, special task camps: Seasonal campsites are small, under 1/4 acre, usually unstratified, with generally thin midden deposits suggesting their brief seasonal use by small groups. Locations vary greatly, although close proximity to small streams and shallow lakes seems to be a consistent pattern.

3. Hunting camps: Rock shelters and caves are considered favorable upland hunting camp locations.

4. Mortuary sites: Mortuary sites and related mortuary practices varied greatly throughout the period, resulting in several site types. Although late Archaic burials were normally incorporated into habitations, Early Woodland cemeteries tended to be located away from habitation camps on wide ridges near large streams. Middle Woodland burial tumuli were often situated on plateaus, promontories, or high slopes overlooking large streams or rivers. The simplified cemetery burials of the terminal Middle Woodland appear to have been associated with base camp locations.

MODE VIII

Settlement

Fortified permanent villages containing 100 plus individuals were located in proximity to lacustrine, marsh, or swamp zones for aquatic resource exploitation. Maize horticultural gardens and hamlets were relatively close to surrounding villages, depending on soil distribution. Hunting, fishing, gathering, and trapping sites at resource nodes elsewhere in the territory received small numbers of villagers, as needed.

Site Types

1. Fortified, permanent villages: Sandy knoll locations. Highly fortified with palisade. Population of 100 to 120 or more. Round houses, approximately 25 ft in diameter. Permanent, year-round settlement. Intensive lacustrine/marsh/swamp resource exploitation with supplemental maize horticulture.

2. Cemetery: Large, planned cemetery associated with village (Site Type I). Extended burials, many with diverse and exotic grave goods.

3. Fishing/fowling camps*: Specialized seasonal extraction sites for fishing and fowling.

4. Maize gardens/hamlets*: Small, cleared maize gardens located on better drained areas in vicinity of village.

5. Hunting/trapping camps*: Specialized trapping and hunting areas located in swamp forest.

MODE IX

Settlement

Although restricted to northcentral and northeastern Ohio between A.D. 500 and 1350, this model is a very elastic one. Horticultural villages and spring-fall fishing camps contained the majority of the population; hunting camps were either visited sporadically or were used as winter residences by individual families. Specific versions of the model (i.e., local phases) exhibited differing emphases in the seasonal concentrations of populations for agricultural or aquatic resource pursuits.

---

*Due either to their location or highly situational use, Site Types 3-5 may be difficult or impossible to detect archeologically.

Site Types

1. Horticultural villages: Multifamily villages along alluvial floodplains in mixed mesophytic forests. Season of occupation varied from summer-only to spring through fall. Populations generally less than 100.

2. Fishing/fowling camps/villages: Multifamily villages adjacent to horticultural villages and/or spawning grounds. Tendency toward greater populations in spring and fall.

3. Hunting camps: Nuclear to multifamily camps in interior or along ridges adjoining lake plain.

MODE X

Settlement

The addition of agricultural crops to the diet led to some slight settlement modifications in Zones 4 and 5. This system was centered around warm weather occupation of a horticultural village or hamlet by the local territorial group, coupled with seasonal abandonment and dispersal of family units to seasonal hunting and fishing camps. This pattern apparently characterized early historic Delaware groups (Newcomb 1956). In most respects the pattern is essentially that of Mode VII with the addition of cultigens to the diet. All previous site types remained in use and no doubt occupied essentially similar locations.

Site Types

1. Summer agricultural villages: Villages usually small (less than 3 acres), highly nucleated, and often palisaded. Storage features are common. Oblong to true longhouses occur. Summer village locations are correlated with large streams and rivers, are in defendable topographic locations, and are in close proximity to tracts of level, well-drained loamy soils.

2. Winter hunting camps: Winter hunting camps may be large, possibly palisaded, and are located in higher interfluvial settings near a water source.

3. Mortuary sites: Ossuary burials appear as an additional site type in this pattern. Ossuaries may be located some distance from settlements on raised, well-drained topography.

MODE XI

Settlement

Fortified, agricultural villages located near the lake plain or river floodplain are the principal sites of this mode. Activity-specific sites should be located in the immediate vicinity of villages. Fishing camps may constitute a real settlement alternative for individual families during the late fall to early spring. Uplands, especially in well-watered, dissected areas, should contain specialized deer-elk hunting camps of adult male hunters.

Site Types

1. Agricultural villages. Villages located on lake plain and interior upland on bluffs overlooking the floodplains. Sites are fortified with earth enclosures. Agricultural economy predominates, based on maize-beans-squash. Rectangular structures.

2. Special task camps: Small fishing, fowling stations with temporary occupation, associated with Site Type 1. Clustered around villages.

3. Fall-spring fishing camps: Single-family or small multifamily campsites situated on lakeshore or interfluvial plateau with a heavy emphasis on fishing.

4. Upland hunting camps: These are on dissected, interfluvial uplands. Occupied by male hunting parties for short periods.

MODE XII

Settlement

Fortified agricultural villages located on promontories overlooking major river valleys are the principle sites of this mode. Unlike Mode XI, these villages are probably occupied year round by a larger fraction of the total community. Campsites, some of which may be fortified, are located in the same river valley, and are used for special economic pursuits (e.g., fishing, fowling, or as farming hamlets). Upland deer-elk hunting camps persist.

Site Types

1. Agricultural villages: Fortified villages containing longhouses built on isolated high promontories over major river valleys. Fewer sites than in Mode XI. Emphasis on agriculture.

2. River valley campsites: Located in same valley or along lakeshore, for fishing and fowling. Many may be fortified. Contain small wigwam structures. Low density of artifacts.

3. Hunting camps: Small camps on interfluvial plateau, several miles inland.

3.4 SETTLEMENT MODES: A FIELD EVALUATION

This section will provide a field evaluation of the twelve settlement modes presented in the previous section. The modes will be tested against field data on known sites in the repository of the Department of Anthropology, SUNY-Buffalo; Office of the State Archeologist, William Penn Memorial Museum, Harrisburg, Pennsylvania; and the Offices of the Regional Archeologists for the Northeast and Northwest Districts in Ohio. The testing of the modes with data obtained from state sources has been subdivided into three sections. Each section focuses on the field test in a part of one of the three-state study areas: Ohio, New York, and Pennsylvania.

For purposes of demonstration, we treated the sites as if they were independent of those discussed in the literature. Had this not been done, our reasoning would have been circular--sites are discussed in the literature, settlement modes are derived from the literature, and the modes are evaluated against the sites. In reality, the sites in the site files represent a set of information that overlaps that discussed in the literature, the degree of overlap being unknown. Thus, the field test uses both the original site and data for other sites.

The evaluation procedure followed focuses on "case studies," or discrete areas within zones to which each particular model is applied. Most commonly, a "case study" area embraces the major portion of a tributary flowing into Lake Erie. Where tributaries reach many miles into the interior, we emphasized their lower (or lakeward) portions, since it is these areas that will probably be of most concern during natural gas development. Settlement research at the observation level selected has its advantages, given that archeological collections often focus on individual drainages and that a nearly complete settlement may be included within the boundaries of a case study.

As pointed out earlier, available information about the locations and descriptions of prehistoric sites is better for Ohio (Zone 1-3) than for New York and Pennsylvania (Zone 4-5). For this reason, the Ohio sites can be located on maps that contain specific environmental data. Therefore, settlement maps could be generated for Zones 1-3 and correlated with reconstructed environmental data on factors such as soil type. All reconstructed data was accomplished using the methods outlined in the previous chapter.

The same level of detail about cultural and environmental relationships could not be presented for Zones 4 and 5, particularly since many site locations reported in the literature have not been precisely relocated. In lieu of specific data, no correlative maps could be made with environmental factors, although a discussion about basic cultural and environmental relationships could be presented.

3.4.1 Ohio: Zones 1-3

The archeological data from the state files used to test the proposed modes were selected from two subareas: the northeastern and northwestern parts of the state. For these areas, the site-form data are uniformly complete for the recent sites, but not for earlier site forms. The overall high quality of the data allowed for an accurate temporal and functional classification of many sites. These site data consist of 336 occupational components from 266 sites in the eight-country area of the survey. Only 59 of these sites, mostly nondiagnostic lithic scatters, could not be classified as to site type and archeological period.

The available data from the files were organized into a uniform coding system although many such codes are blank, since information had not been provided at the time of original recording. This resulted in extremely variable data. The data base cannot be used inductively to generate a series of settlement modes at the local level, nor can it be used in a strict statistical sense to "test" the predictive value of the general settlement modes previously generated. Instead, the use of these data will be limited to an expository exercise of the qualitative relationship between certain environmental parameters (notable soils, hydrology, and topography) and the general settlement modes on a local basis. Should the relationship between site location and environmental parameters hold, we can have added faith in the settlement modes as predictive tools, even though their value cannot be quantitatively specified.

In addition to the early surveys of Whittlesey (1852), Squier and Davis (1848), Mills (1914), Greenman (1935a and b, 1937a), and Kraus (1942), which formed the initial base for northern Ohio, a number of modern research and resource management surveys have been performed. Perhaps the most specialized, intensive, and exhaustive surveys are those associated with impact statements or contract surveys conducted in the area. Although these surveys cover only limited areas of investigation, the explicit nature of their methodology and the intensity of the survey efforts provides a rough quantitative dimension to occupations in various environmental zones as well as to post-depositional processes pertinent to the area. Complementary to these surveys are the more extensive sampling designs developed by Brose and others (Brose, Werner, and Wolynec 1977) for settlement modeling in northeastern Ohio and Northwestern Pennsylvania. The rigorous sampling methods and ecological stratification of these surveys have provided a systematic, inductive base for the generation of settlement modes.

It is the combination of these three types of survey data--1) the sporadic casually reported sites, 2) the intensive and exhaustive investigation of small areas, and 3) the systematic, ecologically stratified sampling design--that has provided a broad and useful data base with which to evaluate the settlement modes generated in this study.

As stated earlier, there is a positive correlation between site location and environmental resource loci. The task, therefore, becomes one of identifying these resources at a fine enough scale to have local predictive value.

3.4.1.1 Statement of Approach

For northeastern Ohio, Brose utilized an unaligned random sampling scheme, stratified by topographic relief, dominant floral community, surface geomorphology, and annual temperature and precipitation. Brose (1976b:7) stated that principal component analysis indicated that site location is a function of topography and floral community, and these were considered "independent" variables in his analysis of prehistoric site distribution. We, however, contend that topography and floral community are not ecologically independent, but that these factors are linked by at least one additional variable--soil type. Brose chose to disregard soil types since they "introduced great non-independence among variables of topography, geomorphology, and vegetation, biasing subsequent analysis" (Brose 1976b:7). Although this is true and although the type of analysis Brose was conducting was perfectly justified, the principal component analysis would seem to indicate that soil type is the most important environmental variable if topography and floral community comprise 80 percent of the variance in site location. Soils could account for even more of the variance since the environmental variables are actually nonindependent.

Brose's analytic purposes were different from ours. However, the results of his research, when applied to the scale of site prediction being dealt with in this report, suggests that soils are indeed a useful starting point for development of site-location criteria.

Brose's concern about placing too much importance on agricultural soils alone has been dealt with in this report by the inclusion of soils that are productive for other resources utilized by humans. Brose was also correct in pointing out that a number of variables are required to specifically define and predict site location and function in order to use a settlement approach. It is obvious, for example, that soil indices alone cannot predict aquatic resource potential, defensive positioning of sites, or other such factors important to prehistoric people in selecting a site location. However, on the basis of the type of data dealt with in this project, these other non-environmentally controlled factors may be adequately addressed in a residuals analysis, independently of soil's influence on site location in a settlement system. This will be done on the basis of individual settlement systems and will, we hope, result in the generation of even more precise predictive statements concerning site location and site function for each study area.

Soil types can be evaluated for their potential productivity of such resources as maize, oak, hickory, and walnut, and a ranking of the resource potential of these soils can be made following the procedures discussed in Chapter 2. Such a ranking does not necessarily imply that these soils contained these resources. All these values simply imply that (in the case of nut-bearing trees): 1) a single tree species is more likely to occur on a particular soil and 2) if such tree species were on a particular soil they would produce at a rate relative to the same species on a different soil. The soil maps included in this section do not imply either the necessary occurrence of a tree species on a particular soil or the frequency of tree resources on that soil. It might very well be the case that, for historical reasons, a certain species of tree occurred on a poorer soil rather than on a more favorable one, and, hence, resources at this locus would be favored for exploitation over other areas that were theoretically better suited for optimum production.

Another important consideration is that certain resources might be located at loci that are not related to soils. These include, but are by no means limited to, lithic resources, animals, fish, and non-tree bearing plant resources such as grass seeds. Thus not all sites are expected to perfectly correlate with the soil maps utilized in this analysis. Instead, we only hope to demonstrate that such correlations do, to varying degrees, exist. The residuals, or unexplained sites, will, we hope, be explained by reference to more specific factors associated with a particular site's location, identification, or specific cultural pattern as described in the ethnographic literature.

It is important to remember that the environment of Lake Erie was not constant through time. Major fluctuations in climate, hydrology, and vegetation occurred, and drastic topographic alterations via lake rise, drowning, and shoreline erosion also occurred. These factors must, in some way, be controlled so that the relationship between archeological resources and environmental data can be properly evaluated. Soils, for example, have different characteristics during wet and dry climatic regimes. We therefore generated maps of the appropriate soil series for varying climatic regimes throughout the prehistory of the Lake Erie Basin as discussed in Chapter 2.

Beside the difference in resource production as a function of climatological effects on soil potential, settlements were also affected by erosion, drowning, and sedimentation. Settlement patterns were, in many cases, disrupted--in some examples, such as in the Western Basin, to the point where no record of these systems exists. In such cases, the settlement mode itself must stand in lieu of substantive data.

No attempt was made to analyze all settlement modes for all areas and times. The variability in the quality and coverage of the site data was one factor in making this decision. It is also impossible to spatially divide the entire survey area into "regions" representing the boundaries of a given settlement system. Any attempt to do so would have been totally arbitrary given the nature of existing archeological research in the area and the severe post-depositional disruption of many sites. In many portions of the survey area, certain archeological periods are poorly known, nor have corresponding settlement modes been discussed in the literature.

The implication of these considerations is that not all of the site data will be utilized in the following analysis, nor will the entire survey area be considered. Instead, a series of specific "case studies" will be selected for modeling as a guide to understanding the nature and extent of prehistoric occupation in both these areas, as well as in areas with ecological conditions that approximate the specific study areas.

3.4.1.2 Settlement Mode I: Case Study, None

The settlement mode for the early Paleo-Indian, or Llano Period, in the survey area has been treated somewhat differently than those for subsequent occupations. This is due to the paucity of data and to the fact that ecological conditions, including soils, were dramatically different from those observed during the Holocene. The resources utilized by humans during this time period probably cannot be correlated with any existing soil types; thus the use of this variable for analysis is unwarranted. The specific nature of the adaptation and settlement mode has already been discussed in Section 3.3. Although this mode cannot be tested against existing data, it is possible that some sites of this time period could remain on the lake bottom. Locating these sites would be of great importance, particularly if groups of contemporaneous sites were recovered.

3.4.1.3 Settlement Mode II: Case Study, None

The Plano, or late Paleo-Indian occupation, has also been left out of a consideration of specific testing and, for that matter, has not been dealt with in any settlement mode. The reasons for this are that the rapidly changing characteristics of the environment and the inconclusive nature of the resources utilized during this period preclude any cogent development of a settlement mode. Elements of both the earlier Plano type adaptation and the later Archaic adaptation are probably to be found at this time. Sites of this period may still exist in the lake bottom of current Lake Erie; the probability of finding these sites in a preserved state is slightly less than that for the previous period due to environmental factors (see Chapter 2).

3.4.1.4 Settlement Mode III: Case Study, Huron-Vermillion Rivers

The first settlement mode that can be specifically investigated is one characteristic of all areas in the survey during Early and Middle Archaic times; in some areas it extends later in time than in other areas. This settlement mode is tested against extant data from the Huron-Vermillion River

Valley of northcentral Ohio. This area was chosen as the case study for the Type III settlement mode for two reasons. First, Erie County has a modern soil map that allows for the accurate mapping of the highly productive soil types. Second, the area has been subject to a series of comprehensive surveys (Shane 1974a and b) resulting in a large body of site data suitable for testing the appropriateness of the settlement mode.

Two classes of soils are relevant for the spatial evaluation of natural resources. One of these represents maximal oak and hickory production, the other the most productive walnut soils (Figs. 3.1 and 3.2). It should be pointed out that walnut utilization has not been archeologically demonstrated for the Early Archaic Period, but this is not of concern since it is quite difficult, from the site-file data, to differentiate Early and Middle Archaic components since most of the relevant sites are multicomponent. Environmentally, this era was much moister than the present, and so the soil catena for the cited resources was shifted accordingly (see Chapter 2). The type III settlement mode also applies to this region during the Late Archaic Period. This latter time period, however, is characterized by a drier climate and thus another set of appropriate resource maps were prepared for these conditions (Figs. 3.3 and 3.4).

Since it is clear that the environment was much drier during the Late Archaic than it is now and that the Early and Middle Archaic was much wetter than today, there must have been a period during the end of the Middle Archaic that was modern in terms of precipitation. Therefore, modern climate soils maps were also prepared for the Middle Archaic (Figs. 3.5 and 3.6).

One initial problem in the investigation of the Type III settlement mode is that it is difficult to differentiate base camps and temporary camps from site-file data. Ideally a distinction could be made on the basis of size, the intensity of occupation, and the range and diversity of artifacts and tools. But, since many of the artifact inventories were reported by local collectors, we are uncertain about the representativeness of the collections and of the intensity of collecting from site to site.

Another problem in the evaluation of this mode is that the data for this region exists in two separate formats; that in the site files and that from Shane's (1974) survey. Shane's survey report, the Lake Erie Nuclear EIS Final Report, does not contain exact site proveniences. It does, however, have a base map with the sites located on it. While the sites on the map are numbered, the numbering system differs from that of the Ohio Site Files in the District 2 Office. The Shane map is also at a different scale from those utilized in our study. Despite these difficulties, we were able to combine both sets of data.

The initial step in analyzing the data was to enlarge the Erie Nuclear EIS site map to the same scale as ours by using a map enlarger. Once this was accomplished, the locations of Shane's sites were transferred onto our base map. Two difficulties arose during the transfer. First, there was some optical distortion in the enlarging process. Second, the already quite large and approximate site provenience notation on Shane's maps became even larger and, therefore, even more approximate. We were able to partially correct for this latter problem by positioning Shane's sites on the most reasonable topographic setting in the immediate area, but the assumptions on which this

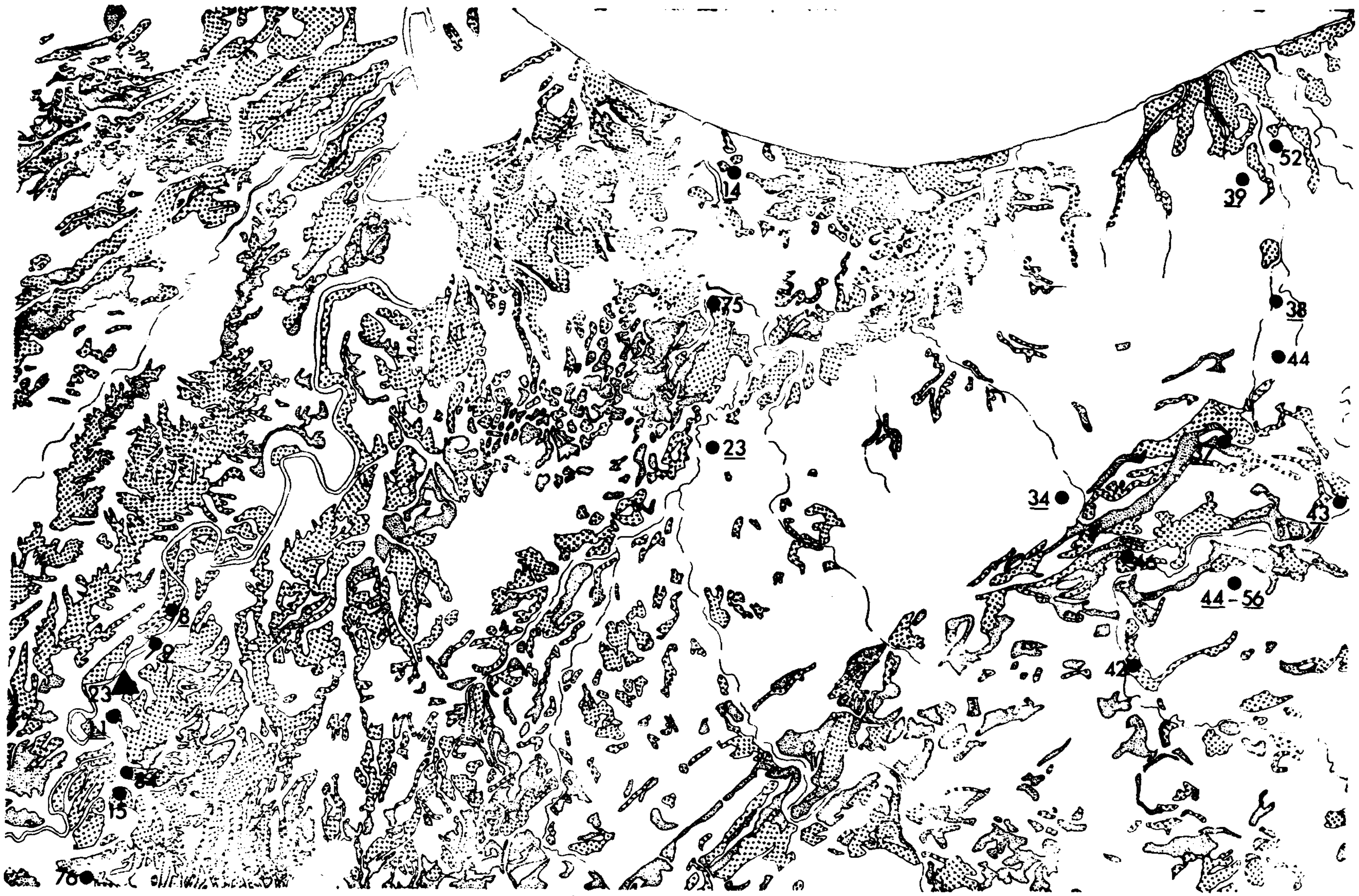


Figure 3.1. Settlement Mode III: Oak-Hickory Soils, Wetter Regime

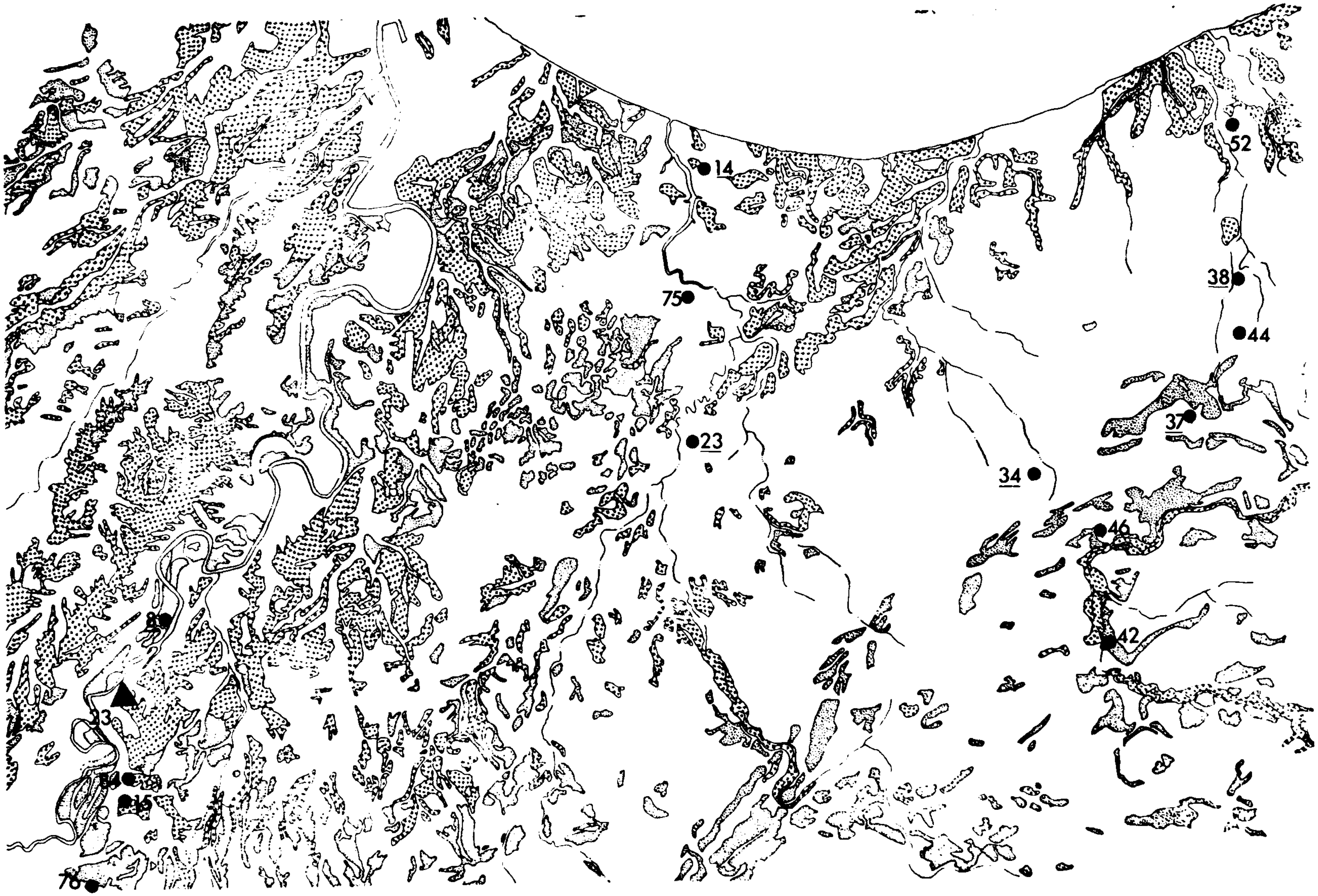


Figure 3.2. Settlement Mode III: Walnut Soils, Wetter Regime

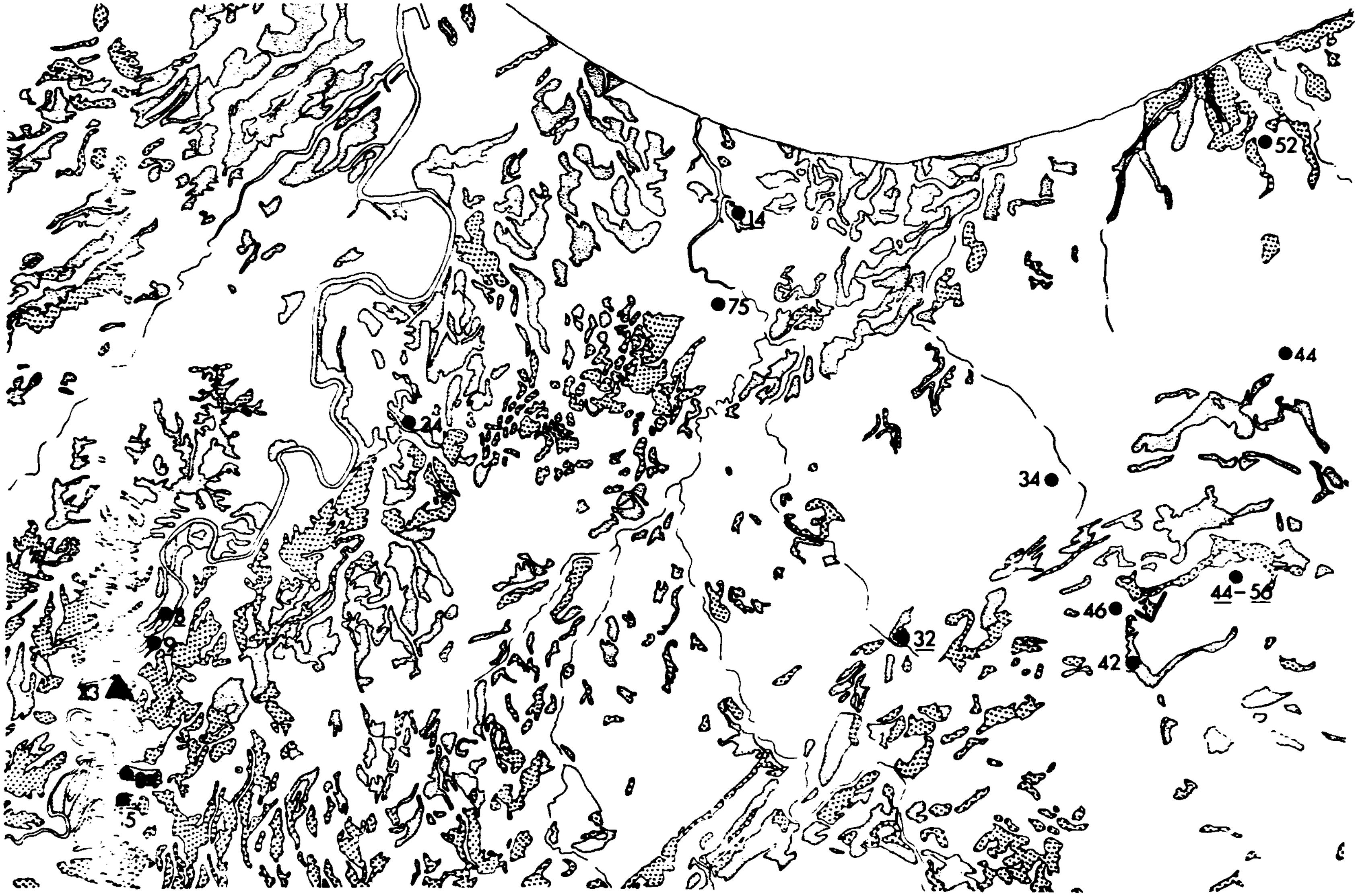


Figure 3.3. Settlement Mode III: Huron River Oak-Hickory Soils, Drier Regime

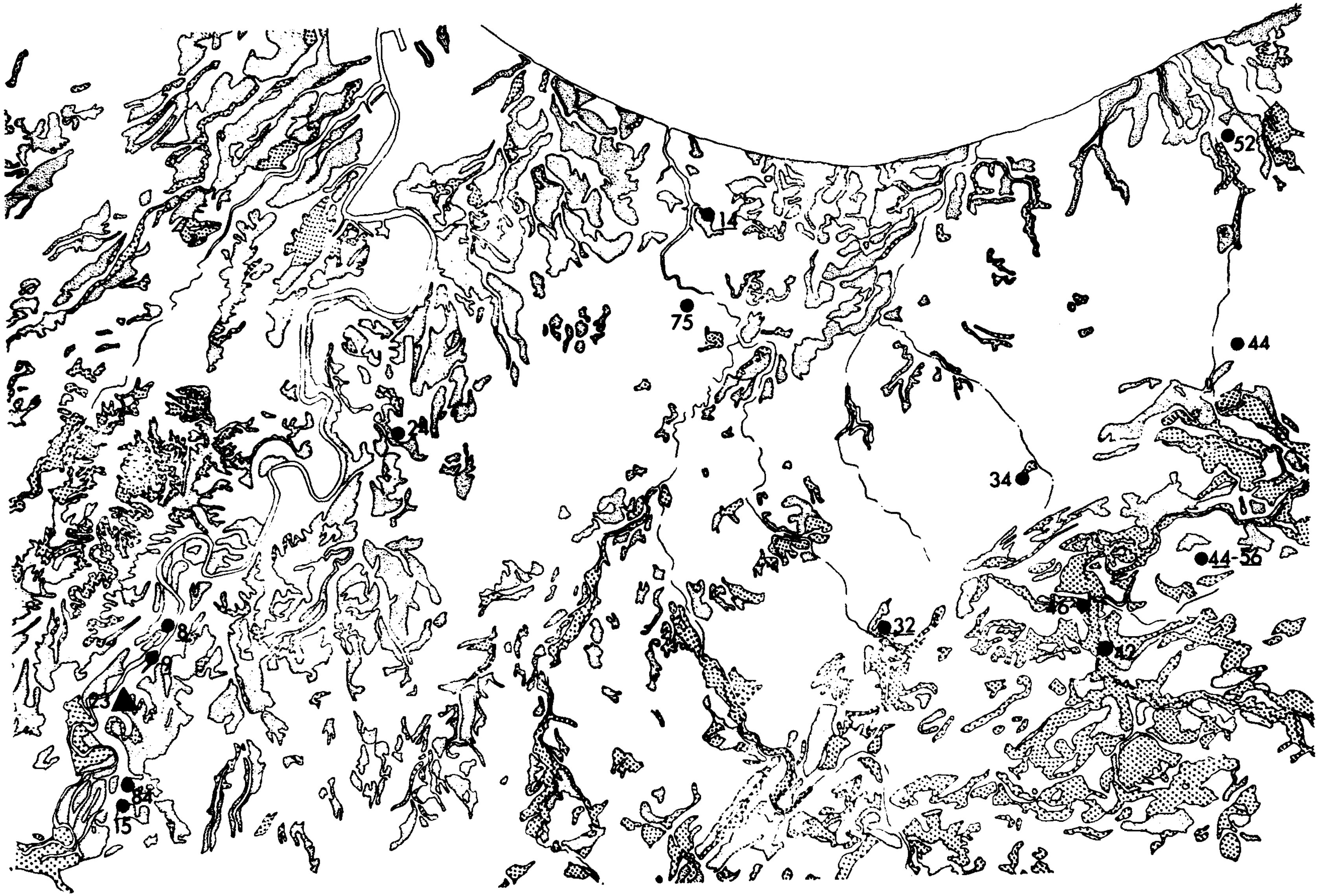


Figure 3.4. Settlement Mode III: Huron River Walnut Soils, Drier Regime

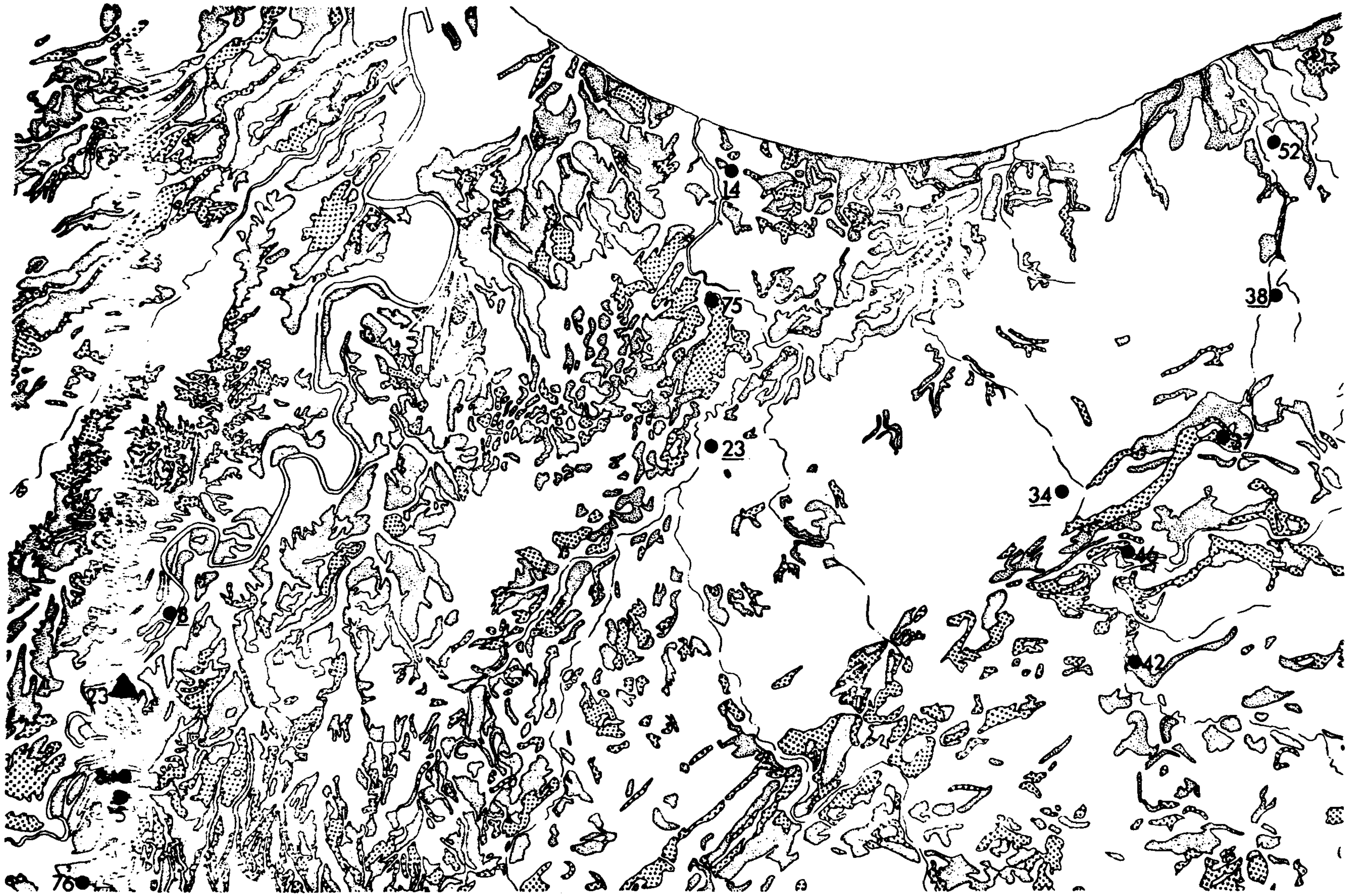


Figure 3.5. Settlement Mode III: Huron River Oak-Hickory Soils, Modern Regime

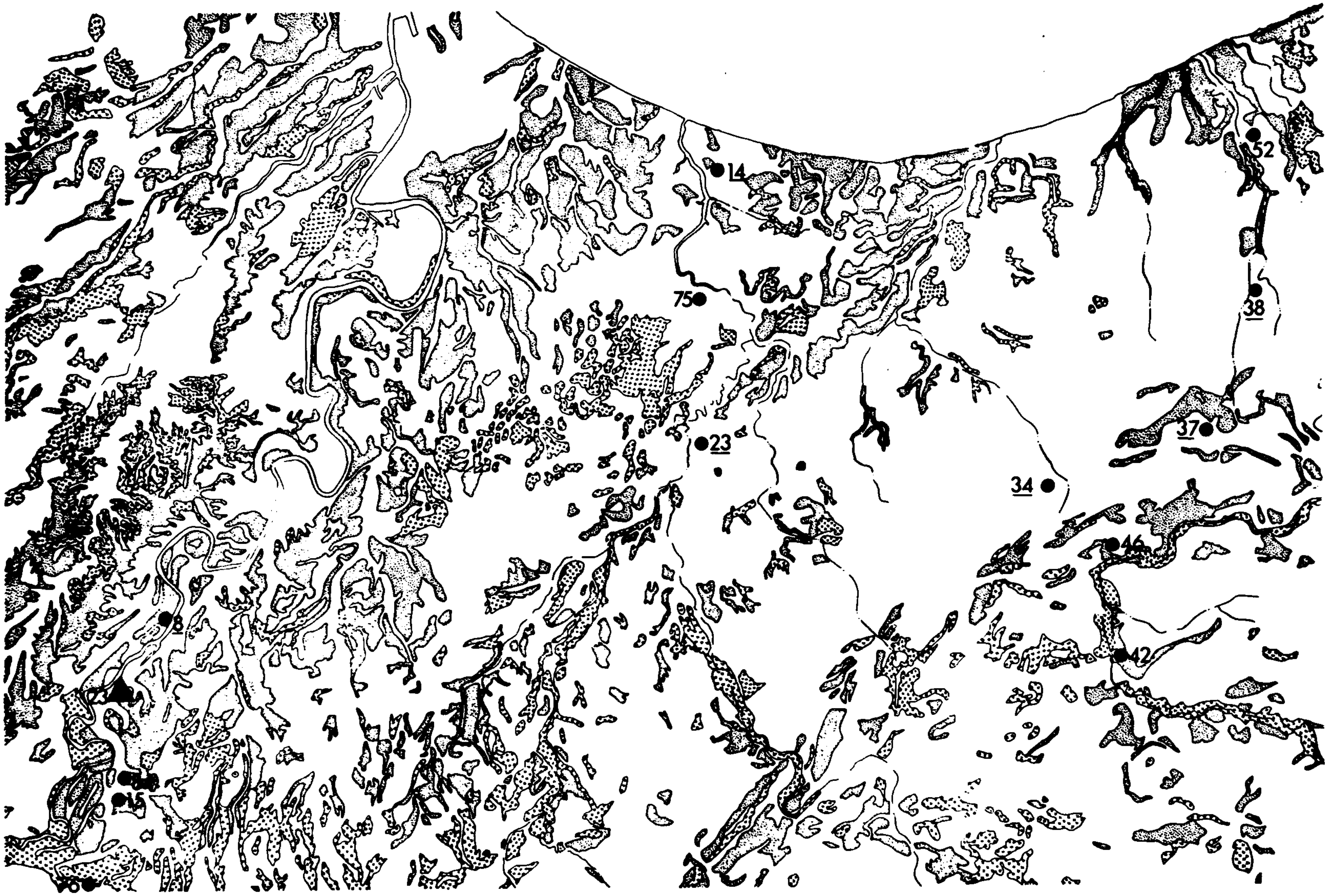


Figure 3.6. Settlement Mode III: Huron River Walnut Soils, Modern Regime

procedure were based are in themselves a potential source of error. Thus the provenience of Shane's sites as positioned on our base maps are only approximate; this might account for disparity from expected site predictions.

The next step in the combination of site data involved the identification of overlapping sites. In many cases these were easily detected, particularly where site names were given; in other cases it was not possible to absolutely determine whether two sites were indeed different. For some areas the basic pattern of sites was the same on both maps, but slightly shifted. In such cases it was obvious that the sites were the same. This could further be checked by comparing Shane's site classification with that found in the site file.

Since there are two distinct sets of site data, we used two sets of notations on our maps. Shane's sites are underlined and numbered according to the system found in the Erie Nuclear EIS report. Sites from the regional site file are not underlined.

Thirty-two sites that contain Early Archaic and/or Middle Archaic components can be identified. All of these, with one exception, have been classified as seasonal, temporary campsites in lieu of more specific data. The single exception is the Paul Site (Er 23). This site has been classified as a base camp because of the great amount of Archaic cultural material recovered from it, including around 250 projectile points (95% of which are Archaic), 20 drills, and more than 40 grooved axes. Its large surface area of 30 × 120 meters also supports its classification as a base camp. Since all periods of the Archaic are represented at the site, it is impossible to determine if it was definitely used as a base camp during the Early and Middle Archaic. The recovery of more than 40 grooved axes, a common Late Archaic artifact, suggests such a function during this time period.

The fit of Early Archaic components to the soil productivity maps for oak and hickory in a wetter climate reveals that 13 of the 17 sites (76.5%) are in the Class I oak and hickory soils and 4 (23.5%) are in the Class II oak and hickory soils (see Fig. 3.1). Thus, all of the identified Early Archaic components are accounted for by association with Class I and II soils, and no residuals are recorded. This clearly indicates a correlation between site location and high quality oak-hickory soils, suggesting the importance of these resources in the Early Archaic adaptation. The unusually good fit may also be a function of the relative youth of the oak-hickory deciduous forest in the region, with only a limited establishment of these species in the forests of the Early Archaic and these on the best soils suited to their growth.

Another factor important in site location is proximity to water. For each of the Early Archaic sites, there was a close spatial association of site and water. As Brose rightly pointed out, this relationship is in part a product of collection bias, i.e., collectors only look for sites along stream banks. Water is certainly an important resource in human adaptation and there is no reason to believe that expedient access to water does not in part predicate site location. Fortunately, our soil maps also contain drainage patterns. Besides the water itself, streams and streambeds provide additional important resources such as amphibians, fish, plants, game, and, in many cases, lithic resources.

The Early Archaic high quality oak-hickory soil distribution map shows a large percentage of the total area as containing high quality soils and much of these other areas lack sites. Because of the incompleteness of the site survey data, this apparent absence should not be considered in evaluating the proposed predictive mode. However, those high quality areas with an associated drainage are the zones where sites are known to be located. With Brose's cautionary statement clearly in mind, the combination of these two variables--quality oak-hickory soils and proximity to water--would appear to be the most powerful predictive indices for Early Archaic site location. It is difficult to evaluate base camp location versus temporary camp location, given our sample. The only recognized base camp is situated in the Huron Valley drainage, whose riparian ecozone is considered to have a higher resource potential than those drainages found to the east. Hence, the occurrence of base camps is expected in this area; but this does not rule out the possibility of finding such sites to the east.

An analysis of the relationship of Middle Archaic components to a wetter climatic regime, with both oak-hickory and walnut soils, shows a much poorer fit (see Figs. 3.3 and 3.4). Only 3 of 15 sites (20%) are located on Class I soils for both oak-hickory and walnut. An additional 2 sites (13.3%) are situated on Class I walnut and II oak soils, and 6 sites (40%) are on Class II oak-hickory and walnut soils. Two sites (13.3%) are on Class II oak-hickory soils with no walnut correlation. And 2 other sites have no correlation to either oak-hickory or walnut high-productivity soils. However, it should be remembered that this was a dynamic period climatologically and that there had to have been a moderating environmental/climatological shift preceding the xerothermic. That such a shift took place is clearly demonstrated by the pollen profiles discussed in Chapter 2. Thus it is necessary to comparatively interpret Middle Archaic associations in the context of a more modern moisture regime.

When this is done, site association for both Class I oak-hickory and walnut soils jumps from 20% (3 components) to 60% (9 components), with a Class I oak-hickory and Class II walnut associate of 6.7% (1 component). There is a similar frequency to Class I walnut and Class II oak-hickory soils. However, no shift is seen in the Class II oak-hickory, nor to a correlation with walnut, and the non-correlation for both oak-hickory and walnut soils remains. Thus, 86.7% of the Middle Archaic components can be correlated with quality soils for either a wetter or more modern regime.

Two components do not correlate with any of the higher class soil categories in either climatic regime. These components are ER 38 and Shane 44. Both sites are relatively close to high quality soils and both are favorably situated with regard to drainage (particularly Shane 44, which is situated on a knoll in a fork between two drainages). Site location, in this case, might be a function of hunting or butchering activities that would not necessarily have favored a nut-resource extractive correlation. It may also be the case that favorable groves of nut-bearing trees extended into this area even though its soils did not favor maximum productivity. In either case, a favorable resource zone is seen for the loci of these two sites, irrespective of soil predictors. Riverine resources could also been the focus of these sites.

Twenty-eight components are recorded for the Late Archaic Period. This period corresponds with the xerothermic, a time of drier climatic conditions than those found at present. Accordingly, a set of drier regime soil maps for oak-hickory and walnut were prepared. As shown on the maps, of the 28 components (75%) corresponded to the highest ranked soil class for both oak-hickory and walnut. One component (3.6%) was associated with Class I oak-hickory and Class II walnut soils, 3 components (10.7%) corresponded to Class II oak-hickory and class I walnut soils, and a single component (3.6%) was associated with a Class II walnut soil only. Two components (7.1%), the same sites discussed for the Middle Archaic (ER 38 and Shane 44), could not be correlated with either oak-hickory or walnut soil types.

In summary, more than 90% of the Late Archaic components were associated with high production nut-bearing tree soils, with 75% of the sites being located on the best soils for both oak-hickory and walnut. The only clearly defined base camp (ER 23) for this period is associated with Class II oak-hickory and Class I walnut soils. This comparatively poor association with quality nut-tree soils may reflect a shift in natural resource utilization in the Late Archaic period to a more broadly based economy.

As discussed earlier, it was at this time that seeds (both wild and domesticated) became prevalent in the diet. Although we have no maps referring to the ranking of soils for these resources, we can presume that such seeds occurred in the naturally disturbed (seasonally flooded and scarred) areas along the alluvial floodplain of the Huron River. Thus sites with a late summer (pre-nut gathering) seasonal occupation would be expected to appear in the settlement mode, and nut-bearing resources would not necessarily be the only good predictors for settlement. A high correlation does exist between quality nut-tree bearing soils and Late Archaic components, but many of these high quality soil types occur along bluffs adjacent to the alluvial valley of the Huron River. These sites could well be tied to highly productive areas as discussed.

A substantial percentage of lake plain that may once have been inhabited by Late Archaic people no longer exists due to erosion and lake inundation. This circumstance has affected our perception of the settlement patterns throughout the Archaic Period. We would expect to find more base camps in relation to temporary camps as we move closer to the original lakeshore, due to the greater potential of wild plant and animal resources, particularly fish, in the larger drainages. Alluvial resources should also be greater since broad floodplains, containing larger nutrient inputs due to maximum drainage inputs, would be found. Also, since the lake level would be lower, the marshes and swamps found in many of the drainages close to the present shoreline would not exist. These areas would be much better drained, perhaps containing nut-bearing trees or other resources used by humans. We would therefore anticipate increased numbers of components closer to the original lakeshore, particularly Early and Middle Archaic components.

In summary, the findings of the Type III settlement analysis are such that we can expect oak-hickory soils and walnut soils of high productivity to be sensitive site locations. The greater the area of this type of soils, the greater the sensitivity for type III occupation and for frequency of components. Although we do not yet have a way of numerically stating the relationship between drainage rank and these soil classes, there is a definite correlation between sites and quality soils irrespective of drainage proximity; when high quality soils are adjacent to a drainage, there is a very high correlation for all periods and climatic conditions.

3.4.1.5 Settlement Mode IV: Case Study, none

The likelihood of an Archaic adaptation to the rich lakeshore resources of the Western Basin (Zone I) was discussed in Section 3.2. While we can anticipate a settlement system for such an adaptation, lake-level rises have effectively obscured all traces of it. As a result, site file data cannot be used to address its spatial characteristics. If such sites ever existed, they will only be discovered through a program of underwater testing near the now submerged confluences of major drainages in the Western Basin.

3.4.1.6 Settlement Mode V: Case Study, Huron Valley

Settlement mode V is also situated in the Huron Valley (Figs. 3.7 and 3.8). The climatic regime for this mode is dry, as it was for the Late Archaic Period. A total of 28 components are recorded for this settlement mode, with 5 sites being classified as villages and the remaining 23 as campsites. Of these sites, 89.3% (25 components) are situated on top-ranked soils, with 78.6% (22 components) associated with Class I oak-hickory and walnut soils, and 10.7% (3 components) associated with Class I oak-hickory and Class II walnut. Three sites are not correlated with either variety of high ranked soil. One of these noncorrelated sites is, surprisingly, a village, site ER 75, situated on a ridge adjacent to a broad expanse of floodplain swamp along Old Woman Creek. This area would have been better drained when the lake level was lower and thus may have been a productive area for wild seeds or nut-bearing trees. This site is found at the broadest expanse of floodplain along Old Woman Creek.

A similar setting is to be found at the Esch Site, ER 1, and at ER 25, which is also situated in a prime oak-hickory and walnut soil zone. Shane's Site 18 does not appear to be correlated with a major drainage, although it is situated in an area with extensive tracts of the highest quality nut-bearing tree soils. It might be that this site is the same site as ER 75, but there is, at present, no way to evaluate this possibility. ER 52 is located on a minor drainage but in a very broad expanse of oak-hickory and walnut soils. Thus it appears that not all villages are located adjacent to prime floodplains. It is possible that villages in the northern sector are related to settlements that have since eroded into the lake or that have been inundated.

One aspect of our settlement mode that is not found in the site file data is the presence of fortifications. Since none of these village sites has been excavated, it is presently impossible to evaluate this feature of the Type V settlement mode.

Compared with the earlier Late Archaic Period, we can see a clear increase in the number of sites during the later part of the period. This might simply be due to a population resettlement caused by the rising lake level, resulting in the greater visibility of sites for this period. All but one of the villages are close to the shoreline, indicating a lacustrine orientation that has greater archeological visibility as the lake level rises. Our soils-based predictive mode accounts for a large percentage of known site locations. It does not, however, adequately account for the greater number of sites situated in the northern section of the study area compared to the southern section. Riverine, floodplain, and lakeshore resources, additional predictive criteria for village location within this settlement mode, are in accord with the

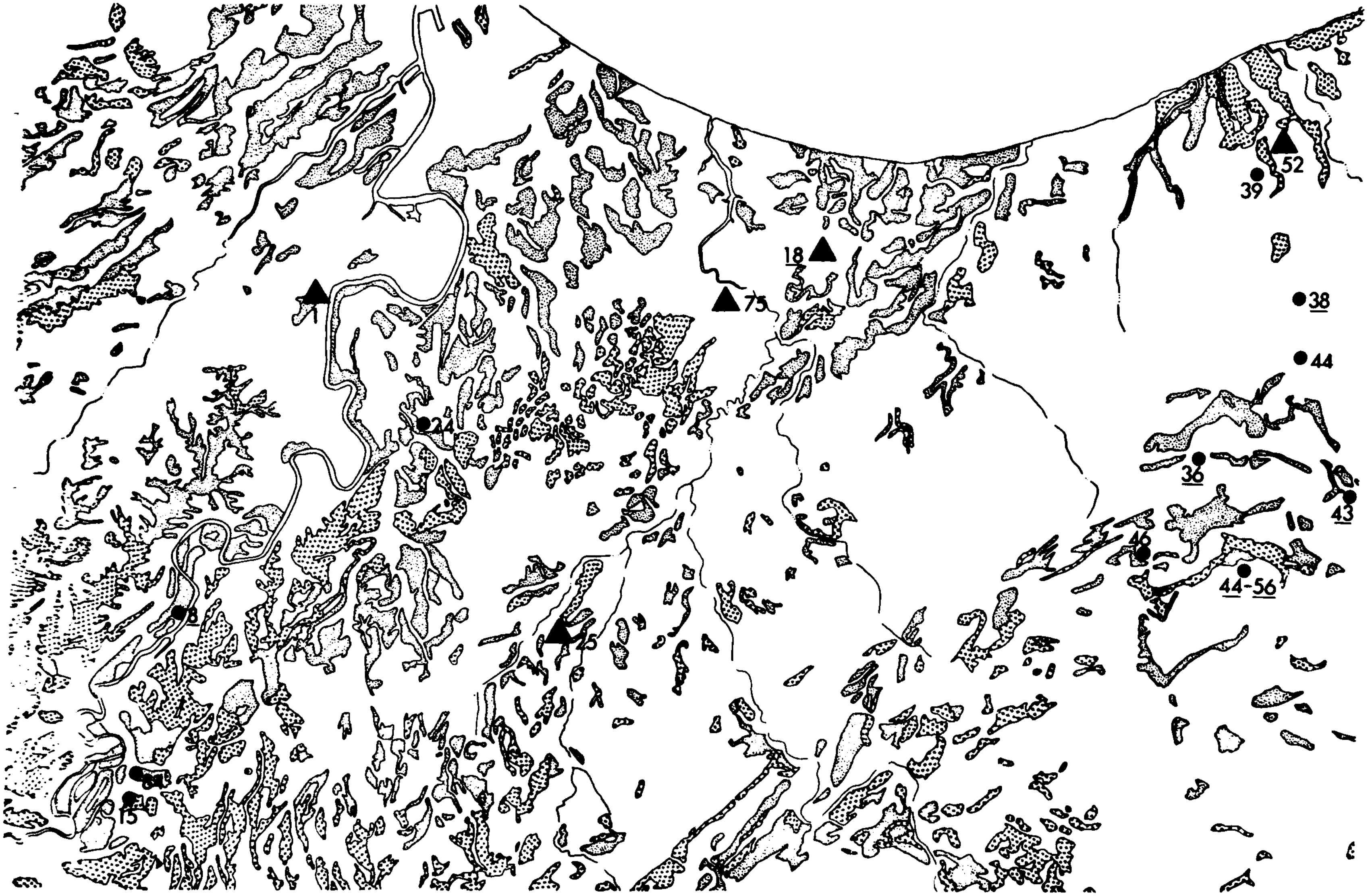


Figure 3.7. Settlement Mode V: Huron River Oak-Hickory Soils, Drier Regime

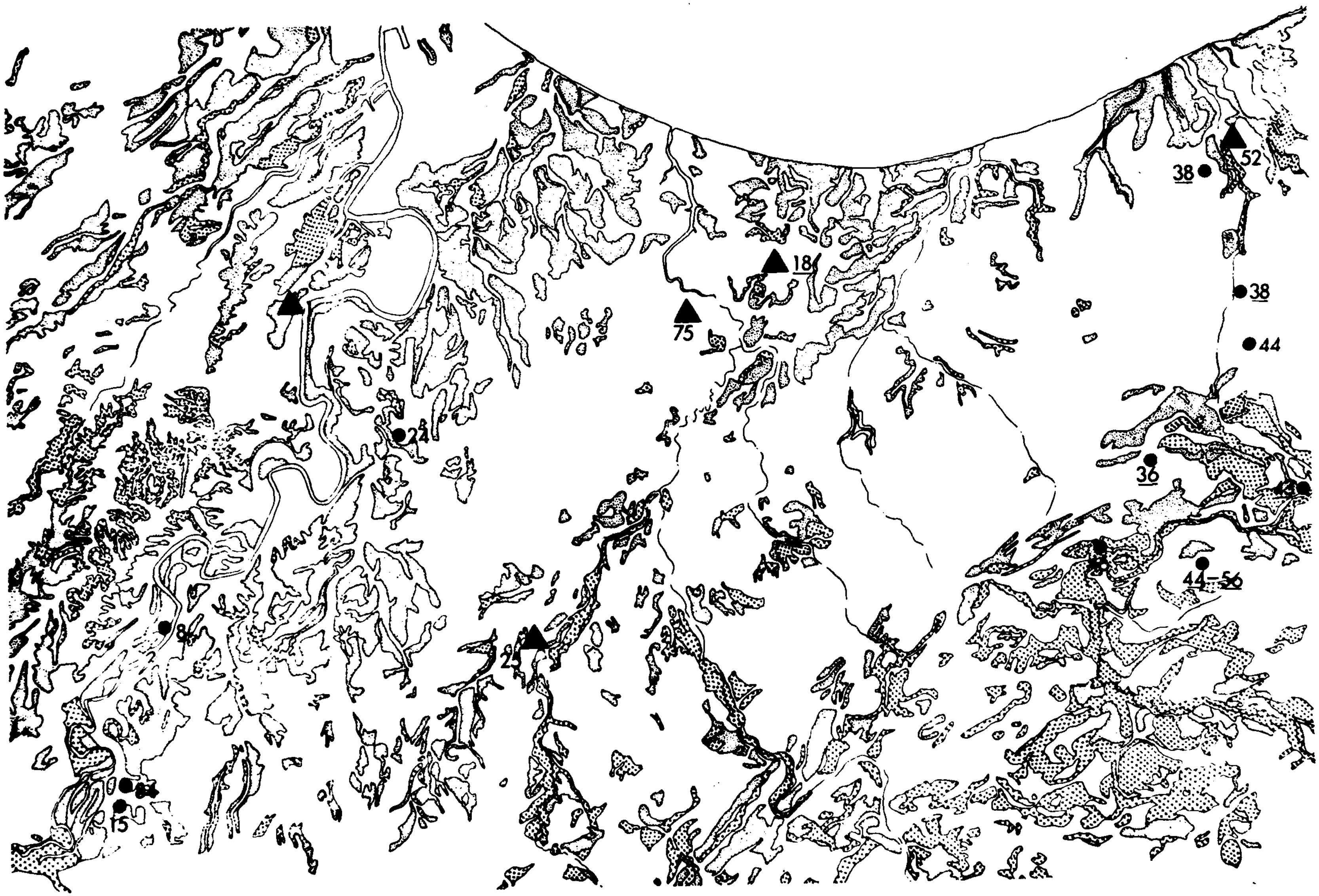


Figure 3.8. Settlement Mode V: Huron River Walnut Soils, Drier Regime

postulated adaptation for this mode. The soils criteria we devised are, when used alone, inadequate for distinguishing village as opposed to campsite locations. But when this soils data is combined with riparian and lacustrine variables, a more precise predictive statement can be made.

3.4.1.7 Settlement Mode VI: Case Study, Huron Valley

The Type VI settlement mode is similar in structure to that of the Type V mode, with the notable exception that fortifications are absent from the villages. The initial part of this period exhibited a dry climate, but toward its end it must have shifted through a modern regime since the next period is characteristically wetter. Thus, both a drier and a modern set of soil productivity maps had to be prepared in order to evaluate this settlement mode (Figs. 3.9-3.12). A total of 25 Middle Woodland components are recorded in the site files for the Huron Valley. Two of these are villages, the remainder are campsites. Once again, more than 75% of the components are associated with Class I oak-hickory and walnut soils. Nineteen of the 25 (76%) components are associated with these soil classes for a dry climate. This figure jumps to 22 sites (88.0%) of the total for soils under a modern climate regime. Only one of the villages is associated with this soils class, the Esch site, ER 1; the remaining village site, ER 75, has no association with either soil class under a dry climate regime, and a Class II oak-hickory association only for the modern regime. The reasons for the residual location of these villages was discussed in the section on Mode V.

A greater overall degree of fit is seen with the modern soils (88%) compared to those under a drier regime (76%). This difference has two important implications. First, although there is no strong palynological evidence for a shift to a modern environment in Middle Woodland times, the superior fit of the modern regime soils argues for such a situation, always assuming that our soil catena methodology is correct. Second, the reduction in the number of villages from 5 to 2 suggests a restructuring of the settlement mode in response to environmental shifts and, presumably, to the stress placed on the existing adaptation. This might also be reflected in the first appearance of burial mounds in the study area at this time, suggesting a need for greater political centralization in order to effectively maintain a successful subsistence strategy. We also see a movement of village settlements toward the lake.

It might be suggested that the rising lake "created" this pattern by drowning and eroding archeological components associated with this phase. But, since a similar readjustment, including a reduction in the number of villages, took place in the southern portions of the drainage, rising lake level cannot be used to explain this settlement shift.

3.4.1.7 Settlement Mode VIII: Case Study, Portage River

Settlement mode VIII, the Libben-Peterson settlement system is best discussed for the region embracing the Portage River and upper Sandusky Bay. Two environmental regimes are relevant for this analysis, a wetter regime from A.D. 500 to 1350 and a modern regime after A.D. 1500 However, a detailed and up to date soil survey has yet to be performed in this region, so only a set of modern regime maps could be prepared (Figs. 3.13-3.15). In spite of the long period of time under discussion, it appears that only a single settlement

Figure 3.9. Settlement Mode VI: Huron River Oak-Hickory Soils, Drier Regime

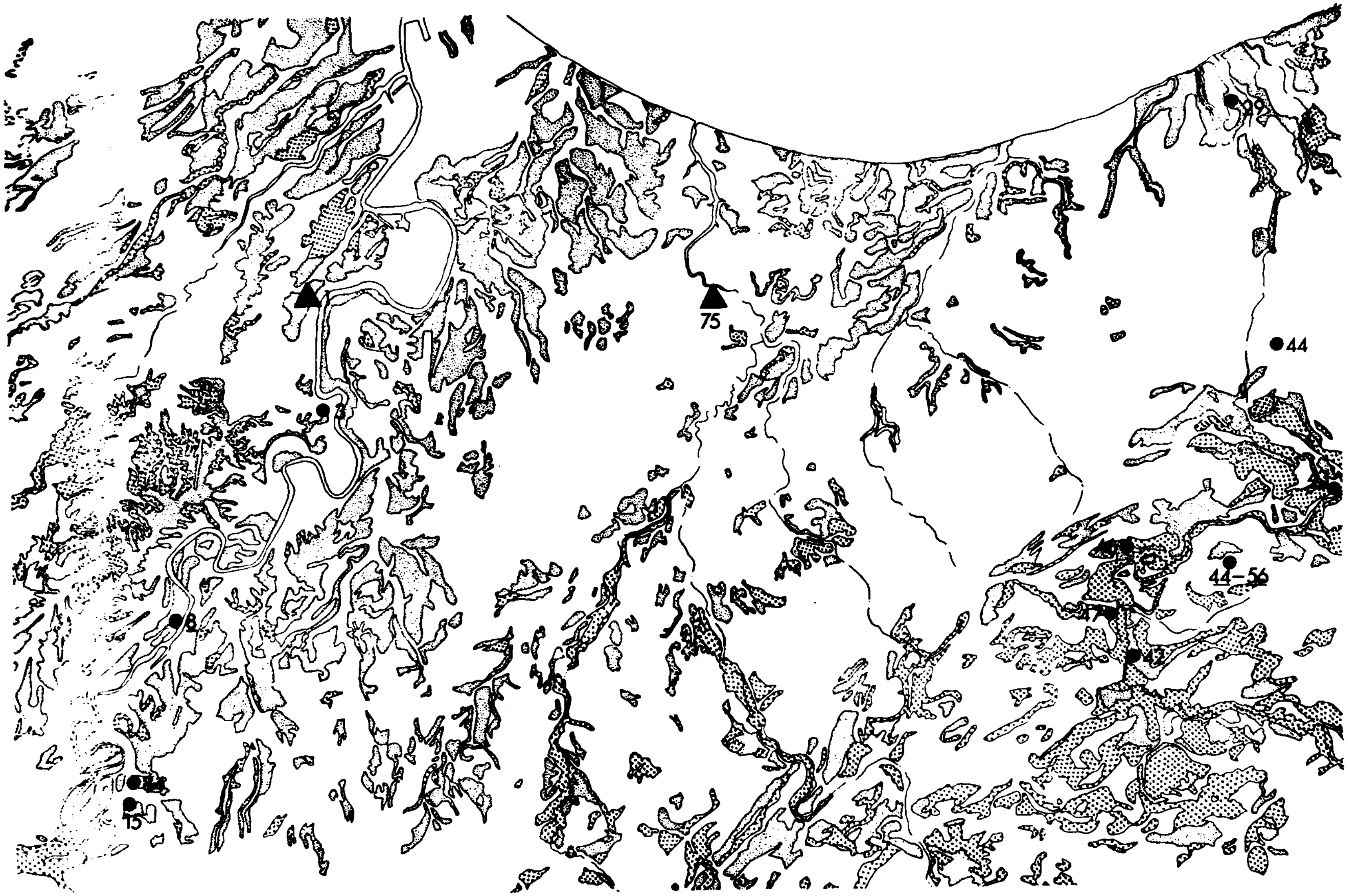


Figure 3.10. Settlement Mode VI: Huron River Walnut Soils, Drier Regime

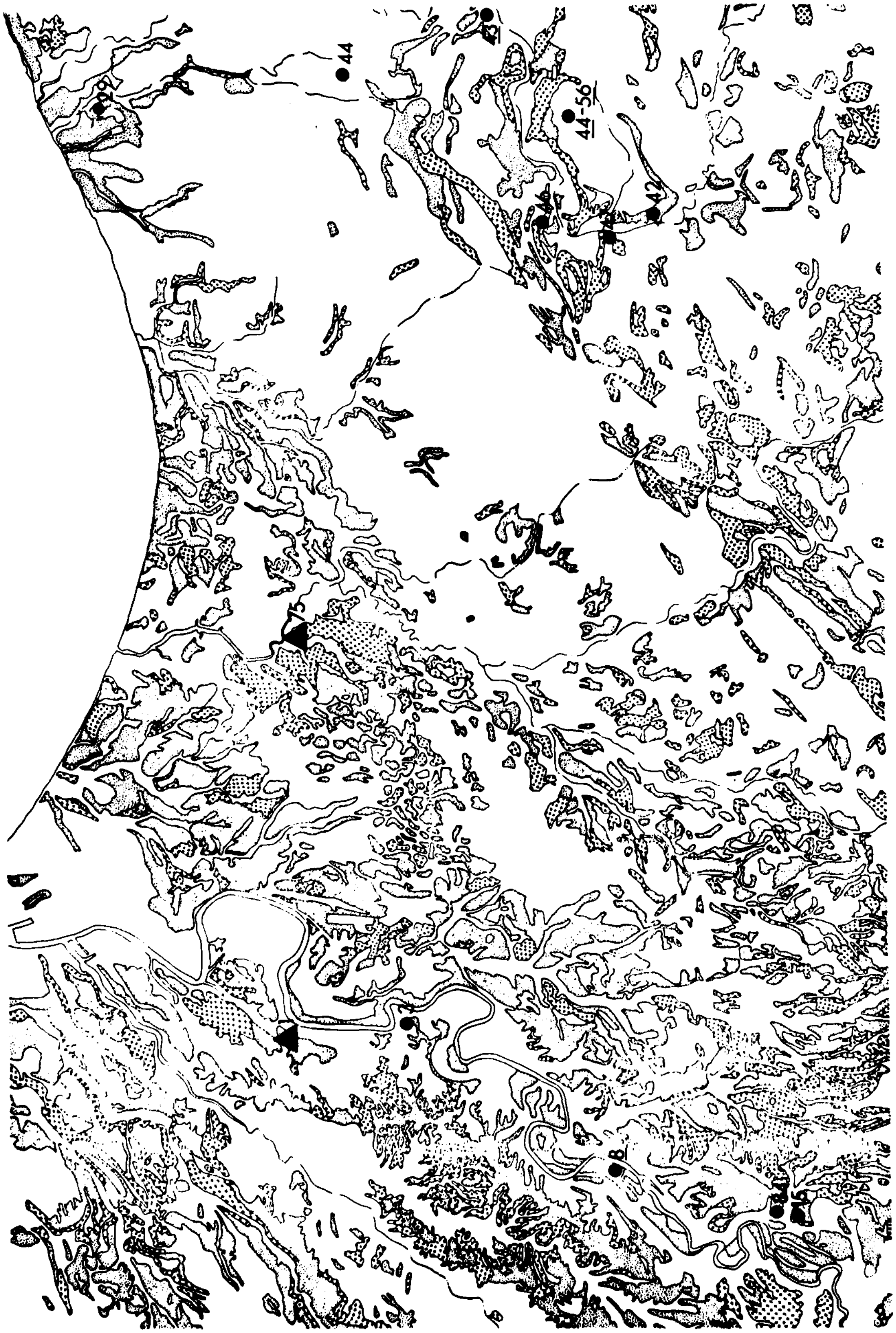


Figure 3.11. Settlement Mode VI: Huron River Oak-Hickory Soils, Modern Regime

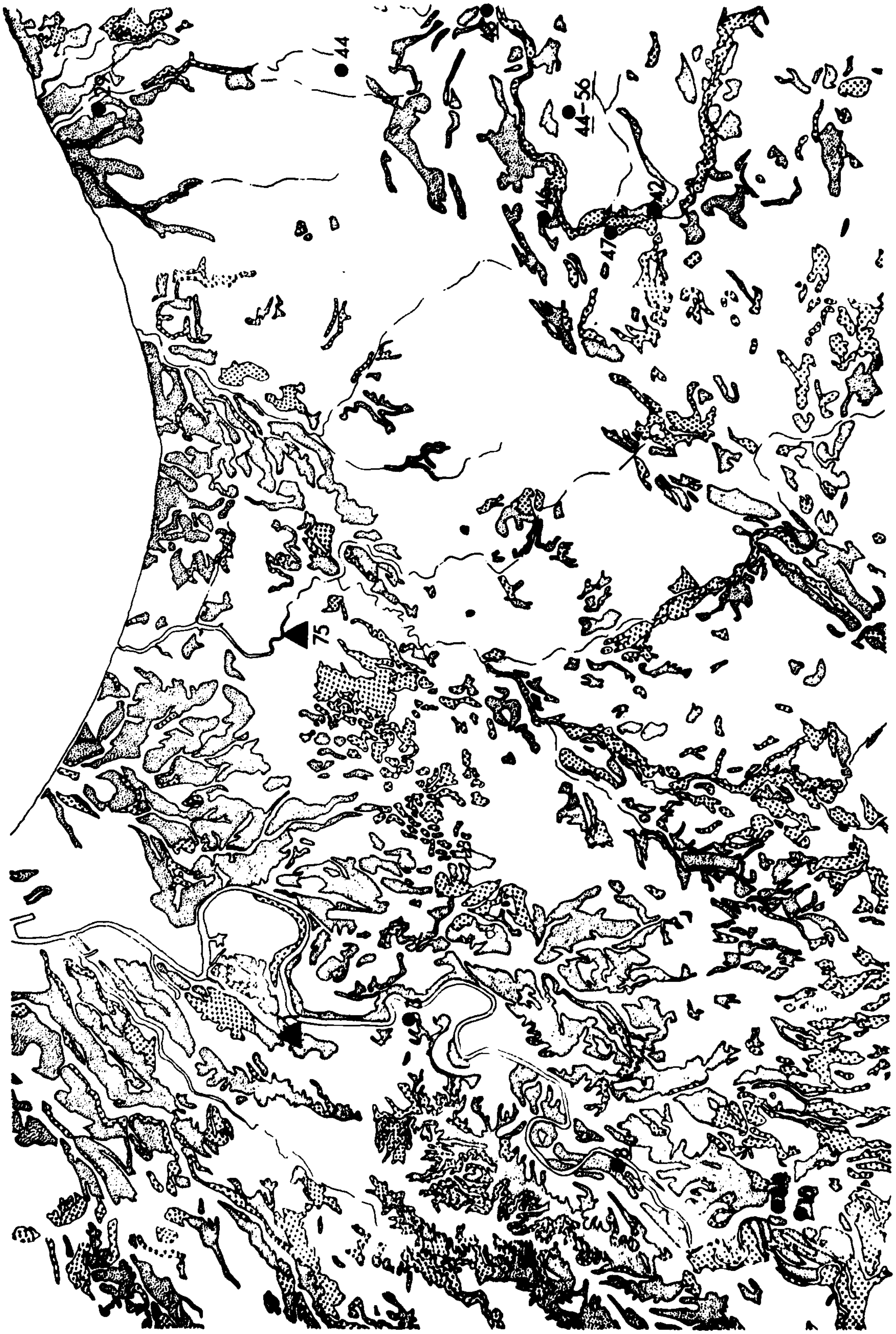


Figure 3.12. Settlement Mode VI: Huron River Walnut Soils, Modern Regime

Figure 3.13. Settlement Mode VIII: Portage River Oak-Hickory Soils, Modern Regime

Figure 3.14. Settlement Mode VIII: Portage River Walnut Soils, Modern Regime

Figure 3.15. Settlement Mode VIII: Portage River Agricultural Soils- Modern Regime

system existed in the region. Since agriculture is now recognized as part of this adaptation, an agricultural productivity map (see Fig. 3.15) was prepared for this area in addition to oak-hickory and walnut soil maps.

Seven components in all are recorded for this settlement mode; 5 of these are large villages and 2 are small camps or extraction stations. One of these latter sites, Ot37, is probably a hunting station; this assumption is based on the fact that only one triangular point and some chippage was recovered. In comparing site locations with the resource maps, we note a striking disparity when compared to the other settlement modes discussed. The 4 Late Woodland villages in the vicinity of the junction of the Little Portage and Portage rivers are not associated with highly productive agricultural soils. The Libben Site, Ot6, is the best known of the four, and contains the largest early Late Woodland component. It is associated with Class II oak-hickory and Class I walnut soils, but these cover a very small area. The fifth village, Ot18, is located adjacent to a small patch of Class I agricultural soil, as is Ot29, a campsite. It is doubtful that the small, highly circumscribed patch of soil adjacent to Ot18 is adequate to support a sedentary village. Ot29, on the other hand, contains ceramics and might be a small agricultural hamlet. However, this is also an area of Class I oak-hickory and walnut soils. Ot37 is defined as a hunting camp, and it exhibits no associations with oak-hickory soils, only with Class II walnut and agricultural soils.

There are two possible geomorphological explanations for the apparent incongruence between settlement and resource locations. The first of these is that the lake drowned many of the sites as it rose, or that it drowned the alluvial soils associated with the floodplain and bayshore. Thus, what we see is a drowned river valley without extant agricultural soils. Another possibility is that the water table may have risen to a point where it was no longer feasible to farm due to poor drainage. With the lake level and the water table at a lower level, drainage might be improved, even with the moister climate postulated for the early part of this period.

The lack of detailed soils maps unfortunately precludes an evaluation of these possibilities. We can only assume that our soil maps accurately reflect the actual prehistoric pattern in the area and that neither agricultural soils nor oak-hickory or walnut soils are important site predictors for this region. It seems that riparian or lacustrine resources are the important subsistence elements in this adaptation, with maize and nuts providing supplemental rather than primary nutrients. This is reflected in the faunal assemblage from Libben, where fish constituted 78% of the usable meat. This pattern may have persisted into the terminal Late Woodland as well, although no archeological data currently exist to support this idea. Small tracts of Class I agricultural soil are located up-river, and it may be that these areas were utilized for agricultural purposes. The cluster of 4 villages, two of which are known to have fortifications and cemeteries, suggests that this region was rich in resource potential. It would appear to have been ideally suited for fishing and trapping. People may have used nets, weirs, traps, fishhooks, spears, or some combination of these implements; these implements could also have been adapted for defense. It may also be the case that this was one of the few elevated, non-flooded spots along the river.

The predictions of our Type VIII settlement mode can be upheld. Five of the 7 sites are permanent villages that served one special function, hunting camp. One site appears to be a campsite or small hamlet (Ot29), but it was partially obliterated by the rising lake level. The basic nature of the settlement system and the settlement modes is clearly reflected in the site file data, which represents a markedly distinctive pattern compared to earlier occupations in this area.

3.4.1.8 Settlement Mode IX: Case Study, Black River

Our next settlement mode is tested for the Black River area. Although this area is more closely associated with the Western Basin, it closely resembles the Whittlesey Focus of northeastern Ohio from an adaptive perspective. In fact, Greenman originally included Burrill Hill in this focus. Environmentally this area is similar to Whittlesey in that a river bisects a series of high bluffs. Since this is the case, it was felt that both the Eiden Phase and the poorly understood Hale Phase could be investigated in this area as well. This is important, since there is a paucity of early Late Woodland sites in the area to the east.

Three soil maps, one each for oak-hickory, walnut, and agricultural soils, were prepared for the wetter climate that characterized the early Late Woodland from A.D. 600 to 1000-1300 (Figs. 3.16-3.18). Only two components, both fortified villages, are known for this period. Both are surprisingly associated with Class II, not Class I, agricultural soils. LN2 is situated adjacent to an extensive tract of Class I oak-hickory soil with only minimal floodplain alluvial soils. LN3 is on a bluff near the confluence of French Creek and Broad River, and has a broad band of Class II oak-hickory soil and an equal area of Class I walnut soil nearby. These settings appear to represent the two optional locations in the study area in terms of high quality nut-bearing soils. The fact that neither site is associated with Class I agricultural soil suggests that natural resources still played an important role vis-a-vis agricultural resources in this adaptation.

Another pattern is that of the nucleation of population into villages and an absence of campsites. This, however, might be a function of inadequate surveys in the interior area. Nonetheless, looking at the total number of known components in the region, very few are early Late Woodland.

If the site file data are accurate, the settlement data for the Black River suggests a continuing decrease in population, a decrease in the number of sites, and a nucleation of population into the most favorable resource zones. These zones are defended, as evidenced by the fortifications associated with the village sites. Fortifications are not characteristic of Middle Woodland occupations in the areas to the west, as discussed earlier. We do, however, see a different pattern here than that proposed by Brose (1976b) for the northeastern area for this time period, even though the general trends he suggests hold locally. There is evidence for increased sedentism and nucleation of population compared to the earlier period. In the Black River area, no summer-winter dichotomy in site occupations can be seen. While fall-winter camps may be located farther south than the area encompassed in this study, it is also possible that differences in the environments between northeastern Ohio and this area may be responsible for the pattern discrepancies.

Figure 3.16. Settlement Mode IX: Black River Oak-Hickory Soils, Wetter Regime

Figure 3.17. Settlement Mode IX: Black River Walnut Soils, Wetter Regime

Figure 3.18. Settlement Mode IX: Black River Agricultural Soils, Wetter Regime

3.4.1.9 Settlement Mode XI: Case Study, Black River

In the terminal Late Woodland period of the Black River drainage, the environment was climatically modern. A developed agricultural economy was probably in operation. Environmentally speaking, this is the most predictable of all the settlement configurations. All four sites, including three villages and one campsite, are associated with Class I oak-hickory, walnut, and agricultural soils (Figs. 3.19-3.21). Even more important, we see an abandonment of the down-river site, LN2, at this time, coinciding with a shift from Class I oak-hickory and walnut soils to Class II soils. Hence, we see a regrouping in the vicinity of the junction of Black River and French Creek. We also see an absence of fortifications at the well-documented Eiden Site, suggesting relaxation of tensions as soils and climatic conditions, along with improved maize varieties, resulted in a dramatic rise in subsistence production. The vicinity of the Eiden Site, LN14, contains the area's most expansive tract of prime agricultural, oak-hickory, and walnut soils. Population growth is inferred for the terminal Late Woodland as well, since LN40 and LN46 are thought to be contemporary and to post-date the Eiden Site. These sites are also adjacent to the highly productive area. Site LN15 is listed as a campsite in the site file data; it might have functioned as a hamlet, or as a hunting or collection station.

One pattern that persists from the early Late Woodland era is the limited number of campsites on the Black River. The exact significance of this is unknown. The Black River settlement data does, however, effectively show a shift in the importance of maize in the subsistence base of the terminal Late Woodland compared to the early Late Woodland. Thus, these soil types, especially when linked with highly productive nut-bearing tree soils, clearly become useful predictive variables for site location in northcentral Ohio and perhaps in northeastern Ohio as well.

The implications of both Black River periods, early Late Woodland and terminal Late Woodland, indicate that the settlement system history for this region is unique. The early Late Woodland system is somewhat similar to that of the Western Basin, and shows a lack of small campsites associated with the large fortified villages. Upland game and nut resources take on the importance of the fish and swamp game associated with the Libben Phase. Although the settlement configurations are similar, some features of the adaptation clearly are not.

In the later Eiden Phase, we again see a clear difference in adaptation from that of the contemporaneous Peterson Phase. A shift towards the largest expanses of high-yield maize soils occurs during the Eiden Phase, a pattern not observed in the Peterson Phase on the Portage River. Thus, in spite of similarities in settlement and artifact assemblages, as well as in mortuary, disease, and demographic patterns, the adaptations are distinguishable. Fish are not nearly as important in the Eiden Phase subsistence base, and maize, deer, and elk make up the bulk of the subsistence base. This pattern reflects the marked circumscription of high productivity soils in both the Portage and Black river areas, as can clearly be seen by comparing the maps for the two drainages. Thus the similarity in settlement patterns between these two areas is based on artifact and resource distribution on the landscape rather than on the types of resources involved.

Figure 3.19. Settlement Mode XI: Black River Oak-Hickory Soils, Modern Regime

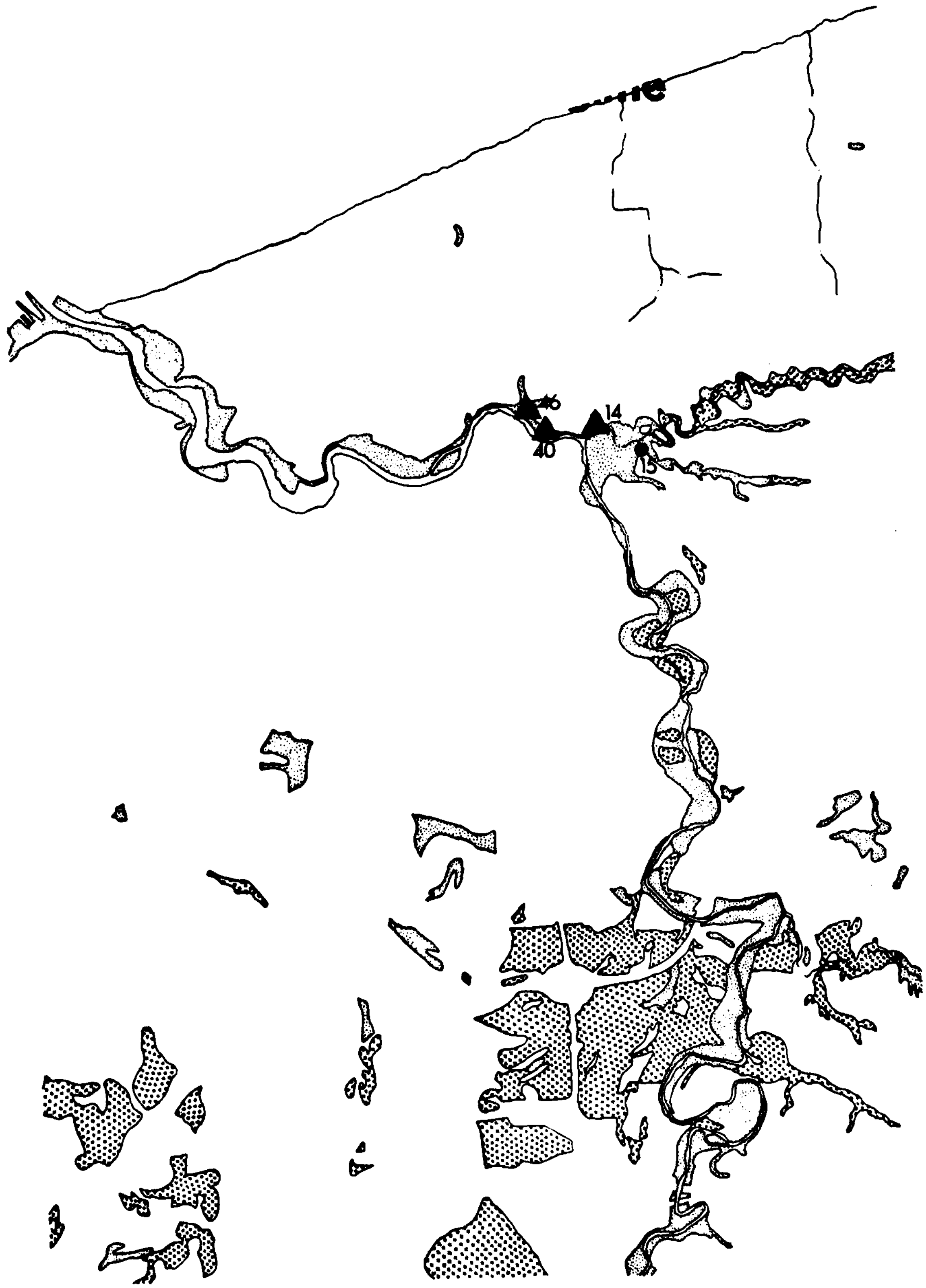


Figure 3.20. Settlement Mode XI: Black River Walnut Soils, Modern Regime

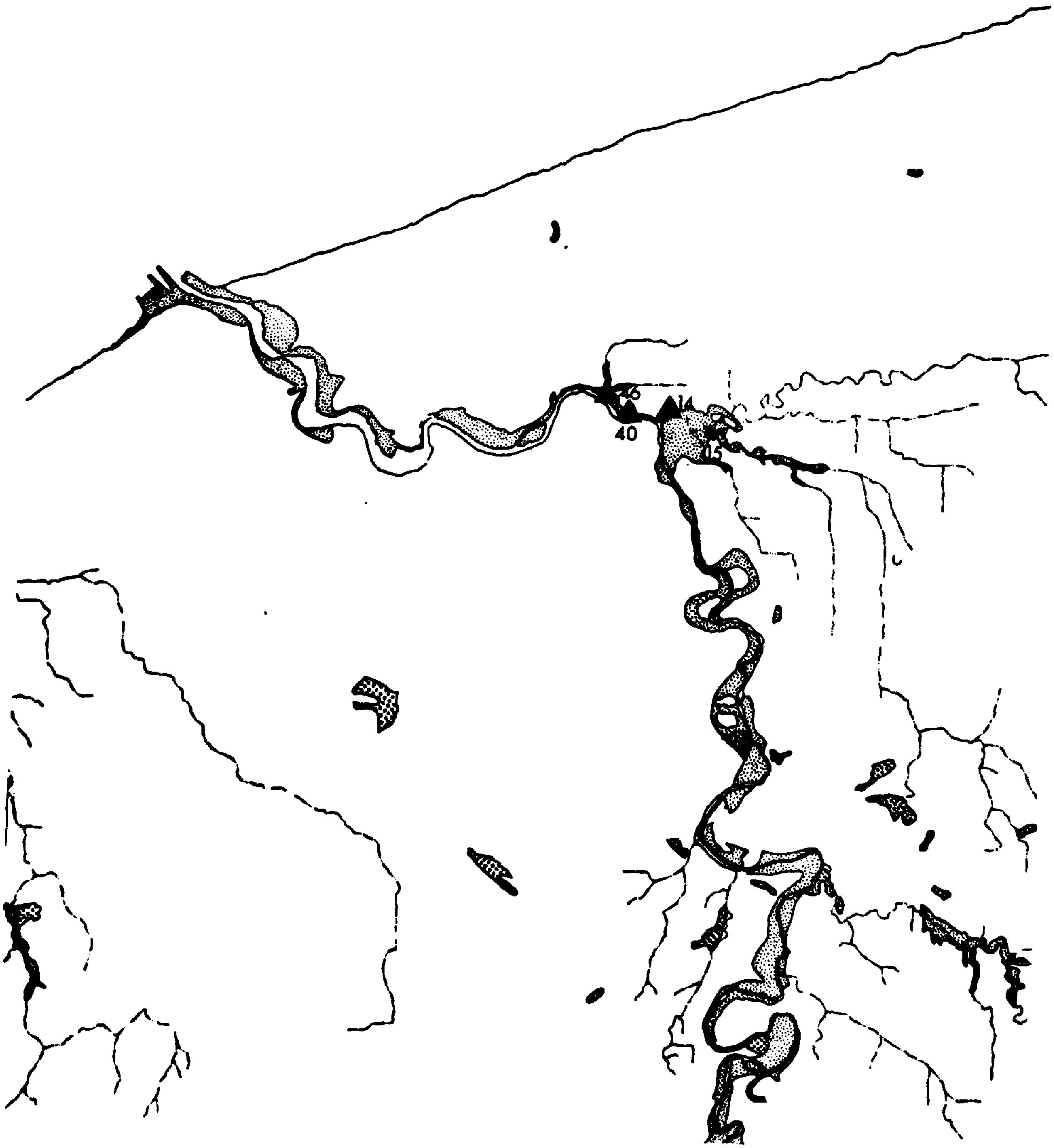


Figure 3.21. Settlement Mode XI: Black River Agricultural Soils, Modern Regime

3.4.2 Settlement Modes in Zone 4: Southwestern New York Lowlands

The Lake Plain between Silver Creek in Chautauqua County, New York, and Mill Creek in Erie County, Pennsylvania, represents an area of sufficiently distinctive geomorphological and hydrological characteristics to be treated as a separate unit for cultural analysis.

3.4.2.1 Regional Setting

This section of the Lowlands is in the form of a narrow 3-to-10-km wide belt of "nearly undissected lacustrine plain developed on littoral deposits of proglacial lakes which preceded Lake Erie in the Erie Basin" (Muller 1963:10). From the plain, the land rises steeply to the lake escarpment behind the Whittlesey and Warren strandlines. The residual glacial complexion of the plain has been only slightly modified by a subdentritic drainage pattern; streams are short, often steep, and run within narrow, deeply eroded paths sometimes approaching "gorges" to the shore. Along parts of the shore, especially in the southwestern corner of New York, the nearshore topography is one of high bluffs rising sheer from the lake some 20 m, producing a shoreline where easy access to the plain is limited to the larger stream mouths. These physical characteristics have been crucial in the formation of soils suitable for nut-tree growth as well as agricultural use and consequently may have been a fundamental factor in the pattern of aboriginal settlement in the zone. The discrete distribution of top quality soils in the form of beach ridges and lesser expanses of alluvial bottoms, as well as topographic and hydrological features of the landscape, has allowed us to form fairly clear expectations about the patterning of aboriginal settlement.

Parker's (1922a:Plate 153) map of Chautauqua County shows the approximate locations of at least 3 villages, earthworks, or "forts"; 2 camps; 3 mounds; and one burial. Some of these have been relocated on modern maps and additional locations have become available from the limited systematic surveys in the Pomfret and Sheridan areas (Miller 1975). Our sample for the entire zone includes 26 sites. Although all phases are probably represented, our data was insufficient to make discrete age estimations for most sites. Consequently, we will discuss their distribution with respect to the pre-Late Woodland settlement system, Mode VII, and the Late Woodland settlement, Mode XII. Although future research may reveal evidence for an Early Late Woodland semi-sedentary settlement mode (Mode X), sufficient settlement data do not exist at this time from Zones 4 and 5 to evaluate their spatial characteristics.

3.4.2.2 Settlement Mode VII

The evidence for settlement prior to the Late Woodland is very poor for this zone. Parker (1922a:510) reported the location of several mounds, probably of Middle Woodland age, in the vicinities of Sheridan and Fredonia, although little information about them is available. One has been relocated, UB 391, the Risely Mount in Fredonia, located on high ground adjacent to Canadaway Creek. Although we have no evidence for an associated habitation camp, the mound's location on high yielding nut-tree soils (Dunkirk loam) and adjacent to equally high yielding alluvial stream terrace deposits suggests an optimal location for settlement.

Although we expect the placement of large, warmweather base camps to be at the mouths and lower reaches of large lake tributaries near prime fishing locations, no such sites are presently known. This, however, may be a result of modern survey bias. We estimate that lakeshore erosion over the last few centuries has eliminated from 500 to 1000 m of original beach, which doubtlessly has resulted in the destruction or submerging of an undetermined number of campsites once occupying the creek outlets and deltas along the lakeshore.

One area of particularly high potential is Dunkirk Harbor. In addition to its attractiveness as a prime fishing location, our lake-level reconstruction suggests the existence of a large island, about 1 × 0.5 km, presently under some 6 ft of water but no doubt dry and accessible to habitation prior to the end of the xerothermic. The probability of extensive base camp occupations on this underwater feature as well as along the original beach lines of the surrounding bay are extremely high.

Although information on large base camps is completely lacking, some useful information on small campsites is available from recent surveys in the Pomfret and Sheridan areas. A total of 8 prehistoric sites were recorded; all appear to date prior to the Woodland and are probably Late Archaic. Both areas surveyed occupy similar settings along the lower sloping lands fronting the lakeshore from about 1 to 3 km inland. Neither area possesses major water courses, encompassing instead the middle portions of small stream drainages whose headwaters can be found in the glacial lake beach ridges about 1 km to the east. Their outlets are to be found in small natural bays at the lakeshore in Van Buren Bay and Eagle Bay. Miller (1975) systematically surveyed and subsurface tested a total of 600 acres, which made up a sample of about 25% of the total acreage. The resulting settlement patterns were strikingly similar in both areas. All 8 sites--4 from each area--occurred within the eastern or farthest inland portion of the surveyed areas on higher elevations. In the Pomfret area, all loci occurred between 635 and 670 ft of elevation; none were found on the lower slopes near the shore between 635 and 600 ft. Since several small streams are located in the area, sites were always within several hundred meters of water and usually situated on elevated ground such as a knoll. At Sheridan all four sites also occurred in the eastern or inland portion of the area that forms an elevated plateau at between 690 and 720 ft; no sites were found on the lower sloping western half of the area between 640 and 690 ft. As at Pomfret, all loci were near a stream. The consistent pattern of higher-ground, inland settlement locations does not seem to be attributed to variations in present soils; instead, it implies forest resource availability within areas since both regions are characterized by poorly drained clayey soils with limited nut-tree productivity. Miller suggests that sampling bias due to the greater surface visibility in the eastern sections surveyed may partially explain this distribution. In addition we suggest that, under the generally drier conditions prevailing during the Late Archaic, soils of the higher eastern slopes within and bordering the survey areas would have supported prime nut-bearing forest stands as they presently do on the higher slopes and beach ridges to the east.

In terms of the structure of mode VII, the Pomfret and Sheridan surveys appear to have disclosed several small seasonally used ancillary camps probably associated with as yet undiscovered base camps located at the mouths or lower reaches of the larger streams in the general vicinity. Most importantly, Miller's (1975) study made clear the fact that systematic surveys of even small areas of the lake plain can uncover numerous small sites hitherto largely unrecognized as a result of previous biases toward the recognition of larger, more visible mounds and earthworks. If Miller's results are an accurate indication of the frequency of such small loci within similar nearshore areas, 2 to 4 km inland, a density of 0.015 to 0.016 sites per acre surveyed can be expected (Miller 1975:33,49). Since both surveys sampled areas of minor drainage, densities several times this are to be expected within the larger stream and river valleys.

Several of the few remaining pre-Late Woodland sites from the southwestern New York Lowlands zone in Erie County, Pennsylvania, may fit this general pattern. ER 8 and ER 10 in the Twenty Mile Creek valley, and ER 18 along Four Mile Creek, may represent small camps associated with larger base camps at the stream mouth now destroyed or submerged by rising lake levels.

In addition to campsites, two additional site types are represented by ER 66 and ER 67. Both are quarry sites near gravel outcrops on the glacial beach ridges inland near Four Mile and Sixteen Mile creeks, respectively.

To conclude, although evidence for pre-Late Woodland settlement is very limited, the location of known sites, which are primarily small ancillary camps, do conform generally to the expectations of settlement mode VII.

3.4.2.3 Settlement Mode X

Early investigators in southwestern New York were impressed by the seemingly consistent patterning of large Late Woodland forts. The presence of large earthworks positioned along the higher topography of the gravel beach ridges was recognized as early as 1860 by Cheney. With few exceptions villages were not reported to occur along the lakeshore; a conclusion that has been recently accepted by Schock (1974). And although alluvial bottomlands are very restricted in their occurrence along Chautauqua, Canadaway, and Walnut creeks, there are no villages presently associated with the lower reaches of these waterways. Sample bias must certainly be considered as a reason. But it is also true that these lower valleys may not have offered the easily defensible topography characteristic of the beach ridges further upstream, which were also prime areas for agriculture. Hence, although the lower reaches of some large streams provided suitable agricultural lands, their usefulness was constrained by the absence of an easily defensible landscape that was critical to late prehistoric village location. The sites recorded can be briefly described as follows:

UB 907. Little is known about this village situated on an "abrupt eminence" at the steep bank of a small creek. The wall was apparently circular and encompassed about an acre. Its location at the upper reaches of Canadaway Creek is in close proximity to water as well as expanses of cultivable glacial beach deposits and nearby alluvial bottom.

UB 119. Sheridan Earthworks is one of the largest of the forts recorded in western New York. It is situated on a slight eminence at the headwaters of Beaver Creek, just above a marshy area.

UB 917. Parker (1922:509) reports this as an elliptical work on the west Bank of Fays Creek.

UB 452. The Westfield Village Site was reported by Parker (1922:509) as a "walled enclosure and village plot." A nearby ossuary was also reported as well as several additional sites in the vicinity of Westfield. The village was later excavated by Guthe (1958). Although the site occurs several kilometers from Chautauqua Creek, it is actually positioned to take advantage of the cultivable beachstrand deposits near the headwaters of a small lake tributary stream. Although fairly large expanses of alluvial soils do occur in the wider Chautauqua Creek valley to the east, this valley may have been avoided due to military considerations.

Perhaps contemporaneous with Westfield or somewhat earlier is the Peacock site (UB 817) situated at the mouth of Chautauqua Creek. This may have been a large fishing camp used seasonally by village groups.

UB 1369. Little is known about the Falvay Site, which appears to be an Iroquois ossuary located at the headwaters of a small lake feeder several km inland on the glacial beach ridge. Its location is similar to known village sites, and chances are it represents another such site.

ER 6. Following the beach ridge west into Erie County, Pennsylvanis, Wintergreen Gorge occurs on an escarpment above Four Mile Creek.

ER 13. Little is known about the East 28th Street Village and Cemetery Site. It is apparently an early historic settlement situated on a gravel knoll inland from the lake within the city of Erie. It was probably near the floodplain of Garrison Run.

Although the distribution of prehistoric forts appears to be fairly well correlated with the distribution of glacial lake beach ridges in this zone, there is also evidence for important exceptions to this pattern. Most notable is the Ripley Site.

UB 113. Parker excavated the early historic Ripley Village and Cemetery Site in 1907. It is located on the shore of Lake Erie adjacent to a small stream on a high bluff known as "Dewey Knoll." The site measured some 180 × 90 m, although the earthring encompassed only the central area of occupation, about 55 m in diameter. There was evidence of additional occupation outside the walls.

The Ripley Site appears problematic at first glance in view of the Late Woodland pattern described. Its location is unique for its rare occurrence of nearshore expanses of well-drained loam soils occurring to the south of the occupied knoll. Furthermore, the site's location was readily defensible by virtue of the sheer bluff walls formed by the lake on the north and the deep gorge on the east.

Further west in Erie County, Pennsylvania, is another large Woodland site presumably of similar age (ER 63). It is situated near the lake on a high slope at the mouth of Twelve Mile Creek. The immediate topography around the site, as at Ripley, is defensible on two sides. Agricultural soils occur directly below the site as alluvial deposits along the lower terrace of Twelve Mile Creek.

As noted earlier, shoreline erosion has greatly altered the extent and configuration of the original beach along the entire southeastern shore. This has raised the question as to whether additional Late Woodland villages located in settings similar to Ripley and ER 63 have been submerged or destroyed. Parker noted during the Ripley excavations that a portion of the site had disappeared as a result of erosion of the bluff. In addition, Parker noticed the existence of several small villages at the mouths of streams east of Ripley; these have never been located again. We must conclude that some unestimated loss of large village sites through shoreline erosion occurred, although probably not to the same degree as is likely for large base camp sites of earlier periods. The postulated pattern of Late Woodland village location assumes site placement decisions to have been based upon the occurrence of three parameters--agricultural soils, defensible topography, and a water source. Consequently, high probability areas within this zone of the Lowlands correspond most highly with the distribution of beach ridges near streams some 2 to 4 km inland from the lake. Equally likely locations directly on the lakeshore are much less frequent and are limited to the lower reaches of streams and stream outlets where suitable topography for defense occurs; easily defensible positions would include steep shore bluffs and stream gorges in conjunction with cultivable soils either in the form of alluvial terraces or rare expanses of nearshore glacial beach gravel deposits. Besides the Ripley and Twelve Mile Creek locations already noted, other probable nearshore sites may occur at the mouths or lower reaches of Walnut, Canadaway, Twenty Mile, Sixteen Mile, Twelve Mile, Eight Mile, and Six Mile creeks. Parker did report a fortification on Walnut Creek near Silver Creek as well as "recent village sites of the Seneca" near the shore at Dunkirk Harbor, neither of which is recorded on modern maps. Within the city of Erie, the mouths and lower courses of Four Mile and Mill creeks may also contain sites, although any evidence has no doubt been obscured or destroyed by modern settlement. The innumerable smaller lake tributaries that occur between the larger streams from Silver Creek to Mill Creek appear to have developed insignificant alluvial terraces and may not have supported large village settlements.

3.4.3 Settlement Modes in Zone 5: Western New York Lowlands

3.4.3.1 Cattaraugus Valley

We have recorded the locations or approximate locations of 20 archeological sites within the Cattaraugus Valley, from Gowanda to Lake Erie. Since much of this area lies within the Cattaraugus Indian Reservation, direct access to archeologists has been tightly restricted since the early part of this century. Most data available on settlement locations is derived from the original descriptions of early investigators (Parker 1922; Clarke 1909; Cheney 1860). Of the sites originally recorded, many have never been located again in modern site files, and fewer have been excavated. Still, this river valley, by virtue of its relatively protected status as a reservation, supplies the best documentation of the Mode VII and Mode X settlement patterns in the Western New York Lowlands zone. We will describe the cultural resources defining these patterns in some detail. A briefer discussion of settlement in the remainder of the Western New York Lowlands will also be presented.

Parker's (1922) maps and descriptions for Erie, Chautauqua, and Cattaraugus counties indicate that the middle portion of the Cattaraugus Valley was particularly rich archeologically. As he noted, a "principal archeological center" of this region of New York was "the region about the mouth of Cattaraugus Creek along its banks as far south as Gowanda" (Parker 1922:493). From the stream's mouth to Gowanda, Parker mapped some 11 villages, 4 earthworks, 14 campsites, 9 burials, 8 mound locations, and a large number of "occupation traces" probably corresponding to small camps. Parker's evidence of occupation upstream from Gowanda drops off abruptly, however, suggesting that most settlements were concentrated within the 20-mi. stretch along the lower and middle reaches of the valley, below 1000 ft. This part of the valley provided the greatest potentials for fishing and farming activities, which appear to have been important factors in site location everywhere in this zone.

Three categories of sites are distinguishable from our site file search and published site descriptions: 1) mounds, 2) villages and/or forts, and 3) camps. Mounds all appear to represent Middle Woodland age mortuary sites, some with associated settlements. Villages appear to represent the Late Prehistoric (A.D. 1300-1500) and early Historic (A.D. 1550-1650) periods. Camps were more difficult to date, but several do bear Late Woodland materials and have been considered within the Mode X distribution; the remaining camps appear to be pre-Late Woodland and are considered components of the Mode VII distribution.

Cattaraugus Creek, a major drainage for the Western New York Lowlands, has its headwaters high in the Allegheny Plateau. From Gowanda to Sunset Bay on Lake Erie, the creek has carved a wide valley within soft shale deposits. The recent course of the creek is along the southern edge of the valley, which is bounded by generally much steeper topography. Associated with the stream's wide meander path are alluvial terraces up to 5 km wide occurring along most of the lower and middle valley. The topography of the lower valley--the lower 3 km or so of the river--can be distinguished from the middle valley by its more gentle landscape and wider expanses of low and often marshy alluvial bottoms, particularly at the creek's delta. In the middle course, from about Irving upstream to Gowanda, the alluvial bottoms occur as terraces predominantly along the creek's northern flank, while the southern flank is made up of a series of steep shale and gravel bluffs about 35 m above the creek. These bluffs are broken only occasionally by small streams that have eroded deep side ravines and formed, at their confluences with the Cattaraugus plain, a number of promontories or peninsular bluffs that were apparently prime locations for Late Woodland villages.

The valley would originally have been heavily wooded with northern hardwoods and mixed mesophytic forests. On the lower terraces, butternut and walnut were common, while on the wetter slopes, beech, maple and hemlock occurred. In the drier interfluvial areas, an oak-chestnut forest was to be found (Gordon 1966). Associated with these heavy mast-producing forests must have been the standard temperate forest fauna, including deer, turkey, raccoon, and perhaps some of the more northerly species such as moose. The creek itself, along its lower and middle sections, is historically noted for its seasonal runs of anadromous fish, particularly sturgeon and catfish (Douglas in Doty 1940; Harrington 1922a).

3.4.3.1.1 Settlement Mode VII. Seven mound or mound groups, 2 of which have evidence of a probable base camp habitation, and 9 small loci, probably representing small ancillary hunting and collecting camps, have been recognized within the Cattaraugus Valley.

Burmaster (UB 704) and Mouth of Cattaraugus Creek (UB 707) Mounds. The best described sites in this pattern were located at the mouth of Cattaraugus Creek. Parker wrote,:

> Near the mouth of the Cattaraugus on the north side are several large sites each covering from 50 to 100 acres. Several occupations are apparent, but the influence of the mound culture is plainly evident. On the site nearest the mouth of the creek was a mound since removed by the local sand company. Skeletons and portions of a buffalo skull were found by E.R. Burmaster in 1914.
>
> The adjacent village site has yielded innumerable notched sinkers, several bird stones, banner stones, celts, gouges, grooved and notched axes. Several broken monitor pipes, one complete form and one clay pipe and several fragments of thick cord-stamped pottery were found by Mr. Burmaster. Chipped flints are numerous. The forms are notched arrow points of several types, scrapers, drills, spears and knives. Long flakes of chalcedony and jasper are also found (Parker 1922:90).

Nothing is known about a nearby site, UB 707.

From Parker's description of Burmaster Mound and Habitation it seems certain that a substantial Middle Woodland occupation was once located at the stream's mouth.

UB 703, 705, 274, 275, 144. Five additional mound locations occur above the stream mouth. UB 703 is north of the creek near the headwaters of Muddy Creek. UB 274 occupies a hillside overlooking the Cattaraugus flood plain below. Benedict in 1901 recovered burials and lithics from the site but no adjacent habitation is known. UB 705 occurs on the creek bluff just south of UB 274.

UB 275 may represent another mound--habitation complex. It occurs near the creek on a terrace across from the Late Woodland Double Wall Fort village. Parker described the location as follows:

> Burial mound on the south bank of the Cattaraugus creek . . ., near Little Indian creek . . . The mound is one of the largest in the state but not more than 8 or 9 feet in height, though it shows evidence of having been plowed considerably.
>
> It is about 30 feet in diameter. The fields about show evidence of early occupancy, notched points of flint and chalcedony have been found. Several skeletons have been taken from the mound . . . Accompanying relics are recorded to be four notched spears of knives, a copper chisel, and a knobbed end lunate banner stone. The pottery is cord marked. During a visit . . . [was] found half of a fish effigy. The mound stands on the edge of the bluff and a portion has fallen over. Almost exactly north and across the Cattaraugus on the opposite and corresponding terrace are two other mounds . . . the ground about the mound is strewn with flint chippings, and a number of arrow points, celts and pestle have been found (Parker 1922:89).

Parker's description suggests another area of floodplain-terrace Middle Woodland settlement in this upstream location similar to those at the creek mouth some 8 miles downstream.

UB 144, Cheney Mound, is the last mound location recorded and is the furthest upstream from the lake. It is located on a broad alluvial lower terrace formed by an old meander course of the creek.

Evidence of Middle Woodland sites in the valley suggests that mounds were probably closely associated with habitations, perhaps large, warm weather base camps. From Parker's descriptions as well as our own study of mapped and recorded sites, it appears that these sites tended to occur on low topography, usually first terrace settings, below 700 ft, within several hundred yards of the main creek. In two cases, mounds were situated in elevated locations but at the margins of the valley overlooking the floodplain. Although we have no evidence for habitations with these mounds, such remains would be expected on or directly adjacent to lower terraces. The choice of prime fishing locations, implied by the lower terrace locations, is supported in both habitations by the presence of numerous net sinkers.

In contradiction to this evidence, recent subsurface sampling and surveys of the mouth of Cattaraugus Creek and Snow Island have yielded no indications of aboriginal occupation (CRMS 1977). The investigators concluded:

> A . . . specific appraisal of the beach-creek mouth sector shows it to be often a tenuous area of occupation, yet sought seasonally as a high energy zone of aquatic resources, especially for spring and fall migrating fish . . . On the other hand, back beach and near inland sites on available areas of relief provide access to the shoreline while taking advantage of the mitigating climatic effect of the Great Lakes. Again sites offer summer and fall access to the migrating activities of several major fish species as well as habitats of waterfowl . . .
>
> The egress of Cattaraugus Creek, to Lake Erie is a typical geomorphological feature of the Great Lakes Areas, unprotected by harbor and with an offshore bar forming across its mouth created by long currents. Just as typically storms, floods, the autumn and winter "westerlies" coming offshore, changing channels, all would seem to mitigate against human settlement . . . . Geological and preliminary field evidence indicated that the area where the shoreline and creek delta were constantly modified by natural forces (CRMS 1977:10-11).

Although we concur with this assessment of present conditions at the delta, our environmental reconstruction suggests somewhat more favorable conditions for occupation at the end of the xerothermic during the Middle Woodland period. It is likely that the beach extended out some 0.5 to 1 km from the present shoreline. Lower water tables and a generally drier climate suggest that the presently low and marshy delta area would have been higher, drier, and more suitable for settlement, at least on a seasonal basis. The failure of recent survey investigations to document the use of this location probably reflects the altered physiography of the lower creek in the recent past. Changes in the course of the creek, the doubtlessly heavy alluviation at the creek mouth (particularly in the wake of modern agricultural practices on upstream slopes), and the enroachment of the lakeshore in conjunction with higher water levels, probably contributed to the destruction of some formerly present settlements, while concealing or obscuring the locations of remaining materials. It is clear, therefore, that this location must be considered as having especially high archeological potential.

A total of 9 sites that appear to date prior to the Late Woodland were also recorded in the Cattaraugus Valley. All are characteristically small, and are usually reported in the site files as isolated surface "finds" or "scatters" of lithic artifacts. Most of these occurred in the higher topography of the hills flanking the plain above 700 ft, and tended to occur along the upper courses of small tributary streams.

When Mode VII sites were plotted against the distribution of first-rate nut-bearing tree soils, the results were inconclusive, although mounds (and presumably associated base camps) were correlated in 4 of 7 cases, with floodplain alluviums having high walnut potential. However, the determining factor may have been proximity to aquatic resources rather than tree resources. Even less correlation was evident between small camps and nut-tree soils. In these cases proximity to a small stream was a stronger predictor of site location. Due to the small sample size involved in this comparison, caution must be used in assessing the results.

3.4.3.1.2 Settlement Mode X. Seven villages and 3 possible camps dating from the Late Woodland and probably from the Late Prehistoric and early Historic periods have been identified in the Cattaraugus Valley. Schock (1974; 1976) and White (1976) have suggested that the village settlements may represent the relocation history of a single community moving downstream from Gowanda toward Irving. Considering the spacing between sites, about 1 to 3 miles, this is probably the case. The latest sites, with evidence of European trade goods--Highbanks, the Silverheels cemetery, and possibly another village-cemetery complex, the Newton-Livermore sites--occur at the downstream end of this sequence and may have been characterized by less substantial earthworks than earlier prehistoric villages. All the earlier villages occur along the middle reaches of the stream from about 3.5 to 8 mi. from the lake. All are heavily earth embanked and are usually described in the early reports as "forts."

The principal village sites for which information is available will be briefly described as follows:

High Banks (UB 887). This early historic village, originally recorded by Cheney (1860) and later by Parker (1922), is situated on the north bank of the creek about 1.5 miles upstream of Irving. The village was apparently quite small (less than an acre), but embanked and palisaded. "The wall has now been nearly obliterated. It was formerly some three feet in height; and can be distinctly traced . . . from the course which the creek here assumes, the area embraced is some three-quarters of an acre" (Cheney 1860:38). From Cheney's drawing it seems that the creek may have eroded a portion of the old earthworks, leaving the semicircular works reported by both Parker and Cheney (Cheney 1860, Plate 1). Later investigations by Clarke (1909) seem to indicate that the creek had shifted south and was some one or two hundred meters from the site. Clarke noted: "It is situated on a natural knoll perched upon the edge of the alluvial bluff that overlooks the Cattaraugus Valley. It is a spot well adapted for fortification or refuge. At the base of the bluff are copious springs" (Clarke 1909, 55). Of the site's setting, Cheney wrote: "The valley here forms a wide and beautiful expanse, the hills rising in shadowy outline upon either side . . . and the creek, a shallow but broad stream, glides away to mingle with the waters of Erie . . ." (Cheney 1860:38). The floodplain at this location is several hundred meters wide during most of the year providing optimal farming opportunities. Furthermore the alluvium is periodically rejuvenated by the spring floodwaters which may cover the entire plain.

Silverheels (UB 787). This prehistoric village is upstream from the lake in a similar setting as High Banks. Harrington, who excavated part of the site in the 1920s, wrote that it occupied "a flat-topped point projecting into a swampy portion of the Cattaraugus floodplain--a point where bold steep banks arising from the swamp made it easy to defend from a possible enemy by the embankment and the palisades which doubtless surmounted it in ancient times" (Harrington 1922b:208). Excluding the marshy areas described, the site sat adjacent to wide expanses of fertile cultivable bottoms and near the creek. As at High Banks, springs emanated from the immediate bluff walls providing ready access to potable water. In village storage pits were recovered corn, beans, squash and acorns. Fishing was important as indicated by fish bone--predominantly catfish and sturgeon. Significantly, faunal remains reflect a focus on small game like woodchuck and raccoon and less on large game like deer. Perhaps this village was used primarily during the warm months for farming and fishing, rather than the year round. If so, it may represent a semi-sedentary pattern postulated for the early part of the Late Woodland.

An important observation by Harrington was the presence of a possible "annex" camp occupation outside the village walls on the adjacent floodplain where the remains of net sinkers and other remains suggest a nearby fishing camp.

Burning Springs (UB 774). This is another small (1 acre) prehistoric village fort situated on a promontory bluff formed by Big Indian and Cattaraugus creeks. Parker who investigated the site wrote: "The site is one admirably adapted by its natural surroundings for a fortified refuge, the treacherous Cattaraugus on the north preventing easy access from that direction and the high, almost perpendicular, slate cliffs of Big Indian Creek on the west forming effective barriers there" (Parker 1922:10).

The creek valley in this location, several miles from the lake, is more narrow than in its lower reaches, although appreciable expanses of alluvial bottoms occur below the site on the north side of the creek some 100 meters distant. Excavation of the village features by Parker resulted in abundant remains of corn and wild plants--walnut, butternut, and wild plum. Large game were also plentiful and fish remains as well as net sinkers indicate active fishing near the site.

Double Wall Fort (UB 772). Most impressive of the ancient forts in the valley is Double Wall Fort located upstream from Sunset Bay. It is situated on a high bluff formed by Cattaraugus Creek and a small side ravine. Harrington noted: "The ancient stronghold lies on a long flat-topped point almost separated from the rest of the terrace by a deep ravine in the bottom of which flows a small brook . . ." (Harrington 1922a:238).

The terrace deposits are of course gravel and sand underlaid by clay and "the banks are steep and the ascent is very difficult, either from the creek or the gully. The top of the bluff is about 50 feet or more above the creek level" (Harrington 1922a:238). The village wall is heavily defended with a double embankment on its rear upslope flank. The location, like others along the valley, permitted direct access to broad expanses of rich alluvial bottoms, which at the time of Harrington's (1922) visit were under intensive corn cultivation by the Seneca Indians. On-site features included a spring within bounds of the palisade line which would have provided a nearby water source even while under attack.

"Annex" camps appear also to have existed on the adjacent plain, as Harrington notes: "occasional chips, points, net sinkers, and potsherds with a few fire-cracked stones scattered over several acres . . . There are other sites of this kind on the flats" (Harrington 1922:241).

<u>Other Forts</u>. Several additional forts were reported by Parker (1922) as far upstream as just below Gowanda. Although little information is known about them, all were apparently located on high plateaus, hills, knolls or bluffs overlooking the creek floodplain.

Our review of site descriptions and mapped locations suggests a rather clear and consistent pattern of village location in the Cattaraugus Creek valley, which exemplifies settlement Mode X described earlier. All villages were situated on topography having natural features conducive to easy defense, while also affording immediate access to prime alluvial bottom soils and a nearby water source. Such features characterize much of the landscape along the middle reaches of the valley and it is within this stretch that all known villages are located. In contrast to earlier Middle Woodland base camps, Late Woodland villages are not found immediately at the delta or along the lowest reaches of the creek. While other factors may have contributed in part to this distribution, a critical factor appears to have been the co-occurrence of easily defensible topography and prime agricultural soils. Nearshore delta and lower creek plain locations are characterized by low topography, and although broad expanses of alluvium do occur, poorly drained or marshy conditions may have restricted the usefulness of much of these otherwise suitable soils during the wetter climatic conditions of the Late Woodland. Upstream alluvial bottoms are somewhat better drained, and the more deeply dissected landscape provides easily defensible locations for village placement. Further upstream, the co-occurrence of these two critical parameters becomes less frequent as prime agricultural soils diminish.

In summary the Cattaraugus valley villages exemplify a Late Prehistoric village settlement pattern adapted to agricultural soils, defensible topography and water.

Only three sites on the Cattaraugus Creek valley have been identified as possible Late Woodland camps (UB 145, 1229 and Parker No. 78). One is located on the lower reaches of the creek and may represent a seasonal fishing camp, although we have no artifactual evidence for this. UB 145 is a complex of four loci which also bear materials of an earlier period, and appear to be small hunting camps situated on elevated knolls at the headwaters of a secondary stream in the interfluvial hills to the north of the valley. Parker No. 78 probably occupies a similar setting although we have little information about this site.

3.4.3.2 Eighteen Mile Creek to Buffalo Creek Area

North of the Cattaraugus Creek valley several large creeks or rivers drain the lake plain and adjacent western slopes of the Allegheny Plateau from the Eden Valley to Buffalo. Aboriginally the natural setting was probably quite similar to that described for the Cattaraugus Valley, although much of the land today has been extensively altered by urban settlement associated with Buffalo and its suburbs. From the literature and site files, the location or approximate locations of some 67 sites have been recorded. Although sites and components probably represent all periods from Early Archaic to Historic, individual site information was insufficient to classify many sites as to their phase. The temporal categories represented were as follows: Late Woodland (18), Middle Woodland (1), Early Woodland (1), Unspecified Woodland (2), Archaic (10), Unspecified (35). For the purposes of our analysis, these sites were evaluated in terms of their correspondence to the expectations of either the Mode VII or Mode XII. Although a semi-sedentary pattern (Mode X) may have existed as an Early Late Woodland variant in this region, we do not possess the seasonality data required to assess this at the present time.

3.4.3.2.1 Settlement Mode VII. Parker (1922) described the location of a number of camps, some of which are apparently pre-Late Woodland in age. However his provenience descriptions are quite limited, revealing only that such loci tend to be in very close proximity to a waterway. For those locations which we have been able to map, all loci occurred less than 500 meters from a watercourse and 38 of 49 were within 200 meters. In all but six cases, sites were associated with rivers. The remainder, one Meadowwood camp and five Archaic camps, were all near a fossil lake that is presently a marsh. From our mapped distribution there is also a clear pattern of favoring upstream and near-the-headwaters locations, although this may be in part an artifact of our sample. We have virtually no sample from the lower reaches of Buffalo and Smoke Creeks due to urban settlement. On the other hand, Rush and Eighteen Mile creeks demonstrate a similar pattern of favoring upstream locations despite the less urbanized conditions of these lower stream valleys. Our present sample then does not confirm our original expectations of large base camps at the lake shore stream mouths. A possible factor contributing to the lack of evidence for such sites may be the loss of original beach due to higher lake levels as well as the extensive shoreline erosion, as already noted. Prior to the historic period, a minimum of 200 to 500 meters of additional beach would have been present and it is entirely possible that once existing sites at the mouths of Eighteen Mile and Rush creeks have since been inundated. Some support for this is also provided by Parker's (1922:554) "fort" No. 54, once located at the mouth of Eighteen Mile Creek, which has not been relocated and was presumably lost to shoreline and creek mouth erosion. It is also possible that the smaller creeks did not provide the anadromous fish resources as did the larger rivers like Cattaraugus Creek to the south. The Buffalo River would no doubt have been a good fishery, although any evidence for camps lies under the city.

3.4.3.2.2 Settlement Mode X. One of the earliest investigators to describe the locations of Late Woodland settlements in the area of Buffalo was Squier, who wrote: "Along the shores of Lake Erie and bordering Buffalo Creek are low and fertile alluvials; back of these we come to the limestone formation; and the country rises, forming a second grand terrace, along the brow of which most of the ancient works are situated" (Squier 1849:51).

Squier recorded at least a dozen "forts" along Buffalo Creek and its tributaries. Although only a few of these have been definitely relocated, his descriptions are clear with regard to the kind of setting favored for locating forts. The critical factors were proximity to a waterway, alluvial bottom soils, a nearby spring, and a defensible second terrace, or high knoll. Springs frequently emanate from the bases of second terrace formations along the margins of recent flood plains as they do in the Cattaraugus Valley and are recognized by the associated marshy area on the plain margins. The nearby occurrence of marshy areas is commonly noted in connection with forts of both the Buffalo and Cattaraugus Creek drainages and may provide a useful clue to their relocation.

From our analysis of the mapped locations of some 18 Late Woodland sites along Eighteen Mile, Rush, Smoke, and Buffalo creeks and their tributaries, the impressions about site location from the early literature are largely born out. Eleven of these sites were within 200 meters of a present water course and all were within 500 meters. Our data did not allow us to evaluate the distribution of springs against village locations. The sites for which information on surrounding landscape was available, showed that there was a definite tendency toward bluff, knoll or second terrace positions. However, the sample is inadequate to show any possible favoring of the lower, middle or upper courses of the waterways. In contrast to Cattaraugus Creek, one fort reported by Parker (1922, No. 54) occupied a high topographic position at the mouth of Eighteen Mile Creek but has disappeared, probably as a result of shoreline erosion. Close proximity to top quality agricultural soils appears to have been a determining factor in conjunction with defensible topography. Of the seven villages for which soils information is available (two occurred within the city of Buffalo) all are on or adjacent to top quality Genesee silt loam and Chagrin silt loam soils which occur in limited distribution as alluvium along the margins of the larger streams. It is likely, given their close proximity to the Buffalo River, that the additional two villages presently within the city were also once in direct association with alluvial terraces of Genesee silt loam.

Several non-village Late Woodland sites were also noted, including one cemetery (associated with a village) and six possible camps. Their patterning on the landscape was indistinguishable from village sites based on our information--always occurring near a watercourse and, in cases where soil information was available, in or near Genesee or Chagrin silt loam soils. Along with good agricultural properties, these are also excellent walnut soils.

3.5 SUMMARY AND DISCUSSION
(Sue Ann Curtis and James W. Hatch)

The purpose of this chapter was to present some generalized statements about where prehistoric sites are likely to be found in the lake bottom and on the lake shore. When this study was originally designed, the authors believed that the end of the chapter on prehistory would conclude with the creation of large maps for the entire study area demarking zones with different probabilities for having sites. However, the authors believe that highly specific micro-environmental factors most strongly affect the distribution of the habitation, food collection and food processing sites in the settlement system of a group, and that the level of detail needed to identify all prime site locations for the entire project area would not be feasible. Therefore, an alternative approach was selected.

This approach involves the construction of 12 settlement modes that describe site functions and their distribution relative to certain soils, water and topographic associations. The models of prehistoric adaptation were evaluated in terms of their spatial characteristics and ecological correlates. This evaluation must be thought of as highly preliminary. The evaluation procedure discussed here relies primarily on site information from the files in Ohio, New York and Pennsylvania. In general, the settlement modes were supported by the case studies. Modes III, V, VI and VIII compared well with the site file and environmental data. Modes VII and XII could be generally associated with scattered case study data, but details were available in insufficient quantities to produce environmental maps. Modes I, II, and IV could not be evaluated with case study information. Overall, the modes did reflect on-the-ground conditions, and sites could therefore be predicted on certain types of landscapes.

It is believed that these modes have equal utility throughout the project study area, since the lake bottom and lakeshore area has a moderate to high probability for cultural resource sites. Only by fitting specific modes for the major time periods to specific locations can programs for site identification be executed.

If these modes were systematically applied to all of the land surfaces of the project area, including the submerged surfaces, a large number of potential sites would be expected. This kind of coverage would be necessary for evaluating the potential landfalls for all gas pipelines, pumping facilities, etc. that could occur. This coverage cannot be provided here for three reasons. First, to carry out a comprehensive evaluation of the potential for the shoreline impacts alone at the scale at which we are working is beyond the scope and resources of this study. Second, if a comprehensive evaluation were carried out using larger scale units of observation, then critical observational detail would be lost. Third, any comprehensive evaluation would probably impart to the planner a false sense of security--the erroneous belief that all prehistoric sites were somehow known and located. This is absolutely not true, not even in the cases where study areas have been presented. To varying degrees, every area selected for construction will necessitate an archaeological survey to insure against the destruction of potentially important sites. The important question, of course, is "What degree of intensity is required and in what areas?"

Smaller scale study areas than those provided in this chapter were also considered undesirable for this presentation. Planners will, of course, be operating at a very small scale; for example, the landfall of a pipeline may involve a corridor a few dozen meters wide and a few hundred meters long, and sites within this corridor may be their exclusive concern. However, we feel that the best service this document can provide is as a planning aid, not as an instrument for operationalization. As such, we should do more than simply, but honestly, report that important sites could be situated in any particular corridor. We are attempting to provide a framework, based on the limited data currently available, by which planners can roughly predict the potential for sites on certain types of landscapes (based on soils, terrain and hydrology) and the survey archaeologist, contracted to discover sites in selected corridors, can evaluate the significance of his discoveries.

However, several observations about the kinds of locations in which sites are more likely to be found can be summarized for various time periods. The data presented in this chapter and the environmental discussions in Chapter 2 will be combined and discussed in greater detail in the concluding remarks of Chapter 6.

3.5.1 Early Paleo-Indian Period

Paleo-Indian sites are known for the project area although the descriptive data about settlement systems is not available and the proposed settlement mode (Settlement Mode I) cannot be evaluated with case study information. The most likely locations for finding sites of this period are on beach ridges or knolls near creeks which flow into the lake. Sites tend to be clustered. Sites are usually associated with wet areas reflecting the proposed subsistence emphasis on exploiting the habitat and migration routes of major game animals such as caribou. Although other kinds of locations for sites are expected, incomplete settlement data preclude making generalizations. However, submerged sites are expected beneath the current lake along former beaches or ridge lines that may have been associated with swamps.

It is likely that more submerged sites may be located in the western basin where the authors determined that there were comparatively more wetlands and broad meandering drainages. The eastern lake basin was more rapidly drained after the glacial retreat, limiting habitats associated with high caribou productivity.

Therefore, when field surveys are initiated, special attention should be given to areas with topographic relief near to former lakes, bays and streams. When one site is located, more may be expected in the vicinity. Special attention should be given to field surveys on land and in the lake bottom in the western basin where Early Paleo-Indian sites may be more frequent.

3.5.2 Late Paleo-Indian Period

This period was associated with a climatic change and associated rise in the lake level. Associated cultural remains of this period are reported to be almost three times more frequent than for the Early Paleo-Indian Period. Sites become more common in the southern drainages and are found further away from the current lakeshore. Reported sites are still situated on high topographic locations and tend to be clustered. Environmental changes are expected to be associated with a slow economic shift to exploitation of the faunal assemblage of the more forested environments.

Because of dramatic environmental changes which are not well understood in great detail, Late Paleo-Indian sites cannot be associated with specific soils or vegetational types. Therefore, Settlement Mode II cannot be tested against a case study. Survey researchers would be well advised to emphasize inspection of high areas as well as other kinds of topography, particularly in the western and southern lake drainages. Sites may be located in other parts of the basin as well, and could occur in some of the submerged lands.

CHAPTER 4

THE ETHNOHISTORY OF THE LAKE ERIE SHORELINE AND ITS IMMEDIATE REGION

CHARLES C. KOLB

4.1 INTRODUCTION

The purpose of this chapter is to discuss the ethnohistory and early history of the Lake Erie shore and the adjacent area for the period 1570-1850. Twenty-three culturally distinct groups or tribes were located in the research area during this 280-year period. These were the Cayuga, Chippewa, Delaware, Erie, Fox, Huron, Iroquois, Kickapoo, Mascouten, Miami, Missisauga, Mohawk, Neutral, Oneida, Onondaga, Ottawa, Potawatomi, Seneca, Shawnee, Susquehannock, Tobacco/Tionontati, Wenro, and Wyandot. Fourteen groups were located in southeastern Michigan, ten in northern Ohio, eight in northwestern Pennsylvania, and nine in northwestern New York. During the period under discussion, the region experienced migrations, military and economic incursions (many related to the fur trade), and dynamic cultural adaptations. The research problem was one of defining the intensity of tribal occupations within the Lake Shore Plain during the relevant time period (1570-1850) and of describing and explaining these occupations within a cultural-ecological framework.

The underlying premise of this research project is that human social behavior is patterned and that such patterning is the product of the dynamics of interaction of the cultural systems with the social, physical, and biological environments. The research objectives of this chapter were to

1. prepare a summary of the aboriginal ethnohistory of the region (with emphasis on the period 1570-1850);
2. reconstruct the culture history of the region in relation to the ecological zones, and to discern settlement patterns and site hierarchies as the data allow;
3. summarize ethnographic data on current Native American residents in the region and discern sacred, ritual, resources, burial, and other lands they deem part of their heritage.

To complete the project, vast amounts of available, and often conflicting, ethnohistoric data had to be studied and evaluated. No ethnohistoric synthesis of this area was available. Ethnohistoric knowledge of the area has only recently come into focus, especially since the Whittlesey Focus in Ohio is now no longer considered to be the archeological manifestation of the Erie/Eries/ Eriez Indians (Brose 1976b, Kolb 1977a).

Chapter 4 follows this format: 1) a political and ecological definition of the region; 2) a statement on regional chronology, including a general synthesis; 3) a brief summary of the method and theory of ethnohistory; 4) an evaluation of source materials; 5) a review of Native American settlements and movements within the ecological zones; and 6) a synopsis of ethnographic data on the Seneca of western New York State.

4.2 THE REGION

4.2.1 The Political Units

The southern Lake Erie shoreline, extending some 306 to 359 miles from Detroit to Buffalo, forms the lacustrine border of four states whose lake plain varies in width from 3 to 70 miles. The lake plain thus described encompasses more than 3200 square miles. Important ecological data affecting the ethnohistory will be briefly summarized by state from west to east. Michigan data have also been included in this chapter because data from this area are applicable to the understanding of adjoining areas.

Michigan

The Lake Erie shoreline from Detroit to the Ohio border extends some 30 to 37 miles; the latter figure includes the perimeter of Luna Pier (Peninsula). The width of the Lake Shore Plain varies from 5 to 20 miles and includes two rivers and three creeks. Geological surface formations are primarily Silurian with significant erosion and sedimentation; the physiographic region is classed as Interior Lowland, and soils are categorized as alfisols. The vegetation pattern is predominantly Laurentian Mixed Forest. It is inferred that initial European contact was made in 1620; settlements, however, were not established until 1668. Major archeologic, ethnohistoric, and early historic settlements are found in the vicinity of present-day Detroit and Monroe. Major political units are the City of Detroit and Monroe County.

Ohio

The Lake Erie shoreline from the Michigan to the Pennsylvania border extends some 170 to 184 miles; the latter figure includes the perimeter of Sandusky Bay. In addition, there are 3457 square miles on four islands in Lake Erie. The Lakeshore Plain extends up to 70 miles in northwestern Ohio, a swamp, riverine area fed by the Maumee and Sandusky rivers, among others. Eleven rivers and eleven major creeks cut through the plain, and two major lakes, Mosquito Creek Lake and Pymatuming Reservoir, are located near the Pennsylvania border.

In the west, geologic formations are primarily Silurian with intense erosion and sedimentation; the physiographic region is characterized as Interior Lowland with alfisol soils. The vegetation pattern is Laurentian Mixed Forest. Along the central and eastern shore of Ohio, the geology is Devonian with moderate erosion and sedimentation. The physiography is categorized as Appalachian Mountain System, and alfisols are present within Eastern Upland Forests. Initial European contact did not occur until 1749; the first settlement, Conneaut, was established in 1796. Major archeological, ethnohistoric, and early historic settlements are found in the drainage area of the twenty-two major watercourses; and seven major lake ports were established. A Seneca

Indian reservation (80 mi^2) was located on the Upper Sandusky River from 1807 to 1869.

Nine counties comprise the shoreline: Lucas, Ottawa, Sandusky, Huron, Erie, Lorain, Cuyahoga, Lake, and Ashtabula.

Pennsylvania

The Lake Erie shoreline from the Ohio to the New York border extends some 43 to 63 miles; the latter figure includes the perimeter of Presque Isle. The Lakeshore Plain varies in width from 3 to 10 miles and includes sixteen creeks and thirteen runs. Three lakes (Pymatuming, Edinboro, and Le Boeuf) are significant ecological modifiers. The geological formations are in the main Devonian with slight to moderate erosion and sedimentation. The region is physiographically classed as Allegheny Mountain System with alfisols, and the vegetation pattern is Eastern Upland Forest. Presque Isle State Park is a unique ecological preserve and water recreation area within the region. The mouths of five creeks are significant ecological and recreational zones.

Initial European contact was in 1728 and the first European settlement was established in 1790. Major archeological, ethnohistoric, and early historic settlements are found in the creek drainage in the City of Erie and on or near Presque Isle. Erie County and the City of Erie are the major political units.

New York

The Lake Erie shoreline from the Pennsylvania border to Buffalo and the Niagara River extends some 68 to 75 miles; the latter distance reflects the inclusion of various bays and of Buffalo Harbor. The Lakeshore Plain varies from 3 to 30 miles in depth and includes three rivers and nine creeks. The geological formations are primarily Devonian with slight to moderate erosion and sedimentation. The physiographic region is classified as Allegheny Mountain System with alfisol types of soils in Eastern Upland Forest. Cassadaga and Chautauqua lakes are important ecological modifiers; the latter is located near the Pennsylvania border.

Initial European settlement in this area of western New York began in 1687. Major archeological, ethnohistoric, and early historic settlements are found in the vicinity of the City of Buffalo, Cattaraugus Creek, and in or near the communities of Dunkirk and Ripley.

Two Indian reservations were established in 1797. The Buffalo Creek Reservation (130 mi^2) was sold in 1846. The Cattaraugus Reservation (42 mi^2), which is still in existence, is the site of an important annual religious ritual, the Newtown Longhouse Ceremony. Major aboriginal flint quarries are located near Buffalo and Niagara Falls.

In addition to the City of Buffalo, Chautauqua and Erie Counties are the major political units.

4.2.2 Ecological Considerations

In Chapter 2 the study region was divided on the basis of physiographic, geologic, edaphic, and glacial-historic factors. Five zones (a-e) were delineated for the lowland area and four zones (a-d) for the upland area. These nine zones were

- Ia Glacial Till Plain: from Toledo, Ohio, to Pipe Creek near Sandusky, Ohio. This region has no upland as it is the old bed of Lake Warren.
- Ib Western Ohio Lowlands: from Pipe Creek, Ohio, to the Cuyahoga River at Cleveland.
- Ic Eastern Ohio Lowlands: from the Cuyahoga River near Cleveland to Mill Creek at Erie, Pennsylvania.
- Id Southwestern New York Lowlands: from Mill Creek at Erie, Pennsylvania to Silver Creek, New York.
- Ie Western New York Lowlands: from Silver Creek, New York, to Buffalo, New York.
- IIa Glacial Till Uplands: from Sandusky, Ohio, to the Cuyahoga River at Cleveland.
- IIb, IIc, IId Allegheny Plateau Uplands: from the Cuyahoga River to Buffalo, New York. These three zones are all in the glaciated portion of the Allegheny Plateau. They are considered identical and correspond to the lowland units.

Hence, the following correspondences can be made:

Zone Ia
Zones Ib and IIa
Zones Ic and IIb
Zones Id and IIc
Zones Ie and IId

These ecological zones, rather than the modern political units, will form the basis for the ethnohistoric analysis.

4.3 REGIONAL CHRONOLOGY

Preliminary comparative research on the archeology, ethnohistory, and early history of the southern Lake Erie Plain indicated that five chronometric periods would prove useful for synchronic and diachronic analyses. These periods are

Late Woodland	ca. A.D. 800-1600
Late Prehistoric/Early Ethnohistoric	1570-1657
Late Ethnohistoric/Early Historic/Colonial	1657-1750
Middle Historic	1750-1850
Recent Historic	1850-present

Because of the size of the research area, it was necessary to generalize the chronology. The Late Woodland was defined on the basis of archeological data and was discussed in Chapter 3. The Late Prehistoric Period begins with the theoretical founding of the League of the Iroquois (Ho-dé-no-sau-nee) in 1570 and ends with the defeat of the Erie/Eries/Eriez (Nation du Chat) by the Seneca and their allies during the 1653-1657 wars. The Huron (1649-1650) and Neutrals (1650-1651) were also defeated and dispersed by the Seneca and their allies at about this time. In the Western Basin of Lake Erie, the Chippewa, Fox, Huron, Miami, Neutral, Ottawa, and Potawatomi inhabited various locales (Figs. 4.1-4.4).

During the Late Ethnohistoric Period there were Iroquois incursions along the southern shore of the lake and into what are now southeastern Michigan and central Illinois while the Seneca gradually consolidated their power along the Niagara Frontier and western New York. The Seneca warred against the Susquehannock of north central Pennsylvania ca. 1675, and by 1700 they had reached the apogee of their political power along the southeastern shore of Lake Erie. Meanwhile, the Wyandot, formed from remnants of the Huron and Tionontati (Tobacco) tribes ca. 1650, and the Miami occupied lands in the Western Basin of the lake. Tribes in southeastern Michigan included the Fox, Kickapoo, Mascouten, Miami, Ottawa, and Potawatomi (Figs. 4.5-4.7).

The Middle Historic Period begins with the French and Indian Wars (1754-1763), which were fought over control of the Ohio Valley and French attempts to control what is now western Pennsylvania. During the subsequent American Revolution (1775-1783), many tribes became allies of the British; the Revolution ended with the defeat of these Indians and their dispersal. Reservations were established in New York State in 1797 and in Ohio in 1807. The period is also characterized by massive migrations of Native Americans from the eastern seaboard into the Lake Shore Plain, its major rivers, and adjacent uplands. Among those tribes migrating through or adjacent to the research area were the Delaware and Shawnee from east to west and the Ottawa and Wyandot from the Western Lake Basin to the east and southeast. Some tribes remained in southeastern Michigan, including the Huron, Potawatomi, Mascouten(?), Ottawa, and Wyandot. The Western Lake Basin, and especially the Maumee River, was inhabited by Chippewa, Delaware, Miami, Ottawa, Potawatomie, Seneca, Shawnee, and Wyandot (see Figs. 4.7 and 4.8).

In 1799, the vision of Handsome Lake initiated a religious renaissance among the New York State Iroquois, especially the Seneca, in response to the Euro-American population influx into lands bordering the eastern segment of Lake Erie. By 1846, two reservations had been sold and a third reduced in size. Indian "removal" to Oklahoma accompanied the emigration of U.S. farmers, manufacturers, and tradesmen from the east.

The Recent/Historic Period is marked by the partial acculturation of the Iroquois into U.S. society, but it is also characterized by a strong conservatism among the New York State Iroquois and by the continuation of traditional and "modern" religious ceremonies. Foremost among these is the Longhouse Religion. There is also the beginning of the Native American (Red Power) movement among some tribal members as well as some distrust of the federal government as a result of the construction of the Kinzua Dam, which obliterated the Cornplanter Reservation (Seneca) in northwestern Pennsylvania.

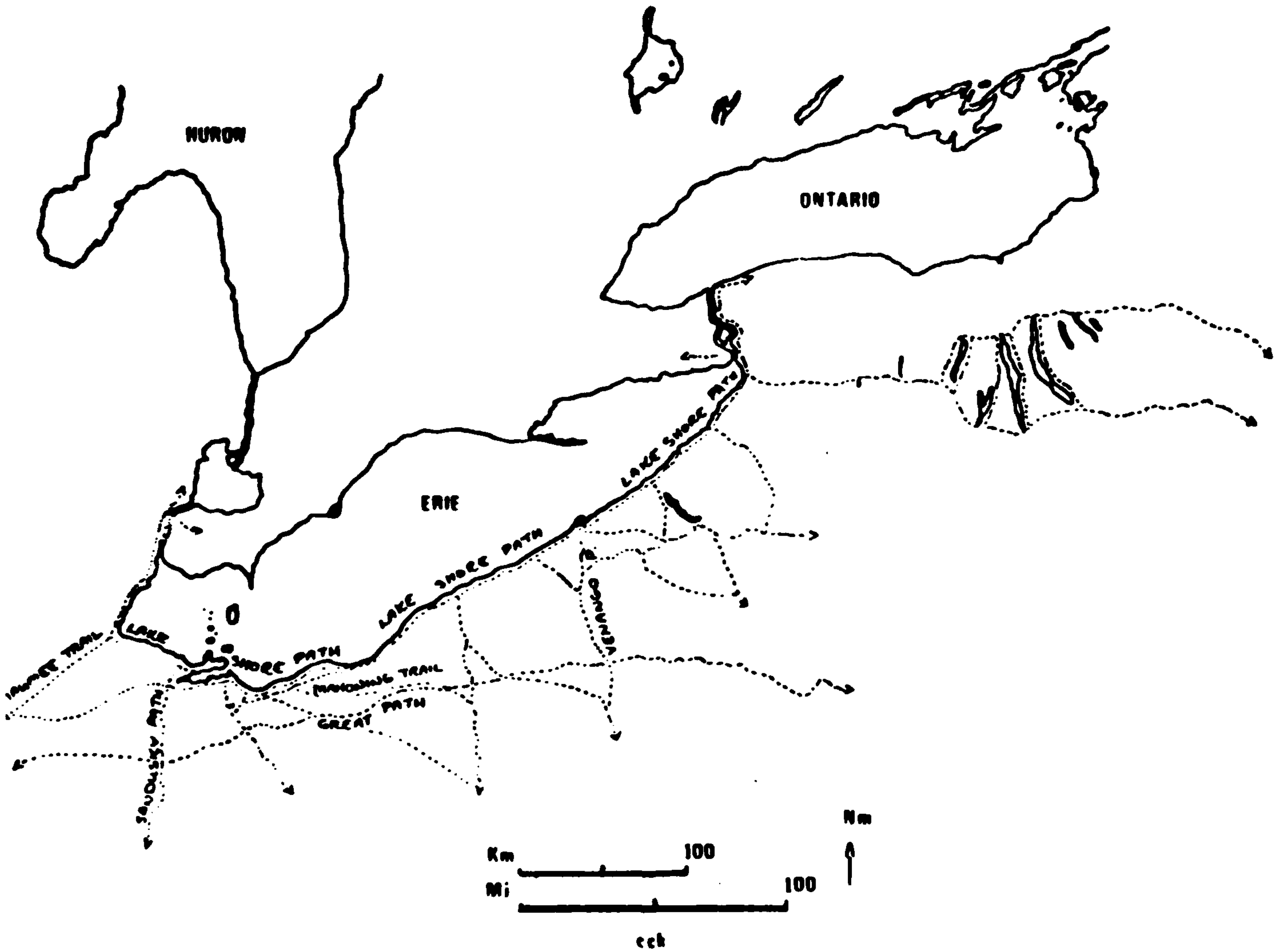


Figure 4.1. Major Indian Trails and Paths, ca. A.D. 1570-1750.

Key for Figures 4.1-4.8

Abbreviations for Tribes:

CA	*Cayuga
CH	Chippawa
D	Delaware
E	Erie/Eries/Eriez
F	Fox
H	Huron
I	"Iroquois" (League of the Iroquois, Ho-do-no-sau-nee)
K	Kickapoo
MA	Mascouten
MI	Miami
MS	Missisaugua
MO	*Mohawk
N	Neutral
OA	*Oneida
ON	*Onondaga
OT	Ottawa
PO	Potawatomi
PE	Petun
SE	*Seneca
SH	Shawnee
SU	Susquehannock/Andaste
T	"Tobacco"/Tionontati (became Wyandot)
WE	Wenro/Wenroe
WY	Wyandot (originally Tionontati-Huron)

Symbols:

?	Questionable occupation and/or location
--→	(Dashed Arrow) Temporary or transitory migration/raid/trading venture
——→	(Solid Arrow) Major migration or population movement

Note:

* Members of the League of the Iroquois, Ho-do-no-sau-nee; often some or all tribes participated in raids or warfare against an enemy.

The societal data presented on these maps was derived from numerous sources including state histories, ethnohistoric and ethnographic articles and monographs, and archeological reports for the Late Prehistoric period. A major set of resources was the Handbook of North American Indians, Vol. 15: Northeast (Trigger, ed. 1978), which provided descriptions of locations as well as maps for twenty-one of the societies that inhabited or passed through the research area between 1570-1850. The works of Buchman (1976), Walmsley and Conlin (1968), and P. A. W. Wallace (1965) contained maps and descriptions of aboriginal Native American trails and paths in Ohio and Pennsylvania. Conover (1889), Evans (1755), and Morgan (1851) yielded similar information for New York State.

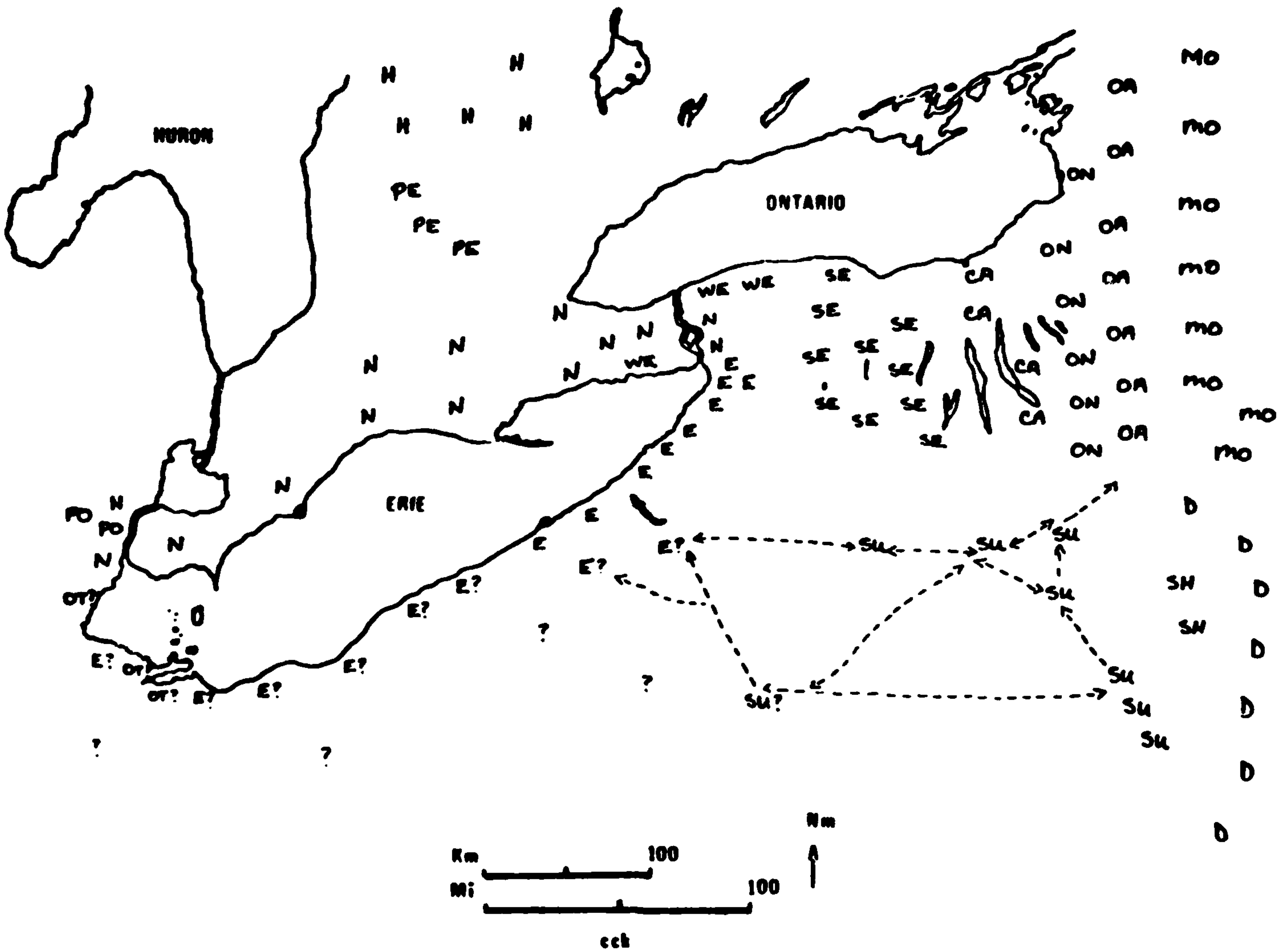


Figure 4.2. Distribution of Tribes, ca. A.D. 1570.

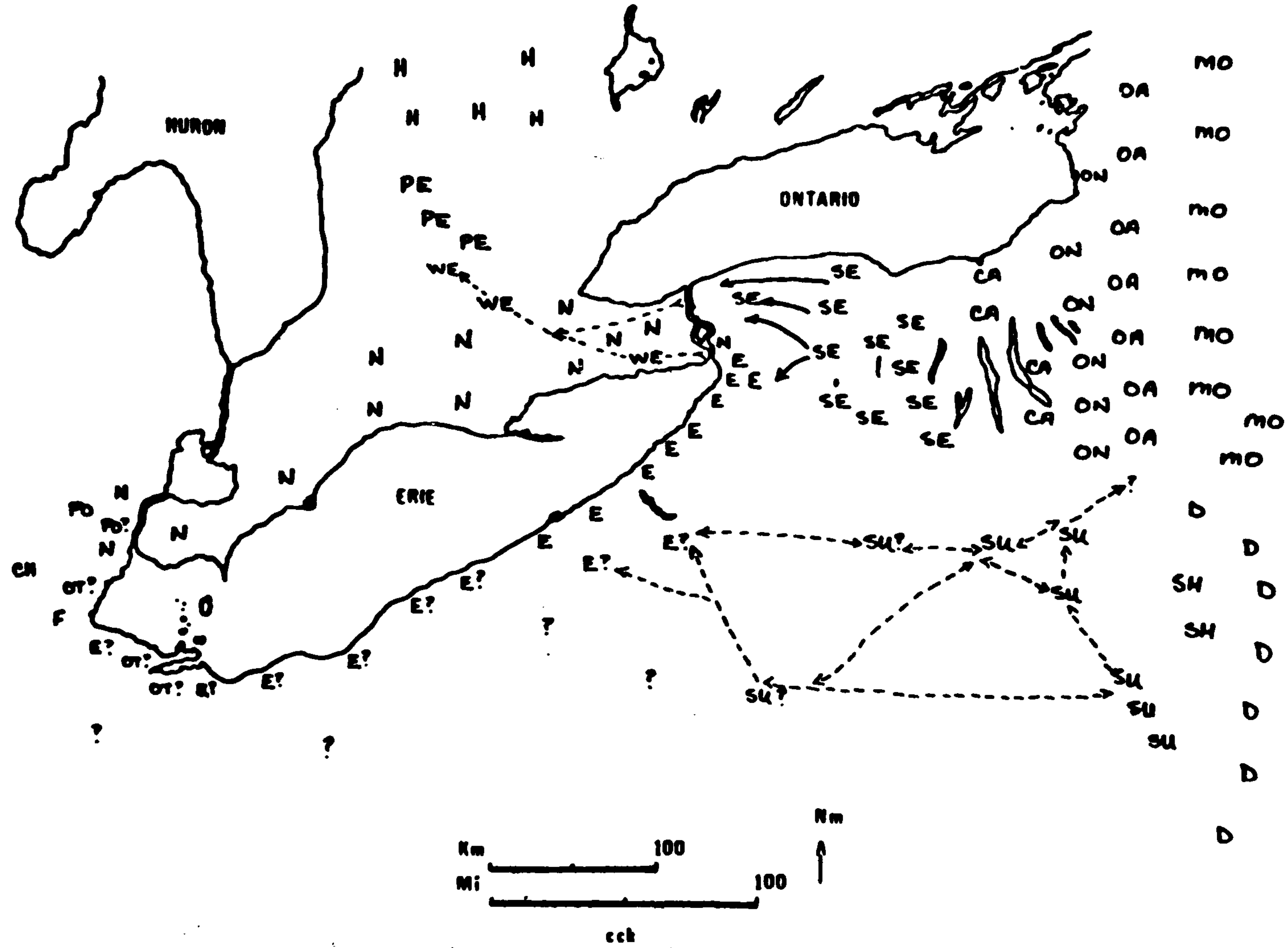


Figure 4.3. Distribution of Tribes, ca. A.D. 1600.

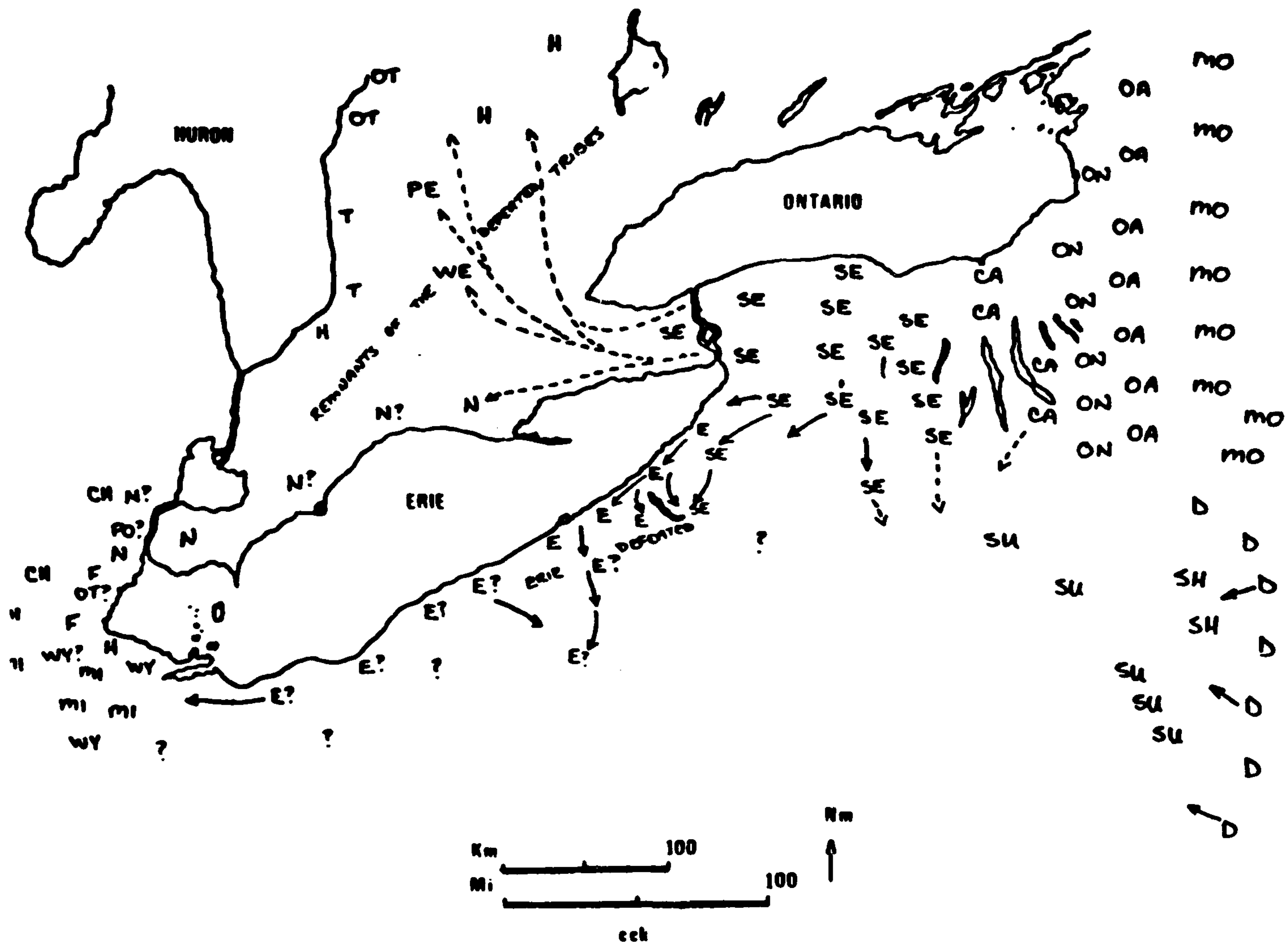


Figure 4.4. Distribution of Tribes, ca. A.D. 1649-1657 (Erie, Heron, Neutral, Petun, Wenro, defeated and dispersed).

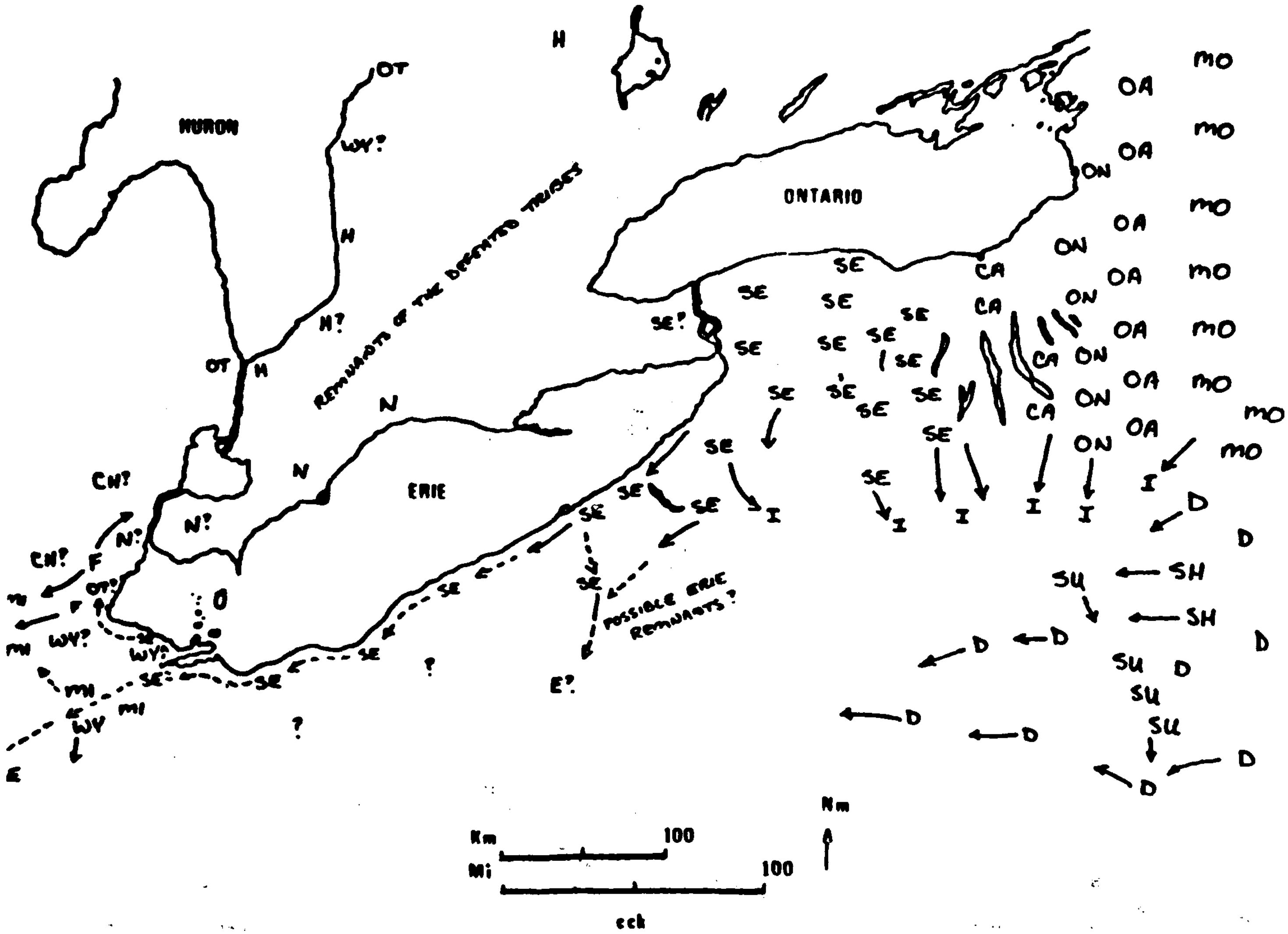


Figure 4.5. Distribution of Tribes, ca. A.D. 1660.

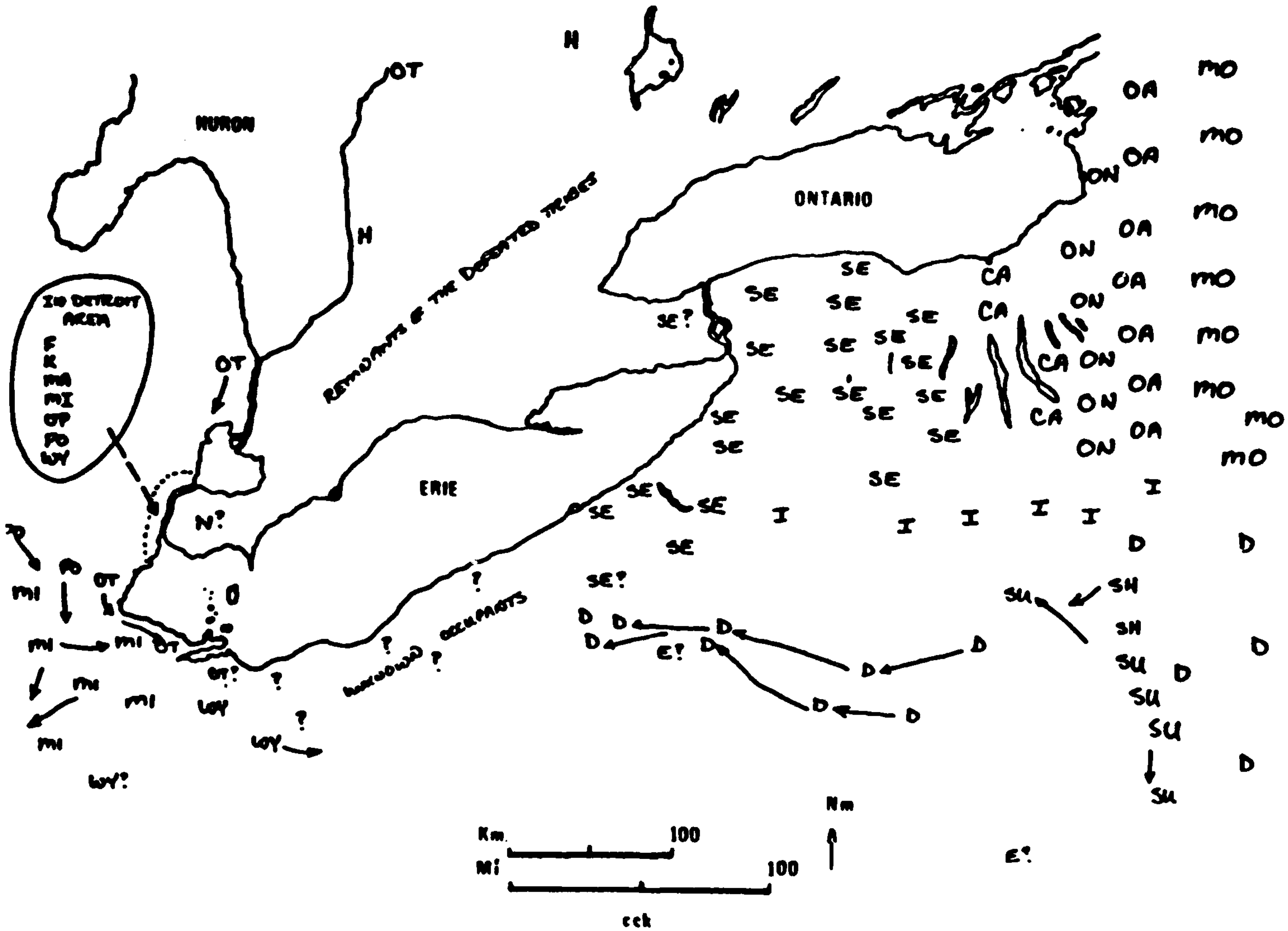


Figure 4.6. Distribution of Tribes, ca. A.D. 1700.

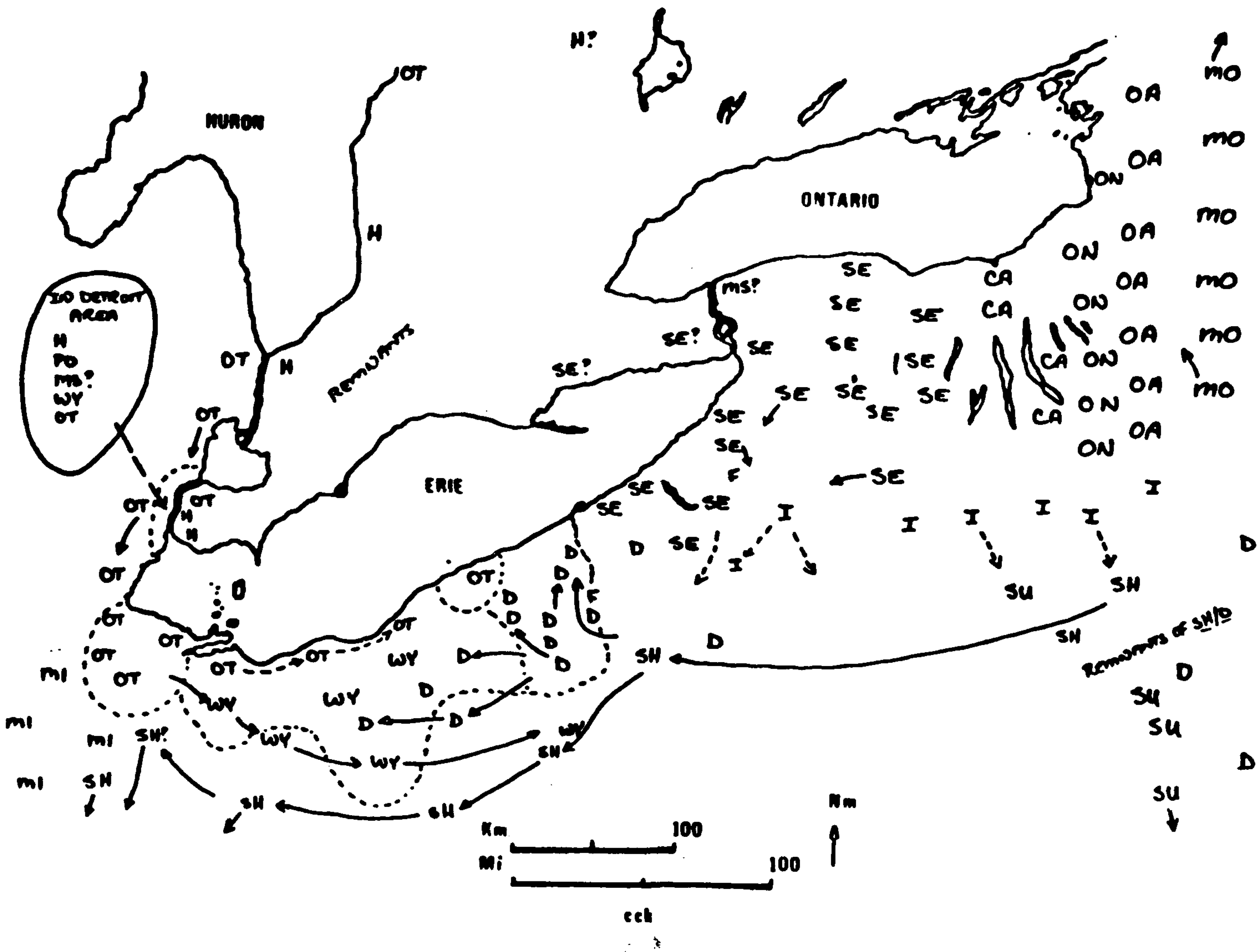
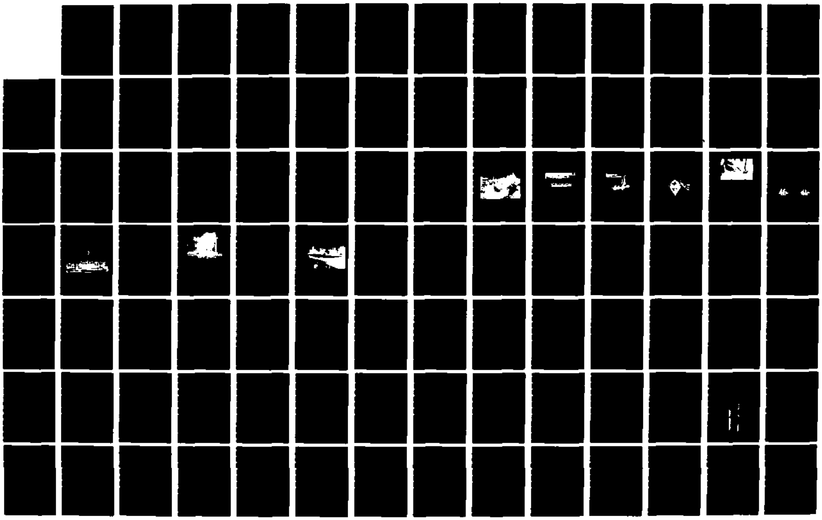
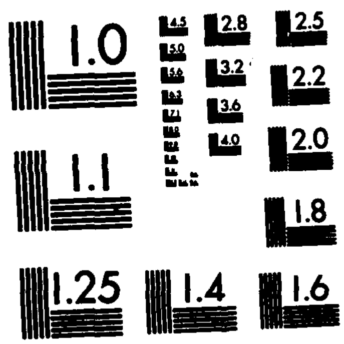


Figure 4.7. Distribution of Tribes, ca. A.D. 1750.

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981 4/7

UNCLASSIFIED F/G 5/1 NL





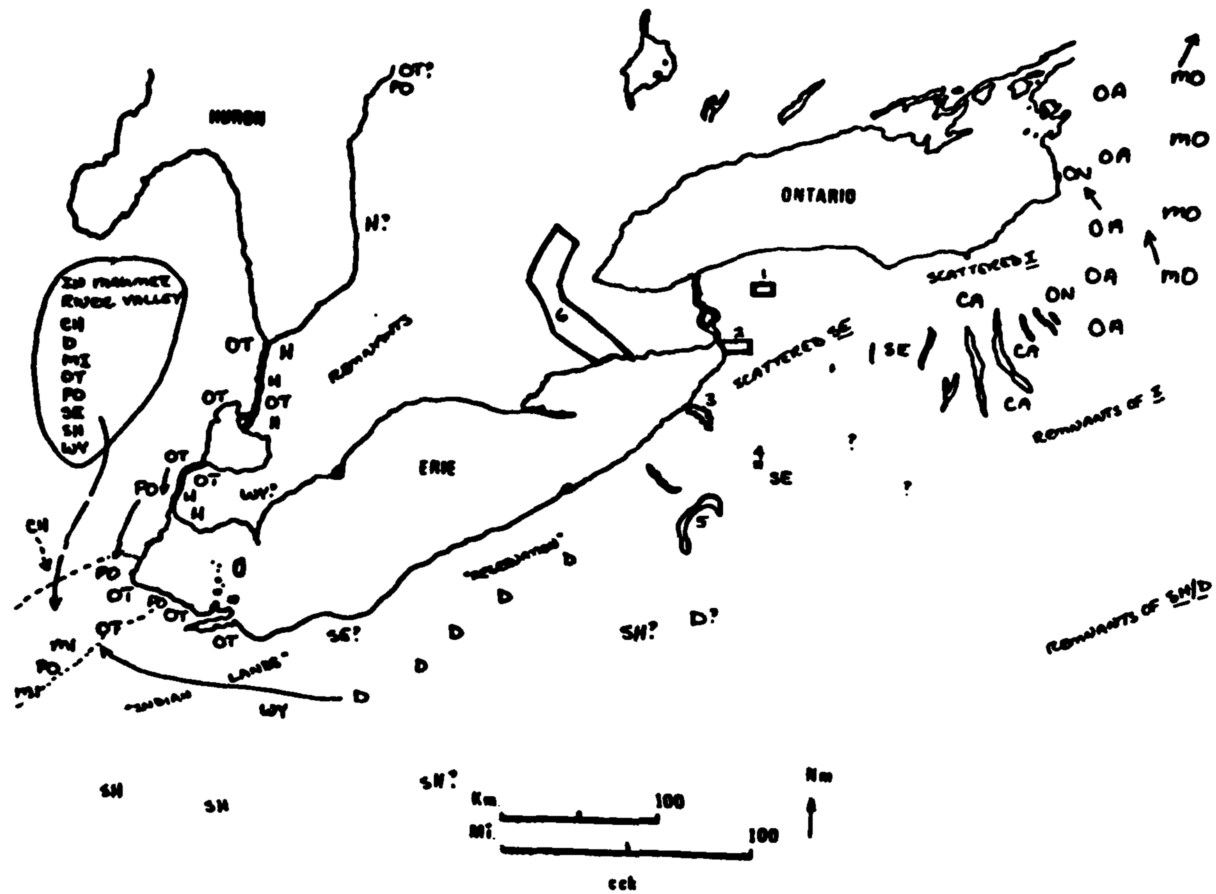


Figure 4.8. Distribution of Tribes, ca. A.D. 1800.

Reservations: (Iroquois)

1. Tonawanda (SE)
2. Buffalo Creek (SE)
3. Cattarugus (SE, CA)
4. Oil Creek (not occupied)
5. Allegany/Cornplanter (SE)
6. Six Nations (I)

4.4 ETHNOHISTORY

In a recent review/article, Carmack (1972) delineated the development, methods, and aims of ethnohistory; this was the first serious reevaluation of the field since Cohen (1968). As Carmack noted, "A field of study which might be termed 'ethnohistory' has yet to be defined. In fact, the derivation of the term itself is not known for certain, and its meaning varies widely from one context to another" (Carmack 1972:230). Nearly all authorities on ethnology, historiography, and history emphasize that ethnohistory is not a separate discipline but rather a method or technique of collecting and evaluating data (Adams 1979-1980; Barzun and Graff 1977; Braudel 1972; Cantor and Schneider 1967; Cochran and Hofstadter 1972; Laslett 1968; Murtaugh 1976; Robinson and Beard 1972). Ethnohistory thus combines elements of cultural anthropology, history, and archival research, just as archeology is a unique method of collecting cultural anthropological data on extinct human societies.

The term ethnohistory has been used systematically by North American historians, cultural anthropologists, and archeologists since the 1940s to describe research on the history of the native inhabitants of the New World. More recently it has come to mean the historical study of any non-European peoples. This study utilizes archival, oral, and archeological sources; the conceptual frameworks of cultural and social anthropology; and historiography (Cohen 1968:448). Such investigations attempt to reconstruct the culture history of indigenous peoples and to discern the causes and effects of mechanisms of cultural dynamics; in essence, these studies try to determine how and why change occurs--to comprehend cultural processes. It is vital that the ethnohistorian have training in historiography as well as ethnology, and if the investigator has a background in archeological method and theory, so much the better. Familiarity with the archeology, natural ecology, and cultural resources of the region to be investigated are likewise essential (Fenton 1962; Greenberg 1968; Thomas 1963; Voegelin 1954).

Ethnohistorians of North America have been especially concerned with the location and migration of Indian tribes, changing cultural adaptations to the environment, demographic history, and the relationships of particular Indian societies with Europeans (Barzun 1972; Fenton 1962). There seems to have been minimal effort to build a body of generalizations either through a diachronic approach or by comparison. Methodologically the ethnohistorian who uses written documents faces the same problems and employs the same techniques as does the conventional historian. Oral traditions, which are especially valuable to the ethnohistorian, must be carefully evaluated. Invaluable materials have resulted from fieldwork among living natives that used the focused or semi-structured interview, life history, and genealogical methods (cf. Lewis Henry Morgan's (1851) The League of the Ho-dé-no-sau-nee or Iroquois). The approach of ethnohistory is conditioned by the nature of the aboriginal society/societies being studied, the time period, the kind and duration of European contact or domination, the types of documentation available, and the theoretical orientations of historians, cultural anthropologists and/or archeologists who have studied the region (Cohen 1968; Carmack 1972). Additional discussion of the method and theory of ethnohistory may be found in the "Symposium on the Concept of Ethnohistory" (1961) and Keith Thomas's (1963) article, "History and Anthropology."

Ethnohistory is thus a method that utilizes techniques of historiography. Therefore, the ethnohistorian studying the Lake Shore Plain uses the written sources, especially the 117 county histories from the sixteen counties bordering the Lake Erie Plain and its adjacent uplands. These histories must be appropriately evaluated (Barzun and Graff 1977; Cantor and Schneider 1967; Gray et al. 1956; Stern 1972). In addition, the 65 state and regional histories from the four states, some written by professional historians, others by less than professionals, must be adequately evaluated, with special reference to the theoretical view or interpretation used by the authors (Cochran and Hofstadter 1972; Robinson and Beard 1972; Stern [ed.] 1972). The evaluation keys for critiquing the sources include opportunity, objectivity, transmission, and meaning (Gray et al. 1956).

For an evaluation of source materials for Zones I and II, see Appendix K.

4.5 RESEARCH RESULTS

4.5.1 Introduction

The nine ecological zones delineated will be considered in five appropriate groupings from west to east; Ia, Ib and IIa, Ic and IIb, Id and IIc, Ie and IId. The political units encompassed in each zone will be noted and a statement as to primary state sources and county sources will be made. Bibliographic references to germane archeological, ethnohistoric, early historic, and ethnographic data will also be made. This will be followed by a summary of the evaluated enthnohistoric data with reference to the Native American societies or tribes known to have inhabited the zones.

Figure 4.1 depicted known major Native American trails or paths ca. 1570-1750. Significant within the Lake Shore Plain was the Lake Shore Path, which followed the south shore of Lake Erie from present-day Buffalo to Toledo (Wallace 1965:85-88). East of Erie, Pennsylvania, the path was located about one to one and a half miles back from the present shore, along the shores of then existent Lake Warren. West of Erie, the path followed the sandy beach or went through the forests at the top of the cliffs along the shoreline. The most important trails, paths, and portages from east to west were Seneca/Finger Lakes Path (Buffalo, New York), Buffalo Creek Path, Cattaraugus Creek Path (Irving, New York), Chautauqua Portage, Presque Isle Portage (Erie, Pennsylvania), Conneaut Path, Ashtabula Trail, Cuyahoga Path (Cleveland, Ohio), Huron River Path, Mahoning Path (east-west), Sandusky Path (Sandusky, Ohio), and Maumee Trail (Toledo, Ohio, to Fort Wayne, Indiana, and beyond) (Hulbert 1900; Wallace 1965).

Figure 4.2 depicted Native American societal locations ca. 1570. This is about the time the League of the Iroquois (Ho-dé-no-sau-nee) was reputedly formed and prior to major expansion by Iroquoian-speaking tribes into the Finger Lakes region of New York State. Figure 4.3 reflected the tribal expansions and westward movements ca. 1600; Figure 4.4 attempted to illustrate the extremely dynamic period from 1649-1657 during which the Seneca and their Iroquoian allies defeated and dispersed the Huron, Neutral, Petun, Wenro, and Erie/Eries/Eriez, and occupied segments of the territories of these tribes. Figure 4.5 depicted the rapid Seneca expansion along the southern shore of Lake Erie into the Maumee River Valley; it also showed their brief forays into what are now central Indiana and Illinois as well as southeastern Michigan.

Miami and Wyandot movements were also noted. Figure 4.6 reflected the westward migrations of the Delaware and the movements of the Miami, Ottawa, Potowatomi, and Wyandot into the Western Basin by about 1700.

These migrations became intensified over the next several decades and Figure 4.7 illustrated the complexities of these movements ca. 1750. Delaware and Shawnee migrations from the east and Ottawa and Wyandot movements from west to east and southeast characterized the period. Figure 4.8 depicted societal locations ca. 1800. By that time, reservations had been established in New York and at least eight tribes were active in the West Basin, fighting against George Rogers Clark in 1780, Colonel William Crawford in 1782, General Arthur St. Clair in 1791, and General Anthony Wayne in 1793. The Battle of Fallen Timbers (1794), near present-day Maumee, Ohio, and the treaties of Greenville (August 1795) and Fort Industry (Toledo, July 4, 1805) ended aboriginal resistance to European settlement in the research area.

Table 4.1 is an alphabetical listing of the Native American tribes that inhabited the research area between 1570 and 1850, regardless of time within this 280-year-long span. The table is essentially a presence and absence tabulation; major and minor occupations, trading enterprises, and military incursions are noted.

The data bases for the table and other enthnohistoric-ethnographic interpretations in subsequent sections are lengthy. Since all but three of the twenty-four societies occupied more than one zone, the major sources are tabulated by tribe or society in Appendix L.

4.5.2 Zone 1a

4.5.2.1 Ethnohistoric Summary

The expanded Zone Ia, including southeastern Michigan, had twenty of the twenty-four societies (see Table 4.1). Southeastern Michigan had sixteen, while western Ohio (Ia) had fourteen represented during the period 1570-1800. The major occupations in southeastern Michigan included the Chippewa, Huron, Miami, Ottawa, Potawatomi, and Wyandot. Minor occupations in this area included the Fox, Kickapoo, Mascouten, Missisauga, Neutral, Tionontati, and Wenro. Trading enterprises reflected incursions by the "Iroquois" (Seneca and allies), Kickapoo, Mascouten, Ottawa, Petun (?), and Seneca. Military expeditions in southeastern Michigan included incursions by the Fox, Iroquois, and Seneca.

Zone Ia, with fourteen societies, had major occupations by the Delaware, Erie (?), Miami, Ottawa, Potawatomi, Shawnee, and Wyandot. Minor occupations of Chippewa, Fox, Huron, Neutral (?), and Seneca were also evident. Trading enterprises by the Fox, Iroquois, Mohawk, Ottawa, Seneca, and Wyandot, and military expeditions by the Iroquois, Mohawk (?), and Seneca also occurred during the 1570-1800 period.

4.5.2.2 Southeastern Michigan Culture History

By approximately 1570 (see Fig. 4.2), southeastern Michigan was occupied by the Ottawa, Potawatomi, and, apparently, the Neutrals. The west bank of the narrow Detroit River was the location of Ottawa and Potawatomi villages,

Table 4.1. Tribal and Zonal Occupations

Native American Tribe/Society	Southeast Michigan	West Ohio Ia	West Central Ohio Ib, IIa	East Ohio/West Pennsylvania Ic, IIb	Eastern Pennsylvania/ Southwest New York Id, IIc	Western New York Ie, IId
Cayuga	--	--	--	--	T,W?	T,W
Chippewa	M	X	X?	X?	--	--
Delaware	--	M	M	M	M	--
Erie/Eries/Eriez	--	M?	M?	M	M	M,T,W
Fox	X,W	X,T	--	--	--	X?
Huron	M	X	--	--	--	X,T,W
"Iroquois"	T,W	T,W	T,W	T,W	T,W	T,W
Kickapoo	X,T	--	--	--	--	--
Mascouten	X,T	--	--	--	--	--
Miami	M	M	X	--	--	--
Missisauga	X	--	--	--	--	--
Mohawk	--	T,W?	T,W?	T,W?	T,W	T,W
Neutral	X	X?	--	--	--	M,T
Oneida	--	--	--	--	T,W?	T,W
Onondaga	--	--	--	--	T,W?	T,W
Ottawa	M,T	M,T	M,T	X,T	--	--
Potawatomi	M	M	--	--	--	--
Petun	T?	--	--	--	--	--
Seneca	T,W	T,W,X	T,W,X	T,W,X	T,W,M	T,W,M
Shawnee	--	M	T	X,T	X?	--
Susquehannock	--	--	--	T	T	T?
Tobacco/Tionontati	X	--	--	--	--	--
Wenro/Wenroe	X	--	--	--	--	M,W
Wyandot	M	M,T	M	X,T	--	--

M = Major occupations/settlements (multiple communities of long duration)

X = Minor occupations/settlements (few communities of long or short duration)

T = Trading enterprises (special activities not necessitating large or permanent settlements)

W = Military Incursions (long or short duration, incursions and raids, expeditions and wars, and/or occupations)

? = Uncertain or unclear data

the latter apparently stockaded. Slash-and-burn maize cultivation and hunting activities are assumed to have occurred in the area (Dunbar 1971; Wing 1890). Ottawa probably resided in Monroe County, Michigan, during this time.

According to Champlain's maps of 1612 (Wing 1890), the area that was to become Detroit was visited by French traders as early as 1610; a community appears on this site on the maps. By about 1600, the Chippewa had several communities in southeastern Michigan, about forty miles west of Lake Erie (see Fig. 4.2). In 1620 Etienne Brulé explored sections of what is now the State of Michigan for France, but it was not until July 24, 1701, that Antoine de la Mothe Cadillac established a settlement at Detroit; settlements on Lakes Huron and Superior dated from 1668 (Cadillac 1947, Santer 1977; Vexler 1978). In 1632, some unconfirmed attacks by Ottawa and Iroquois against Algonkians (Chippewa?) occurred in southern Michigan (Hyde 1952), and some Huron visited Detroit in 1634. Neutrals defeated a band of Potawatomi in southern Michigan in 1643.

The period from 1649 to 1657 (see Fig. 4.4), which reflected sudden Seneca and Iroquois incursions on the northern and southern sides of eastern Lake Erie, was one of relative calm in southeastern Michigan. The evidence shows that Ottawa occupation probably diminished, but the occupations of Neutral and Potawatomi continued. There was also an eastward migration of the Fox (1650) and the Miami (1654). Chippewa territory appears to have expanded northward. The Miami occupied significant areas to the southeast, in the Maumee and Sandusky river valleys. On the northern shore of Lake Erie, the Seneca and their allies defeated the Huron in 1648-1650, the Tobacco/Tionontati in 1649, and the Neutrals in 1650-1651. Remnants of these defeated peoples moved southwestward across the Detroit River into southeastern Michigan. The Huron and Tionontati survivors became known as the Wyandot and had moved into the Maumee River Valley by 1657.

By 1650 (see Fig. 4.5), the Chippewa may have migrated out of southeastern Michigan. Evidence of Neutrals and Ottawa in this area is also weak. The Miami continued in the settlements previously established; the Fox had moved northeast and southwest from their initial settlements.

In 1700 (see Fig. 4.6), the Detroit area showed evidence of Fox, Kickapoo, Mascouten, Miami, Ottawa, Potawatomi, and Wyandot. The Fox migrated west from the region in about 1705, while the Kickapoo and Mascouten were in the area only briefly and in small numbers between 1702 and 1712. In 1695, the Potawatomi moved into Miami territories in southeastern Michigan and also displaced some Ottawa who moved southeastward. Some Ottawa were at Detroit from 1710 to 1712, and a Wyandot village was established at Detroit in 1732. In 1739, some Wyandot migrated from Detroit to the Sandusky River.

By 1750, the Ottawa had moved across the Detroit River frontier in substantial numbers (see Fig. 4.7). Some Huron from old Huronia and a large population of Ottawa, Potawatomi, and Wyandot were in the vicinity of Detroit. It is possible that Mascouten were also present in the Detroit area by 1752. By 1770, nearly all of southeastern Michigan was within Ottawa territory; they had established other settlements along the Lake Erie shore as far east as Cleveland. The first treaty by which Native American lands in Michigan were ceded to the United States was signed at Greenville, Ohio, in 1795 (Washburn 1973: 2295-2303; Tanner and Wheeler-Voegelin 1974).

Migrations southwestward into the Maumee River Valley were in evidence by 1800 (see Fig. 4.8). The Treaty of Detroit (1807) settled land claims with the Ottawa; the second Treaty of Greenville settled Wyandot, Delaware, Shawnee, Seneca, and Miami claims (Washburn 1973:2328-2331, 2345-2347). The last major segment of Michigan to be given up by the Native Americans was ceded to the United States by the Treaty of La Pointe in 1842. The State of Michigan, in 1970, had a Native American population of some 16,854, or about 0.14% of the total state population--the Detroit Standard Metropolitan Statistical Area had a population of 5,683 Native Americans in 1970 (Taylor 1972:183, 206). Many of these were Ottawa, Potawatomi, and Wyandot.

An excellent, brief summary of the historic Chippewa, Ottawa, Potawatomi, Miami, and Huron is found in Fitting's The Archaeology of Michigan (1970:192-201).

4.5.2.3 Zone Ia Culture History

By approximately 1570 (see Fig. 4.2), western Ohio, especially the Western Basin of Lake Erie, was occupied by the Ottawa and possibly the Erie (Moorehead 1900; Shetrone 1900; Randall and Ryan 1912; Potter 1968). Claims of Erie occupation are conjectural. The Erie occupations in Wood (Evers 1897), Seneca (Leeson 1886), Sandusky (Williams 1882; Frohman 1965, 1968), Lucas (Downes 1948; Waggoner 1888), Erie (Aldrich 1889; Hills 1925) and Huron counties (Williams 1879) are unsubstantiated and seem to reflect a perpetuated error. According to McKenzie and Blank (McKenzie et al. 1972; McKenzie and Blank 1976; Lallo 1979) the Eiden site in Lorain County was occupied prior to 1600; they also suggest that the site was an Ottawa or Potawatomi village. The Portage-Sandusky-Vermillion River region has archeological materials that parallel the Younge Tradition of southern Michigan (Prufer and Shane 1976), although other investigators (Prahl, Brose, and Stothers 1976) do not accept this interpretation. Stothers (1979c:25) contends that the Western Lake Erie Basin was "essentially vacant between ca. A.D. 1400 and early historic times."

Figure 4.3 reflects some of the changes that had occurred by 1600. Ottawa occupations continued; the number of communities actually increased, especially near the lakeshore and along the Sandusky and Maumee rivers. Although the Erie were still said to be inhabiting the Western Basin near Lake Erie, this is unproven. Fox and Chippewa had moved from the west into Lucas and Wood counties.

The period from 1649 to 1657 (see Fig. 4.4), a time of turbulence in the eastern Lake Erie area, was one of apparent calm in the Western Basin, but it did experience several migrations into Zone Ia from southeastern Michigan. Ottawa occupation apparently continued, while eastward migrations of the Fox (1650) and Miami (1654) commenced and intensified. The Miami occupied significant areas of the Maumee and Sandusky river valleys. Remnants of the defeated Huron, Tionontati, and Neutrals moved into southeastern Michigan from Ontario and eventually occupied segments of Sandusky and Erie counties. The Huron and Tionontati survivors of the wars against the Seneca became known as the Wyandot and had migrated into the Maumee River Valley by 1657. Erie occupations, especially near the littoral, are assumed to have occurred in Erie County, although these cannot be verified.

By 1660 (see Fig. 4.5), the Miami and Wyandot were well established in the Maumee and Sandusky river valleys. Some Miami and Wyandot communities in this area as well as Ottawa villages in Ottawa and Lucas counties may have been temporarily displaced by a military incursion by the Seneca in 1658-1659 (Hunt 1940; Scheele 1947; Snyderman 1948). With the defeat and dispersal of the Erie by the Seneca and their allies (1653-1657), a vacuum along the southern Lake Erie shore existed in the Eastern Lake region. Some remnants of the Erie, who may have "escaped" westward along the lake, were pursued by the Seneca. Hyde (1962) noted that the Seneca allied with some Miami groups in 1678. Seneca military incursions in the Maumee River Valley occurred intermittently over the next twenty years and, in 1680, a Seneca war party attacked the Illinois (Abler and Tooker 1978:506). By 1695, Potawatomi from southeastern Michigan began to move into Miami territory.

In 1700 (see Fig. 4.6), the Miami and Ottawa were the dominant tribes in Zone Ia. The former continued to occupy the Maumee River Valley and to expand its settlements in that region, while the latter, facing pressure from the Potawatomi, moved eastward along the shore. Wyandot from southeastern Michigan migrated to the Sandusky River and Bay in 1739. Small Seneca ("Iroquois") settlements were established in the Sandusky and Maumee river valleys between 1742 and 1831. Major Wyandot migrations occurred in 1748, with some Sandusky Wyandot moving southeastward to settle what are now Bolivar and Coshocton, Ohio, and New Castle, Pennsylvania (Hunter 1978). In 1745 the French built Fort Sandoski at the mouth of the Sandusky River.

By 1750, the Ottawa controlled a major portion of the Sandusky and Maumee river valleys (Feest and Feest 1978). By 1760, at least six Ottawa villages were known to have existed on the Maumee River near the bay. The Enderle site in Erie County, a historic aboriginal cemetery, has been placed at 1760-1780 by its excavators, who also suggested a Wyandot or Delaware affiliation (Seeman and Bush 1979), although they did not consider possible Ottawa affinities. In 1761, the British constructed Fort Sandusky on the southern shore of Sandusky Bay. In 1775, the Sandusky River (to Avon Lake) was granted to the Delaware by the Wyandot.

In June 1782, the Americans began a military action against the Wyandot at the present site of Upper Sandusky; it became a disorderly retreat during which Colonel William Crawford was captured and burned at the stake on June 11 (Meek 1909:62). During November 1782, George Rogers Clark led an expedition into the Miami Valley of southwestern Ohio and burned Shawnee towns and supplies. In January 1785, the U.S. Congress negotiated a treaty with Wyandot, Chippewa, Delaware, and Ottawa to make the northwestern quarter of the State of Ohio into an "Indian reservation," hence the title "Indian Lands" on Figure 4.8. In 1785, the British constructed Fort Miami at what is now Toledo, near the mouth of the Maumee River. The Wyandot and others hunted in the Sandusky and Maumee river valleys in 1789.

In 1790, the Wyandot and Shawnee resisted the establishment of U.S. settlements. General Josiah Harmar was sent from Cincinnati, northward through western Ohio, with 1300 men; they were easily repulsed by the Native Americans. During November 1791, General Arthur St. Clair's army was surprised and utterly defeated in Mercer County. These events set the stage for General Anthony Wayne's appointment as Commander of the Army of the Northwest and the eventual decisive U.S. victory at the Battle of Fallen Timbers on the Maumee River in what is now Lucas County (August 20, 1794). The Treaty of Greenville, signed on August 3, 1795, by ninety Native American leaders and by General Wayne ended hostilities (Washburn 1973; Tanner and Wheeler-Voegelin 1974). In 1795 the Ottawa, Wyandot, and Delaware, as well as some Chippewa, Potawatomi, Seneca, and Shawnee were reported as inhabiting the Maumee River Valley. Ottawa were along the Sandusky River in 1797 (see Fig. 4.8). The 1805 Treaty of Fort Industy (Toledo) resulted in the Native Americans giving up all remaining territorial claims within the Western Reserve west of Cleveland.

The War of 1812 affected northwest Ohio. At Fort Meigs, at Perrysburg in the Maumee River Valley, two sieges, from April through May and in July 1813, by the British and their "Indian" allies failed to dislodge the U.S. contingent led by General William Henry Harrison. In 1818, the Treaty of St. Marys deprived Ohio Native Americans of most of their lands; the exceptions were a few small reservations. Among these reservations was the 30,000-acre Sandusky Seneca Reservation on the Lower Sandusky River. Cayuga, Seneca, and some other "Iroquois" peoples were settled here in 1818 (White, Englebrecht, and Tooker 1978). In 1829, there were 322 Iroquois on the reservation, of whom 157 were Cayuga. The Sandusky Seneca sold their reservation in 1831 and migrated to northeastern Oklahoma (the Indian Territory). In 1842, the Wyandot reservation at Upper Sandusky was abandoned, marking the end of organized, territorial tribal life in Ohio (Tooker 1978d).

4.5.3 Zones lb and lla

4.5.3.1 Ethnohistoric Summary

Zone Ib in west-central Ohio had major occupations by the Delaware, Erie (?), Ottawa, and Wyandot as well as minor occupations by Chippewa (?), Miami, and Seneca. Trading expeditions by "Iroquois," Ottawa, Seneca, and Shawnee, and military incursions by "Iroquois," Mohawk (?), and Seneca were noted. In Zone IIa, the adjacent uplands, there were major occupations by the Delaware, Ottawa, and Wyandot, with minor occupations by Miami and Seneca. Trading enterprises and military incursions in Zone IIa were the same as those in Zone Ib during the period from 1570 to 1800.

4.5.3.2 Zone Ib and Zone IIa Culture History

From about 900 to 1300, west central Ohio was occupied by peoples of the Whittlesey Focus (Brose 1978a). Various county historians claim that during the mid 1500s this area was within the territory of the Erie (see Fig. 4.2). As previously stated, there is no verification of this contention for Erie (Aldrich 1889; Stewart and Page 1874; Hills 1925), Lorain (Duff 1931; Williams 1879b; Stranahan 1896) or Cuyahoga counties (Ellis 1966; Johnson 1879; Kennedy 1896). By 1600 (see Fig. 4.3), there was no change except that a few Ottawa migrants may have entered Erie County from the west.

The wars between the Seneca and their allies and the Erie (1653-1657) in western New York may have resulted in some Erie being displaced into Zones Ib and IIa (see Fig. 4.4). Again, proof for such a contention is lacking. The fur trade may have enticed the Seneca into the rivers of Zone IIb in the period 1659-1663. From ca. 1660-1680, the Seneca moved westward along the shore of Lake Erie into the Sandusky and Maumee river valleys (see Fig. 4.5). The Seneca may have been pursuing remnants of the Erie, but they were also conducting raids in western Ohio, Indiana, and Illinois during this period. They temporarily moved into this shoreline vacuum before returning to western New York State, where they consolidated their power.

It is not known who inhabited the littoral in 1700 (see Fig. 4.6); in the uplands to the south, the Wyandot were moving from the northwest toward the southeast. Fifty years later (see Fig. 4.7) the scene had radically altered. Ottawa moved from Zone Ia along the shore and established settlements on the Cuyahoga River (1755-1760). Undoubtedly some Ottawa settled in the valleys of the Huron, Vermillion, and Black rivers, but the evidence is less conclusive. Wyandot migrations continued from Zone Ia southeastward into central Ohio, while Delaware migrated northwestward from southwestern Pennsylvania into central Ohio into the Cuyahoga River Valley of Summit County and into Medina and Lorain counties. Further to the south, the Shawnee moved from southwestern Pennsylvania into south central Ohio and northwestward into the Sandusky River Valley of Zone Ia. In 1782, lands between Avon Lake, Ohio, and Erie, Pennsylvania, were granted to the Delaware by the "Iroquois" following the Delaware defeat in 1781 at Coschochgung (Coshocton, Coshocton County) eighty miles south of Cleveland, by U.S. forces from Fort Pitt (Bond 1941; Hunter 1978).

By 1800 (see Fig. 4.8), the Delaware occupied lands in Zone IIa and probably Zone Ib. Some Seneca may have occupied sites on the Huron River of Erie County about this time. The Treaty of Greenville ended hostilities to the west (Washburn 1974; Tanner and Wheeler-Voegelin 1974). The Treaty of Fort Industry (Toledo) stipulated that Native Americans give up claims to lands within the Western Reserve west of the Cuyahoga River.

4.5.4 Zones Ic and IIb

4.5.4.1 Ethnohistoric Summary

Zone Ic, the eastern Ohio and western Pennsylvania section of the research area, had major occupations by the Delaware and Erie as well as minor occupations by the Chippewa (?), Ottawa, Seneca, Shawnee, and Wyandot. Trading expeditions by the "Iroquois," Mohawk (?), Ottawa, Seneca, Shawnee, Susquehannock, and Wyandot were noted. The "Iroquois," Mohawk (?), and Seneca also had military expeditions in Zone Ic. In Zone IIb, the adjacent uplands, there were major occupations by the Delaware and Erie, with minor occupations by the Chippewa, Ottawa (?), Seneca, Shawnee and Wyandot. Trading enterprises and military incursions in Zone IIb were as in Zone Ic during the 1570-1800 period. Brose (1976b:47) commented that most of east central Ohio is still archeologically *terra incognita*; the same may be said for the early periods of ethnohistory.

4.5.4.2 Zone Ic and Zone IIb Culture History

Eastern Ohio and northwestern Pennsylvania, west of the modern City of Erie, were occupied by people of the Whittlesey Focus from about 900 to 1300 (Brose 1978a; Johnson, Richardson, and Bohnert 1979). Some county and regional historians claim that this area was within the territory of the Erie (see Fig. 4.2); there is no positive evidence to support this conjecture for Cuyahoga (Ellis 1966; Johnson 1879; Kennedy 1896), Geauga (Williams Brothers 1878), Lake (Lake County Historical Society 1976; Lupold 1975; Writer's Project

1941), or Ashtabula Counties (Large 1878; Williams 1924). Sections of Lupold's (1975) The Forgotten People: The Woodland Erie are especially in error. Lupold failed to critically evaluate the sources and took earlier writings as accurate accounts; parts of his narrative border on good fiction. Stewart's regional history of northeastern Ohio (1935) also claims Erie occupations, as do the state histories by Bond (1941), Howe (1900), Lindsey (1960), Randall and Ryan (1912), Rosenbloom and Weisenberger (1967), and the Writer's Project...Ohio (1940). All Erie County histories consider the Erie or Eries to have been county residents prior to 1657. Jennings (1978), citing Pennsylvania State Archeologist Barry Kent, contends that possible trade between the Erie and Susquehannock existed from 1615 to 1640 (see Fig. 4.3).

It was during the dynamic period between 1649 and 1657 (see Fig. 4.4) that the Erie were defeated and dispersed by the Seneca and their allies; the Seneca raids began as early as 1642, and full-scale hostilities were in evidence from 1653 to 1657 (Kubiak 1970; Wallace 1961; Witthoft 1965). Remnants of the Erie moved south from the Zone IIb highlands into the French Creek and Allegheny drainage. This movement of remnantal Erie and subsequent Seneca migrations southward created problems of archeological recognition and ethnic interpretation in the upper Allegheny River drainage area (Curtis 1971; Kolb 1977a, 1977b; Wolynec et al. 1978). By 1660, the Seneca and their allies, especially the Cayuga and Mohawk, began moving westward along the Lake Plain and adjacent uplands toward the Sandusky and Maumee river valleys (see Fig. 4.5). Some camps and villages were undoubtedly established between 1660 and 1680 as these peoples occupied this "vacuum," but these sites are not identifiable since the Whittlesey Focus is no longer considered to be the archeological manifestation of the ethnic Erie (Brose 1976b; Kolb 1977a).

By 1700, Seneca communities were apparently established in northwestern Pennsylvania; it is unknown who occupied Zones Ic and IIb at this time (see Fig. 4.6). Delaware migrations from the State of Delaware and southeastern Pennsylvania westward into west central Pennsylvania had begun, but these seem to have had no great impact on northwestern Pennsylvania or northeastern Ohio (Goddard 1978; Hunter 1978). However, significant Delaware migrations into Zones Ic and IIb had occurred by 1750 (see Fig. 4.7). Villages had been established in the Pymatuming area and in the middle Allegheny River system (Carpenter 1942a; Dragoo 1964; Pennsylvania Archaeologist 1930, 1934b; Hunter 1956; Weslager 1942; Zakucia 1958). In 1782, lands between Avon Lake, Ohio, and Erie, Pennsylvania, including the northwestern segment of the Allegheny River drainage, were ceded by the Seneca ("Iroquois") to the Delaware (Hunter 1978). Some Shawnee, migrating from eastern Pennsylvania to southeastern Pennsylvania may have joined Delaware communities in the Allegheny drainage (Witthoft 1965).

By 1800, U.S. settlers were in evidence along the southern Lake Erie shoreline; the Commonwealth of Pennsylvania had purchased the Erie Triangle from the federal government in 1792 (Lechner 1975; Reed 1929). The acquisition proceedings began in 1784. Lechner states that "group of Delawares, Wyandots, Chippewas and Ottawas occupied and claimed parts of northwestern Pennsylvania west of the Allegheny River" and were dissatisfied with the land sale negotiations (1975:122). There is no proof that all of these Native Americans inhabited the area. Lechner cites Reed (1925:211-212) as his source, but Reed contains unverified information. Nonetheless, it appears that Delaware villages continued to exist in Zone IIb until the 1830s (see Fig. 4.8).

4.5.5 Zones Id and IIc

4.5.5.1 Ethnohistoric Summary

Zone Id, the eastern Pennsylvania and southwestern New York section of the research area, had major occupations by the Delaware, Erie, and Seneca; there were no minor occupations. Trading expeditions by the Cayuga, "Iroquois," Mohawk, Oneida, Onondaga, Seneca, and Susquehannock were noted, as were military operations by the Cayuga (?), "Iroquois," Mohawk, Oneida (?), Onondaga (?), and Seneca. In Zone IIc, the adjacent uplands, there were major occupations by the Delaware, Erie, and Seneca, with a possible minor Shawnee (?) occupation. Trading expeditions and military incursions were as in Zone Id during the period under consideration.

4.5.5.2 Zone Id and IIc Culture History

Northwestern Pennsylvania, especially eastern Erie County, may have been occupied by people of the Whittlesey Focus from about 900 to 1300, but the evidence is inconclusive (Kolb 1979). Erie County, Pennsylvania, and Chautauqua County, New York, had evidence of Late Woodland/Late Prehistoric occupations (Butler 1936; Dragoo 1959, 1972; Guthe 1953; Johnson 1976; Mayer-Oakes 1952, 1955a, 1955b; Parker 1922a, b, c, g, and h; Rupp 1936a; Schoff 1938a, b, and n.d.). In essence, we see a mixture primarily of Owasco ceramic decorative traits with either Owasco vessel forms and pastes or Monongahela vessel forms and paste. The Allegheny River drainage area was the area in which these traits melded (Curtis 1971; Wolynec et al. 1978; Kolb 1979).

All Erie County histories consider the Erie/Eries to have been county residents prior to 1657 (Barber 1938; Bates 1884; Miller 1909; Moorehead 1876; Reed 1925; Riesenman 1943; Robbins 1894; Sanford 1862, 1894; Spencer 1962; Whitman 1896; Whitman and Russell 1884). Some evidence exists to support this contention (see Fig. 4.2). Jennings (1978), citing Pennsylvania State Archeologist Barry Kent, believes that trade between the Erie and Susquehannock was conducted from 1615 to 1640 (see Fig. 4.3). Late Prehistoric sites at Wesleyville and on East 28th Street in the City of Erie were regarded as Erie villages on the basis of pottery and trade goods (Cadzow 1936; Carpenter 1949; Carpenter, Pfirman, and Schoff 1949; Mayer-Oakes 1955b; Pfirman 1952). In Crawford County, Pennsylvania, immediately to the south of Erie County, the Linesville, Cochranton, Spartansburg, Nelson, Danner, and McFate sites illustrate the blend of Owasco-Monongahela noted above (Anonymous 1934c, 1938, n.d.; Carpenter 1950, 1962; Carpenter and Schoff 1951; Clark, Lantz, and Robinson 1960; Murphy 1973; Schoff 1938b, n.d.). Some historians infer that these Crawford County sites were of Erie origin; this contention cannot be stated with any certainty due to the absence of chronometric dates and ceramic studies (Kolb 1977a and b).

Chautauqua County historians contend that substantial Erie occupations existed in their county (Dilley 1891; Doty 1925; Downs and Hedley 1921; Edson and Merrill 1894; McMahon 1958; Ripley 1966). There is supportive evidence (see Fig. 4.2) for their contention; late prehistoric sites in Chautauqua County have been studied by Guthe (1956, 1958), Harrington (1922b and c), Houghton (1916), and Parker (1922a, b, and c). The Ripley Site, near the New York and Pennsylvania border (Parker 1907, 1922e, and f), and the Westfield Site (Guthe 1953; Wright 1931) were interpreted as being Erie (see Fig. 4.3).

Schock (1976), who recently evaluated the Chautauqua Phase and other Late Woodland/Late Prehistoric occupations on fifteen sites, does not make any ethnic identification except that the sites were "Iroquoian."

The Presque Isle Portage (Lake Erie to the Allegheny River) and the Chautauqua Portage (Lake Erie, Chautauqua Lake, Allegheny River) were vital communication links to the south. The dynamic period of from 1649 to 1657 (see Fig. 4.4), during which the Seneca and their allies defeated and dispersed the Erie, is represented in New York State and, with less certainty, in Pennsylvania (Wallace 1961). Remnants of the Erie were probably pursued by the Seneca into southern Erie and Chautauqua counties, as well as westward along the lakeshore (see Fig. 4.5). Zones Id and IIc remained within Seneca jurisdiction from 1657 to about 1780 (see Figs. 4.6 and 4.7). Some Delaware may have moved into the southern portions of Erie County by 1750, but were in Crawford and Venango counties to the south. Most of the lands in Zones Id and IIc were apparently unoccupied for about a century, from 1660 to 1750.

In the 1730s, the French became interested in the region as a portage to the Allegheny River (Belle Riviere). By 1753, the French had established fortifications called Presque Isle (at Erie, Pennsylvania) and Le Boeuf (at Waterford, Pennsylvania) at either end of the shortest portage--thirteen miles (Hunter 1960, 1978; Kent 1938; Schoenfeld 1979; Stevens and Kent 1941). The former fort was built on the west bank of Mill Creek, as was a village inhabited by about a hundred families. A small Kakhwa Indian camp was reputed to have existed on the location prior to the establishment of the village. The Seneca sent a delegation to visit Sieur Marin during the erection of Fort Le Boeuf and were persuaded to aid the French against the English. A young surveyor, George Washington, was sent to Le Boeuf to warn the French not to advance further into English territory. During this visit, he learned that the Seneca, as well as the Chippewa, Delaware, Ottawa, and tribes in the interior were in league with the French.

Pontiac's uprising in the Western Basin was felt when the Six Nations began assaults on forts in western Pennsylvania. Le Boeuf was assaulted on June 17, 1763, by about 200 Seneca and Ottawa. The French garrison fled to Presque Isle, which fell to the war party five days later. Early in 1764 a British Army of some 3000 men, under the command of General Bradstreet, canoed up the lake and stopped at Presque Isle. After relieving the siege at Detroit, they returned and on August 12, 1764, Bradstreet made a treaty of peace with the Delaware and Shawnee at Presque Isle. There are few documents covering the period from 1764 to 1794.

By 1800, U.S. settlers had migrated into the Lake Erie littoral (Lechner 1975; Reed 1929). Prior to 1800, following the French and Indian War, Pontiac's uprising, and the American Revolution, attention to Zones Id and IIc focused on the fur trade. In about the mid-1780s, Pennsylvania officials embarked on an ambitious program to improve the network of river and roadway communication. In 1787, they proposed to the Confederation Congress that a corridor from existing Pennsylvania northward to Lake Erie, including the harbor at Presque Isle, be bought. In 1790, a boundary commission completed the survey of New York State's western boundary and the land west of this boundary, north of Pennsylvania's northern boundary, became the federally owned Erie Triangle eventually purchased by the Commonwealth on April 3, 1792.

Theoretically no American settlers lived in this region prior to the resolution of all "Indian" claims (Delaware, Wyandot, Chippewa, and Ottawa) in 1795, a year after General Anthony Wayne established a garrison at Presque Isle. The Treaty of Greenville (August 3, 1795) settled all hostilities and land claims (Washburn 1973; Tanner and Wheeler-Voegelin 1974). The last "Indian" encampment in Erie County was in June 1841 when about a dozen Native Americans spent a few days at the southeastern outskirts of the City of Erie (Whitman and Russell 1884:183).

In Chautauqua County, "Indian" villages were reported in 1796 at the mouth of Kiantone Creek, in 1806 at Bemus Point and at Griffiths Point (Downs and Hedley 1921). During the 1802-1805 "frontier period," settlers from Buffalo and Pittsburgh converged on Zones Id and IIc. Scattered references to the Seneca appear in the histories for both Erie and Chautauqua counties after 1805.

4.5.6 Zones Ie and IId

4.5.6.1 Ethnohistoric Summary

Zone Ie, the western New York and Niagara Frontier area, had major occupations by the Erie, Neutral, Seneca, and Wenro; there were minor occupations by the Huron. Trading enterprises by the Cayuga, Erie, Huron, "Iroquois," Mohawk, Neutral, Oneida, Onondaga, and Seneca were noted. Military incursions and occupations in this zone were by the Cayuga, Erie, Huron, "Iroquois," Mohawk, Oneida, Onondaga, Seneca and Wenro (?). In Zone IId, the adjacent upland area, there were major occupations by the Erie, Neutral, Seneca, and Wenro, with minor occupations by the Fox (?) and Huron. Trading expeditions were as in Zone Ie but also included the Susquehannock (?). Military operations were as in Zone Ie for the period from 1570 to 1800.

4.5.6.2 Zone Ie and Zone IId Culture History

Like Zone Ia at the southwestern end of Lake Erie, Zones Ie and IId, at the southeastern terminus of the study region, were areas of substantial ethnohistoric activity. The prehistory of these zones has been summarized by many historians, including Guthe (1956, 1958), Harrington (1922c), Houghton (1908, 1916), MacNeish (1952, 1976), Parker (1922a and b, 1926a, and b), and Ritchie (1969). Major ethnohistoric syntheses include those by Beauchamp (1904, 1905), Colden (1958), Conover (1889), Cusick (1961), Fenton (1940), Houghton (1922), Trigger (1963, 1978), Whallon (1968), and Wray and Schoff (1953). The late Marian White's ethnohistoric works (1956, 1958, 1961, 1971, 1976) are an invaluable source, as are her specific studies of the Erie (1978a) and Neutral (1978b). In her ethnohistoric syntheses (1961, 1963, 1976), White tried to correlate archeological, ethnohistorical, and early historical sources as well as to relate archeological sites and ethnic identities as after careful evaluation.

From 1570 to 1600 (see Figs. 4.1 and 4.2) sections of the Niagara Frontier were probably occupied by the Erie/Eries/Eriez, Neutral, and Wenro; evidence for occupation by the latter two groups is less conclusive for this time period than that for the Erie. There is no evidence of Huron incursions. The Erie occupied the Niagara Frontier from the general vicinity of Buffalo Creek south to Cattaraugus Creek. Before 1644, due to Seneca expansion from the east and north (see Fig. 4.3), they began moving inland into Zone IId between Eighteen Mile Creek and Lake Chautauqua. The Neutral and Wenro are best known from archeological data, although the former are shown on Champlain's 1632 map and Sanson's 1650 map (White 1978b). The Neutral had several villages east of the Niagara River; although these may date from as early as 1600, they are best known at this location from 1630 to 1645 (G. Wright 1963). French missionaries twice visited Neutral villages in what is now eastern Ontario but never established a mission; nor did they visit Neutral villages east of the Niagara River. No Wenro occupation was shown on any of the early maps, but they are assumed to have occupied an area about thirty miles east and northeast of the Niagara River prior to 1638, possibly with some Huron. The Wenro left the Niagara Frontier in about 1638 and moved into Huronia. Jesuits visited Wenro communities before and after this date.

Because the Jesuits never visited the Erie, the materials published in the Jesuit Relations, especially in volume 33 for 1647-1648, were narrated by the Seneca. The Erie appear on Sanson's 1650 map, Du Creux's 1660 map, and Franquelin's 1685 map (White 1978a), the latter possibly reflecting locations after dispersal by the Seneca.

The fur trade, Seneca expansionism, European contact by the Seneca, and other events precipitated the demise of the Erie (see Fig. 4.4). The Wenro abandonment of segments of the Niagara Frontier apparently created a void that the Seneca wished to fill in order to enhance their territorial acquisitions of beaver country. Between 1649 and 1651, the Seneca defeated and dispersed the Neutral, Petun, Wenro, and Huron in a series of wars in Huronia and in the Neutral's southern Ontario territory. The 1653-1657 period was marked by increasing hostilities between the Seneca and Erie; the hostilities began with the death of a Seneca, the murder of twenty-five Erie peace ambassadors, and the killing of an Onondaga leader. The Seneca and their allies, 700 Mohawks, 1200 Onondaga, and unstated numbers of Cayuga and Oneida, united against the Erie, who suffering defeats in 1654 and 1655, retreated inland toward the south and west. The Jesuit Relation of 1655, which is missing, may have clarified the progress of these hostilities. The warfare continued in 1655 and 1656. The Erie were finally defeated and dispersed to the south, as far as Virginia; some Erie were taken captive by the League of the Iroquois. The Black Minqua of northern Virginia and southeastern Ohio may, in some part, be descendants of these defeated Erie. White (1961:21-51) and Kolb (1981) give a detailed picture of these events.

Subsequently, the Seneca and some of their allies, notably the Mohawk and Cayuga, migrated along the southern lakeshore (1660-1680) probably seeking new, unexploited beaver territories as well as pursuing Erie remnants. Eventually they returned and the Seneca consolidated their holdings east of the Niagara Frontier. Seneca villages were scattered throughout Zones Ie and IId, especially near such creeks as Buffalo and Cattaraugus (Parker 1922a). In the meantime, the Seneca and their allies turned their attention to the Susquehannock of north central Pennsylvania (see Fig. 4.5).

County histories for southwestern New York State normally devote at least a chapter to the Erie-Iroquois hostilities and to Seneca expansion; Minard (1896) and Adams (1893) followed this pattern in their histories of Allegany County and Cattaraugus County, respectively. Erie County histories also detail these events (Doty 1925; Horton et al. 1947; Johnson 1876; Ketchum

1864; Smith 1884; White 1898). A comparison of these county histories with the meticulous researches by Marian White demonstrates how history can be and was embellished, how errors can be perpetuated, and how half-truths and suppositions are treated as fact.

The Niagara Frontier had changed markedly in the seventy-five years following the arrival of a few Jesuits on the banks of the St. Lawrence River and their movement into areas along Lakes Huron and Erie (see Fig. 4.6). In 1664, the English conquered New Amsterdam; by 1670, their conquest of the Frontier was permanent. The Dutch were eliminated from the triumvirate of fur traders--Dutch, French, and English. Due to French Jesuit influences, the Huron began to ally with the French, while the Iroquois became trading "partners" of the English. Marquette and Joliet explored the Lake Huron and Superior regions in 1673 and Wentworth Greenhalgh, an Englishman, visited all five League nations (Horton et al. 1947; Smith 1884). The subsequent decades were ones of European exploration and exploitation, including La Salle's exploration of Lake Erie in the Griffon in 1678-1679 (Murphy 1955, 1956a and b). In the summer of 1687, the Marquis de Denonville, with a body of soldiers, crossed Lake Ontario from Fort Frontenac to Irondequoit Bay, then moved overland into Seneca country, burned stores of corn, was nearly ambushed, and retreated to the Bay. These and other Seneca-French activities occurred north of the research area. The Iroquois formally made peace with the French in 1701.

In about 1712, an important event occurred in the history of the Iroquois--the Five Nations became the Six Nations with the adoption of the Tuscarora from North Carolina and their settlement near the Oneida. In 1727, the French finished their construction of Fort Niagara at the confluence of the Niagara River and Lake Ontario. This had been the site of at least two previous French forts--by La Salle in 1679 and Denonville in 1688 (Horton et al. 1947). From 1701 to 1751, the Seneca were primarily in the vicinity of Seneca and Canandaigua lakes and the Genesee River Valley.

In 1751 (see Fig. 4.7), a fortified post, Little Fort Niagara, was established on the east bank of the Niagara River above the falls in order to secure the trade and defense of the straits. The fort was defended by the pro-French Seneca. This post, built by Daniel Joncaire, who was of French-Seneca heritage, was part of France's strategy of fortifying a foothold south of Lake Erie. Forts Presque Isle (Erie), Le Boeuf (Waterford), Mauchalt (Franklin), and Duquesne (Pittsburgh) were all built within a three-year period. Fort Niagara fell to the British on July 25, 1759. An unconfirmed report suggests that Mascouten were present in this area at about mid-century. The Governor-General of Canada, Marquis de Vaudreuil, in September 1760 surrendered Montreal, Detroit, and all other French posts to the British. This surrender, ratified by the Treaty of Paris in February 1763, ceded Canada to the British.

On October 19, 1763, 600 British soldiers, under the command of Major Wilkins, were on their way in boats to reinforce Detroit when about sixy Seneca attacked from ambush at Black Rock (Devil's Hole) on the Niagara River. About twenty-five British were killed or wounded. This was the first recorded conflict of arms in Erie County in which Europeans took part, and it was also the last serious attack by the Seneca on the British (Abler and Tooker 1978:507; Smith 1884:46). The attack was the evidence of Pontiac's uprising in the eastern Lake region.

In 1771, when the American Revolution broke out, the Seneca were said to number some 4000 (O'Callaghan 1849-1851 4:1093). The Seneca remained neutral until 1777 when they were enlisted for Colonel Barry St. Leger's attack on Fort Stanwix. In 1778 the Seneca participated in the Wyoming and Cherry Valley attacks. In retaliation the Americans sent General Sullivan to lead expeditions to the Genesee and southern tier of New York and Colonel Daniel Broadhead along the upper Allegheny River in Warren County, Pennsylvania (Graymont 1972). Many Iroquois fled to the Niagara Frontier and spent the winter of 1779/1780 in that area. The Frontier itself was not the scene of any military action by the Seneca. The Treaty of Paris (1783) ended the war between England and the American colonists but made no provisions for the Iroquois. Some moved to Canada, others made separate peace with the British and Americans.

The Treaty of Fort Stanwix (October 22, 1784) and the Treaty of Fort M'Intosh (January 21, 1785) resulted in land concessions by the Iroquois (Seneca, Mohawk, Onondaga, Cayuga, Oneida, and Tuscarora), Wyandot, Delaware, Chippewa, and Ottawa (Washburn 1973:2267-2271). There was some opposition to these treaties, but the conditions were accepted by the Seneca and others in the Treaty of Fort Harmer (January 9, 1789) (Washburn 1973:2278-2285). Seneca lands that became part of the United States by the Treaty of Paris were established as a part of New York State rather than the Commonwealth of Massachusetts in 1786. The complexities of land rights, preemption rights, and sales, annuities are summarized by Abler and Tooker (1978:508-509).

The Seneca, by the Treaty of Big Tree, which was signed near Geneseo on September 15, 1797, sold most of their lands to the Philadelphia financier Robert Morris who transferred much of it to Dutch bankers. The lands, known as the Holland Purchase, netted $100,000 for the Seneca, who reserved about 310 mi^2 for their own use. This area included ten tracts--four large reservations in western New York and six smaller ones along the Genesee River. A 130-mi^2 reservation along Buffalo Creek was to be used by the Seneca and some Onondaga and Cayuga. The Tonawanda Reservation of 71 mi^2 was established for the Seneca north of the City of Buffalo. Two small tracts, of 42 mi^2 each, to be used by the Seneca were established on Cattaraugus Creek and in the upper Allegheny River section of New York State. It is thought that in 1790 about 1700 to 1800 Seneca lived in New York and that most of them lived on the Buffalo Creek, Tonawanda, Cattaraugus or Allegheny reservations. The one-square-mile Oil Spring Reservation near Cuba, NY, was never inhabited (see Fig. 4.8). The Society of Friends, Presbyterians, Baptists, and other protestant denominations sent missions to the Seneca, and, by 1820, the New York Missionary Society had established a school at Buffalo Creek. A church was built three years later. These missionary activities took place at the same time as the 1799-1815 evolution of the Code of Handsome Lake, a Seneca revitalization movement that helped acculturate the Seneca into U.S. society.

During the early 1800s, pressure was exerted on the Seneca to sell the lands they still held and migrate west. The pressure resulted in sales starting in 1803, the most significant of which was recorded in the Treaty of Buffalo Creek (1826) in which the Seneca sold their remaining lands on the Genesee River and parts of the Buffalo Creek, Tonawanda, and Cattaraugus reservations to the Ogden Land Company. Table 4.2 relates these data for 1826.

Table 4.2. Land Sales, 1826

Reservation	Population	Size (acres)	Sold (acres)	Retained (acres)
Buffalo Creek	550	83,557	33,637	49,920
Tonawanda	325	49,209	36,409	12,800
Cattaraugus	350	26,880	5,120	21,760
Allegany	500	26,880	0	26,880
Genesee	450	--	all	0

In 1838 the Seneca sold their four remaining reservations to the Ogden Land Company, but fraud and corruption played a major role and the agreement was negated and renegotiated by court action in 1842. The Buffalo Creek and Tonawanda reservations were lost, but the Cattaraugus and Allegheny were regained. In 1845, there were approximately 2,280 Seneca in New York State, of whom 710 lived at Cattaraugus, 670 at Allegheny, 500 at Tonawanda, and 400 at Buffalo Creek. In 1848 the "Seneca Nation of Indians" and the "Tonawanda Band of Seneca Indians" became separate political entities (see Able and Tooker 1978:511-514 for details). Ultimately, the Tonawanda regained 7,549 acres of their reservation in 1857, while Buffalo Creek was lost forever in 1846 (Tooker 1978b:452-453). Ethnographic data on the Cattaraugus Seneca will be found in a later section of this report.

4.5.6.3 Protohistoric Site Inventory

The information presented in the following sections was also used to generate an inventory of some of the better known protohistoric sites. Although the information included in this inventory is general, it may provide guidance for identifying areas of cultural resource sensitivity. This inventory is presented in Appendix L.

4.6 ETHNOGRAPHIC RESEARCH

4.6.1 Methods

Since this research was problem oriented and did not require a holistic ethnographic analysis, many standard methods, such as projective tests, participant observation, and life histories, were not used to collect data from Seneca, Cayuga, and Tuscarora who live on the Cattaraugus Reservation in New York State or who were familiar with the reservation and surrounding region. Basic information was initially obtained through ethnohistoric research, especially by reading ethnographic materials about the Seneca and Iroquois. The basic source consulted was Lewis Henry Morgan's The League of the Ho-dé-no-sau-nee or Iroquois (1851), which documented the traditional social, political, and religious organization of the Iroquoian-speaking peoples of New York State. Also useful were ethnographic materials on the Seneca by Curtin (1923), Fenton (1936, 1941), MacElwain (1978), Parker (1926a and b), and A.F.C. Wallace with Steen (1973); and on the Iroquois by Beauchamp (1904, 1905), Colden

(1958), Fenton (1940, 1978), Hertzberg (1966), Speck (1955), Tooker (1970a and b, 1978a and b), and A.F.C. Wallace (1978). Abler's dissertation on Seneca factionalism (1969) and Shimony's study of Iroquois conservatism (1961) also provided important background data.

Basic inquiries were also made at the Seneca/Iroquois National Museum (Salamanca, New York), where Director/Curator George Abrams, a Seneca, provided helpful information and facilitated contact with members of the reservation. Inquiries at the Native American Center for the Living Arts (Niagara Falls, New York) provided additional helpful information.

The specific ethnographic method employed involved the use of key informants, selected on the basis of interviewer judgment, and structured and informal interviews. A more detailed discussion of the type of approach used for the field methods selected may be found in Honigmann (1973), Naroll and Cohen (1970), Pelto (1970), and Pelto and Pelto (1973).

Local residents, both Native Americans and others, in Barcelona, Silver Creek, and Buffalo provided information. Informants are listed in Appendix L. Three informants, including one well-known ethnographer, asked that their names not be associated with information given; in light of the American Anthropological Association code of ethics, "The Principles of Professional Responsibility," and guidelines on human subjects research promulgated by The Pennsylvania State University, their wishes were respected.

4.6.2 Traditional and Modified Culture Patterns

The Seneca tribe or nation was traditionally divided into villages and longhouse families. The descent group was composed of two moieties, each made up of four clans that were, in turn, composed of one or more matrilineages. One moiety consisted of the Bear, Beaver, Wolf, and Turtle clans; the other was composed of the Deer, Hawk, Snipe, and Heron clans. The "fireside" was the basic nuclear or extended family residential unit composed of husband, wife, daughter, and son (until marriage), with wife's mother, wife's brother, wife's sister, daughter's husband and her family coresiding. The matrilineage, (a) segment(s) of a clan, occupied one or more longhouses in several villages. Two or more matrilineal familes made up a clan, the members of which acted as siblings toward one another. The moiety, composed of four clans, was in early times (pre-1650) exogamous, but demographic decimation due to warfare and disease apparently caused the exogamous rule to be modified so that both moiety endogamy and exogamy were practiced. Clans and moieties had primarily ceremonial functions associated with the rites of passage (birth, puberty, marriage, and death) and recreation and, prior to 1795, some militaristic and economic (fur trade) functions. Matrilineal descent, matrilocal post-marital residence, and matriarchal authority within the family and traditional political system were characteristic.

The Iroquoian Kinship System, found in every part of the world and perhaps the most common system of kin terminology, was named for the Iroquoian-speakers of the Northeastern woodlands. Parallel and cross cousins are distinguished and ego's parallel cousins (children of ego's parents' siblings of the same sex) are called by the same terms as ego's own brothers and sisters, whereas ego's cross cousins (children of ego's parents' siblings of opposite sex) are called by different terms of address. Hence father and father's brother are called by the same term, as are mother and mother's sister.

Members of the nuclear family are classed with collateral relatives on the basis of sex in ego's parents' generation and the sex of the connecting link in ego's own generation. Elder and younger siblings are also distinguished.

The Iroquois also had social ranking; primary ranks were the Founders ("Grandfathers of Old"), Civil "Chiefs"/Sachems or Lords ("Trees"), Warriors ("Matbearers"), and Women ("Our Mothers"). Warriors were divided into "Big Tobacco Pouches," "Tree Watchers," and "Props." An Age-Grade System also existed. Additional details as to traditional social characteristics can be found in Lafitau (1724), Morgan (1851, 1877), and Fenton (1978).

The political organization was an extension of the social structure; matrilineages were organized into clans, the clans into moieties, the moieties into tribes or "nations," and the tribes into the League of the Iroquois. The tribe or nation ("native land") was both a kindred and a territorial concept, and was composed of villages. Tribes had "headmen" and councils of elders (clan leaders, elders, and "wise" men) whose offices and titles were ascribed by matrilineal succession or nominated by the ranking matrons of the matrilineages. Both tribal and clan offices were graded, and officers were known by the name of the office. Civil leaders or sachems had their ascribed authority from the clan or achieved their position because of oratorical skills or prowess in military activities. "War" leaders took over power at the time of the American Revolution (Fenton 1978).

Both the social and political organizations underwent acculturative changes as a result of the American Revolution, the Reservation period, land sales, and the dispersal of Seneca as far west as Oklahoma. Fenton (1971:161 states that these events caused the traditional culture pattern to be "shattered"; the people lost their "vital spark." The settling of U.S. settlers among the Seneca, deforestation for farmland, the spoiling of forest for hunting, and American material culture were partial causes for the changes (Oswalt 1978). The establishment of the Longhouse Religion was a Seneca attempt to return to some traditions and respond to unfavorable acculturative agents such as social "frolicking," alcoholism, wife-beating, etc. (Fenton 1971; Oswalt 1978; Wallace 1978).

The social structure was altered so that patriarchal authority was nearly universal in the families and so that there was a patrilocal post-marital residential bias. Bilateral (equal and simultaneous recognition of both the patrilineal and matrilineal ancestors) replaced matrilineal descent in most cases except for certain ceremonial activities for which the matrilineal system is necessary. Today, the primary orientation is to the family, the clan (especially for those practicing the Longhouse Religion), and especially the nation. Separateness and Native American nationalism are maintained by such activities as refusing to vote in federal elections, although this right was granted by the Citizenship Act of 1924, and separately declaring war on Germany during World War I. Payment of state and federal income taxes is also resisted.

The construction of the Kinzua Dam, however, changed the political system forever. The Seneca Nation was transformed into a corporation with assets of more than $15 million as partial reparation for the inundation of nearly 9,000 acres of Seneca land in the Allegany Reservation and Cornplanter Tract. This has precipitated a conservative vs. liberal split among many Iroquois, including the Seneca. Changes include improved housing, educational facilities, medical facilities, tourism, the forming of business corporations to conduct Iroquois enterprises (such as arts and crafts sales), and the establishment of the Native American Center for the Living Arts (historical museum, art gallery, craft shop, Native American restaurant, library, art studios, amphitheatre, etc.) at Niagara Falls. Paradoxes of acculturation exist (Shimony 1961), but need longitudinal investigation.

Strong nationalist feelings among Native Americans--the so-called "Red Power" Movement, is only one part of these sentiments--are reflected politically as lawsuits filed against the state and federal governments over land claims, illegal treaty provisions, and unilateral changes. In 1974 the Seneca were awarded $8 million for lands unlawfully acquired by New York State; in the same year, the Tuscarora won $90,000. The Cayuga have claimed that 62,000 acres of Cayuga and Seneca counties were taken illegally. The claim has tentatively been settled with an $8-million reparation in addition to 5,400 acres of state and federal lands (August 1979). The Oneida claimed the illegal seizure of over six million acres of central New York; a federal district court ruled that Oneida and Madison counties owed rent on those lands to the Oneida (July 1977). The case was appealed, lost, and refiled to claim three million acres (December 1979). Such court cases, which have been pressed by nationalist and traditional Native Americans, have widened the gulf between the nations. In political terms those who follow elected Council leaders and "Western" religions generally are most willing to negotiate with state and federal authorities. The traditionalists, who believe that each tribe or nation is a sovereign political entity, are seldom willing to negotiate. As a result, a mixture of political opinions, religious orientations, neo-nationalism, and economic contingencies color the picture.

4.6.3 The Cattaraugus Reservation

The Cattaraugus Reservation, established in 1797 by the Treaty of Big Tree (Tooker 1978b) contained 21,680 acres on both sides of Cattaraugus Creek and encompassed most of the drainage of the creek, including Big and Little Indian creeks and Clear Creek. The reservation is bounded on the northwest by the shore of Lake Erie and is contained within Chautauqua and Cattaraugus counties, New York. The name "Cattaraugus" is an Iroquoian word meaning "where the mud (or clay) stank." In 1845, the population of the reservation was approximately 710; by 1892, it had increased to 1,355 Seneca plus perhaps 200 Cayuga and some Mohawk, Oneida, and Tuscarora. The 1970 population was about 2,400, including Seneca, Cayuga, Mohawk, Oneida, Tuscarora, and Onondaga. Approximately two-thirds of the Seneca and some of the other Native Americans live on the reservation itself; the remainder live in nearby communities such as Buffalo, New York (Taylor 1972:227). The 1980 reservation population was about 2,550; the total population of the Seneca Nation of Indians was 5,313 as of Fall 1979. In 1970, the Buffalo, New York Standard Metropolitan Statistical Area included 5,775 Native Americans, mostly Seneca and Mohawk (Taylor 1972:183).

By way of comparison, the Allegany [New York] Reservation in Cattaraugus County, also established in 1797, contained 21,880 acres and, in 1892, had a Seneca population of 792. By 1970, the reservation had about 1,200 inhabitants (Taylor 1972:227; Tooker 1978b). The Cornplanter Tract on the Allegheny River in Warren County, Pennsylvania, originally had 87 inhabitants (1892); by

1965, these Native Americans (130 families) had joined the Allegany Reservation because the construction of the Kinzua Dam, upstream from Warren, Pennsylvania, inundated the tract (Abler and Tooker 1978:515; Oswalt 1978:452). A one-square-mile "Reservation" at Oil Spring in Cattaraugus and Allegany counties has never had permanent residents. Thus the Cattaraugus and Allegany reservations are the primary residential areas (along with Buffalo, New York) with Native American populations. The Tonawanda Band of Seneca in Niagara and Genesee counties, which had 824 Native American residents in 1970 (Taylor 1972:227) should also be added to the population count. The Tonawanda Reservation is located about twenty-five miles northeast of the research area. The Cayuga Nation has no reservation of its own; its members live on the Cattaraugus with the Seneca Nation. The State of New York has law and order jurisdiction over all Native Americans whether they reside on or off the reservations (Taylor 1972:87-88); this unilateral law, which was passed by Congress in 1948, is being challenged in the courts.

The major features of the Cattaraugus Reservation are the Newtown Longhouse, Seneca Nation Sports Center, Saylor Community Building (with gymnasium and ultramodern stainless steel kitchen), the Seneca-Cattaraugus Industrial Park, six churches (Presbyterian, Baptist, and Methodist), and six district schools. Strong Quaker influence in the late 1700s and early 1800s has given way to the protestant denominations noted. Still important to the lifeways of the Seneca, especially to the conservative members of the nation, is the Longhouse Religion (Wallace 1978; Abler and Tooker 1978:510-511). The Coldspring Longhouse on the Allegany Reservation is the focal point of religious activity; the Newtown Longhouse on the Cattaraugus Reservation runs a close second in importance and indeed has more members than the former. The major Seneca Newtown Longhouse ceremonies are tabulated in Table 4.3.

All informants were hesitant about specifically locating sacred, ritual, resource, burial, and other lands deemed part of their heritage. Most responses concerned the Cattaraugus Creek drainage, the lands most familiar to the respondents. Some knew of resource areas (clay, minerals, stone, herbs, wild flora, game, etc.) in nearby creeks and runs outside of the Cattaraugus drainage. However, none knew or would claim knowledge of the specific locations of archeological sites ("villages"), burial grounds, or sacred localities used either today or in the recent past. Indeed, in many cases, the interviewer seemed to have a better knowledge of these locations outside of the Cattaraugus drainage than did the informants. No informant had (or claimed) knowledge of areas west of Ripley, New York.

It may be that acculturation has dealt a severe blow to oral traditions concerning the specifics requested in this investigation. The vast majority of inquiries were answered by general statements, wide-ranging locations ("the whole southern lakeshore," "western New York," "these counties," "around Buffalo," etc.), and deception. When asked about specific "sacred" areas, one informant said: "All the lands and waters are sacred, they are part of our past, present, and future." Another, highly acculturated and politically motivated Native American stated that their heritage included all <u>present and former</u> lands, and that all of these were sacred and should be protected from harm.

Some elderly men and women said that every field, timber lot, and stream provided resources for crafts--ceramics, woodworking (especially carving),

Table 4.3. Seneca Ceremonies Held at the Cattaraugus Reservation

Calendrical[a]
Midwinter (New Year's) Ceremony [January-February]
Four Sacred Rituals
Feather Dance
Thanksgiving Dance
Personal Chant
Bowl Game
Life Supporter Dances
Maple Ceremony/Sap Dance
Sun Ceremony
Thunder Ceremony
Seed Planting Ceremony
Strawberry Ceremony
Bear Ceremony
Little Corn Ceremony
Green Corn Dance or Ceremony
Harvest Ceremony/Bread Dance
Non-calendrical[b]
Medicine Society Rituals/Ceremonies
Medicine Men/Shake the Pumpkin Ritual
Little Water Society Ritual
Little People Society Ritual/Dark Dance
False Face Society Ritual [popular]
Husk Face Society Ritual
Mystic Animal Company Rituals/Ceremonies
Bear Society Dance and Ritual
Buffalo Society Dance and Ritual
Eagle Society Dance and Ritual
Otter Society Dance and Ritual
Tenth-day Feast Ritual
Feast of the Dead Ritual

[a]Held annually; seasonal, ecological factors determine the exact date.

[b]Held as needed.

painting, etc., as well as herbs, spices, and edible flora. Peter Jones, a Cattaraugus Seneca who makes clay figurines and wheel-thrown pottery, apparently obtains raw materials (clays, pigments, etc.) and inspiration from the environment of the southern shore of Lake Erie and from its associated creek valleys. Rick Hill perhaps said it best: "The Iroquois lifestyle is compatible with the environment. The lands and the waters are our heritage."

4.7 ETHNOHISTORIC PROBLEMS

Major research problems identified in the chapter include the following: 1) the relationships between archeological components and ethnic or tribal units, 2) the problem of synonymy, 3) the enigma of the Erie/Eries/Eriez, 4) the evaluation of county histories, 5) the imprecision of site locations, 6) major vs. minor occupations, and 7) Seneca factionalism.

Mason (1976:359) stated, "What does it mean to assert that a given archaeological component is Fox, Potawatomi, or Ojibwa? In most cases, we can never be completely sure. In others, we may know in one instance but not in another." Herein lies one of the major problems encountered in this ethnohistoric review for the 1570-1850 period. The Late Woodland Younge Focus in eastern Michigan was identified by Greenman (1937b) as related to the Owasco Aspect of the Finger Lakes region of New York State. It may have been the archeological result of Seneca and "Iroquois" incursions about 1660, but this cannot be proven (Fitting 1964, 1965, 1969). Likewise, the Whittlesey Focus in southeastern Michigan and especially in northern Ohio was related to the Erie tribe of ca. 1590-1650 (Greenman 1937b, 1939b; Morgan and Ellis 1943). Brose (1976b) and Kolb (1977a and b, 1979) contend that Whittlesey is not Erie but do not suggest what manifestation it might be. Ottawa or Wyandot are possibilities, but the time frame is wrong. Hence for Zones Ib and IIa, and for parts of Zones Ic and IIb, the inhabitants between 1570 and 1720 remain conjectural.

The problem of synonymy created serious additional labors in the research and evaluation of the ethnohistoric sources. This problem was recognized by Thwaites (1896-1901) in compiling and translating The Jesuit Relations and Allied Documents, 73 vols. The last two volumes are Indices and contain Synonymy. In some cases, such as the Erie (Nation du Chat), Huron, and Seneca, as many as forty-eight synonyms may be found for each. This is because the missionaries used French (and some Italian) and Latin names for the tribes that were later translated into English. In addition, each tribe had its own names for every other tribe; for example, the Seneca had at least sixteen names for the Huron. These names were for tribal designations, not for clan, lineage, or other social distinctions which also were used by the Seneca and recorded by the Jesuits. Some Jesuits used different spellings for the same word, and, of course, spelling errors crept into the texts. Trigger's edited Handbook of North American Indians, Vol. 15: Northeast (1978) considered synonymy. Each societal presentation has a short section dealing with this topic. Societal synonymy was thus a serious problem in some evaluations.

One special enigma was that of the Erie, Eries, or Eriez. It appears impossible to differentiate and qualify these near synonyms (Kolb 1977a and b). The term "Erie" has been used less than systematically to designate the Nation du Chat, probably "Raccoon Nation," although mountain lion or bobcat has also been a translation (Hewitt 1907; White 1978a). In the Jesuit Relations, some of the "Erie" references designate a "nation" or tribe, in other instances a confederation of tribes or societies, and, in a few cases, they would appear to indicate social organizational units--probably clans--within a tribe. At least fifty-five cases of synonyms exist (Kolb 1977a, 1979). This problem is compounded when some references are actually to villages or communities of the Erie (White 1961; Kolb 1979, 1981).

Some 117 county histories were consulted for the sixteen counties in the research area. The quality of these voluminous compendia ranged from excellent to nearly useless. Most of these works were written in the post-Civil War era, in part to record events before the oral traditions were lost and early settlers or their descendants died. The centennial of the United States was an added impetus. Thus a majority of these volumes are dated from the 1870s and 1880s. For example, twelve major histories for Erie County, Pennsylvania, were published between the 1840s (Day 1843) and today (Spencer 1962). Sanford's early work (1862) is among the best, and, by careful comparison, one can see how Moorehead (1876), Bates (1884), Whitman and Russell (1884), Robbins (1894), and Whitman (1896) used passages, sections, and even entire chapters from her 1862 work. Errors in fact (especially proper noun names, locations and dates) were passed along unchallenged and unverified. Some of these errors appear in later histories by Miller (1909) and Reed (1925). Riesenman (1943), a professional historian, corrected many of these inaccuracies by using primary documents for verification. Similar problems exist for other counties, especially in Ohio.

The first research objective, to summarize aboriginal ethnohistory from 1570 to 1850, was realized, but only a portion of the second objective, to relate the culture history to the ecological zones and discern settlement patterns and site hierarchies within the research area, has been achieved. The quality of data did not permit the latter portion of this second objective to be realized. For example, most sources indicate an "Indian village," or "town," or "camp" in a general location, such as in the Maumee River Valley or in Chautauqua County, New York. This lack of precision, of both location and ethnic identity--which tribal group or groups, renders the development of site hierarchies nearly impossible. This problem is compounded by imprecise chronology; such dates as "in the early 1700s" or "prior to the settlement at Conneaut [Ohio]" or "years before," make a precise interpretation impossible. There is also, of course, no way to resolve the distinctions between town, village, camp, etc. made by early settlers and chroniclers, let alone "large" or "small." In addition, the correlation of archeological sites with ethnic identity, already discussed, is a mitigating issue. Imprecisions in literature sources, locations, ethnic identity, chronology, settlement types and sizes are all part of the reason for the inability to derive good, verifiable settlement patterns and site hierarchies for the period.

The judgment as to "major" versus "minor" tribal occupations in the nine zones was mine alone, based on an evaluation of the sources and data at hand. Major occupation meant verifiable references to multiple communities of long duration--decades or generations at least--in a zone or econiche of the zone. Minor occupation meant verifiable references to "small" and/or impermanent communities of variable duration, both long and short. These distinctions were judgmental.

In conclusion, the collection of ethnographic data on members of the Seneca Nation at the Cattaraugus Reservation in New York State met with several problems. Barriers included factionalism between the Allegany and Cattaraugus Seneca, the liberal vs. conservative dichotomy reflecting political "Red Power," and religious variations of protestantism, the Longhouse Religion, and agnosticism/atheism. These, coupled with strong feelings about the Kinzua Dam construction and its associated legal redresses, relocation of families and rehabilitation fund use or misuse (Pennsylvania Archaeologist 1935; Abler and Tooker 1978:515), have created an uneasiness between the Seneca Nation and its constituents and outsiders, especially for those who are collecting data for agencies of the federal government. The specter of the Kinzua Dam looms large in the lifeways of the Seneca and is a subliminal thought within these Native

Americans, since similar data collecting in 1938 preceded the 1941 congressional authorization to begin the Kinzua project. An analogy between the Three Mile Island nuclear facility and all nuclear power plants could be drawn. Respondents preferred to answer specific inquiries with generalizations, and some informants refused to have their names associated with any response.

4.8 SUMMARY DISCUSSION
(Sue Ann Curtis and James W. Hatch)

Several points should be made concerning the probability of finding ethnohistoric sites and/or finding locations of cultural importance to Native Americans on the onshore locations for support facilities. First, the ethnohistory of some groups, such as the Erie, is not well known, and locations of settlements, special purpose sites, burial areas, etc., cannot be determined from the literature.

Second, given the inadequacies of the available ethnohistoric data for the general area, only limited information can be presented concerning site descriptions chronology and the ethnic identity of site locations for the ecological zones delineated in this area. The locations of most ethnohistoric sites cannot be accurately determined from the literature. State-of-the-art archeological reconnaissance and testing methods must be used to locate the sites that date from this period (1570-1850). Nevertheless, the information and references provided in this chapter will contribute greatly to a better understanding of the cultural identity of sites that may be found during a routine surface reconnaissance within each of the five major environmental zones, thereby facilitating a determination of those sites that may be eligible for nomination to the National Register.

Third, the cultural data base generated by this study will be useful for interpreting the functions of archeologically-recovered material remains from this time period as well as from earlier periods. The recognition of rare or unique remains at a site or group of sites that are ethnographically described and archeologically recovered may also make the site or group of sites eligible for inclusion in the National Register.

Fourth, areas in western New York and northwestern Pennsylvania where gas development takes place may contain important locations for Native Americans who live in or near to reservations. For example, the Cattaraugus Creek drainage has been identified through informant interviews as having particular importance for natural resource sites where raw materials are collected for native crafts, medicines, and other needs. Some informants expressed concern over resources on other properties previously owned by Iroquoian groups (see Fig. 4.8).

It should be noted that the kinds and importance of these natural resource sites appears to vary among individuals and that the locations of known sites seem to be confidential. Although some resources could be in areas that will be affected by lease projects, an individual or group may feel culturally compelled not to divulge its location even though such an action may lead inadvertantly to the site's destruction.

Finally, it must be recognized that the sociocultural climate of Native American communities in the study area is dynamic--that issues and positions of individuals, groups, and communities are changing. Thus, studies of properties in New York State that are considered for leases and locations of onshore facilities must include the collection of current ethnographic data as well as the establishment of contacts with a wide range of Native Americans who may believe that these properties contain areas of cultural importance to them at that time and that the areas in question should be protected. For these reasons, it is important to maintain a strong liaison between: 1) the federal regulating agency of the lease projects, 2) the gas company and its consultants, and 3) representatives of Native American groups. The maintenance of liaison contacts throughout the entire project period would facilitate the monitoring of changes in issues and/or information on natural resource sites that Native American groups may want to have preserved.

CHAPTER 5

THE HISTORIC RESOURCES OF U.S. LAKE ERIE AND ITS ADJACENT SHORELINE

Carl L. Romanek and Christopher E. Hamilton

5.1 INTRODUCTION

The information presented in this chapter is divided into two parts. The first includes a descriptive discussion of the Euro-American history of the lakeshore from 1800 to 1900. Emphasis is placed on the developmental growth of urban areas since these areas contain the vast majority of structures included in historic-sites inventories (Appendix G). The second part includes a description of the history and technology of shipping on Lake Erie. An inventory of the most accessible information on the wrecks of ships 50 ft. or more in length or 50 tons or more in weight is provided in Appendix H. This section also discusses the applicability of shipping data for clarification of Lake Erie historical and technological issues.

5.2 THE LAKE ERIE SHORELINE

5.2.1 Historical Background

The historical background of the lakeshore is complex. The numbers of Euro-Americans who settled in this area increased steadily, and from 1790 to 1860 many small towns were established in this area. Many of these grew in size and importance during this period (Bidwell and Falconer 1925).

Many of the settlers who came to the area bordering Lake Erie came from New England, traveling along a road that passed through Utica, Auburn, Geneva, and Buffalo. After 1800, settlers bound for the Western (Connecticut) Reserve were able to travel by boat from Buffalo to Cleveland. Other roads, such as the Catskill Pike, which stretched across southern New York to Erie, Pennsylvania, and the Franklin Road, which ran from Pittsburgh to Erie, also served to make this area more accessible to settlement during the early years of the nineteenth century (Buck and Buck 1939). Although it was still considered a frontier village as late as 1815, Cleveland grew rapidly after the completion of the Erie Canal (1825); so did other towns such as Sandusky and Toledo. By the time of the Civil War, these cities had grown into important urban centers servicing the rural hinterlands of the Old Northwest Territory.

As each city along the Lake Erie shoreline sought to expand its economic control, it clashed with nearby cities with similar aims. During the nineteenth century, many people believed that a city had to keep growing if it was not to suffer economic decline. Immigration, expanding markets, and improvements in transportation interacted to produce an upward spiral of growth and competition. This is best illustrated in the rivalry between Cleveland and Sandusky. In the 1820s, both towns wished to become the terminus of the canal to be built between Lake Erie and the Ohio River. Although Sandusky's location was more favorable, Cleveland used political influence to obtain its goal. With the canal, Cleveland became more attractive to business, which in turn encouraged a rapid rise in population. By 1850, Cleveland had more than 17,000 inhabitants. The larger population made Cleveland attractive to the railroads as a transportation link, and this in turn promoted more business and more population growth. By 1860, Cleveland's population exceeded 43,000 (McKelvey 1973).

Before the Civil War, urban life in America took place in "walking cities." People of all classes lived in close proximity to one another and usually to their business or work. During the nineteenth century, as cities expanded due to industrialization, immigration, and innovations in public transportation, their spatial structures changed. Moreover, as the cities grew in economic importance, people tried to improve urban life by enhancing the designs and appearances of the cities themselves.

Chicago's City Beautiful Movement, which began in the 1890s, encouraged similar efforts in cities along Lake Erie. Such notable planners and architects as Daniel Burnham and Louis Sullivan, who were responsible for the 1893 World's Columbian Exposition in Chicago, received commissions to design buildings in Cleveland and Buffalo. The architectural styles of the Lake Erie region during the nineteenth and early twentieth centuries largely reflected the mainstream of stylistic development in the United States during that period.

The structures that date back to the early days of settlement in this area possess great historical significance. But the buildings that represent the styles of the late nineteenth and early twentieth centuries possess the most cultural and aesthetic interest. In the buildings included in the survey in Appendix G, examples of the Beaux-Arts Classicism of the Chicago School can be found in close proximity to the works of architects whose influence was more regional than national. Thus, works of John Eisenmann, Charles Heard, and Charles Schweinfurth are represented in the survey as well as those of Daniel Burnham and Louis Sullivan (Burchard and Bush-Brown 1961).

5.2.2 Shoreline Historic Sites Inventory

Historic sites that have been recognized as important by local, state, and federal officials for five areas along the lake are listed in Appendix G. Only structures located within one mile of the lake and published in the Federal Register as of 1979 are included in the inventory. A brief discussion on how these structures were evaluated follows.

5.2.2.1 Arrangement of the Entries in the Survey

The entries in the survey are arranged by state, county, and municipality so that they coincide with the divisions used to organize the locations of the shipwrecks in Lake Erie. In the shipwreck section of the survey (Appendix H), the lake is divided into five areas, A through E (Fig. 5.1), the boundaries of which are as follows:

A - Michigan state line to Sandusky East Light

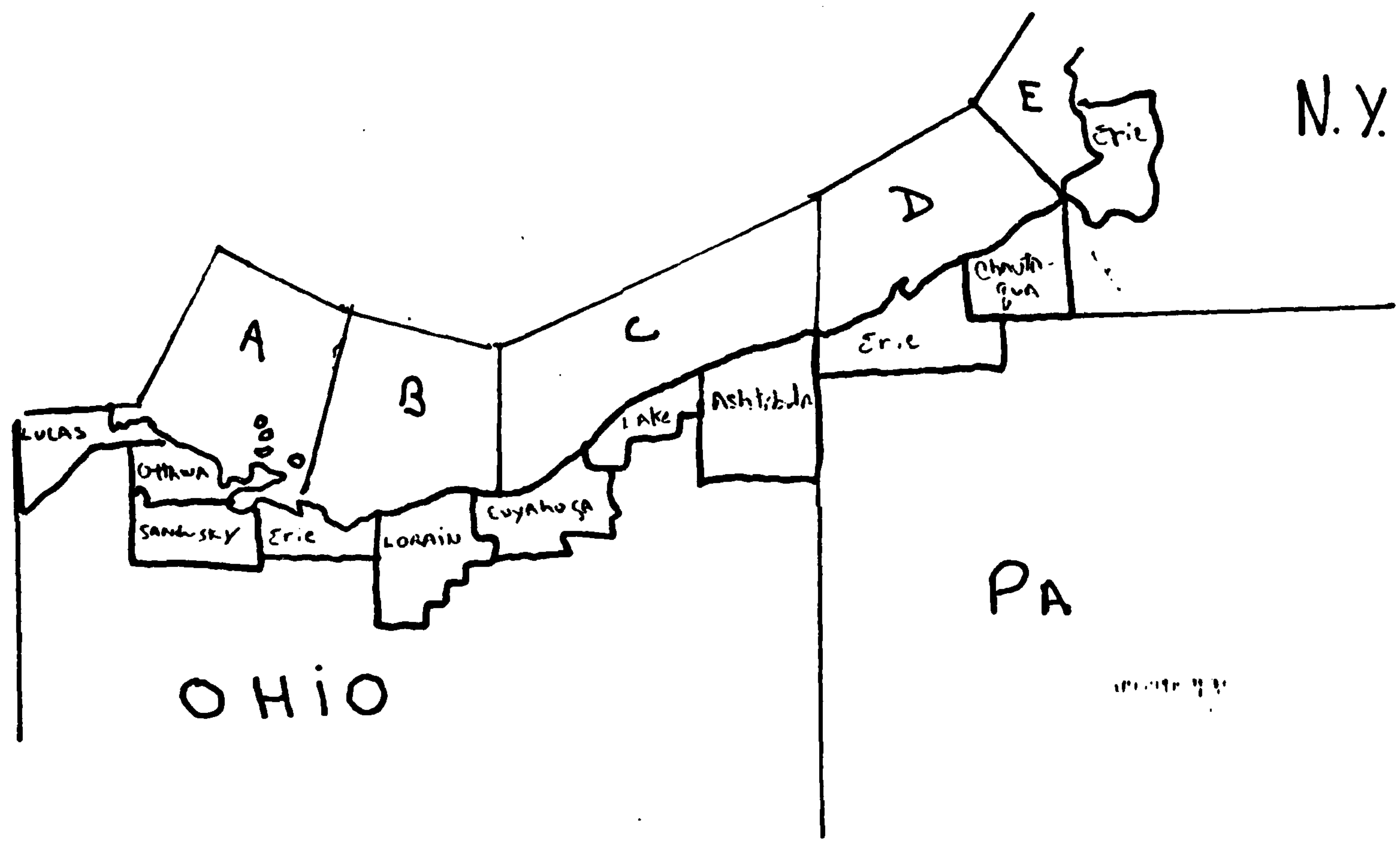


Figure 5.1. Shipwreck Areas A - E Along the Lake Erie Shoreline.

B - Sandusky Light to Rocky River, Ohio
C - Rocky River to Pennsylvania state line
D - Pennsylvania state line to Silver Creek, New York
E - Silver Creek, New York, to Tonowanda, New York

The counties that border Lake Erie in Ohio, Pennsylvania, and New York that roughly approximate these five areas of the Lake are

A - Lucas and Ottawa counties (Ohio)
B - Erie and Lorain counties (Ohio)
C - Cuyahoga, Lake, and Ashtabula counties (Ohio)
D - Erie County (Pennsylvania) and Chautauqua County (New York)
E - Erie County (New York)

The entries in municipalities are listed by street address. Rural properties are listed by distance and direction from the nearest town. The date of construction for a building, structure, or object is listed if known. Historic districts are dated according to the period or periods of the predominant architectural styles. Significant artists and owners are noted in the text. Most of the entries are followed by a description and summary of the significance of the property or of those associated with it. The date on which each property was added to the National Register is given in parentheses. Most entries also have information about ownership and accessibility to the public; the following acronyms are used in the survey:

NHL (National Historic Landmark): a building, structure, site district, or object declared eligible for recognition as a property of national significance by the secretary of the interior under the provisions of the Historic Sites Act of 1935. These properties are not administered by the National Park Service.

HABS (Historic American Buildings Survey): evidence of a building's architectural or historical significance has been documented by photographs, measured drawings, and/or data sheets. The Historic American Buildings Survey is conducted by the National Park Service in cooperation with the American Institute of Architects and the Library of Congress, where the records are deposited.

HAER (Historic American Engineering Record): a property that has been recognized and recorded as an important example of U.S. engineering. The Historic American Engineering Record is conducted by the National Park Service in cooperation with the American Society of Civil Engineers. Records are kept in the Library of Congress.

5.2.2.2 Criteria Used for Entries in the National Register

The following criteria are used to guide the states, federal agencies, and the secretary of the interior in evaluating entries for the National Register. Each entry has been evaluated for the quality of its significance in U.S. history, architecture, archeology, and culture. Districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and 1) that are associated with events that have made a significant contribution to the broad patterns of our history, or 2) that are associated with the lives of persons significant in our past, or 3) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction, or 4) that have yielded, or may be likely to yield, information important in prehistory or history are eligible for listing.

5.2.2.3 Classification and Terminology

Historic properties included in the National Register are classified as follows:

Building: a structure created to shelter any form of human activity.

Structure: a work, constructed by people, made up of interdependent and interrelated parts in a definite pattern of organization.

Site: the location of a significant event, activity, building, structure, or archeological resource where the significance of the location and any archeological remains outweighs the significance of any existing structures.

District: a geographically definable area, urban or rural, possessing a significant concentration, linkage, or continuity of sites, buildings, structures, or objects that are united by past events or, aesthetically, by plan or physical development. A district may also comprise individual elements that are separated geographically but which are linked by association or history.

Object: a material thing of functional, aesthetic, cultural, historical, or scientific value that may be, by nature or design, movable yet related to a specific setting or environment.

5.2.2.4 Limitations of the Survey

In keeping with the overall purpose of the survey, only those buildings, structures, districts, sites, and objects that are approximately one mile or less from the Lake Erie shoreline and that were included in the National Register of Historic Places as of December 31, 1979, are listed in the inventory (Appendix G). Listings in the National Register are made through additions of areas of historical significance to the National Park System, by acts of Congress and executive orders, through designations as National Historic Landmarks by the secretary of the interior, and by nomination from the states and from federal agencies. Names and locations of properties in the National Register are published annually in the Federal Register; additions are published on the first Tuesday of each month.

The historic properties for this area published in the Federal Register should not be considered as a complete inventory of any local region; systematic and complete inventories have not been made for all counties, townships, and communities in this one-mile corridor area. Currently, historic sites that have been identified and submitted for evaluation to state and federal officials represent the preservation interests of select individuals and groups that are aware of these nomination programs. These people may be less aware of potential historic sites in rural areas and small communities. Thus, the various federal and state registers are probably incomplete until such times as comprehensive surveys and inventories have been made for site-specific areas by qualified specialists.

5.2.3 Summary

The history of Lake Erie and its shoreline from 1800 to 1900 is a complex one. The area witnessed settlement and land-use changes by various groups of first- and second-generation Europeans. At first they were attracted to this area because of the fur trade. Settlers and farmers followed. Service centers soon developed and expanded into many of the large urban areas present today. It is primarily within these urban areas that locations and structures of various eras have been identified as having historic importance and have been nominated to a National Register that inventories 1) National Historic Landmarks, 2) Historic American Buildings, and 3) buildings included in the Historic American Engineering Record.

A total of 134 sites that have been published in the Federal Register were identified within the one-mile-wide corridor along the lakeshore (Appendix G). Most of the sites are located in the urban centers of Toledo, Sandusky, Cleveland, and Paineville, Ohio; Erie, Pennsylvania; and Buffalo, New York. The inventory includes numerous categories of sites.

5.3 LAKE ERIE SHIPPING

This section focuses on the shipping history of U.S. Lake Erie, with emphasis on the technological changes in ship construction and the numbers of ships in use in various parts of the lake. These factors are important in assessing the kinds of cultural remains that may be present on the lake bottom and their potential state of preservation. These same data will also contribute to interpreting historical events. Appendix H presents an inventory of known shipwrecks as well as information on the locations where they went down. Ships included in this inventory are 50 ft or more in length and/or weigh more than 50 tons.

5.3.1 Historical and Technological Background

Although Lake Erie was bordered by forests that provided plenty of oak, pine, and walnut timber for the construction of ships, the volume of trade before the opening of the Erie Canal in 1825 did not justify the construction of many large vessels. Most of the craft that sailed the Great Lakes prior to the early nineteenth century were small boats.

Bark canoes, aboriginal in origin, were initially adopted and adapted by European fur traders who explored much of the U.S. and Canadian interior around the upper Great Lakes. The birchbark craft were eventually developed into two general styles, the Montreal canoe, a "big water" craft measuring between 35 and 36 ft in length and capable of carrying up to four tons of goods plus a crew of eight or nine, and the smaller North canoe, which was from 24 to 28 ft in length with a draft of only 18 in. and which had a beam of just over 4 ft. The availability of birch bark for repairs, at least in the eastern ranges of the "Voyageurs" trade routes, and a simple but functional design allowed these canoes to dominate water travel in sparsely settled and uninhabited areas. Birch bark craft were used until the eighteenth century (Fig. 5.2).

The York boat and the bateau (Figs. 5.3-5.6) gradually replaced the birch bark canoe in commercial enterprises during the eighteenth century. Both types were double-ended, flat-bottomed boats, capable of withstanding ice and rough lake weather. They were also capable of carrying heavier loads than the canoe (Wheeler 1972:282).

The Hudson Bay Company created the York boat for its growing fur trade; the bateau was a French import that could navigate shallow, rocky streams and carry commodities such as sugar, coffee, tools, salt and gunpowder. Items such as these, lightweight or small in volume, but high in cost (Nettels 1969:256), were ideal for such a small volume of trade. Thus, these boats met the transportation needs of the people of the Old Northwest at that time. Soon after the beginning of the nineteenth century, however, these small craft were replaced by schooners and other larger craft as the principal means of transportation and trade on the Great Lakes.

The few available records indicate that several larger French craft were constructed and used on Lake Erie for exploratory and/or military purposes. Among the most famous was the Griffon, built by the French explorer La Salle on Lake Erie in 1678. She was wrecked after a short time, probably on the north end of Lake Huron; recent archeological research may have located the remains of this wreck in that area. Other early eighteenth-century French wrecks are reported off Presque Isle, including the possible remains of the La Jean Florin, lost in 1721 near Buffalo (Heden 1966; Van Gemert 1972:282). The general use of Lake Erie by the French ended when they lost to British-American forces in the French and Indian War (1763).

During the War of 1812, Lake Erie became a major theater of operations. One of the United States' prime objectives was the conquest of Canada. To accomplish this goal, the United States constructed a naval squadron at Erie, Pennsylvania, and placed it under the command of Oliver Hazard Perry. Unfortunately, the plans for these vessels have not survived (Dodge 1964), but a replica of the Niagara, which has been criticized for its lack of authenticity, is now on display at Erie (Chapele 1935:112). The plan of a brig that supposedly resembles Perry's craft the Saratoga is presented in Figure 5.7.

Perry's fleet consisted of the Lawrence and the Niagara, brigs of 480 tons each, plus the smaller Caledonia, Amelia, Somers, Ohio, Ariel, Scorpion, Porcupine, Tigress, and Trippe, between 180 and 60 tons each. This fleet was able to outgun and defeat a somewhat smaller British flotilla consisting of the Detroit, a bark of some 490 tons, as well as the Queen Charlotte, Lady Prevost, Hunter, Chippewa, and Little Belt. The latter four ships ranged in size from 90 to 400 tons; all were captured near Put-In-Bay (Metcalf 1948: 245-255; Stacy 1958). These ships and the prize ships that Perry captured suffered various fates, including reuse for subsequent lake trade. It is possible that some of them, or parts of them, may still be in the lake. It has been reported that part of the Niagara is incorporated into the present replica and that the Lawrence was sent over Niagara Falls with a bear and some other animals on board for the pleasure of a crowd of spectators. Some of the prize ships from the naval battle were still submerged near the naval yard at Erie as late as 1851 (Andrews 1853:161). Other sources dispute this information,

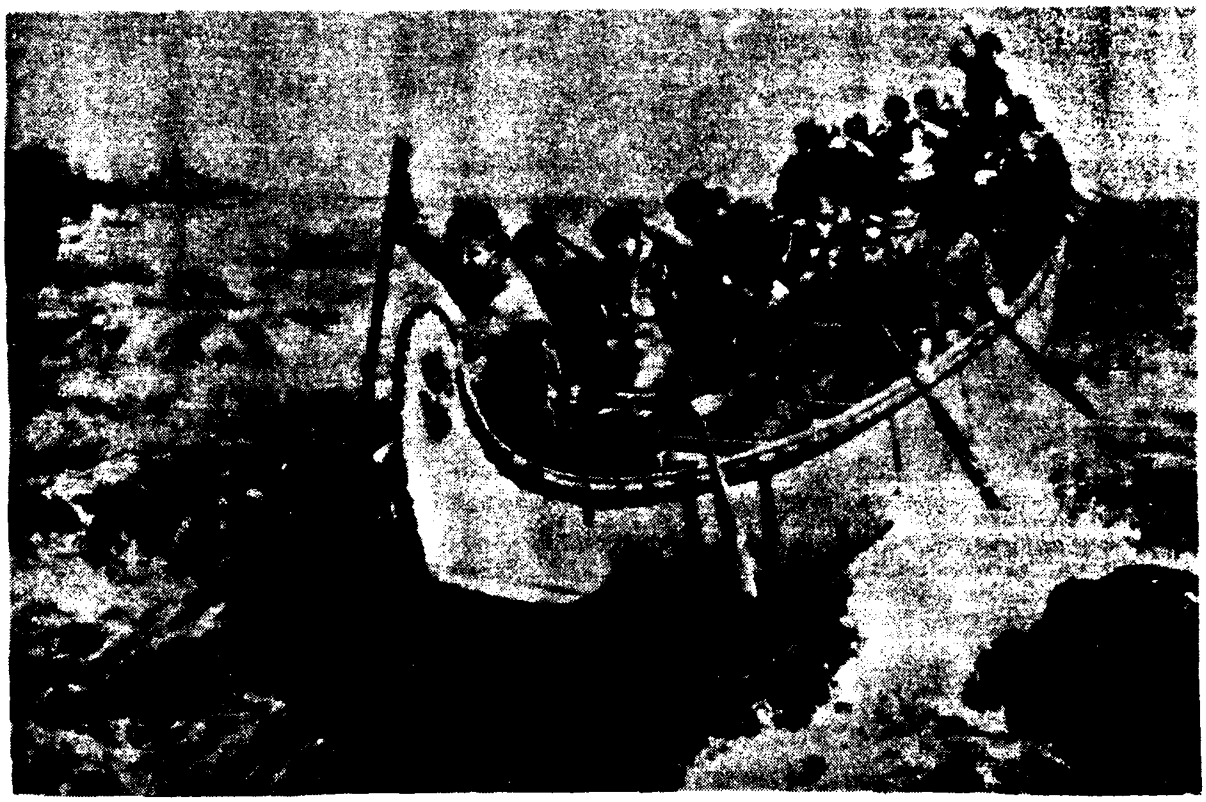


Figure 5.2. Example of a Cargo Canoe. Source: Greenhill 1976, p. 127. Courtesy of Public Archives of Canada. Reprinted from Archaeology of the Boat by permission of Wesleyan University Press.

Figure 5.3. York Boat Being Rowed. Source: Van Gemert 1972, p. 295. From Archeology beneath the Sea, by George Bass. Copyright © 1975 by George Bass. Used with the permission of the publisher, Walker and Company.

Figure 5.4. York Boat Under Sail. Source: Van Gemert 1972, p. 295. From From Archeology beneath the Sea, by George Bass. Copyright © 1975 by George Bass. Used with Permission of the publisher, Walker and Company.

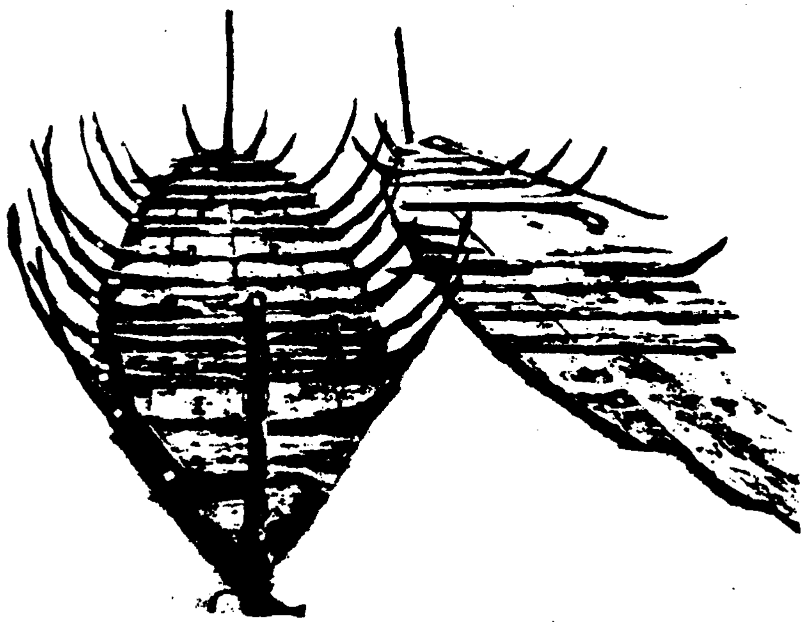


Figure 5.5. Remains of Two 18th Century Bateaux Found by Scuba Divers. Source: Van Gemert 1972, p. 295. From Archeology beneath the Sea, by George Bass. Copyright © 1975 by George Bass. Used with Permission of the publisher, Walker and Company.

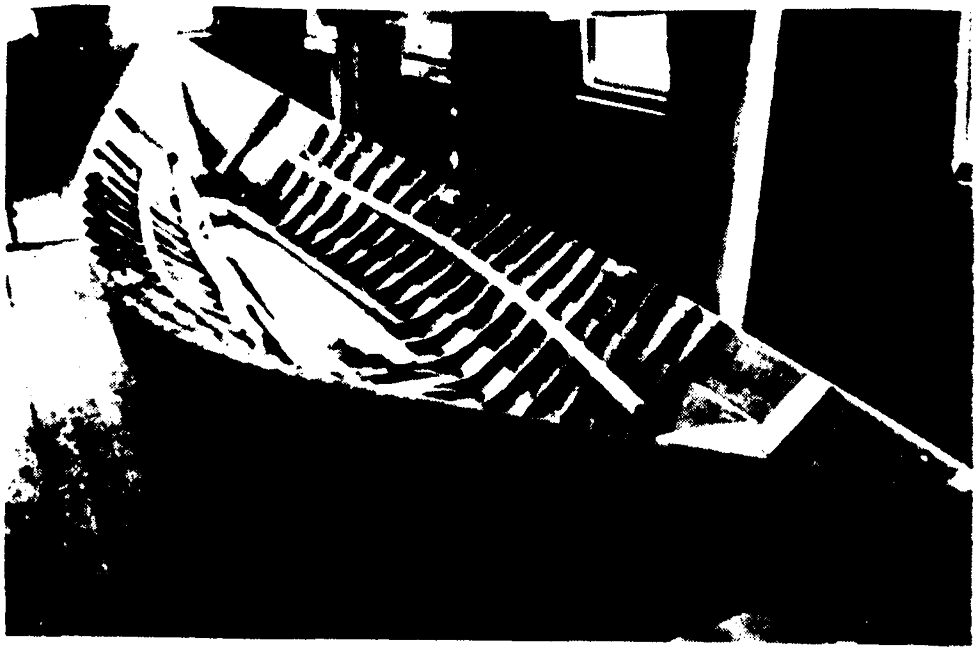


Figure 5.6. Bateau. Source: Greenhill 1976, p. 271. Copyright @ 1976 by Basil Greenhill. Reprinted from Archeology of the Boat by permission of Wesleyan University Press and Basil Greenhill.

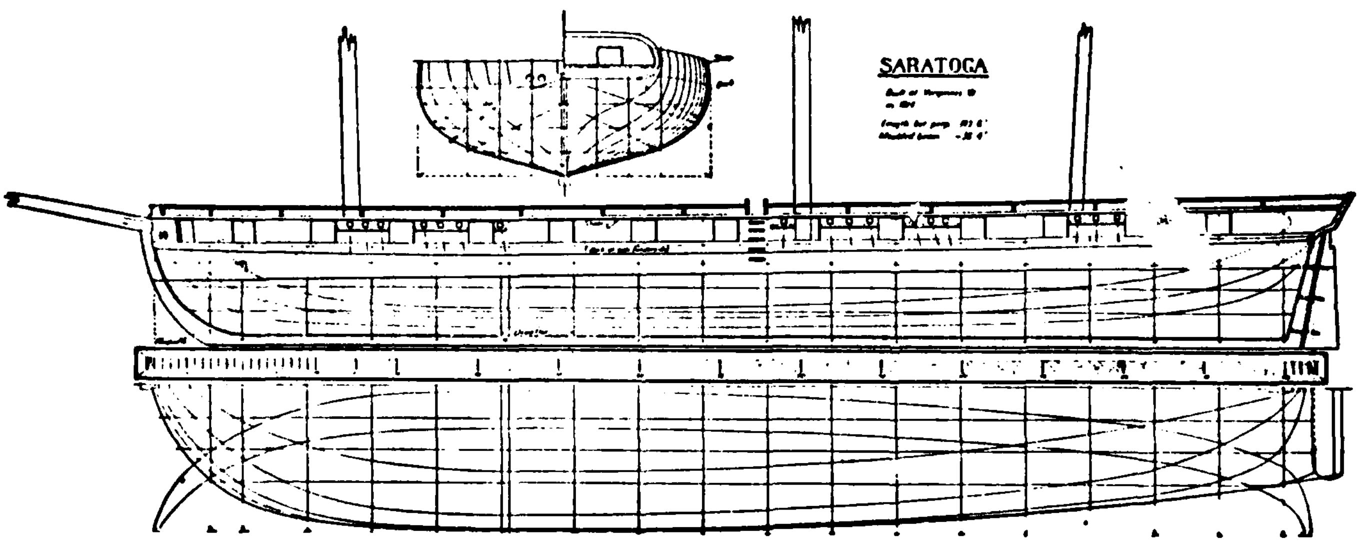


Figure 5.7. Line Drawing of the Saratoga. Source: Chapelle 1935, p. 113.

and it may be that little or nothing remains of any of these ships (Metcalf 1948:245-248).

Most villages along Lake Erie prior to 1825 had shipyards and at least one schooner for local use. By 1818, there were at least thirty-nine sailing craft on the lake, averaging about 45 tons of capacity each (Reeves 1958:97). The first schooner built on the lake, the 80-ton Washington, was constructed in 1797. She was later moved overland to Lake Ontario to take better advantage of her size in what was, at that time, a more commercially active setting (Van Gemert 1972:290).

After the Erie Canal opened, the rapid development of the Lake Erie region made the construction of larger vessels economically viable. One anecdote concerning the effect of the canals on the economy and on ship design is noted. In 1829, "Captain Pickering of Sacketts Harbor committed suicide only moments after arriving at the Welland Canal with his new schooner and finding it two inches too wide to pass through the locks" (Van Gemert 1972:292).

The type of vessel built on Lake Erie at this time reflected the designs and technology prevailing along the eastern seaboard. Two types of wooden ships were popular during this era. The smaller of these was the two-masted fore-and-aft-rigged schooner of from 75 to 100 tons. The other was the two-masted square-rigged brig that displaced from 150 to 200 tons (Fite and Reese 1959:204). Silhouettes of these craft (not to scale) are presented in Figure 5.8.

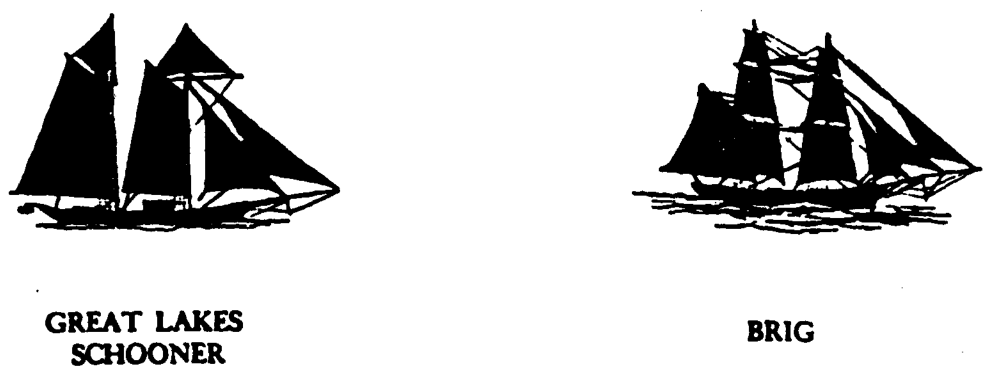


Figure 5.8. Examples of a Schooner and a Brig. Source: Bloomster 1969, pp. 12 and 39.

As the volume of trade increased, larger ships were constructed. By the 1830s, ships of 600 tons were being built, and by the 1850s, ships of more than 1000 tons were sailing on Lake Erie (Morrison 1903; Plumb 1911). In fact, some giants, such as the 2200-ton City of Buffalo, equaled the liners that plied the Atlantic in size and elegance (Taylor 1968:62).

Because sailing craft were usually built to order, they varied in design. New designs, such as the "canallers" (Fig. 5.9), were built to work on the lakes and on the numerous canals that eventually connected the markets of the Great Lakes with the rest of the world. The canallers were, unfortunately, generally unsuitable outside of this closed environment.

Improvements in sailing craft continued to be introduced. Among these were the retractable centerboard, the drop keel, and bulwarks around the deck for protection against stormy weather. These innovations facilitated the production of ships with shallower drafts, a definite advantage in the shallow harbors of Lake Erie.

The development of larger sailing craft had an impact outside of the Great Lakes. The lake clipper schooners (Fig. 5.10) proved so agile and speedy (up to 13 knots) that, after 1852, they were built on the lakes and sent to England for use in its global trade (Reeves 1958:98-99). By this time, however, the share of lake trade controlled by sailing ships was diminishing; steam vessels were getting more and more of the trade. This was true even though sailing ships had economic advantages over the early steamers on the Great Lakes. The use of steam power developed more slowly in this region than it did on the rivers of pre-Civil War America, but more rapidly than in oceanic trade.

The first steamboat, Walk-in-the-Water, appeared on Lake Erie in 1818. It was built by the Erie Steamboat Company of Buffalo. Launched at Black Rock, the Walk-in-the-Water displaced 330 tons (Taylor 1968:61). Although she sank in a gale off the coast of Buffalo in 1821, her engine was salvaged and used in another ship, the Superior, also lost at Buffalo (Reeves 1958:101). In 1826, there were only six steamers on Lake Erie. After the opening of the Welland Canal between Lake Erie and Lake Ontario in 1829, the number of steamboats increased; by 1860, there were 369, totaling 137,771 tons. During the same year, there were 1,207 sailing vessels on the Great Lakes with a combined tonnage of 255,449 (Taylor 1968:62). Lake steamers, which had deep hulls and low superstructures, resembled ocean vessels more than did river steamers (Fig. 5.11). This is not to say that the ships used on the Great Lakes were copies of those in use on the oceans. Indeed, technological innovations sometimes appeared on lake craft before being adopted for ocean-going vessels. John Ericsson introduced the use of propellers in 1849 for commercial use on the Vandalia, a Lake Ontario steamer. By the 1850s, more than half the lake steamboats were "propellers." This at a time when even the finest ocean liners were still using paddle wheels. Since "propellers" were more economical in space, fuel consumption, and crew power, their use was a definite advantage on the Great Lakes. Later, screw propulsion was incorporated by Ericsson in the building of the Civil War ironclad the U.S.S. Monitor (Morrison 1903:366-385; Hatcher 1944:227-232).

In the antebellum United States, lake steamboats were used mainly to carry passengers; cargo was shipped on slower and less costly sailing vessels. The growth of the early trade on the Great Lakes is reflected in the volume

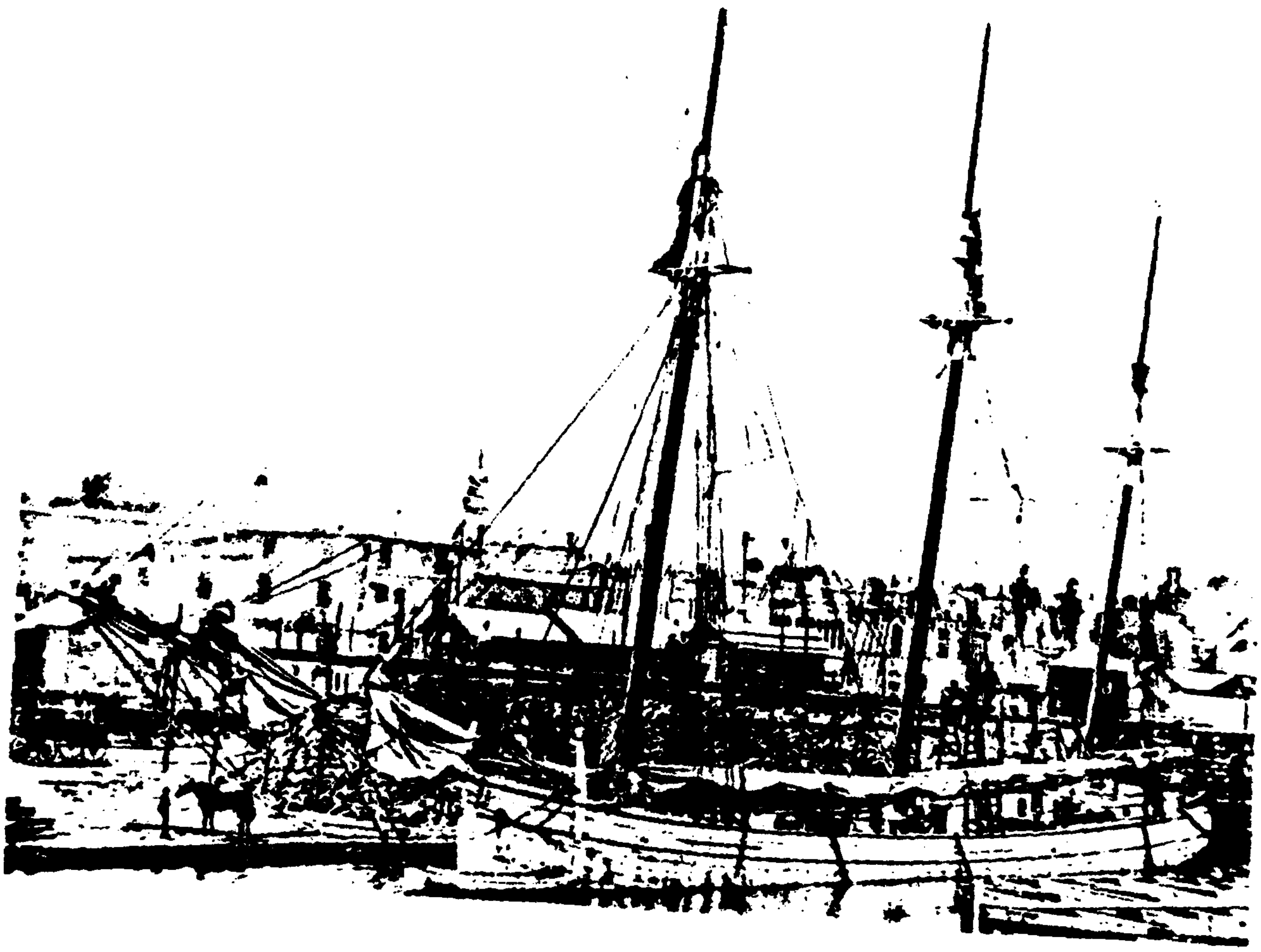


Figure 5.9. "Canaller." Source: Barry 1973, p. 123, courtesy of the Racine County Museum.

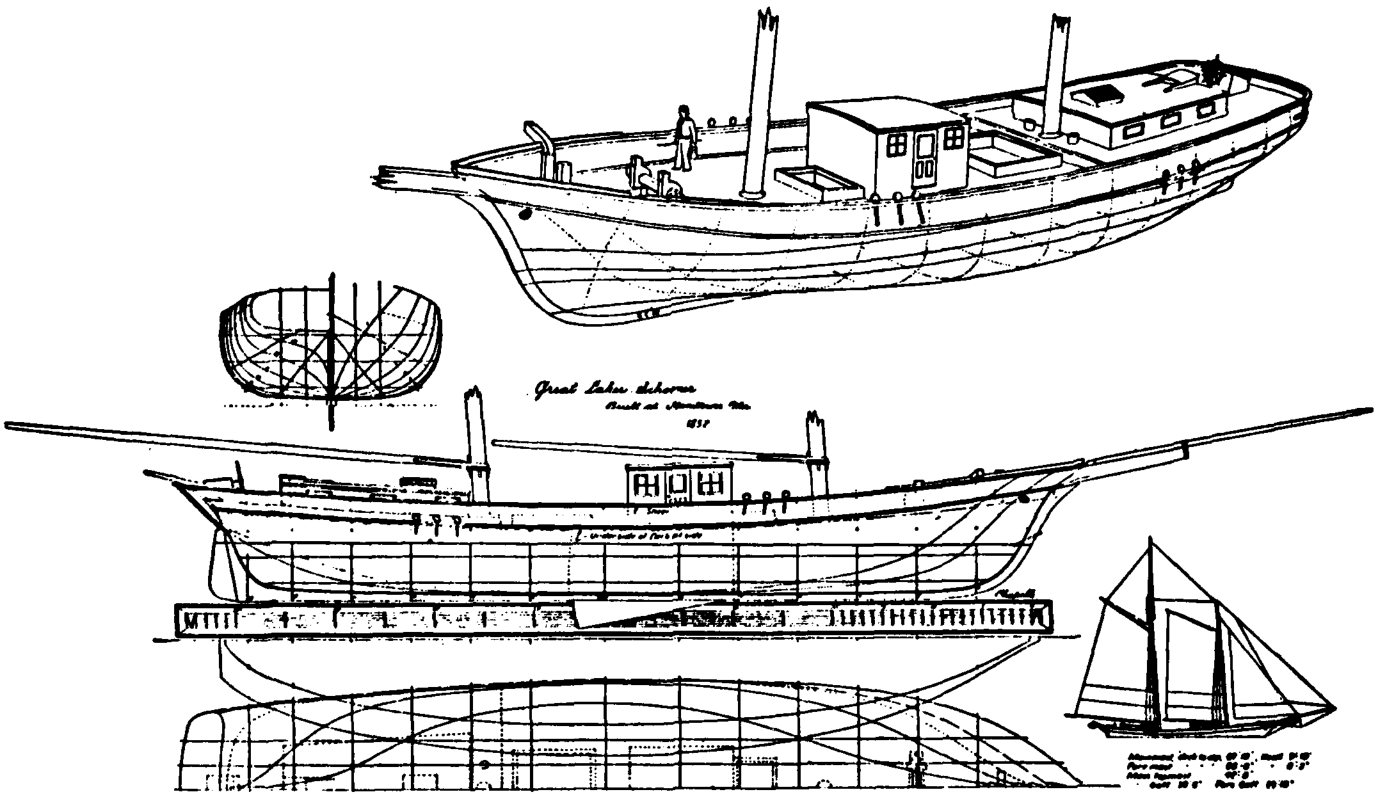


Figure 5.10. Great Lakes Clipper: Schooner Challenge. Source: Chapelle 1935, p. 271.

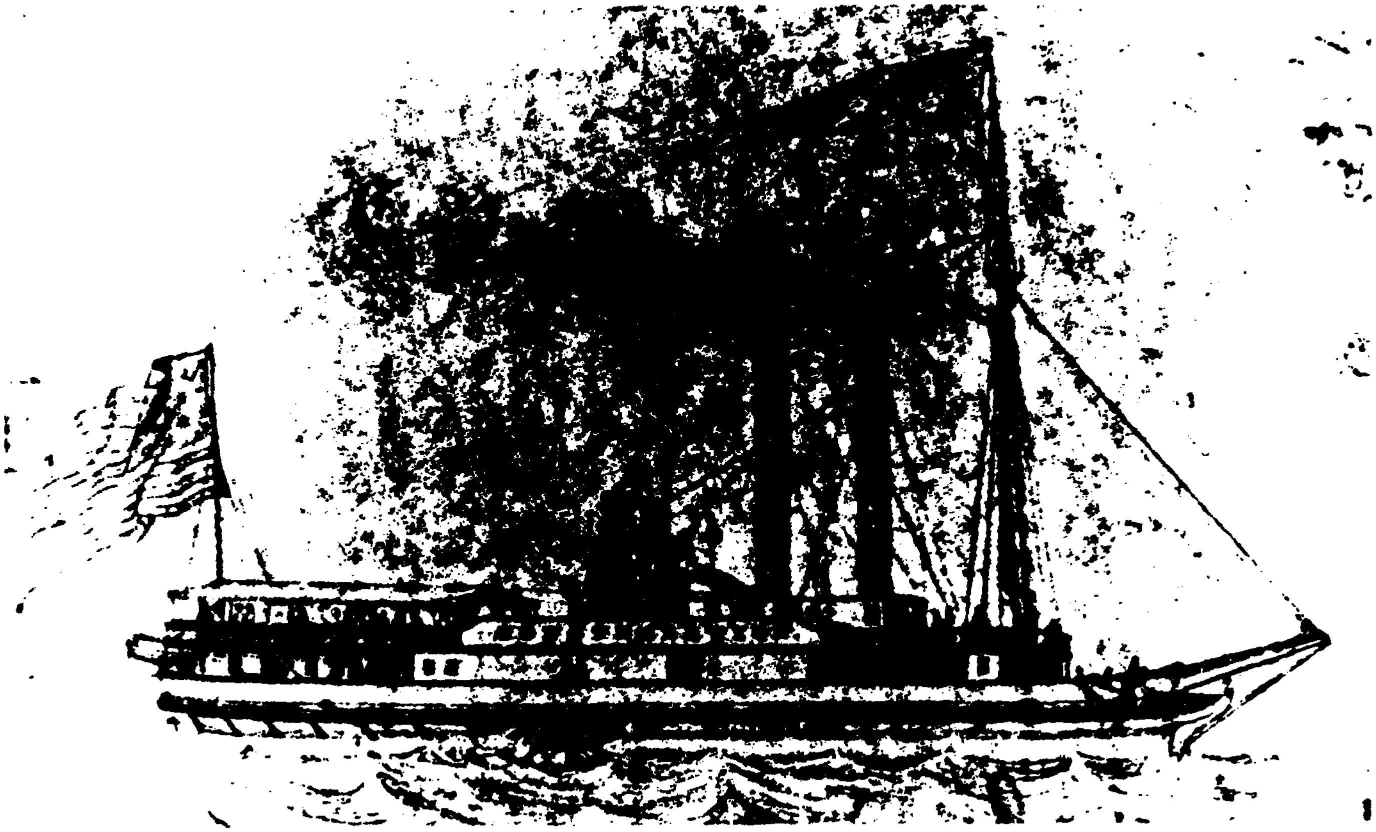


Figure 5.11. Illustration of the Constellation. Source: Hilton, Plummer, and Jobe 1976, p. 29.

and value of wheat and flour shipped from the Midwest to New York via the Erie Canal. In 1835, about 268,000 barrels of wheat and flour were shipped; by 1840, more than 1 million barrels were being shipped; and, by 1860, almost 4.3 million bushels were being shipped (Taylor 1968:160-161). In 1856, the value of all trade on the Great Lakes approached the $500-million mark (Taylor 1968:173).

By the 1860's, the railroads, which offered lower fares and faster travel, had begun to attract passengers. During this decade, shipping on the Great Lakes was used increasingly to carry bulk commodities. After all, shipping via the Great Lakes had advantages over rivers or canals. And, although traffic on the Erie Canal peaked in 1880, the volume of shipping on the Great Lakes continued to grow until well after that date. Because the Great Lakes were deeper than rivers, it was possible to use ships with deeper drafts. Not only could such vessels haul more tonnage, but they were also able to operate at lower costs, especially in the shipping of nonperishable bulk commodities. A comparison of shipping costs between Chicago and New York by lake and canal and by railroad illustrates this point. In 1900, it cost 4.42 cents to ship a bushel of wheat by lake and 9.9 cents to ship it by rail; in 1920, the respective costs were 14.60 and 16.68 cents (Johnson 1906:353-358).

Until the late nineteenth century, the most important bulk commodities shipped east were flour and wheat. After the development of the Mesabi mining area, iron ore began to be sent to such Lake Erie cities as Cleveland, Ashtabula, Conneaut, Lorain, Fairport, and Buffalo. In addition to the manufactured goods that were shipped to the West throughout the nineteenth century, many bulk commodity cargoes after the Civil War were made up of bituminous and anthracite coal. This pattern of trade continued to increase until well after 1900 (Mills 1910; Faulkner 1968:242-243).

The lake ships continued to evolve along with the changing character and volume of trade on the Great Lakes. The schooners attempted to improve their competitive edge by adopting metal hulls and masts and better equipment throughout as well as by incorporating design modifications. The largest steel-hulled lake schooner was the John Fritz, launched in 1898; she weighed 4447 tons and was 436 ft long. Because of the limitations of the Welland Canal (3000 tons), many of the lake schooners weighed in the neighborhood of 3000 tons (Laing 1971:428). Side-loading hulls, introduced for lumber-carrying ships, proved more economical. It was not until the early 1930s that the commercial use of schooners finally came to an end. One of the last lake schooners, the Lyman M. Davis, was intentionally burned on Lake Ontario as a spectacle in 1933 (Van Gemert 1972:292).

The first iron-hulled steamer on Lake Erie, the Merchant, was launched from Buffalo in 1862; twenty years later she was dismantled in the same yard (Plumb 1911:26). Propellers sometimes took the form of the "whaleback" or "pig boat" shape; this greatly increased cargo space for bulk carriers (Fig. 5.12). These and other innovations were all symptomatic of the greater specialization in the lake trade and of the attempt by the shipowners to meet the demands of the growing markets.

Table 5.1 gives the numerical change in wood- and metal-hulled craft by mode of power, either sail or steam. The data were derived from Bureau of Navigation Annual Reports and from other government reports. Gas-powered engines, used in later years, are included as steam. The lower number of ships for later years is somewhat misleading since the previously mentioned increases in tonnage per vessel actually increased the carrying capacity of the lake transport system.

By 1900, most of the commercial vessels in use on the Great Lakes were owned by three groups. Trunkline railroads, hoping to obtain even more control of traffic, held a large share of lake vessels; the Western Transit Company, owned by the New York Central and the Erie and Western, was the largest of these operators. Companies such as United States Steel Corporation and Standard Oil also owned a significant part of Great Lakes shipping. In 1904, for example, U.S. Steel operated seventy lake steamers and forty-two barges. This group of carriers primarily hauled their own products. The third group of commercial vessels were owned by individuals and small companies. The size and diversity of ownership of this group promoted intense competition that resulted in low shipping rates. By 1910, the carrying capacity of the Great Lakes fleet was greater than that of most foreign countries; the exceptions were Great Britain and Germany (Faulkner 1968:244).

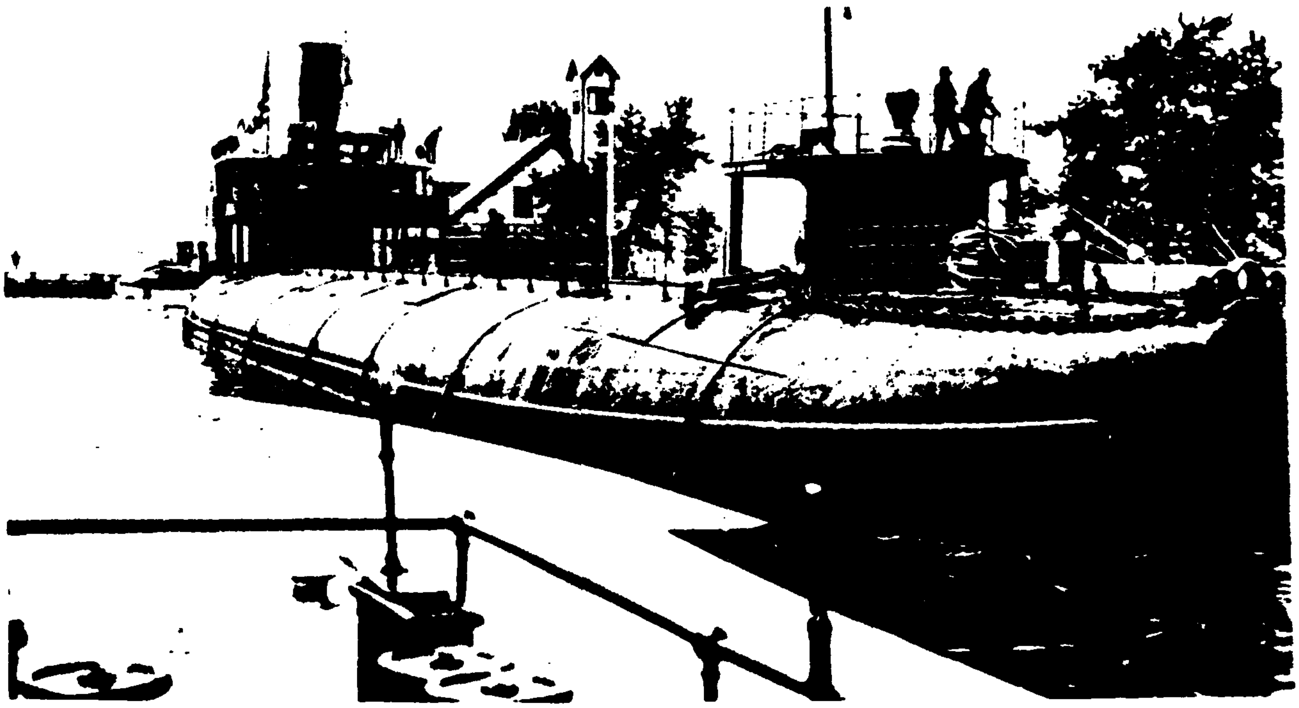


Figure 5.12. Waleback Barge. Source: Barry 1973, p. 152, courtesy of the Newport News Mariners' Museum.

Table 5.1. Sail and Steam Vessels on U.S. Lake Erie

Year	Sail/Wood	Steam/Wood	Sail/Metal	Steam/Metal	Total
1818	39	1	0	0	40
1825	54	3	0	0	57
1826	--	6	0	0	--
1833	--	11	0	0	--
1835	217	45	0	0	266
1840	--	48	0	0	--
1843	--	42	0	0	--
1851	465[a]	67	0	0	532
1860	--	369	0	0	--
1862	--	--	0	1	--
1885	269	281	0	22	572
1894	234	492	0	93	819
1895	237	514	2	96	849
1896	330	428	6	108	872
1897	156	506	10	117	789
1900	175	486	14	127	802
1901	181	500	16	149	846
1915	93	293	5	326	717
1923	55	256	2	388	701

[a]Estimated. Estimates were calculated from known tonnage and from the known average tonnage for this type of vessel.

5.3.2 Archeological and Historical Perspective

The spread of the U.S. frontier is well recorded in the histories and traditions of the various settlements along the shore of Lake Erie. Of interest to economic historians and maritime archeologists is the fact that these developments can also be analyzed through the perspective of the maritime activity that occurred concurrently in the trading districts along the lake.

The five districts described by Andrews (1853) roughly correspond to those defined in Section 4; their commercial development is given in Andrews' concise report to the U.S. Senate. The correlation between known shipwrecks and progressive developments in these districts can serve as a major link between the explanation of the economic/historic evolution of the Euro-American population and the methods of maritime archeology.

Some statistically manipulated spatial and temporal examples will serve to illustrate the value of shipwrecks as a means of discovering the past and of contributing to a better understanding of historical change. The data given by Andrews, when matched with the list of wrecks supplied in this report and additional information given by Heden (1966), produce some very interesting results. This information will be discussed according to the districts referred to by the locations of their ports-of-entry (POE). To reiterate, the POEs are only coincidentally similar to the study areas defined in the previous sections of this report and should not be confused with them.

1. Buffalo Creek District--"This district has a coastline one hundred miles in extent, commencing at the great falls on the Niagara River and thence extends southward and westward, embracing the ports of Schlosser, Tonawanda, and Black Rock, on the river; Buffalo Creek, Silver Creek, Dunkirk, Van Buren Harbor and Barcelona, on the southern shore of Lake Erie; being all the ports between the Falls of Niagara and the eastern State line of Pennsylvania" (Andrews 1853:87).

2. District of Presque Isle--"The district embraces the whole coastline of the state of Pennsylvania on Lake Erie; it contains about forty miles of shore and has three shipping points--Erie, the port-of-entry, North East, and Elk Creek" (Andrews 1853:161).

3. District of Cuyahoga [sic]--"It embraces all that portion of the south coast of Lake Erie which lies between the western state line of Pennsylvania and the Black River, a distance of one hundred miles. It contains beside Cleveland, the port-of-entry, many minor ports of considerable importance such as Conneaut, Ashtabula, Cunningham's Harbor, Madison Dock, Fairport, and Black River" (Andrews 1853:165).

4. District of Sandusky--"The district of Sandusky extends from Black River westward including the ports of Vermilion, Huron, Milan, Sandusky, Venice, Fremont, Portage Plaster Bed, and Port Clinton, being a distance of fifty miles lake coast, and some fifty miles more bay and river" (Andrews 1853:175).

5. District of Miami--"This district has a shoreline of fifty miles in extent, comprising that portion of the lake and river coast lying between Port Clinton and the dividing line between Michigan and Ohio, and

includes the ports of Manhattan, Toledo, Maumee, and Perrysburgh" (Andrews 1853:184).

Andrews gives much information for each of the five districts though it is consistent in neither format nor content from district to district. Five sets of data are presented in Table 5.2 for each of the five districts; this includes several population estimates as well as total clearances and entrances of ships for the year 1851 as well as reports of tonnage. While the population estimate for Presque Isle for the year 1851 is not presented by Andrews, the census figure for 1850 is given for each district so that an average increase could be calculated and applied to that 1850 figure to produce our own population estimate for Presque Isle.

Table 5.2. Cross-Section Data for Lake Erie, 1851

	Buffalo Creek	Presque Isle	Cuyahoga	Sandusky	Miami
Population	50,478	8,700	32,000	8,000	5,000
Number entered	4,533	1,583	1,673	2,843	1,710
Tons entered	1,536,089	314,710	775,720	540,171	437,996
Tons enrolled	46,057	7,882	36,070	4,858	3,424
Wrecks to 1851	32	13	30	16	3

Clearances and entrances are the numbers of ships and their tons arriving and departing from a given district as kept by the federally established customs houses in each POE. The customs houses keep track of interstate and international commerce for purposes of taxation and planning.

The reports of tonnage were difficult to interpret since no distinction was made between gross tons, net tons, and displaced tons (weight of the empty ship, cargo capacity of the ship, and weight of the water displaced by the ship, respectively). This was also a problem with the wreck information. We proceeded under the assumption that the Andrews data was internally consistent and left the problem of the type of tonnage reported in abeyance.

From each of the customs houses located in the POEs, Andrews obtained reports concerning the trade occurring in each of the districts enumerated. Only data concerning the aggregate districts were used in the table. Also, only information regarding entrances (excluding clearances, which were in every case almost the same number) plus tonnages enrolled and entered was considered.

Analysis of the 1851 data reveals a strong correlation between the number of ships using the lake, the number of shipwrecks, and the size of the resident population living along the lakeshore. The figures illustrating the correlation among these factors are included in Appendix I (Figs. I.1-4).

A longitudinal approach supplementing the 1851 cross-section may also be obtained from the Andrews report and from a somewhat later government report listing the tonnages of all the lake districts for the years 1846 through 1856 (Pierce 1857:12) (Tables 5.3-5.5 and Figs. I.5.-10).

Table 5.3. Enrolled Tonnage for Lake Erie Port Districts

	Buffalo Creek	Presque Isle	Cuyahoga	Sandusky	Miami
1846	24770	2993	18526	2914	3163
1847	35413	4990	25493	4322	3163
1848	42623	5360	30403	7160	3163
1849	40667	7794	30047	8366	2929
1850	39679	7870	35315	7326	2629
1851	43603	8210	36070	4858	3236
1852	49614	8122	38238	5887	4431
1853	65184	6921	43491	6028	4620
1854	82678	8210	45483	6054	5479
1855	76952	9269	51078	8051	3763
1856	89292	10386	60916	12448	3136

Table 5.4. Cumulative Number of Wrecks per District by Year

	Buffalo Creek	Presque Isle	Cuyahoga	Sandusky	Miami
1846	20	7	15	8	1
1847	22	8	22	9	1
1848	24	8	24	11	1
1849	25	8	24	12	3
1850	26	9	29	14	3
1851	32	13	30	16	3
1852	36	15	34	19	4
1853	36	16	35	19	5
1854	41	17	39	22	6
1855	42	18	42	23	6
1856	44	20	44	25	7

Table 5.5. Longitudinal Comparison for Buffalo Creek District

Year	Population	Year	Tons Entering	Year	Cumulative Wrecks
1810	1,508	1825	2,449	1810	1
1820	2,095	1830	16,300	1820	1
1830	8,668	1835	30,602	1830	5
1840	18,213	1841	55,181	1840	12
1850	42,261	1846	90,000	1850	26
1851	50,478	1851	153,426		

The sparsity of the data in some of the correlation graphs in Appendix I throws some doubt on the significance of the correlation coefficients. Despite this, the proposition that shipwrecks can provide a reasonable estimate of the amount of shipping associated with a given region and of the population is clearly implied. Conversely, one can expect the economic and technological development of the Euro-American population of the Lake Erie Basin to be reflected in the shipwreck record of the lake. Thus, the shipwreck record becomes an additional source of information, one that should not be overlooked.

Broad generalizations about the past do not serve as useful tools for predicting cultural resource sites; specific data, such as shipwreck records, do. Many of these records are incomplete or inaccurate, but even they serve to give useful information about the commercial role of shipping and of particular ships.

The data presented by Andrews reflect the kinds of deficiences that are to be found in the records. Andrews noted that

> The commerce of [the city of] Cleveland, apart from the rest of the district, is not shown by the returns received; and in such returns as have been sent in--showing the business of the district--the valuation of the very same articles is set at a rate so much lower than in the other districts, as greatly to undervalue the real commerce of Cuyahoga, and to exhibit it at the greatest possible disadvantage. (Andrews 1853:167)

Andrews actually had to multiply his monetary figures to make them comparable to those of the other districts. This discrepancy seems to carry over into the reporting of ships and tons entered into the district. This problem is only one example of how the use of shipwreck data can raise questions regarding "official" history and perhaps produce a more accurate picture of what may have occurred in the past.

As described earlier, a number of significant technological developments in seafaring were first used in lake ships. New technologies, which were often grafted onto existing equipment, may, in reality, have been very different from the idealized plans that survived in libraries. Furthermore, these differences may be crucial to the understanding of the form and function of an entire generation of ships, tools, and implements no longer in use. Thus, shipwrecks as "industrial monuments" will increase in scientific importance as they are used to reveal these technologies (Buchanan 1970).

Cargoes, as well as ships are of importance to historical interpretation; cargoes are significant to an understanding of the economic changes of the region. Much has already been salvaged from the wrecks in the past and deterior ation and disturbance to submerged vessels has probably destroyed other data, but enough information probably remains so as to make the recovery effort worthwhile (see Muckelroy 1975; Mathewson 1977).

5.3.3 Location and Classification of Lake Erie Shipwrecks

The identification and location of the shipwrecks in the U.S. portion of Lake Erie (detailed in Appendix H) is discussed in this section. Data were collected through a search of newspapers and a review of the published literature. However, the list of shipwrecks in Appendix H should not be considered complete, and any further studies should refer also to Heden (1966), Bowen (1952), and Lytle (1952) as well as to museums concerned with Great Lakes maritime history and private sources. Table 5.6 presents greater detail about the sources consulted in preparing this inventory.

Table 5.6. Sources for Shipwreck Information

NEWSPAPERS

- Cleveland Plain Dealer
- Cleveland Weekly Herald
- Detroit Free Press
- The Erie Gazette
- Erie Daily Dispatch
- Erie Morning Dispatch
- Erie Evening Herald
- Port Huron, Michigan Times

GOVERNMENT DOCUMENTS

- U.S. Government Wreck Report for the Great Lakes, 1886-1891
- Merchant Vessels of the United States (published by the U.S. Treasury Department)

JOURNALS

- The Marine Review (Cleveland: Penton Pub. Co.)
- Inland Seas (Cleveland: Great Lakes Historical Society)

For the purpose of this study, it was decided to list only vessels in excess of 50 tons or 50 ft. This is because smaller vessels were relatively insignificant commercially and because the sheer number of the smaller "pleasure" craft would have made such a list too voluminous to be reasonably included in this report.

All but a small number of the shipwrecks mentioned in the record give only approximate locations. In order to allow the shipwreck data to coincide with the planned divisions of the shoreline study of this project, the U.S. side of Lake Erie was divided into five areas, A through E (see Fig. 5.1).

The shipwrecks located in each of the five areas were divided into three time periods. The wrecks that occurred before 1865 were placed in period "1"; those since 1890 were put in time period "2"; and those from 1890 into period "3." The rationale for these divisions was based on the belief that the shipwrecks before 1865 would have more historic significance, especially if they were steamers. Some of these vessels, if relatively intact, might reveal interesting examples of early marine technology. That some ships from very early periods are intact on the bottom of some of the Great Lakes, such as the Acme in Lake Erie, is confirmed by side-scan sonar pictures (Hydroscan Inc.). The period from 1866 to 1890 was chosen because it was a time of transition between the sailing and steam ages with wood-hulled craft being replaced by steel-hulled vessels.

The location of each shipwreck within each major area was gleaned from the historical record and the data varied from exact to vague or very general. In the majority of instances, only approximate locations were reported in the newspapers. Wrecks whose exact location was provided were labeled "a." With the information given, it was likely that such wrecks could be placed within a half-mile-diameter circle on the NOAA navigation charts for Lake Erie (Figs. 5.13-5.15).

When the record provided only an approximate location (e.g., "near Cleveland" or "off Buffalo"), the wreck was given a "b" designation, and an attempt was made to place this information on the charts in the belief that if this information was clustered, sensitive cultural or historical areas could be readily identified. Finally, those wrecks whose location was so vague (e.g., "western Lake Erie" or "west of Buffalo") that any effort to locate them on a map would be impossible, were designated with the letter "c." These wrecks, though listed on the inventory, were not placed on the charts.

An effort was also made to classify the wrecks according to their historical significance. Those considered to possess unusual characteristics in construction, machinery employed, or cultural noteworthiness were rated as having "high" historical significance and an "*" was added to the classification code (see Figs. 5.13-5.15 and Appendix H). Wrecks considered to have a "general" or "some" significance were designated with a "+"; and those with "slight" or "low" historical significance were given an "o." These designations are not to be considered the final word on cultural significance. Such significance can only be ascertained by a thorough onsite investigation and by an exhaustive review of surviving documentation.

The shipwrecks are listed alphabetically in the inventory in Appendix H. They are numbered according to their place in this alphabetical order. Thus,

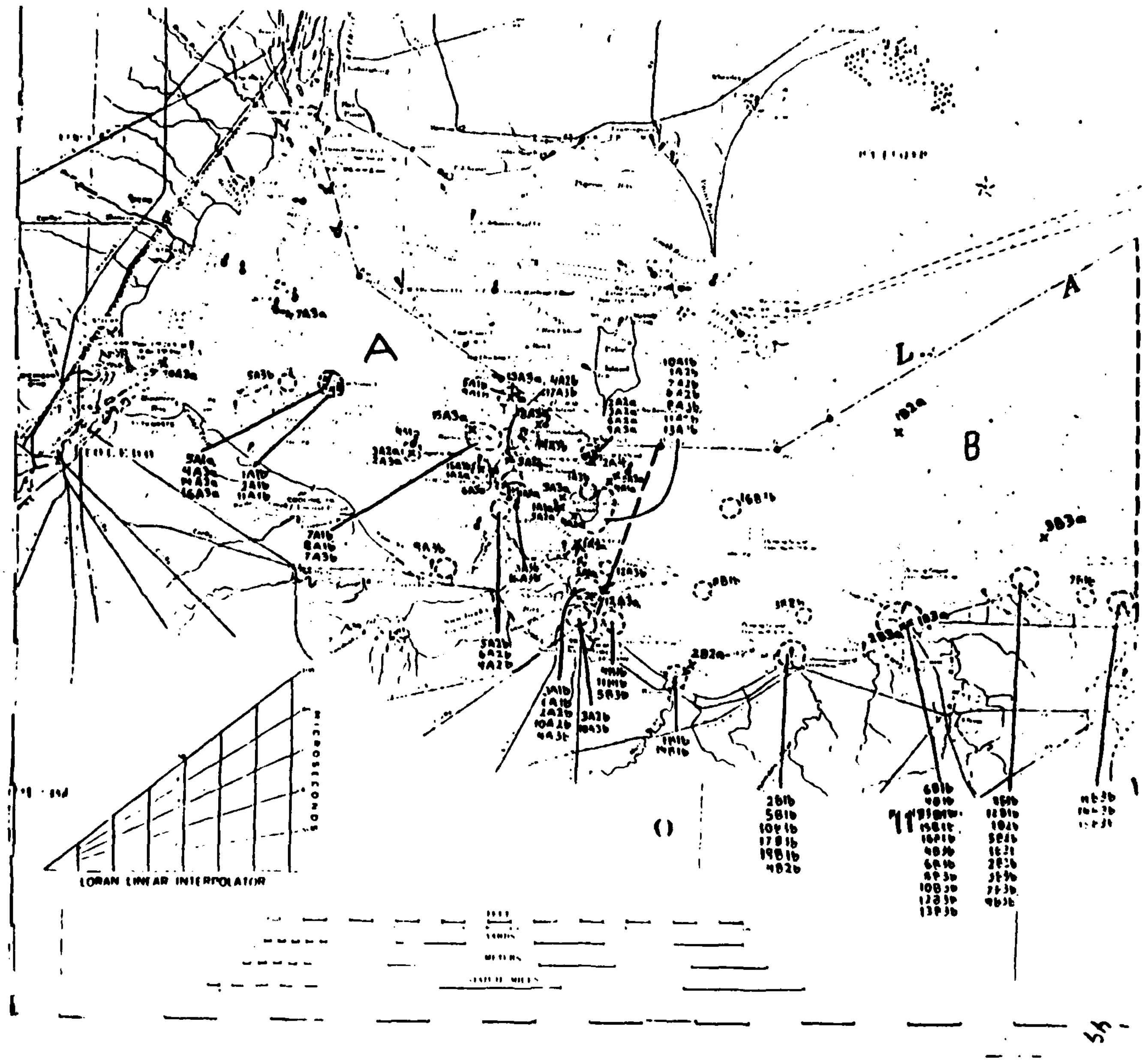


Figure 5.13. NOAA Navigation Chart for Lake Erie, Part 1.

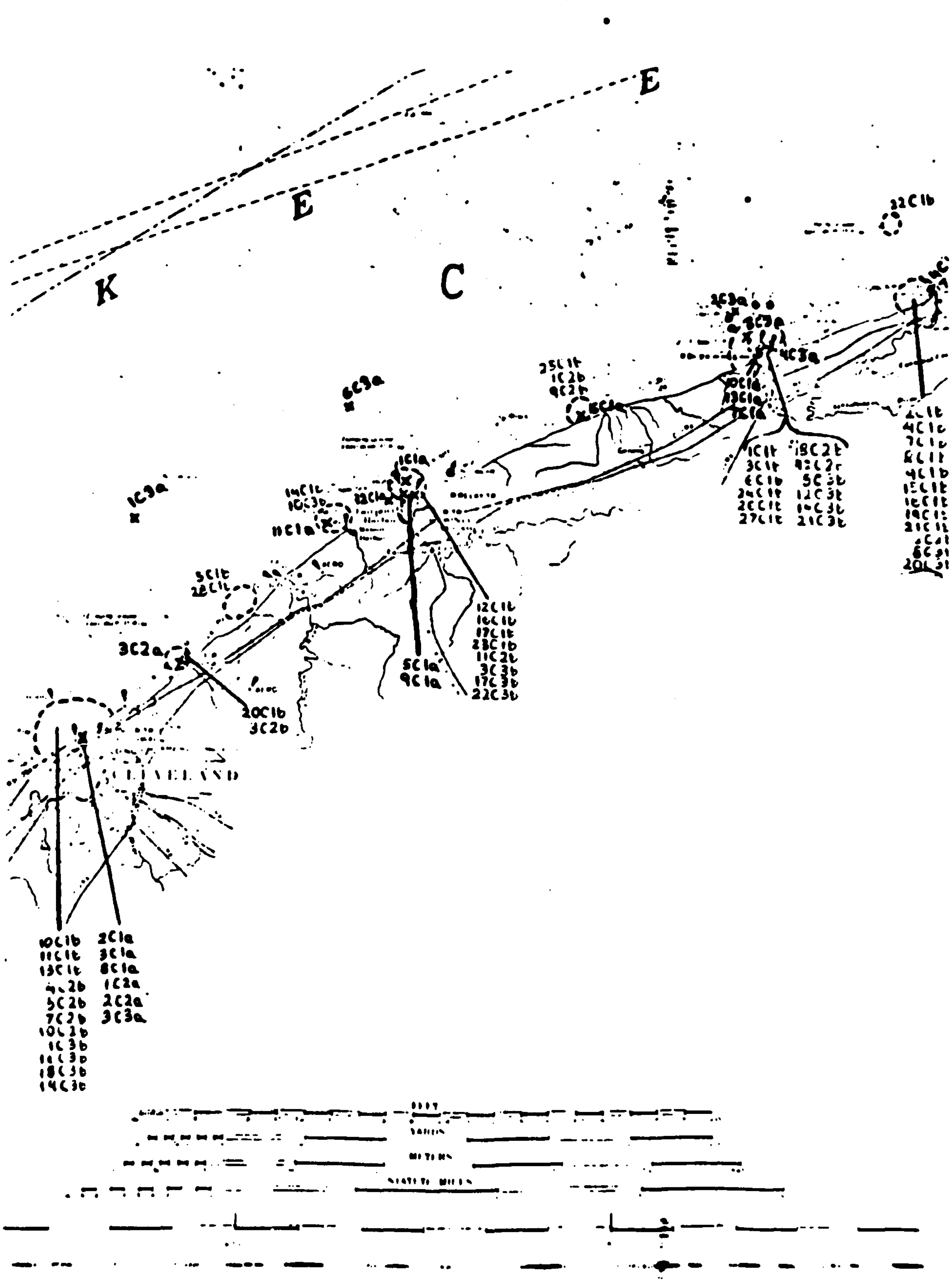


Figure 5.14. NOAA Navigation Chart for Lake Erie, Part 2.

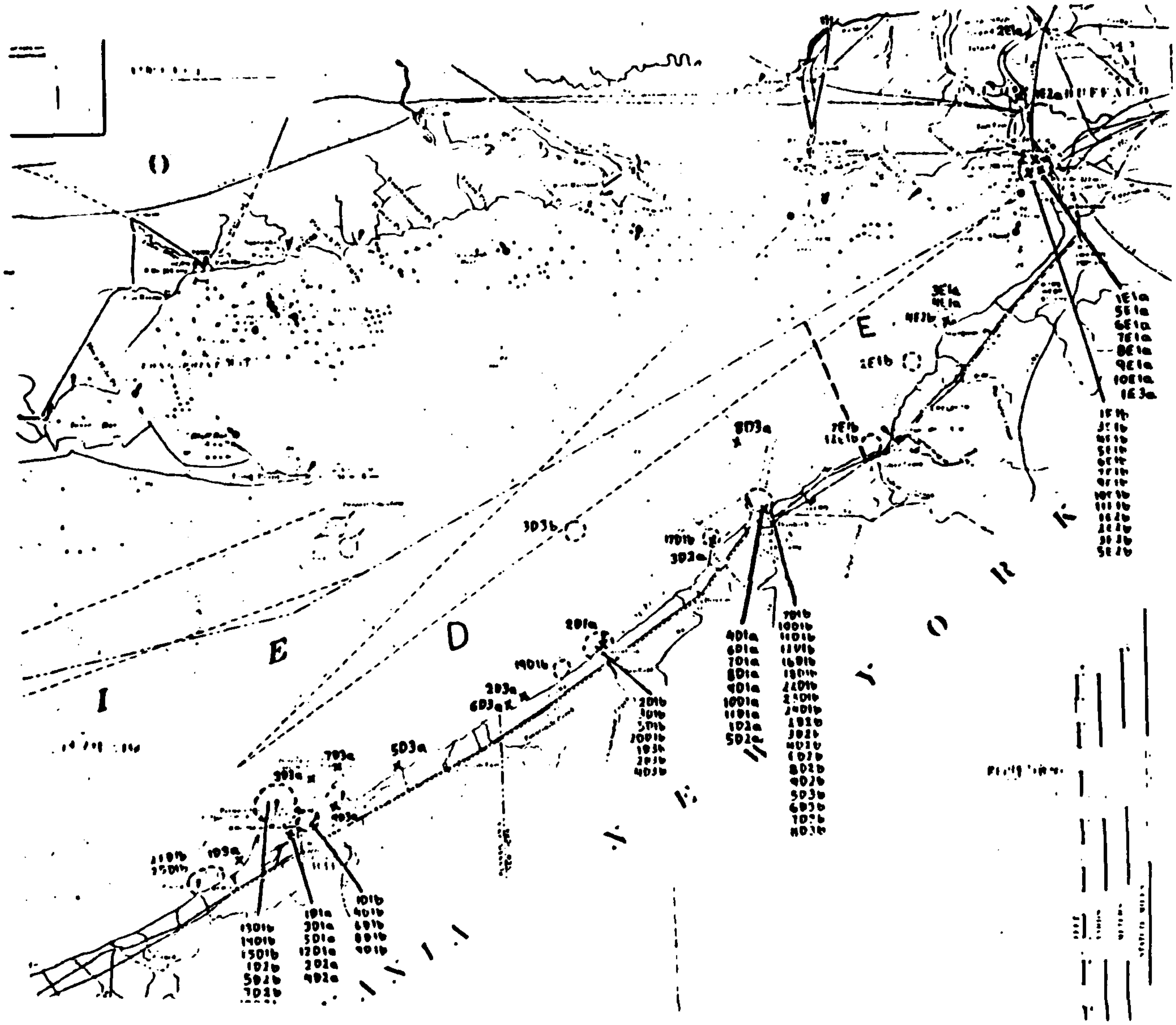


Figure 5.15. NOAA Navigation Chart for Lake Erie, Part 3.

12 C2b+ indicates that this wreck was in area "C" of the lake (between Rocky River and the Pennsylvania state line); that it went down between 1866 and 1890; that its location is only approximate; and that it has some historical significance. The "12" indicates that it is in that order within the wrecks classified C2b.

5.3.4 Conclusions

An inventory of 347 shipwrecks was compiled from a number of newspapers and literature sources. From the available data 197 (56%) of these wrecks could be associated with an exact (a) or approximate (b) location and plotted on a map. A preliminary appraisal was also made of the historical and technological importance of the shipwrecks. Based on this analysis, 85 shipwrecks were identified as deserving special recognition, i.e., high (*) or general (+) historical significance.

5.4 SUMMARY AND DISCUSSION

(Sue Ann Curtis and James Hatch)

In summary, the lakeshore area has been utilized and improved by various Euro-American groups since the mid-eighteenth century. The historical remains of these activities are most often manifested in buildings designed for residential and business purposes. Population centers have the highest and most varied historic architectural remains although important structures and places of historic interest may also remain in rural locations. Caution should be exercised in development of natural gas facilities in rural areas where historic structures and locations may not have been identified and evaluated. Such locations may have strong local historic interest and sentiments. Surveys in these rural areas should therefore include: 1) a review of local histories, 2) contact with local historical groups, and 3) interviews with older residents who can contribute oral histories. All of these factors may contribute to evaluating the importance of a particular location.

The remains of numerous wrecked ships are known from various parts of U.S. Lake Erie. Remains are likely to be found in lake-bottom sediments and to represent a wide range of technologies. The degree of preservation is determined by the circumstances under which the ship sank, the materials from which it was constructed, and its location relative to currents and dredging.

Three principal criteria are used to qualify a shipwreck site for eligibility for nomination to the National Register of Historic Places: 1) antiquity and degree of preservation of the wreck; 2) technological innovation chronicling maritime developments in the Great Lakes region; and 3) preservation of cargo as a record of the Lake Erie regional economy.

The oldest ships used on the lake were made of bark and/or wood and were thus highly perishable. Because of their rarity, these remains are highly valued. By the same token, innovations in maritime technology involving new design features and refittings are of historical and scientific importance. Finally, preserved cargo provides valuable data concerning the quantity and types of goods transported by ship and about the changing nature and scale of the Great Lakes economy.

Once identified, site locations that may be in the path of drilling and other activities require protective and/or mitigative measures.

CHAPTER 6

DISCUSSION OF PROBABLE SITE DISTRIBUTIONS

Randolph J. Widmer, Gary S. Webster, and Ira C. Beckerman

6.1 INTRODUCTION

(Sue Ann Curtis and James W. Hatch)

This chapter identifies areas of cultural resource sensitivity within Lake Erie and a one-mile corridor of lakeshore. The information presented is designed to be of use to those directly involved with the identification and evaluation of cultural resources as well as to those indirectly involved in managing the potential development of the natural gas industry in the lake environs.

General statements on the spatial patterning of shipwrecks in U.S. Lake Erie and historic sites that have been identified as important in the one-mile shoreline survey area in New York, Pennsylvania, and Ohio have already been presented in Chapter 5. By using the inventories in Appendices G and H and additional library research, identification of areas most likely to contain historic sites and shipwrecks can be readily established for an individual lease tract. Criteria for the evaluation of historic and shipwreck sites are determined by a combination of factors; these include associated historic context, nature and preservation of the archeological remains and structures, and scientific value.

For prehistoric and early ethnohistoric sites, zones of high, intermediate, and low site density probability (sensitivity) are identified for five terrestrial regions within the lake basin and for three submerged regions on the lake bottom. Zones of archeological sensitivity are correlated with combinations of paleo-hydrologic, soil, and topographic features that were demonstrated to be of potential predictive value (see Chapter 3). The ranking of each zone is a reflection of the anticipated likelihood of discovering prehistoric sites within these settings. The sensitivity ranking emphasizes the relative numbers of sites expected to be discovered within the different zones. Assessment of importance must be made on the basis of specific data recorded about an individual site or group of sites. In some cases, a large number of sites per unit area may provide information of such importance that some zones of high sensitivity will be eligible for nomination to the National Register of Historic Places. In other cases, an individual site of a particular chronology and structure, such as a Paleo-Indian site with preserved faunal remains, may be in a zone of low sensitivity and still be evaluated as eligible for nomination.

6.2 PROBABLE DISTRIBUTION OF PREHISTORIC SITES IN THE LAKE ERIE BASIN

This section focuses on identifying general locations in which prehistoric sites are most likely to be found within the Lake Erie Basin. The locational generalizations given for different temporal and cultural groups were derived from the descriptive information presented in the foregoing chapters, particularly Chapters 2 and 3. The modes of settlement constructed and tested in Chapter 3 made an important contribution to the development of this section.

6.2.1 Terrestrial Prehistoric Sites

Generalized expectations about site distributions are presented in five subsections, each of which concerns a specific terrestrial subarea along the lakeshore. These subareas include the Western Basin, north central Ohio, northeastern Ohio, southwestern New York Lowlands and western New York Lowlands (see Fig. 2.1). Expectations about the distributions of sites in each of the five subareas involve two levels of observation. The first involves the most archeologically sensitive types of topographic features and soils found throughout a subarea; these probably have the largest number and highest density of sites. The second identifies micro-areas within the subarea that have a comparatively higher probability for prehistoric cultural resource sites.

6.2.1.1 Zone 1: The Western Basin

In the archeological literature, the lake plain of the Western Basin of Lake Erie (Zone I) has long been recognized as having numerous and diverse prehistoric sites region (Prahl, Brose, and Stothers 1976; Pratt 1977, 1978, 1979a, 1979b). Despite the rich environmental setting conducive to aboriginal habitation in this area (see Sec. 3.2), spatial predictors of site location based on the area's current topography are difficult to make.

The rising lake level also raised the water table of the lakeshore, resulting in various prehistoric drainage patterns over time. Consequently, different forest and vegetation characteristics occurred at different points in time. What are today considered marshy and poorly drained soils were, as little as 500 years ago, much better drained. Today much of this area is subject to inundation and severe erosion during storms or high water periods, with standing water existing in some areas throughout much of the year (Pratt 1979a).

Lands that are now poorly drained and unsuitable for occupation were more desirable for human occupation in earlier periods. For example, the Paulsen Site (33Lu247), which is presently located in a marsh/swamp area, was occupied at a time when the area was drier and more suitable for habitation (Pratt 1979a).

6.2.1.1.1 Sensitive Locations. Despite the limitation in data on site prediction published in the archeological literature, site-specific studies are available (Prahl, Brose, and Stothers, 1976; Prufer and Shane 1976; Pratt 1977, 1979a, 1979b). Many of these studies resulted from Phase I investigations made as part of an environmental impact statement (EIS). Without exception, all of the impact statements stress the archeological importance of the entire shoreline area of Zone I east of the Maumee River, at least one mile back from the lakeshore. Using these studies, the authors observed that prehistoric archeological sites can most frequently be found along the current beach area of the Western Basin (Zone I) (Pratt 1979a; Prufer--personal communication).

In addition to current beachlines, areas with relatively higher relief such as knolls and "mounds" also frequently have an abundance of prehistoric sites (Pratt 1979a). These higher areas or mounds are, however, difficult to recognize on available topographic maps since their relief is not readily discernible when larger contour intervals are used.

The extant environmental conditions described in this section do not apply to the islands in the Western Basin and to the regions north and south of Sandusky Bay. These areas are not as swampy or marshy as the regions to the west.

6.2.1.1.2 Sensitive Subareas. Within Zone 1, Sandusky Bay represents a highly sensitive archeological subarea, one in which a high density of unknown sites is expected. Approximately 12,000 years ago, this bay was a river flowing into Lake Erie, one of very few such rivers in the Western Basin. The banks, levees, and terraces of the original river would have been prime areas for aboriginal occupation, and were probably densely occupied. Rising lake levels gradually drowned this river and others like it in the Western Basin. It is highly probable that seasonal flooding of the river originally flowing through what is now Sandusky Bay deposited protective alluvium on the archeological sites situated on its banks and levees. Such alluvial sediments, deposited in a terrestrial context (i.e., above active lake level), may well have preserved the integrity of the archeological material along these banks and terraces. As the lake level rose, the river was drowned and the bay expanded in area. These now-drowned sites, covered by previously deposited alluvium, would have been subject to wave and storm action, but would also have been partially protected given their position in the bay. Thus, we can anticipate intact buried sites along the river channel that once flowed through Sandusky Bay. Mico-environmental circumstances may also have preserved some kinds of perishable material items; if this is the case, such sites would have a high scientific value.

It is also expected that human occupation would have been associated with the shoreline of Sandusky Bay throughout its evolution. While many of these sites have no doubt eroded away, we can expect, that during periods of relatively stable lake level, substantial occupations might have been protected as a result of soil accumulation and deposition.

Drowning of riverine and/or lacustrine sites was reported by Frohman (1976), who attempted to locate early eighteenth century historic and protohistoric sites known to have existed on the shores of Sandusky Bay. He concluded that Sandusky Bay has almost doubled in size since the early seventeenth century, when the sites reported in the literature were described. Consequently it is believed that these sites are submerged. Late Woodland villages, an "absence" of which has also been reported for this area, may be another type of submerged site in this region. Early and Middle Archaic occupations are numerous along the drainages that flow into the southern shore of Sandusky Bay, and additional sites are expected in the now submerged junctions of these drainages and the earlier stages of Sandusky Bay or even along the original river flowing in this channel. Sandusky Bay should therefore be considered extremely sensitive in its potential for archeological sites. A similar potential also exists for other drowned rivers and their terraces that flow into Lake Erie, including the Portage and the Touissant.

Besides drowned or submerged terrestrial sites in this region, there is a strong possibility that fish weirs might have been constructed and preserved in Sandusky Bay as well as in the Portage and Touissant rivers. The unusually large fish assemblage from the Libben Site on the Portage River, comprising more than seventy-five percent of the vertebral diet, suggests possible importance of the use of weirs or traps as an efficient technology for harvesting this resource. Siltation and anaerobic bottom conditions would have preserved these features. Fish weirs dating to circa 2500 B.C. have been preserved in similar situations in the Atherly Narrows of southern Ontario (Johnston and Cassavoy 1978); similar features could exist in the survey area.

6.2.1.2 Zone 2: North Central Ohio

Topographic and environmental conditions in Zone 2 differ considerably from those found in Zone I and result in a somewhat different set of sensitivity indicators. Unlike the flat, poorly drained lake plain characteristic of much of Zone I, Zone 2 has a series of limestone bluffs, knolls, beach ridges, and end moraines. Some of these topographic features are of high relief and are dissected by numerous drainage systems.

6.2.1.2.1 Sensitive Locations. The limestone bedrock in this area has affected the soils by contributing to increased productivity. This resulted in a very rich resource zone for human occupation, one whose plant and animal resources could be exploited. Highly productive soils for supporting oak-hickory and walnut trees discussed in Section 3.4 will be considered here in terms of their topographic setting. The most sensitive areas for concentrations of prehistoric archeological sites in Zone 2 have high topographical relief where highest quality nut-producing soils are located within about 300 m of a stream. Three hundred meters was selected as an appropriate average distance between streams and knolls and bluffs. The bluff and knoll slopes often extend a distance of 250 m or more. Thus, the 300-m value takes into consideration the intervening distance from bluff or ridge top to the adjacent stream or drainage. This area also includes alluvial margins reported to contain an almost continuous distribution of sites (Shane 1974). It is the combination of high, relatively level topographic relief, high nut-yielding soil type, and association with a drainage stream of any size that is the important key variable for predicting high sensitivity areas in Zone 2.

Areas of intermediate sensitivity in Zone 2 exhibit high relief but are not situated within 300 m of a drainage channel. This would include such relief areas as ridges, bluffs, knolls, and moraines. Shane (1974) observed the importance of sandy knolls located on the lake plain below the 200-m contour. These intermediate sensitivity areas may have been very densely occupied, although not to the extent of some of the high sensitivity areas. Relatively speaking, one might predict that sites will be found in 90 percent of high sensitivity areas and in only 75 percent of the intermediate sensitivity areas.

Major drainages located in Zone 2, such as the Huron and Vermillion, would not be considered highly sensitive archeologically, since the rising lake level drowned at least the first two miles of the rivers and their associated floodplains in Zone 2. The result is that no such terraces or floodplains currently exist within one mile of the lakeshore. This is clearly seen in the U.S.G.S. 7½ quadrangles for this region, which depict drowned floodplains and terraces as marsh or swamp. Archeological sites may well be present in these drowned floodplains and terraces, particularly sites dating to the Archaic Period. Active floodplains and terraces probably existed between the bluffs at that time. Conceivably some floodplain and terrace sites were buried during the Archaic Period by sediments sufficiently thick to protect the *in situ* materials from erosion occurring after the drowning of the river. If this is the case, sites are likely to occur in the swamp-marsh expanse of the one-mile stretch of river that empties into Lake Erie. Thus, these areas are considered to be as sensitive as Sandusky Bay for containing a large number of prehistoric sites.

Drowning of the floodplains and terraces was probably complete by A.D. 700. This date has been assigned because of the absence of post-Middle Woodland village sites on bluffs along these sections of rivers and creek floodplains, a pattern quite common in Middle Woodland times (e.g., the Esch Site). Given that villages of this time period and earlier were situated on bluff tops adjacent to the river floodplains, campsites rather than additional villages are most likely to be found in the now drowned river floodplains and terraces.

Low site sensitivity areas are very infrequent in the one-mile lakeshore area and would include steep slopes, poorly drained soils or soils not well-suited for nut-bearing trees, and the active lakefront before the escarpment. Archeological material found in this latter area is very likely to have been either eroded from the escarpment or redeposited by wave action from archeological sites further out in the lake.

6.2.1.2.2. Sensitive Subareas. The criteria used in the ranking of sensitivity for Zone 2 identify areas comparable to those defined by Shane (1974) for the north central Ohio area. Shane (1974, Figure ER 2.6-3) identified four regions within Zone 2 that he considered to be archeologically sensitive. These are the Hudson Valley, the Berling Heights beach ridge, the Vermillion Valley, and the Black River. These regions account for approximately two thirds of the area within the one-mile strip under study in Zone 2.

6.2.1.3 Zone 3: Northeastern Ohio

Zone 3 extends from Rocky River east to near Erie, Pennsylvania, and includes a number of areas in which archeological research has been undertaken for various kinds of studies, including planning statements, environmental impact surveys, and site excavations. The project-specific EIS reports pertinent to Zone 3 include the Cleveland Harbor and Big Creek reports in Cleveland (Bush 1976a, 1976b), the Perry Nuclear Power Plant EIS (Brose and Lee 1975), the U.S. Steel Primary Study (Brose 1977), the U.S. Steel Secondary Study (Brose, Werner, and Wolynec 1977), and the Northwest Pennsylvania Survey (Johnson, Richardson, and Bohnert 1979). Additional stratified sampling and settlement surveys have been conducted in this area (Brose 1976).

Two of the studies just cited involved field investigation and include maps of the project areas showing the types of archeological inspection actually undertaken (Brose and Lee 1975; Brose 1977). When survey data such as these are combined with soil productivity studies (see Sec. 3.4), predictive statements can be made about where sites are likely to be found.

6.2.1.3.1 Sensitive Locations. Cultural resource sensitivity ratings were determined for Zone 3 by superpositioning soil productivity maps onto the U.S. Steel survey results. It was found that archeological sites were situated 1) on moderately well-drained Berrien or Claverack soil types, 2) on or adjacent to beach ridge soils (sandy soil over silt, clay, or till), and 3) in close proximity to streams (i.e., within less than 100 m). All locations within the U.S. Steel survey area that contained sites included all three of these characteristics. Similar settings are therefore classified as highly sensitive as regards the probability of containing prehistoric archeological sites, particularly those of the Archaic periods.

Other locations classified as highly sensitive in Zone 3 are the regions within about 200 m of the mouths of major drainages. It is important to note that high sensitivity exists in drainage mouth areas even though soils might be otherwise undesirable.

Alluvial floodplain soils are also assigned a high sensitivity rating and their occurrences are powerful predictors of site location within Zone 3. Identifying floodplain soils is particularly important for predicting the location of Woodland village sites. Two other factors were also found to be useful for predicting Woodland sites: 1) the relative area of high quality soil and 2) an associated high bluff position. It is apparent that this combination is associated with an agricultural village adaptation in Zone 3. High topographic position is considered by Brose to be an important site-location variable and is clearly associated with community defense (Brose 1976b; Brose, Werner, and Wolynec 1977). These factors became particularly important during the terminal prehistoric period, A.D. 1500 to 1640. During this time, warfare seems to have been endemic in Zone 3, and settlements involved the concatenation of villages and movement to the most defensible position within a stream drainage. Other large tracts of high quality alluvial soil with smaller bluffs and in smaller stream drainages are also expected to contain sites. While these locations were probably not as desirable from a defensive standpoint, during periods of less intensive warfare they would have been more attractive if the acreage of quality soil was greater than in those areas having the highest bluffs. Therefore, it is necessary to treat all large expanses of these alluvial soils as highly sensitive. The soil types comprising these large tracts of high productivity alluvial soils include Chagrin, Tioga, and Lobdell.

Areas rated as intermediate in sensitivity within Zone 3 include the mouths of small tributaries that flow into Lake Erie. These locations contain archeological sites that functioned as fishing/fowling stations during the Late Woodland Period. Many of these camps were eroded away subsequent to their occupation, hence a smaller number of potential locations remain and not all drainages' mouths were utilized as fishing camps. Such sites, when found, will usually be located within a 200-m radius of the mouth of a stream drainage. The confluence of streams, irrespective of soil criteria, may also contain sites. This situation largely accounts for those residual locations not associated with high productivity soil but which, nonetheless, contain sites at a greater than random frequency.

The foregoing statements regarding site sensitivity in Zone 3 are closely paralleled by the independent secondary area analysis of Erie, (Pa.), Crawford, (Pa.) and Ashtabula (Ohio) counties (Brose, Werner, and Wolynec 1977). In these counties, the ecological variables of 251 sites were recorded and combined with the ecological parameters for 6723 locations within the U.S. Steel Greenfield Plant Site. Cultural resource sites were then evaluated by a factor analysis, and the ranking of the key ecological variables became the sensitivity measure. The important variables in site prediction and sensitivity are very similar to characteristics identified in this section, although differently stated. The results probably would have been even closer if soil productivity had included both nut-bearing trees and agricultural soils.

6.2.1.3.2 Sensitive Subareas. Brose, Werner, and Wolynec (1977) generated a series of maps showing the archeological sensitivity for the three-county secondary study area. Their ranking scheme has four sensitivity levels: extreme, high, moderate, and low. An inspection of their maps again shows a high congruence with our general statements regarding site sensitivity. It also illustrates that all of the area within Ashtabula and Erie counties, to at least one mile back from the lake, is of moderate sensitivity or higher, with at least 50 percent of the area classified as of high or extreme sensitivity. The characterization based on these counties is probably applicable to the entire one-mile strip within the study zone defined in this report.

Because of the high sensitivity rating that has been assigned to the entire lakeshore and the general similarities of key environmental factors throughout, specific subareas could not be identified. If soil reconstruction maps were prepared for this entire area, it seems likely that some sensitive micro-areas could be identified. Micro-areas would have a differential distribution of environmental attractions for the Archaic and Woodland periods. However, the preparation of extensive soil maps for the entire area is not within the scope of this study.

6.2.1.4 Zone 4: Southwestern New York Lowlands

This area includes the lands that extend from Mill Creek, Pennsylvania, to Silver Creek, New York. The data available for this subarea are less complete in both quantity and quality than those for the subareas of Ohio. Despite this, trends in site probabilities compare well with the Ohio data.

6.2.1.4.1 Sensitive Locations. The areas of greatest archeological potential occur less than 200 m from the delta or lower reaches of larger streams. The immediate setting of a site may be a bluff top, promontory, or other feature of local relief. Such settings may be considered to have particularly high potential when occurring in conjunction with large expanses of moderately to well drained alluvial deposits (i.e., stream terraces), with moderately to well drained glacial soils, or with suitable agricultural soils.

Glacial lake beachstrand deposits, located with 200 m of a water course are also given a high sensitivity rating. Such settings are likely to contain sites when the immediate environment offers high topographic relief (i.e., knoll or bluff), a small to moderate sized stream, or a spring. Examples include the Westfield Fort and Sheridan Earthworks.

Areas having an intermediate probability for finding archeological sites are within to 200 m of a permanent water source; including streams, brooks, small lakes, ponds, marshes, and springs. Areas along the western slopes of the lake escarpment, from 2 to 4 km inland from the lake and between the elevations of 600 and 700 ft. ASL also have an intermediate probability for containing sites. Why settings such as these were attractive site locations is not yet well understood, but this type of location was defined on the basis of two systematic surveys in the Sheridan and Pomfret areas (Miller 1978). Areas of low relief (i.e., low knolls and ridges) have also been identified in the literature as being likely locations for containing prehistoric sites.

6.2.1.4.2 Sensitive Subareas . Subareas within this zone are determined by the geographic distribution of stream deltas. On this basis, the authors note that the lower reaches of the following streams should be considered as highly sensitive: Mill Creek, Chautauqua Creek, Canadaway Creek, Walnut Creek, and Silver Creek.

6.2.1.5 Zone 5: Western New York Lowlands

The study area extends from Silver Creek to the Buffalo River in New York State. The expectations for sites in this subarea are basically similar to those prepared for Zone 4 although the specific environments differ between regions.

6.2.1.5.1 Sensitive Locations. The distribution of glacial features in Zone 5 appears not to have been as important a factor in site location as in Zone 4. However, particularly high archeological sensitivity ratings can be assigned to 1) locations of high relief, 2) areas within 200 m of the middle sections of larger streams (2 to 15 km from the lake), 3) tracts with moderate to well drained alluvial deposits, and 4) natural springs. Special attention should be called to areas of high relief formed by peninsular bluffs at the intersection of small ravines, with or without permanent water, and broader stream floodplains (e.g., Double Wall Fort in the Cattaraugus Creek Valley). Identifying springs and associated marshes at the base of recent stream floodplain margins may prove a valuable visual predictor of Late Woodland villages in this zone, particularly in Cattaraugus and Buffalo creek valleys. This location needs to be confirmed by more field studies.

Areas of intermediate archeological sensitivity within Zone 5 are located within 200 m of the headwaters of small tributary streams. Most often the sites found in this kind of setting are camps.

6.2.1.5.2 Sensitive Subareas . Sensitive subareas within Zone 5 are located on stream deltas. Thus, the lower reaches of the following streams should be given particular attention: Cattaraugus Creek, Eighteen Mile Creek, Rush Creek, Buffalo Creek, and Smoke Creek.

6.2.2 Submerged Prehistoric Sites

Much of the area within current Lake Erie was, for some 8,000 years, dry land. As such, it is likely that between about 12,500 and 4,400 B.P. prehistoric populations utilized some of the area that is now submerged.

Identifying the location and frequency of archeological sites that may remain under the current lake depends on three types of data. First, information about the settlement-subsistence system for the current dry landscape is needed. This information can then be used to predict the location of sites on underwater landforms on the lake bottom. Second, information is needed about the natural processes that distribute and redistribute sediments in lakes in order to estimate those areas where the preservation of sites would be most likely. Third, information is needed about the visibility of preserved site remains to archeologists.

6.2.2.1 Prediction

From 12,500 to 4,500 B.P. (encompassing the Paleo-Indian and Archaic periods), the inhabitants of this area engaged in a hunting and gathering lifestyle. Only at the end of the Archaic are there indications of larger and more permanent sites supported by incipient horticulture. Thus, most of the submerged sites in the lake would have functioned as hunting camps, processing stations, fishing stations, and base camps, i.e., the full variability of site types that would have been found on the present land surface during the same time period.

Sites would not be expected within areas known to have been small lakes and ponds that made up Early Lake Erie (see Fig. 2.10). During the Paleo-Indian period, the two moraines--Pelee, which separates the Western and Central basins, and Norfolk, which separates the Eastern and Central Basins--would have been prime caribou migration routes. By analogy to ethnographic and archeological data, these areas would have attracted hunting communities, and would have been the most likely areas for prehistoric sites of these periods. In addition, the shoreline zone around the Early Lake Erie lakes and ponds would have been suited, particularly during the Archaic Period, for both fishing and marsh plant procurement. It must be understood that the shoreline zone would have shifted as the early lake levels rose in response to the isostatic rebound at the Niagara outlet. Certainly by 10,000 B.P., both the Norfolk and Pelee moraines would have been drowned, leaving only the higher points above water. This time period fairly well bounds the Paleo-Indian adaptation in this area, so that we might expect the distribution of Paleo-Indian sites to fall between the two lines drawn for the shoreline at 12,500 and 10,000 B.P. Paleo-Indian materials are expected to be sparse since population densities were probably very low; this is in part due to the fact that the actual shoreline would have been stable for only brief periods.

It would be expected that all low-lying areas not inundated by Early Lake Erie would have been marshy, probably similar to the nearshore areas found between Sandusky and Toledo today. Because the Eastern and Central basins are much more regular in topography than the Western Basin, the only areas of high ground in these two basins would have been the morainal ridges. Moraines have already been targeted as prime usage areas. The Western Basin, however, had a different geologic structure. Resistant underlying bedrock has produced numerous areas with higher relief. Today, we see this resistant bedrock as islands such as Pelee, Kelley's, North Bass, and South Bass in the Western Basin.

At 12,500 B.P., ponds and lakes are assumed to have covered all areas below the current elevation of 420 ft. ASL. Therefore all land at or above 420 ft. ASL would have been available for human occupation. On the basis of extrapolations from the rise in the lake level of the Eastern and Central basins, it is presumed that the Western Basin was inundated to a level of 520 ft. ASL by 10,000 B.P., and to a level of 530 ft. ASL at 4,500 B.P. Shortly thereafter, the lake level in the Western Basin rose to within 10 ft. of its current elevation of 568 ft. ASL so that, after 4,500 B.P., only a small portion of original dry land surface remained. What is important about these shifts is the relative stability of the lake level between 10,000 and 4,500 B.P. (at 520 to 530 ft. ASL). It is likely that a majority of the archeological remains submerged in the current lake would have been formed at elevations above 520 ft. ASL (for the elevation of glacial till, not recent lake mud). Because of relatively recent sedimentary deposition in the lake, a bathymetric reading of 520 ft. or higher would be a conservative estimator of the possible area of greatest archeological habitation.

Within this elevational constraint we believe that it is possible to specifically define the qualities that would have been most favorable for human land use during the Archaic. The characteristics associated with high probabilities for sites on contemporary land in western Ohio are nearness to water and high relief (ridges, bluffs, knolls, beaches, and terraces). In the Old Glacial Lake Maumee Plain of western Ohio, any land with some relief and better than poorly drained soils constitutes a high probability location. For the currently submerged areas in the Western Basin, high relief has already been defined as of greater than 520-ft. elevation. Nearness to water is more elusive, but if one presumes that during the 10,000 to 4,500 B.P. period, river drainage pattern followed the preglacial drainage pattern, it is possible to map out some of the areas that would have been closer to streams and would thus have been more favorable for habitation (Herdendorf and Bradeich 1972; Hobson, Herdendorf, and Lewis 1969). The detail to which the preglacial drainage can be mapped will influence the accuracy of estimating the prehistoric use of an area. It is assumed that any area within a mile of an inferred preglacial drainage and above an elevation of 520 ft. would be a highly favorable area. This includes the inferred stream valley that cut through the Pelee Moraine, near Lorain.

6.2.2.2 Preservation

If the areas described in the previous sections were indeed used more intensively than other areas by prehistoric inhabitants, there is still the question of how much of this archeological material has been preserved in its original context. A combination of above-ground erosional movements and below-water bottom current actions may have removed and redeposited much of the archeological record. The more severe below water disturbances would have occurred as the ground was inundated by the advancing shoreline.

There is a direct relationship between the depth of water and the available energy that shore waves can impart to the lake bottom (see Chapter 2). Thus, waves affected the old shoreline in the breaker zone by chewing and removing the shoreline over time and most of the inundated ground between the Early Lake Erie shoreline and the current shoreline would have been removed and redeposited. An important exception to this destructive action would have been those areas protected from wave actions, including areas behind beach ridges, on peninsulas, in drowned river channels, and in marshy areas behind barrier beaches.

Bottom currents have also had an effect upon site preservation, especially in shallower areas, such as the Western Basin. Bottom sediments are loosened by wave action and then transported by wind-generated currents or seiches to other areas. In Lake Erie, the major seiche follows the northeast-southwest axis of the lake, and, since the current wind direction is predominantly from the west, the currents tend to flow to the east (Hartley 1961b). Given that the inter-island area is protected from waves, the area on the eastern side of the inter-island area would receive the greatest protection from both wave and seiche action. The area immediately east of the islands area would also receive some protection from most of the seiches, since this area is protected from the prevailing winds.

The assumptions made here hold only under current climatological conditions. If previous climates in the area had prevailing winds from the east, the western shadows would have been more protected.

In nearshore areas, wave action breaks down glacial till and currents sweep the finer sediments away, leaving a sand and gravel lag in its place (Herdendorf and Bradeich 1972). In the Western Basin, excess wave orbital energy appears to mix and redeposit sediments to a depth of from 14 to 20 cm (Thomas, Jacquet, and Kemp 1976). Thus, it would appear that archeological materials protected by only a thin veneer of lake sediment could have undergone mixing and disturbance. Finally, waves and currents tend to keep the bedrock projecting above the bottom clean of sediments. Gravity also keeps steep slopes from accumulating sediments (Hartley 1961b). It must be expected, then, that both the highest and steepest areas now submerged would not have maintained a protective veneer of sediments, and that any archeological materials deposited on them would probably have been disturbed and redeposited elsewhere.

The problem of natural disturbance to submerged archeological sites is analogous to that of Paleo-Indian sites in open areas. Due to rapid environmental changes at the end of the Pleistocene, many Paleo-Indian sites were eroded away or deeply buried under sediment. In Lake Erie, we would expect much the same situation. Sites protected by intervening high ground (reefs or knolls) or situated on a protected floodplain would have had the best chances for preservation. Sites on lower slopes may also have been protected, especially if they had been covered by upslope wash prior to submergence. The specific conditions for preservation of these sites included such locations as coves protected from wave action, elevation high enough to be on dry ground at their time of occupancy, and relative location in low areas. These conditions would have pertained to all three basins, although the Western Basin, has a larger number of areas with relief. It is likely that the Western Basin has more occupational remains than the Eastern and Central basins, which tend to be flat.

6.2.2.3 Visibility

Visibility is another important factor to consider in identifying submerged sites. There are two aspects to this. First, because of wave action and mixing and redeposition, surficial sediments do not necessarily reflect original conditions. Second, because of rapid sedimentaion within Lake Erie, much of the area of the lake bottom is covered with up to 30 m of recent mud--mud deposited after 12,500 B.P.

The movement of bottom sediments from their original contexts is most graphically illustrated in several borings in sand-dredging areas in the lake (Hartley 1960). All things being equal, one would suspect that, if the surficial sediments were coarse and in a higher topographic position, a remnant of high ground might be assumed; such areas would have high archeological potential. Conversely, areas covered with recent mud would tend to have a low archeological low potential. Boring 67, taken from Maumee Bay, shows a surface at 7 ft. below lake level composed of fine sand and pebbles (Hartley 1960:23, Plate 5). This overlies silt and mud, which overlie till. Although there could have been an archeological component at the till-mud interface, this possible component in the fine sand and pebble strata probably never existed, since the silt and mud was deposited by the lake prior to the sand and pebble strata. In this case, the sand and pebble strata probably represent a zone of high energy wave action, not a remnant of a topographic feature favorable to preserving archeological sites. Boring 87, from Maumee Bay (Hartley 1960), shows mud overlying a gravel zone that overlies mud, indicating that a zone of high energy may have at one time entered that location and then left. Borings 15, from Cedar Point Pumping Grounds, R118, from Lorain-Vermilion Pumping Grounds, and 50, from the Fairport sand area (Hartley 1960: Plates 12, 18 and 25) all show potentially favorable site conditions obscured by subsequent sediments. In theory, it could be assumed that the interface areas between zones of high and low wave energy would be the most suitable for inspection for archeological sites (Thomas, Jacquet, and Kemp 1976, Figure 15), especially between zones A-B and C-D. However, this presumes some uniformity in wave zones through time, which, as seen in the boring data, probably did not occur. It would therefore be unwise to use surficial sediments to predict favorable archeological habitation areas or zones of preservation. Since boring data, which would be much better, are not as consistently available for the lake, borings that are taken in areas where gas drilling may occur would be useful to cultural resource managers.

6.3 SUMMARY AND DISCUSSION
(Sue Ann Curtis and James W. Hatch)

Chapter 6 has focused on establishing guidelines as to where prehistoric archeological sites are more or less likely to be found on the lakeshore and submerged in the lake bottom. Discussion was organized by natural subareas within the Lake Erie Basin, as defined earlier in Section 3. Terrestial subareas include the Western Basin (Zone 1), northcentral Ohio (Zone 2), northeastern Ohio (Zone 3), the southwestern New York Lowlands (Zone 4), and the western New York Lowlands (Zone 5); submerged subareas included the Western, Central and Eastern basins of Lake Erie.

Each terrestrial and submerged subarea was examined with regard to archeological site-density probability. Sensitivity ratings, scaled as high, intermediate, or low, were based on the relative densities of sites expected to be found within specified environmental settings within each subarea. The associations between site types and such environmental factors as soil, topography, and hydrology, which were defined, modeled, and tested in Chapter 3, were used to evaluate the subareas. Table 6.1 summarizes findings for the five terrestrial subareas; Table 6.2 does the same for the submerged areas. In both cases, an attempt has been made to be as specific as current data and understanding permit.

A rising lake level over the past 13,000 years has led to the drowning of up to several kilometers of the drainage channels that feed the lake. Most of these channels are located in the Western Basin, and the now submerged areas would undoubtedly have constituted important areas of human settlement prior to their inundation between 11,000 B.C. and A.D. 700.

Both the rich sediments of the Central and Eastern basins and the drowned river channels of the Western Basin must be regarded as potentially rich cultural resource areas yet to be tapped. Their value lies in providing information concerning highly successful human adaptations about which very little is currently known.

Because the geomorphology of the current lake bottom has not been as extensively studied as the surrounding terrestrial environment, any attempt to produce predictive statements concerning the potential for finding submerged archeological sites must be viewed with caution. For example, areas of topographic relief are generally regarded as favorable to site locations, but the current lack of relief does not preclude the occurrence of such locations. Natural processes of leveling and filling probably buried previously favorable locations with sediments of varying thickness. Rates of sedimentary deposition ranging from 0.11 to 0.35 ft per century have been estimated for the Western Basin (Herdendorf and Bradeich 1972). Thomas, Jacquet, and Kemp (1976) estimated that up to 20 m of Holocene sediment were deposited in the Central Basin, up to 40 m in the Eastern Basin, and less than 5 m in the Western Basin, which was inundated at a much later date. These estimates support the idea that some prehistoric archeological sites could be deeply buried in the current lake bottom.

Table 6.1. Archeological Sensitivity Ratings by Zone for Terrestrial Sites[a]

Site Density Sensitivity	Zone 1 Western Basin	Zone 2 Northcentral Ohio	Zone 3 Northeastern Ohio	Zone 4 New York Lowlands	Zone 5 Western New York Lowlands
High	1. Somewhat poorly drained to well-drained soils[b] 2. Current beach lines 3. Knolls and other natural elevations 4. Sandusky Bay: banks and levees of the river that flowed into the bay after 12,000 B.P. 5. The Sandusky Portage and Touissant drainage exits into Lake Erie (especially those areas now submerged by the rising lake level	1. High relief within 300 m of any drainage (limestone bluffs, knolls, beach ridges and end moraines) and on high quality soils suitable for nut-bearing trees 2. Most areas within one mile of the current lakeshore 3. Hudson Valley, Berling Heights Beach ridge, Vermillion Valley, Black River, the Maumee beach system	1. Moderately drained Berrien or Claverack soil types on or adjacent to beach ridge soils (sandy soil over silt, clay, or till) less than 100 m from a drainage channel 2. All areas within 200 m of the mouths of major drainages 3. Highly defensible locations--particularly high bluffs adjacent to large tracts of alluvial soils (Chagrin, Tioga, or Lobdell [new series]) 4. All areas of moderate to well-drained alluvial soils	1. Areas within 200 m of the deltas of larger streams--especially bluff tops, promontories, and other local relief in proximity to large expanses of moderately to well drained alluvial deposits, moderately to well drained glacial soils, or to good agricultural soils 2. The lower reaches of the following creeks: Mill, Chatauqua, Canadaway, Walnut and Silver and Elk 3. Inland settings on glacial lake beachstrand deposits within 200 m of a water course--particularly areas with relief (knolls and bluffs) 4. Beach ridges within 500 m of any drainage channel	1. Areas of high relief within 200 m of the midsections of large streams (2-15 km from the lake) adjacent to moderate to well drained alluvial deposits--especially high peninsular bluffs at the confluence of two or more streams 2. The lower reaches of the following creeks: Cattaraugus, Eighteen-mile, Rush, Buffalo, and Smoke
Intermediate	All other areas within the one-mile strip along the lakeshore	1. Same types of areas as above but more than 300 m from a drainage channel 2. Submerged river terraces and floodplains that were on dry land between 11,000 B.C. and A.D. 700	1. All areas within 200 m of small drainages 2. The mouths of small tributaries and drainages 3. All areas within 200 m of the confluence of streams	1. All areas, other than those above, within 200 m of a permanent water source (stream, brook, small lake, pond, marsh, or spring 2. Knolls, ridges and foot slopes between 600 and 700 ft. ASL and from 2 to 4 km inland	Same as Zone 4

Table 6.1. Continued.

Site Density Sensitivity	Zone 1 Western Basin	Zone 2 Northcentral Ohio	Zone 3 Northeastern Ohio	Zone 4 New York Lowlands	Zone 5 Western New York Lowlands
Low	None	All other areas, particularly steep slopes, poorly drained and low productivity soils, the active lake front before the escarpment		All Other Areas within One-mile Strip	

[a]Table applies to areas above current lake level (573 feet A.S.L.) and within 1 mile of current shoreline.

[b](Zone 1) See Chapter 2 Appendix for specific soil types corresponding to classification used in this table.

Table 6.2. Archeological Sensitivity Ratings by Basin for Submerged Sites

	Western Basin	Central Basin	Eastern Basin
HIGH SENSITIVITY	1. All areas higher than 500 ft. ASL[a] and within one mile of Holocene streams, lakes, and ponds 2. Submerged end moraines, river valleys, first and second terraces, and lacustrine beaches	1. Submerged end moraines 2. Deltas of large streams submerged less than 10 ft. (563-573 ft. ASL[a]) 3. Islands submerged less than 10 ft. (563-573 ASL[a]) 4. Courses of submerged streams	Same as High Sensitivity category for Central Basin, Items 2-4
INTERMEDIATE SENSITIVITY	Low energy wave zones in areas without clay bottoms and greater than 420 feet A.S.L.		
LOW SENSITIVITY	All other areas of current lake bottom		

[a]Corrected for isostatic rebound.

CHAPTER 7

METHODS FOR SITE DISCOVERY IN THE LAKE ERIE BASIN

Christopher E. Hamilton, James W. Hatch, and Carl Bebrich

7.1 INTRODUCTION

(Sue Ann Curtis and James W. Hatch)

Numerous archeological sites are likely to be encountered during the development of natural gas facilities in the Lake Erie Basin. To minimize the impact of these facilities on the cultural resources of the area, systematic site surveys will be needed. These efforts will result in an inventory of cultural resources within a specified area (lease tract, pipeline corridor, etc.) and in the possible evaluation and nomination of sites and districts to the National Register of Historic Places. Decisions concerning the mitigation of direct and indirect impacts on these sites must necessarily be based upon site-specific conditions and on project design.

Since archeological sites are likely to be found in a variety of terrestrial and submerged contexts, it is anticipated that a number of different site-discovery techniques will have to be employed. The nature of two of these techniques and appropriate settings for their application will be discussed later. The first deals with terrestrial surveys, the second with underwater surveys. The latter is given more extensive treatment because underwater archeology is a comparatively new and developing field likely to have special importance for the Lake Erie Basin.

Because the probability of site discovery is, for all of these methods, conditioned by the intensity of their use, an effort was made to suggest minimum levels of effort in their application. We recommend that developers be wary of potential archeological contractors whose proposals specify work efforts that are orders of magnitude more superficial than those suggested here, regardless of how cost-effective these proposals may appear. At the same time, it must be recognized that, as the state of the methodological art advances, archeologists with experience in local conditions will undoubtedly propose new approaches and creative combinations of old ones that will yield a greater return of information than those suggested here. Developers should, therefore, be prepared to give potential contractors considerable latitude in their survey designs.

7.2 METHODS FOR TERRESTRIAL SURVEYS

At present, no consensus exists among archeologists concerning the specific quantitative limits of the techniques traditionally used to discover archeological sites. Despite this, a degree of methodological congruence is apparent among the better survey reports. "Walkover" or surface inspection techniques, applied to landscapes without vegetation (e.g., plowed agricultural fields), are certainly among the most commonly used. Road cuts and river banks are also commonly inspected for evidence of sites. Buried sites or sites obscured by the growth of vegetation are most frequently surveyed by shovel-test programs (controlled volume shovel cuts distributed in a grid-like arrangement across an area), auger cuts, or backhoe trenches.

Many other site-discovery techniques are available to the archeologist, including chemical soil analysis, aerial photography (using a variety of lighting and film combinations), and resistivity apparatus. While these latter techniques may be used under certain circumstances, the discussion that follows will focus on the more commonly used techniques only.

7.2.1 Surface Surveys

7.2.1.1 Walkover Surface Survey

The walkover survey involves the visual inspection of the ground surface in those places where it is essentially free of vegetation; in the study area, recently plowed agricultural fields will be the most frequent example of cleared land. By examining the surface, artifacts and/or soil discolorations indicative of cultural resource sites can be spotted. One or more individuals walking across the land, looking ahead and from side to side, can systematically cover a field by walking its length, turning, moving one unit of sighting distance (approximately 5 to 20 m), walking its length again, and repeating the procedure until the survey is complete. As the boundaries of artifact concentrations are detected, small survey flags are placed in the ground. After the field has been completely examined, the location and size of any sites are visually apparent.

7.2.1.2 Inspection of Road and River Cuts

Dirt roads and their embankments are often examined for artifacts that may have been locally eroded or disturbed during the road's construction. As with walkover inspections, systematic coverage is imperative. Deep vertical cuts produced by road construction or stream channelization may also expose buried archeological sites in profile. These can be traced horizontally by using one of the subsurface techniques described in Section 7.2.2.

7.2.2 Buried-Site Surveys

7.2.2.1 Shovel Tests

Constant volumes of soil, dug with a shovel at regular intervals, provide an effective way of locating sites that are buried or otherwise invisible from the surface. The fill of such probes is examined for the same sorts of artifacts as one encounters in all the other techniques described here: lithic tools, debitage, ceramic shards, charcoal, etc. The shovel-test technique is limited by the depth of the test hole that can be dug while maintaining a cost-effective test program.

7.2.2.2 Augering

This category embraces a number of mechanical devices used for detecting sites and buried strata at intermediate depths. Post-hole diggers, of either the two-handle or T-handle variety, are commonly used. Screw augers ranging from one-person, manually operated types to vehicle-mounted, multisegment types have been used as well. Within reasonable limits of accuracy, this technique is useful for tracing the horizontal distribution of archeologically significant strata. A careful examination of the soil removed from the borings is needed to discover artifacts.

7.2.2.3 Backhoe Trenches

Backhoes are frequently used in archeological surveys to expose the more deeply buried strata. Trenches are dug quickly by the backhoe and can be used to either 1) expose deep stratigraphic profiles or 2) remove unwanted "overburden" from archeologically relevant layers. The large volumes of soil that quickly accumulate during backhoe operations preclude all but a cursory spot-checking for artifacts in the fill removed during trenching. However, artifacts, charcoal, or bisected features (floors, hearths, etc.) may well be detected in the trench profile. Backhoe trenches will be of great importance in the study area along developed alluvial floodplains, where many meters of deposit may cover even comparatively recent sites.

7.2.3 Discussion of Method Applications

Few detailed, quantitative evaluations of these techniques are available in the published literature. The few explicit treatments of evaluations of methods that have been developed tend to be part of contracted survey reports; these evaluations involve the same data sets they were responsible for discovering. The works of Lovis (1976) and Chartkoff (1978) stand as good examples of explicit survey methodology. Lovis's survey covered portions of a densely forested region in northern Michigan. Clearing 1-ft. × 1-ft. areas of their vegetation and examining the exposed ground surface for artifacts, he concluded that these "proved to be adequate techniques for the discovery of low density sites in areas of low surface visibility" (Lovis 1976:371). However, he thought that the 100-m interval between inspection units was probably too great and that 25-m intervals would probably have yielded a more reliable sample. Unlike Lovis, whose concern was the discovery of sites, Chartkoff's research dealt with the optimum volumes and spacing intervals of shovel tests used to determine the boundaries of buried sites. He recommended screened shovel tests at 10- and 25-m intervals.

Shovel-test transects are currently being evaluated as part of a field reconnaissance study being conducted in a midwestern hardwood forest (Curtis et al. 1980). When shovel tests were made in a dense upland forest at 14-m intervals, small Archaic sites were identified. A sector of the survey area was divided into two subareas with similar topography and vegetation. One area was shoveled at 14-m intervals, the other at 7-m intervals. Four prehistoric sites were identified in the area with the 7-m spacing; one site was found with the 14-m spacing. While these findings cannot be regarded as conclusive, they do indicate that a test interval of less than 10 m may be required to adequately locate small archeological sites.

An important methodological contribution is anticipated from the work being done by Hay and his associates (in prep.). Inspired by the need for selecting the optimum combination of shovel-test volumes and spacing intervals, they are creating hypothetical distributions of sites of varying sizes and artifact densities. They are also using probability theory to decide on the most suitable techniques for use in their region.

Until the parameter values related to these techniques can be specified for sites in the Lake Erie Basin, we recommend that the following be adopted as standard field procedure for terrestrial surveys in the study area. The values specified were chosen by consensus among the archeologists involved in the writing of this document on the basis of considerable archeological experience in a number of areas in the eastern United States.

The complete contents of all shovel tests should be screened through 1/4-in. (1/8-in. in sandier soils) mesh screening; auger tests and backhoe trenches should also be judiciously sampled and screened. The spacing intervals between observation units or transects should be no greater than 10 m for walkovers; from 7 to 25 m for shovel tests, depending on the kinds of sites anticipated; 50 m for auger tests; and 200 m for backhoe cuts. Intervals greater than these should be carefully justified by the archeological contractor. Walkover techniques should be employed whenever possible, even in those areas requiring buried-site techniques. These guidelines are summarized in Table 7.1 by technique and probable site density.

7.3 METHODS FOR UNDERWATER SURVEYS

The following discussion presents a review of the state of the art of underwater archeology. These methods are of particular relevance for developing and managing the archeological resources of the Lake Erie Basin.

The discussion is divided into two sections. The first deals with indirect methods for conducting archeological surveys, commonly referred to as "remote sensing," including devices and systems utilizing different segments of the electromagnetic (EM) spectrum, as well as (magnetometry and sonar techniques) to detect archeological remains. The suitability of the various EM segments is also discussed. The second section deals with direct methods for conducting underwater archeological surveys, including direct search procedures involving divers, habitat/saturation diving, and direct-sampling procedures.

7.3.1 Indirect Underwater Search Procedures

Indirect or remote search may be defined as the nondestructive, remote observation of archeological sites. Remote-sensing techniques can be divided into active and passive systems depending on whether or not a source of artificial illumination is used. Illumination, in this case, is not limited to the visible light band of the electromagnetic spectrum but may include any portion of the spectrum as well as any other source of energy capable of being remotely sensed by its reflection from a target Targets in this case refer to shipwrecks or submerged prehistoric sites.

Underwater archeology offers both special problems and special opportunities for the application of remote-sensing techniques. While the terrestrial archeologist has a wide segment of the EM spectrum available to him or her,

Table 7.1. Archeological Discovery Techniques for Terrestrial Surveys[a]

Probable Density of Archeological Sites (i.e., Area Sensitivity)	Context	Spacing Intervals Between Observation Units				Inspection of Road and River Cuts and Areas of Rodent Disturbance
		Walkover (m)	Shovel Test (m)	Auger (m)	Backhoe (m)	
High	Surface	10	7	--	--	X
	Buried	10	7	50	200	X
Intermediate	Surface	10	15	--	--	X
	Buried	10	15	50	--	--
Low	Surface	10	25	--	--	--
	Buried	10	--	50	--	--

[a]The spacing intervals and combination of techniques shown are recommended minimum standards for an adequate site survey.

the underwater archeologist is denied the use of most of the spectrum. However, conditions permitting, the underwater archeologist has the opportunity to examine, photograph, and excavate an entire site without disturbing any portion of the site outside of that part actually being worked on. Certain underwater remote-sensing techniques can cover wide areas at a much more rapid pace than can land-bound techniques, the latter often being susceptible to the vagaries of topography and human occupations. In other respects the function of remote sensing in both settings is largely the same; it often is the only method by which an underwater archeologist can "see" the site, due to depth or other adverse conditions.

7.3.1.1 Electromagnetic Remote Sensing

Some understanding of the EM spectrum is important for this discussion. For more detailed presentations of this subject, consult Verstappen (1977), Reeves (1968), Estes (1974), Lyons and Avery (1976), and Morain and Budge (1978).

The EM spectrum (Fig. 7.1) is a continuum of radiated energy that moves at light speed in harmonic waves that can be characterized by their wavelength, frequency, and amplitude or strength of signal. It is often convenient to think of the EM spectrum as a set of bands, each consisting of a set of adjacent wavelengths with a common characteristic (e.g., the visible band). For remote sensing, particularly in underwater contexts, the significant aspect of the EM spectrum is that profound changes occur in each of the bands as they move through any medium other than a gravity-free vacuum.

The atmosphere, water, or any other material through which EM radiation passes can scatter, absorb, refract, reflect, or transmit any or all of the radiation. What happens to the radiation is a function of its wavelength (or energy level) and of the size and nature of the constituent particles of the medium through which the radiation passes. In general, the shorter the wavelength, the more likely that the radiation will be attenuated by a given medium.

While the atmosphere greatly affects the higher frequency, shorter wavelength bands, water and particles suspended in it have an even more drastic effect on the EM spectrum. The otherwise informative visible band can, for example, be totally eliminated as a viable means of remote sensing in waters with sufficient turbidity or depth.

7.3.1.1.1 X-Radiation (X-rays). The highest frequency EM radiation for which a use has been found in underwater archeology takes the form of X-rays. But, since X-rays do not reflect well, they are not useful for surveys. Thei. ability to pass through material objects and to expose photographic film has been used to investigate concretions from underwater sites suspected of containing artifacts or the molds of artifacts (Peterson 1964; Bass 1966; Arnold 1976). The concretions must, however, be removed to a laboratory for the X-ray procedure.

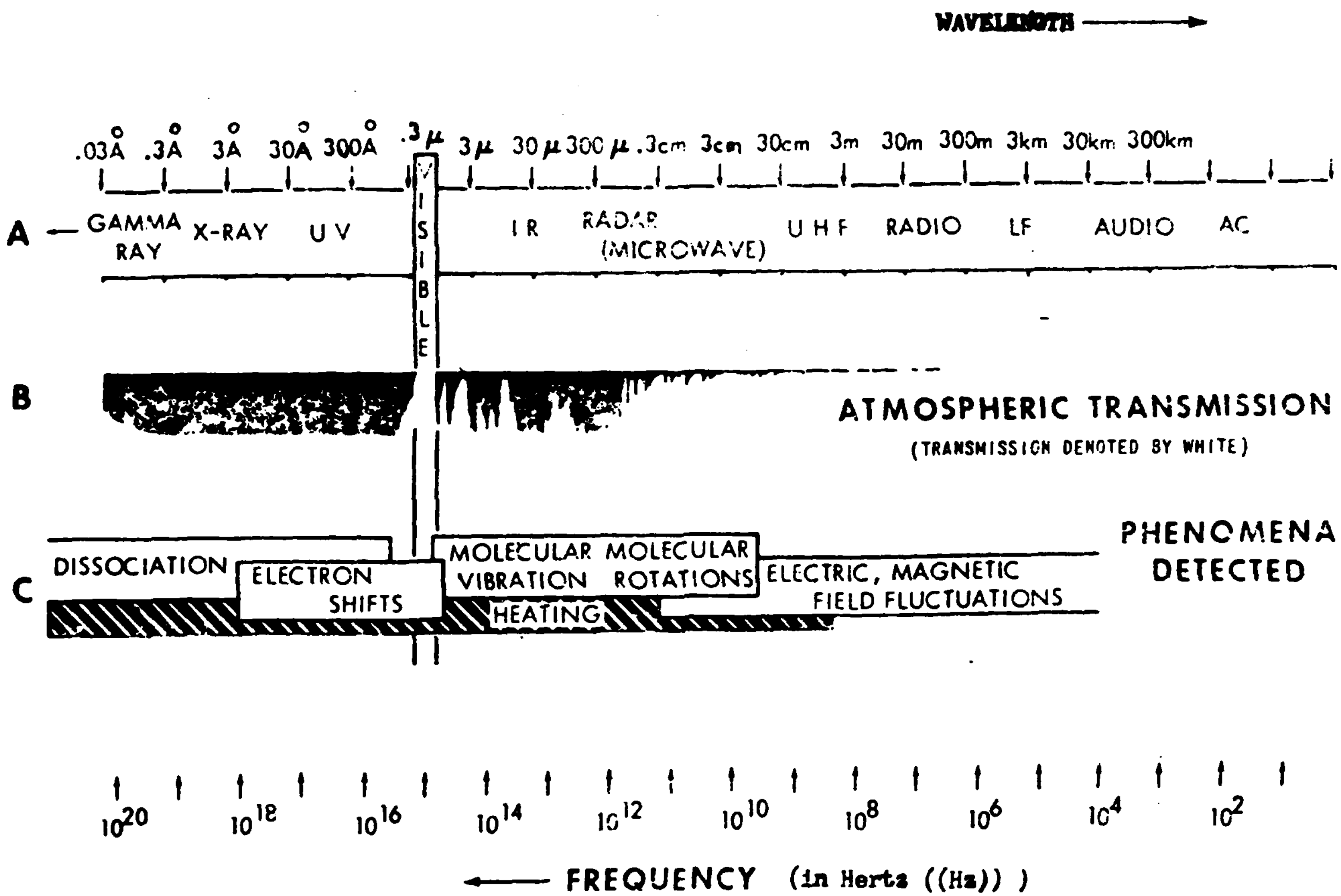


Figure 7.1. The Electromagnetic Spectrum, Customary Divisions
Source: Reeves 1968.

7.3.1.1.2 Ultraviolet Radiation (UV). UV radiation, the EM band between X-rays and visible (deep purple) light, is not widely used in remote sensing for archeological purposes because it tends to be easily scattered or absorbed. While UV can be used photographically in its lower frequencies, a special quartz lens must be used because glass will not transmit UV. Mechanical scanners designed without lenses are useful, but costs rise with more sophisticated equipment. No examples of the use of UV in underwater archeological surveys has been reported. But UV has been used in the investigation of the chemical composition of ship nails (de Borhegyi 1965), and Morain and Budge (1978:9) indicated that it might be employed "in areas of rough terrain to 'see' into areas of prolonged or deep shadow." To date, these seem to be the only evident uses of UV in an underwater archeological context.

7.3.1.1.3 Visible Radiation. The visible band of the EM spectrum is the one that has been most used. Apart from the human eye, the camera is the least expensive and most readily accessible receiver of visible radiation. Unfortunately, the conditions of good visibility necessary for the most efficient application of this technique are not common in underwater archeology. In Lake Erie, secchi disc surveys in 1959 indicated transparencies ranging from 1.2 to 1.8 m in the Western Basin and from 1.2 to 10.1 m in the Central Basin (Beeton 1963). Seasonal variations in the growth of obscuring microorganisms, differing depths, and proximity to sediment-laden runoff all affect these parameters. In general, one cannot expect the visible spectrum to deliver good results in any large-area survey to be made for identifying archeological sites.

The visible spectrum is most effectively utilized in underwater work that entails photomapping and inspecting of sites already located. Peterson (1964) refers to a number of methods by which clear water and shallow depths have allowed aerial and aquatic reconnaissance for shipwrecks. One included the use of a balloon in which an observer was towed behind a boat at an altitude of 100 to 300 feet above the water. This method successfully located several wrecks off the coast of Bermuda. Unfortunately, this technique demands clearer waters than those likely to be encountered in Lake Erie.

Diver propulsion vehicles (DPVs), also known as swimmer propulsion units (SPUs), and towed sleds are two means by which a diver in a self-contained underwater breathing apparatus (SCUBA) might survey large areas. DPVs are torpedo-shaped, battery-powered, screw-propelled units capable of pulling a diver, who steers the DPV by aiming it in the desired direction. Buoys can be released during the search to mark the location of suspected sites that appear on the bottom. These methods are not necessarily expensive, but they are limited by the conditions of visibility, the diver's air supply, the amount of exposure, the water's depth, the amount of bottom time accrued by the diver, and hazards such as the loss of equipment caused by excessive towing speeds when open towvanes are used (Cleator 1973; NOAA 1975).

Submersibles, in the form of towvanes and self-propelled submarines, are also available for use in underwater searches and surveys. George Bass (1966) utilized both of these methods in his work in the Mediterranean Sea.

Comparing closed-circuit television to towvanes, Bass (1972) found that towvanes offered both advantages and disadvantages. Towvanes permit the scanning of larger side-to-side areas, and, because the operator is actually present, there is no problem of a changing image scale. Moreover, towvanes are unaffected by tossing of the surface craft pulling them. But, because of their large mass (e.g., 800 kg), handling problems are substantially greater. For example, the towvane capsule might be towed into an obstacle not recorded by the ship's fathometer, presenting a risk to the diver operator. In addition, towvanes cannot be stopped for leisurely inspection of target areas. Finally, the image-enhancement controls of closed-circuit television can provide superior visualization in turbid water.

Bass's submersible, the Asherah, was of great value as a platform both in searching for targets already sensed by sonar and for photographing the sites (Bass 1972).

Photography is certainly one of the most widely used techniques for recording data in archeology. The satellite imagery of Landsat I and II and the ill-fated Skylab resulted in hundreds of multispectral pictures of the earth. These pictures, covering approximately 185 km^2 per frame, are composed of many picture elements (pixels). Each pixel covers about 80 m^2 (Morain and Budge 1978). Unfortunately, this remote-sensing resource is of very little use to the underwater archeologist. Not only is the attenuation of EM radiation severe below the surface of the water, but the scale of each pixel is generally too large to identify sites the size of a shipwreck or smaller.

Lower altitude multispectral scanning, with its synoptic viewing capabilities, could be of value in shallow, clear water. It is possible that some inundated sites could be detected by their spectral signature or "fingerprint" with the aid of multispectral scanning techniques. As Morain and Budge pointed out,

> We can discover what those fingerprints are by partitioning the optical and infrared portions of the spectrum into discrete bands so as to record the reflectance or emittance properties of each entity in each band, and select only those necessary for unambiguous identification." (1978:10)

Underwater photography has been thoroughly discussed by a number of scientists. Edgerton (1970) indicated that even with extremely clear conditions, an underwater camera can seldom be used at 30 m from a lake bottom or from a subject under study. The light scattering and absorption effects of the water would act as fog does in the air to limit the range and performance of the camera.

In deep water, where light is lacking, the use of floodlights or strobe lights can substitute for that of the sun. A camera platform with artificial lighting was lowered from the research vessel Alcoa Seaprobe to take some 2000 photographs of the Civil War ironclad U.S.S. Monitor sunk in 220 ft. of water off the coast of North Carolina (Newton 1975).

Even under turbid conditions, it is possible to perform some photographic missions if the target is in a known location. One system, designed for turbid water photography by Dimitri Rebikoff, utilized a modified DPV with both lighting and a camera attached. The camera has a specially designed water-corrected lens, while the lighting is adjusted to conditions of turbidity and depth. The system relies on scanning, that is, on a large number of small-area photographs at regular adjacent intervals along parallel lines on the bottom of the sea; this yields a precise and detailed photographic mosaic when the individual pictures are assembled along a proportionally scaled-down pattern.

This photomosaic technique is not as simple as it might at first sound. Some scientists have found that an attempt to simply mount a camera on a DPV was not practical. Some eventually constructed a rigid frame to produce a photomosaic of wrecks.

The use of closed-circuit television has had some use in underwater archeology. George Bass (1972) made an assessment of such a system in the Mediterranean Sea. Compared to the towvane and submarine systems, he believed that such a TV was the easiest system to use.

Bass concluded that the TV system had the following advantages:

1. It was relatively simple to operate because camera and cable were light. (The camera was thrown over the stern and the cable fed out by one or two men until the bottom was seen on the monitor.)

2. A television system could at times see better and further in turbid water than could the human eye since the camera is more sensitive to light. It is also possible to increase contrast electronically with a camera.

The disadvantages were as follows:

1. It was impossible to guess the size of unfamiliar objects seen on the monitor because, as the ship tossed about on the surface, the camera distance to bottom varied, also varying the scale of the image.

2. Resolution of objects was not as good as with the naked eye.

3. Once an object was sighted, it was soon lost again because the camera was always in motion; it was virtually impossible to stop the boat quickly or to keep the camera trained on a target long enough for identification.

4. The search area was limited since the camera could not easily be panned from side to side.

Possible solutions to the problems of closed-circuit TV include the use of videotape to record scenes for review or the use of two cameras with overlapping views to increase the field of vision. The placement of TV cameras on independent submersibles or remote-controlled platforms is also possible.

TV was used by a Duke University team to confirm that the wreck their "fish finder" sonar had located was the U.S.S. Monitor (Newton 1975). They were able to avoid some of Bass's problems because the location of their target was already known, thus allowing a stationary platform from which to suspend their cameras. In this manner they were able to make a leisurely inspection of the wreck site.

Similarly, Cederlund (1977) used a TV camera to document and produce a deck plan of the eighteenth century Swedish merchantman, Alvsnabben. This wreck now lies in 12 to 17 m of water off the Swedish Baltic coast.

TV was used to monitor excavations at the Warm Mineral Spring limestone sinkhole in southern Florida, producing excellent real-time documentation through the use of videotape, and direction of excavation procedure through direct communication between the monitor observer and the diver-excavator (Cockrell and Murphy 1978; Murphy 1978).

The use of closed-circuit TV and videotape is also discussed by Lenihan (Lenihan et al. 1977) under the heading of Data-Recording-Videography. Lenihan was very enthusiastic about the potential of closed-circuit TV in low-visibility situations and about its ability to be linked into a system having instantaneous feedback for controlled underwater excavations.

Bascom's (1976) investigations into the role of TV in deepwater surveys have also been informative. He found that a system using cameras with 600 resolution lines can operate at light levels of less than one-foot candle-power. For seawater, blue green is the best wavelength of light transmitted so that an emerald-green thallium-iodide vapor light would be used to illuminate the area. In Lake Erie, the best wavelengths of light would certainly be different from those found at sea. Investigations into the proper lighting needed for the various systems that might be used in any underwater archeological work performed should be done prior to its actual use in the lake.

Finally, compared to sonar systems, TV was found to be superior for use in rocky areas if the visibility was adequate and the target was not buried.

7.3.1.1.4 Infrared Radiation (IR). The near infrared band, between the visible band and thermal IR, is measured by the reflectance of infrared waves. It is usually recorded on high contrast, black and white photographic film sensitive to green, blue, and red color bands, as well as to a narrow portion of the adjacent IR radiation. IR color omits blue and is sensitive to green; red and reflective IR produce false-color images. Both IR black and white and IR color are used in terrestrial archeology; they have not, so far, been used in underwater archeology because IR is rapidly absorbed by water. One researcher, however, was able to "extend the range of underwater photography by a factor of two by the use of infrared film with tungsten lamps covered with a Wratten No. 25A red filter. The lamps are placed at the corners of a square and about halfway to the subject" (Edgerton 1970:263). Further experiments with this active system appear to be warranted.

Thermal IR, even more than the near IR band, is severely attenuated by water, and no methods for its use in underwater archeology have been reported. Its use in terrestrial archeology is described by Morain and Budge (1978).

7.3.1.1.5 Microwave Radiation. The next band, microwaves, is detected by radiometers and radio detection and ranging (radar) devices, among others. While passive microwave sensing with radiometers is useful in soil moisture evaluation, Morain and Budge (1978) reported that there are virtually no experimental or empirical results upon which to base an adequate archeological assessment.

Active radar systems have proven to be of value in terrestrial archeology. These systems can be either imaging or non-imaging in output. Some training and talent is required to interpret the non-imaging printouts. The imaging techniques, while not like photographs, are more intuitively understandable if one keeps in mind that the image is that of reflected microwaves, not light.

Radar's long wavelengths possess certain properties that are extremely valuable in archeology. Vickers and Dolphin (1975) reported on the use of radar to locate subsurface features, particularly walls, in Chaco Canyon. They acknowledged that radar was probably appropriate only in a limited number of environmental circumstances and that, in wetter soils, resistivity surveys would be more successful.

Ground-penetrating radar has continued to be applied with good results at sites where buried archeological features are substantial. Bevan has demonstrated the method and inherent difficulties in interpreting reflected radar signals (Bevan and Kenyon 1975). In a very rapid but highly informative survey, radar was chosen over other nonexcavation methods because of the excessive time required by resistivity surveys; the proximity of electrified rail lines, which ruled out magnetic surveys; and foliage density, which eliminated aerial photography. According to Bevan, ground-penetrating radar can be used for the following: identification of profile discontinuities within soil or rock to a depth of 2 to 10 m; location of air- or water-filled cavities, buried pipes, and wires; mapping soil stratification; detection of metal and stone concentrations; conducting surveys over soil, rock, or fresh water (but not in areas with saline water); and determination of depth and location of buried objects.

It should also be noted that Lake Erie is the most saline of the freshwater Great Lakes so that an assessment of the electrical resistivity of the lake should be carried out to ensure the usefulness this type of equipment before it is engaged.

Bevan has also stated that, "since the reflectivity of air-water interfaces is lower for radar than sonar, and the wavelength of radar is greater, radar should have fewer problems with gas bubbles" (Bevan 1979). The problem of gas bubbles and the inability of sonar to penetrate them will be discussed later.

Side Looking Airborne Radar (SLAR) is another option available to the archeologist, but it is one that has seldom been used. In this case, the sensor is placed at an oblique angle to the ground while the line of flight, in conjunction with synchronized flight and film speed, makes the whole platform act as a scanning device (Morain and Budge 1978). Unfortunately, this type of radar system has had no use in underwater work; in terrestrial surveys, only those cultural features that are above ground and generally angular in appearance, e.g., walls, are detectable. This technique may, however, be applicable to finding some kinds of submerged resources such as mounds, shipwrecks, earthen embankments, etc.

7.3.1.1.6 <u>Electric Currents</u>. Resistivity surveys are valuable for acquiring data about terrestrial archeological sites. A concise definition of the technique was offered by Anthony Clark. He stated that

The ability of a mass of soil or rock to conduct electricity is due to water in the interstices which contain salts dissolved from the material and humic acids of biological origin. If an electrical potential (voltage) is applied between two electrodes connected to different points on the mass, the solution will separate into positive and negative ions by the process of electrolysis, and these will flow respectively to the negative and positive electrodes thereby setting up an electric current. The ratio of applied voltage to the magnitude of the current is known as the resistance between the electrodes, and varies with the compactness and dampness of the mass and on the solubility and quantity of the salts and acids. (Clarke 1970:696)

Clark further noted that it is a "rough rule...that a measurement... will detect remains down to a depth about equal to the horizontal probe spacing. Thus, if probes are too close together, deeper, features may be missed, on the other hand wider spacing, although giving deeper penetration, reduces the precision of location and, as the current spreads through a larger volume of soil, may fail to detect the smaller features and tends to suppress the effect of large ones" (Clark 1970:701).

Christopher Carr (1977) conducted a resistivity and correlative soil survey at the Crane Site on the lower Illinois River. He concluded that the appropriate unit of analysis for this method was the activity area and not the individual feature, which is difficult to discover on terrestrial sites. Activity areas are, according to Carr, much more susceptible to discovery, and the data retrieved is amenable to mathematical manipulation.

Aitken said that "resistivity is largely dependent on water content" and that "rainfall seriously affects the resistivity measurements" (Aitken 1961:4). Whether or not submergence in water automatically precludes the use of resistivity due to excessive "noise" or short circuits in the system is an important question for the underwater archeologist. Attempts to utilize resistivity on the ocean bottom have been relatively unsuccessful and water, whether saline or fresh, is generally so conductive as to override and mask any readings attempted in an underwater medium (Greenfield 1980). This would seem to eliminate resistivity as an option for the underwater archeologist. This technique has been discussed because future refinements may make it more applicable to underwater survey work.

A final method directly utilizing electric current is similar to resistivity surveying but does not use probes. This method, commonly called "metal detecting" will be referred to here as conductivity surveying.

Bascom (1976) noted that there were several varieties of metal locators that work on similar principles. Two loop antennas are generally used, one transmits a predictable electromagnetic field and the other measures distortions in the field caused by a buried metallic object. The signal strength is directly proportional to the cube of the target diameter and inversely proportional to the sixth power of the target depth.

The use of conductivity systems has been restricted to mapping the locations of metal objects on sites already discovered by other means. These types of detectors are superior to magnetometers for this purpose because of their ability to detect all types of metal, not just ferrous objects such as are detected by magnetometers. However, their limited range prohibits their use in a "search mode" configuration over broad areas, giving magnetometry greater versatility in archeological surveys.

A more complete description of a submersible, diver-held model is provided by E.J. Foster (1970). An excellent application of the technique can be found in Green, Hall, and Katzev (1967). Their survey of a fourth century Greek wreck in the Mediterranean, along with systematic probing, produced a map of the locations of metallic objects at the site for the direction of future excavation.

7.3.1.2 Non-electromagnetic Remote Sensing

Three other types of remote sensing include gravimetry, magnetometry, and sonar. Gravimetry, which measures local gravity anomalies caused by objects of differing masses, has had no application in archeology and will not be further discussed. Magnetometry and sonar, however, have had significant uses in archeology in general and in underwater archeology in particular.

7.3.1.2.1 Magnetometry. Magnetometry has had fairly extensive use in both terrestrial and underwater contexts. As explained by Weymouth

> The success of magnetic surveying depends upon changes produced in the earth's magnetic field by the presence of subsurface features which have a different magnetization than the surrounding soil.... Any object, such as soil, rocks, etc., in the earth's magnetic field becomes magnetized. That is, the constituent atoms of the object that are magnetic line up with the external magnetic field. The strength, or degree, of this "induced magnetization" depends upon the property of the substance known as its "magnetic susceptibility." For soils or clays magnetic susceptibility depends upon the amount of iron oxide in the soil, as well as its crystallographic form (Weymouth 1976:3-5).

The several classes of objects susceptible to detection include iron objects; fired structures such as kilns, furnaces, ovens, and hearths; pits and ditches filled with topsoil or rubbish; and, in some circumstances, walls, foundations, roads, and tombs (Aitken 1970).

When objects or features have magnetic fields that are of sufficient strength to be differentiated from the local magnetic field, they produce unusual readings recognized as anomalies. Several properties of magnetic anomalies were listed by Weymouth.

1. The maximum value of the anomaly occurs to the south of the feature at a distance equal to about one third of the depth of the feature (distance from where the measurement is taken to where the feature is actually located).

2. The size of the anomaly (that is, the strength of the maximum value) drops off as the inverse cube of the depth of the feature.

3. The width of the anomaly at one half maximum value is about equal to the depth of the feature.

4. If the feature has a lower magnetic susceptibility than the surrounding soil, the anomaly will have the same shape but will be negative. (Weymouth 1976:6)

Several types of magnetometers exist, including cesium, rubidium, and proton magnetometers. Though cesium and rubidium magnetometers are more sensitive than proton magnetometers, the use of the proton magnetometer is considered by some sources to be the best compromise between expense and sensitivity (Weymouth 1979b).

Limiting factors involved in the use of magnetometers include the fact that two or three individuals "are required for operating the equipment. Surveys cannot be conducted within 25 meters of a traveled road, closer than 3 meters to a brick wall or wire fence, or within 2 km of an electric train line. Local geology and historical land use must be considered as a source of 'false alarm' anomalies. Facilities for recharging batteries are required. Weight of equipment is 100 kg for the cesium magnetometer and 50 kg for the proton magnetometer" (Bevan 1979).

Obviously, such problems as electric train lines are minimal in underwater work. However, deceptive anomalies can and do occur. Arnold gives an account of site testing for anomalies north of the mouth of the Rio Grande on the Gulf side of Padre Island. While looking for a 1554 wreck site, an anomaly that turned out to be a large steel tank was checked; this probably represented a magnetic marker left by treasure hunters in order to relocate the site after stripping it of all iron artifacts (Arnold 1978). This brings up two other points worth noting. First, treasure hunters often use quite sophisticated techniques to find underwater sites, particularly if an intrinsic monetary value is placed on the artifacts involved. Such underwater sites in Lake Erie could, therefore, have already been "salvaged." Second, "false alarm" anomalies in the form of pipelines, wire cables, and the like lace the bottom of Lake Erie. These should be located in advance so that they can be avoided when a magnetic survey is attempted.

Underwater magnetometry surveys have been of significant value in locating historic shipwreck sites. State marine archeologists employed by the Texas Antiquities Committee have been very active in this field of research; Carl Clausen and J. Barto Arnold III have published numerous articles on their work. They have been particularly successful in dealing with two problems: positioning control and data recording during the survey. Their system works well near shore and consists of a "proton magnetometer, a radio positioning system, and a calculator-plotter system [which] provides vessel guidance and even coverage over an area defined by the user and on tracks of any desired direction and spacing. Data are recorded on magnetic tape for later automated analysis and displayed as acquired, the magnetic data on a strip chart recording and the position data on an X-Y plotter" (Arnold and Clausen 1975a:354).

Concerning the time required for magnetometer surveying, two modes of data collecting should be considered. The search mode entails looking over a large area to locate anomalies; the onsite delineation mode produces a local magnetic map of the anomalous area. The search mode is not generally employed on land, since sites are usually identified through other indications such as surface scatter of artifacts and other less sophisticated and less expensive means than remote sensing.

The data from onsite delineation can be used on both land and water to prepare contour maps of the sites discovered. For examples of this type of contouring see Weymouth (1979b) for a land survey and Clausen and Arnold (1976) for an underwater site.

For a terrestrial on-site delineation survey, Bevan (1979) estimated that an area of about 50 m × 100 m could be surveyed in a day at a 2-m spacing. At sea, one reported search covered about 0.62 km^2/hr, while the onsite delineation proceeded at a rate of 0.03 km^2/hr (Arnold and Clausen 1975).

Another important point emphasized by Clausen and Arnold is that the 150-m spacing intervals recommended by the U.S. Department of the Interior for surveying underwater cultural resources with the magnetometer was insufficient. They thought that blanket surveys were ineffective, and that more concentrated search patterns of 50-m intervals would be more productive and much less likely to miss important resources (Clausen and Arnold 1976).

For onsite delineation surveys on land, it has been recommended "that the grid-unit distances should be somewhat smaller than half the width of the anomaly and no greater than the depth of the feature. Keeping in mind that the magnetometer sensor is usually above ground surface by, say, 50 cm, it follows that features 50 cm deep are best surveyed with a grid of less than one meter" (Weymouth 1976:10).

The use of two magnetometers in two separate configurations can often lend speed and accuracy to the survey. Two simultaneous readings, one from a reference station and the other from the grid, obviate the need to repeat readings at the reference station to measure the diurnal variation in the earth's magnetic field. This type of configuration is known as the differential mode. By using two magnetometers, the gradient mode makes simultaneous readings taken at different heights above an anomaly; this provides information for determining the depth of the anomaly (Weymouth 1976:11).

7.3.1.2.2 Sound Navigation and Ranging (sonar). According to Horton (1959:4), "the merit of any observational agent is evaluated in terms of three basic factors: its range of penetration, its velocity of propagation, and its resolving power." While light certainly constitutes the best "observational agent" in air, it must relinquish this position to sound in the medium of water. Although sound carries less information due to its lack of resolution and slow speed, its ability to penetrate and propagate through water makes it a primary tool in underwater remote sensing.

Although sonar has terrestrial applications in the geosciences, its archeological use has been restricted to underwater contexts. Sonar can be used in two ways: 1) to sense (map) bottom topography and 2) to profile stratification below the ocean, sea, or lake floor. The mapping of bottom topography may be accomplished by either a vertical bathymeter or by side-scanning sonar.

The fathometer and bathymeter are depth finders capable of sensing and recording bottom topography, including any wrecks that may be standing upright on the bottom directly below the transponder/receiver aboard ship. At frequencies of from 1 to 12 kHz, sonar is capable of penetrating bottom sediments to significant depths. The depth of penetration depends on the wavelength used and on the composition of the sediments. "It has been found experimentally that 12 kHz serves very well in most mud and clay sediments if there is no gas at the surface or in the material. Sand, on the other hand, is not penetrated very deeply by 12 kHz, but 5 kHz gets through in some places". (Rosencrantz, Klein, and Edgerton 1972:264). Other considerations include intensity and pulse duration. These may be adjusted to obtain the penetration needed and the resolution required as well as the type of bottom being surveyed.

Attempts to utilize sub-bottom profiling in the Western hemisphere have been less than successful. In a search for evidence concerning maritime culture contact between Post-classic Precolumbian peoples along the east coast of the Yucatan Peninsula, an investigation of inland Lake Chungaxchen was executed. This lake is connected to the coast by an artificial canal and it was thought that the aboriginal ruins and ancient roadway indicated the use of the area as a trade center. However, research with a sub-bottom profiler in the lake led to the conclusion that the archeological remains could not be located by sonar (Farriss and Miller 1977).

Farriss and Miller (1977 145) also stated that they "obtained very detailed bottom profiles on our various sweeps across the lake, but instead of the clear sub-bottom profiles we had expected, only multiple echoes from the sediments' surface appeared on the sonar record. The sediment's poor acoustical qualities are probably due to a high gas content that reflects the sound waves at the surface instead of permitting their penetration to reveal buried objects of greater density. Vegetation on the lake bed is scanty, but during our shallow-water test excavation we found deposits of decomposing calcareous algae mixed with the silt, which could produce enough gas bubbles, though barely visible, to interfere with the sonar."

Looking at Lake Erie, it should be noted that pollution as well as decomposing algae could cause gas bubbles to form in the lake bottom sediments. The existence of these gas bubbles in Lake Erie would preclude the use of sonar remote sensing in at least some locations.

Sonar used in its side-scan mode is an extremely effective means of search in many underwater situations. Like SLAR (radar), side-scan sonar views the bottom at an oblique angle and can produce images of almost photographic quality. It has no penetrating capability and can only sense protruding objects or those sitting on the bottom. In Lake Ontario, two spectacular finds were made by Dr. Dan Nelson, a research associate with the Royal Ontario Museum. Two American armed schooners from the War of 1812, the Hamilton and the Scourge, were located after searching 40 to 45 mi^2 of the lake with a combination of magnetic methods, side-scan sonar and a radar navigation system.

Lake Erie will likely prove to be an excellent area for detecting wrecks or other objects that lie on the bottom. Its relatively flat basins allow for unambiguous reflections from targets with little or no masking noise from rocky protrusions.

Side-scan sonar can be expected to view a total width of 400 m of bottom in two tracks. An area of one square mile every four to eight hours can be surveyed depending on conditions. Newer innovations are constantly being produced in this field, including microprossesor slant-correction bottom-mapping systems (Arnold 1979b). These systems have not been described in the literature; this means that manufacturers need to be consulted about the most recent equipment available and its specifications.

A combination of both side-scan sonar and sub-bottom profiling can be accomplished simultaneously with some equipment. One company providing this type of option is Klein Associates, Inc. of New Hampshire.

Additional systems based on sonar, as well as microwaves, but not yet in practical operation or not available to the public are acoustic and microwave holography. Among the articles dealing with the plausibility of such systems are those of Daubin (1970); Kock (1973, 1974); Kujoory and Earhart (1978); and Yue, Rope, and Tricoles (1975).

7.3.2 Direct Underwater Search and Sampling Procedures

The following paragraphs will outline several procedures that can be used to facilitate direct rather than remote underwater investigations.

7.3.2.1 Direct Search Procedures

Scuba divers utilize three basic physical search techniques in an open-water situation. These include the circular search, the Jackstay, and the "Z" search. Table 7.2 compares the three search techniques.

7.3.2.2 Habitat/Saturation Diving

In conjunction with the use of scuba diving, a habitat could be used to extend the bottom time of any dive in excess of about 100 ft. A habitat is an artificial environment placed on the bed or suspended within a column of a body of water from which divers can move over a period of time while performing prolonged tasks. Its use, while expensive, can greatly reduce unproductive decompression time and can allow the maximum use of trained personnel. According to George Fischer:

> Considerable potential for the use of habitats exists in the Great Lakes...Conditions of preservation in the cold fresh water are excellent, so although the materials which would be recovered are comparatively recent, the artifacts should be excellently preserved and would not require the extensive conservation treatment necessary for chloride impregnated materials. Additionally, although recent, such wrecks have much to say about the technological history of our culture. Names, dates and events are well documented in history, but details of the life of the lower classes, specific information on forms, periods of use, etc. of mundane artifacts are often poorly documented. (Fischer 1974:84)

In a similar fashion, saturation diving extends dive time since a pressure chamber that can be removed from the wreck area is used.

7.3.2.3 Direct Sampling Procedures

Taking samples of bottom sediments is a necessary part of any search of Lake Erie for archeological sites. This can be accomplished through the use

Table 7.2. Comparison of Search Techniques[a]

Search	Brief Description	Advantages	Disadvantages
Circular	Involves search in a circular area defined by the tethered radius of the diver.	Easiest and fastest method available. Requires only one search line. Can utilize any number of divers.	Difficulty establishing overlapping circular perimeters to prevent segments of incomplete search...hence, most inefficient of the three methods.
Jackstay	Uses a rectangular search area laid down by a diver. Two divers traverse parallel paths back and forth across the width using a pair of search lines.	More efficient than circular method. Methodical elimination of area already searched.	Requires two divers who must be separated by up to 100 ft. Hence, the need for buddy lines. Requires more preparation, equipment, *and execution* time than the circular search.
Z	Also uses a rectangular search area. Diver(s) search across width of area and return diagonally.	Most thorough search. Adaptable for one or two divers. If more than one diver is used, they remain in contact.	Slowest method of the three. A single diver must be tethered.

[a]*Source:* *NOAA 1975.*

of dredges, grabs, drills, and piston or gravity corers. R.J. Ruppe (1978) has had success in discerning midden strata in his coring of inundated sites on the west coast of Florida. He reported that

> Both the sub-bottom profiler and the coring tool produce a profile of sub-bottom stratigraphy but they differ in the way the task is accomplished, the speed with which the work can be done and the form of the final evidence. Coring devices are limited by the length of the core that can be taken, the nature of the deposit they are penetrating and they often drastically alter the sediment being sampled. They are dependent upon a source of power to drive the sampling tube which sometimes is a problem. (Ruppe 1978:119)

C.F.M. Lewis (1966) discussed the use of coring and drilling devices with a ship for an operating platform in relation to investigations into the sedimentology of Lake Erie. Comparing the grab sampler, gravity corer standard piston corer, and free-piston corer, he concluded that the free-piston corer was the most suitable tool. His observations on the free-piston corer are as follows:

> The free-piston corer does not require the time consuming preparations of a lever-trigger release assembly as with the standard piston corer. The ship need be stopped on station only long enough to lower and raise the assembled corer--approximately 15 minutes. Fourteen cores collected by the apparatus demonstrated that it could take cores of equal length (up to 13.7 m.) and comparable quality to those of the standard piston corer. However, the operation of the free-piston corer and the recovery of good quality cores is basically very unstable. (This occurs particularly when long cores are taken in shallow water due to the operating characteristics of the free-piston corer.) The recovery of good quality cores with this apparatus requires some knowledge of the expected penetration and much experience. It is not suited to studies where the full sediment column including the soft uppermost layers is important because these are usually bypassed or destroyed before the piston is released. The free-piston corer is good for recovery of stiff sub-bottom strata deeply buried beneath a soft overlying material the upper layers of which hold little of interest for the investigator. (Lewis 1966:86-87)

The dredge is the final direct mechanical means of sampling with which we will deal. There are three basic types of dredges (Herbich 1975): 1) the mechanical repetitive, e.g., dipper, dragline, or clamshell; 2) the mechanical continuous, e.g., bucket line or conveyor; and 3) the hydraulic continuous, e.g., suction, airlift, jet lift. For a long description of these types, see Herbich (1975). The salient point is that continuous dredging, particularly with hydraulics, will do essentially the same job as a backhoe on land. In addition, since this technique brings up a slurry, it is possible to simultaneously sort material using screens under the outfall.

If pipelines are to be laid and dredging is to be employed, it makes sense to combine an archeological inspection with the dredging operation as it is being performed. The only additional activity is the periodic checking of the slurry for artifacts. If any are discovered, the exact location of the dredge head must be determined in order to pinpoint the location of their source.

7.3.3 The Study of Shipwrecks

Shipwrecks are likely to constitute one of the most commonly encountered types of archeological sites in offshore Lake Erie. The condition in which shipwreck sites are found is determined by the physical structure of the ship, the materials of which it was constructed, environmental and locational factors, and port-sinking cultural treatment. Table 7.3 summarizes archeological discovery techniques for shipwreck sites. Muckelroy (1976, 1978) provided a detailed treatment of shipwreck formation. Figure 7.2 present a flow diagram representing the transformational development of a shipwreck from the ship's intended use to its context of archeological discovery and study. The flow chart, which was developed from data derived from wrecks in waters off Britain, provides valuable insights into understanding the formation of shipwreck sites in Lake Erie.

Using a sample of twenty wrecks, Muckelroy performed a statistical analysis on the marine environmental circumstances affecting their archeological context. His analysis included eleven factors (Muckelroy 1978):

Table 7.3. Archeological Discovery Techniques for Shipwreck Sites[a]

Probable Density of Shipwrecks	Remote Sensing	Recommended Spacing Interval (m)	Direct Search and Sampling
High	1. Vertical and side scanning sonar 2. Magnetometry	≤10	Scuba, habitat saturation and towvane diving Aerial observation and photography may have application in shallow water contexts
Intermediate	Same as above	≤25	Same as above
Low[b]	Same as above	≤50	Same as above

[a]Exact methods dictated by survey conditions.

[b]Due to the somewhat more random nature of shipwrecks, low probability areas are not well defined, thus requiring more consideration than do submerged terrestrial sites.

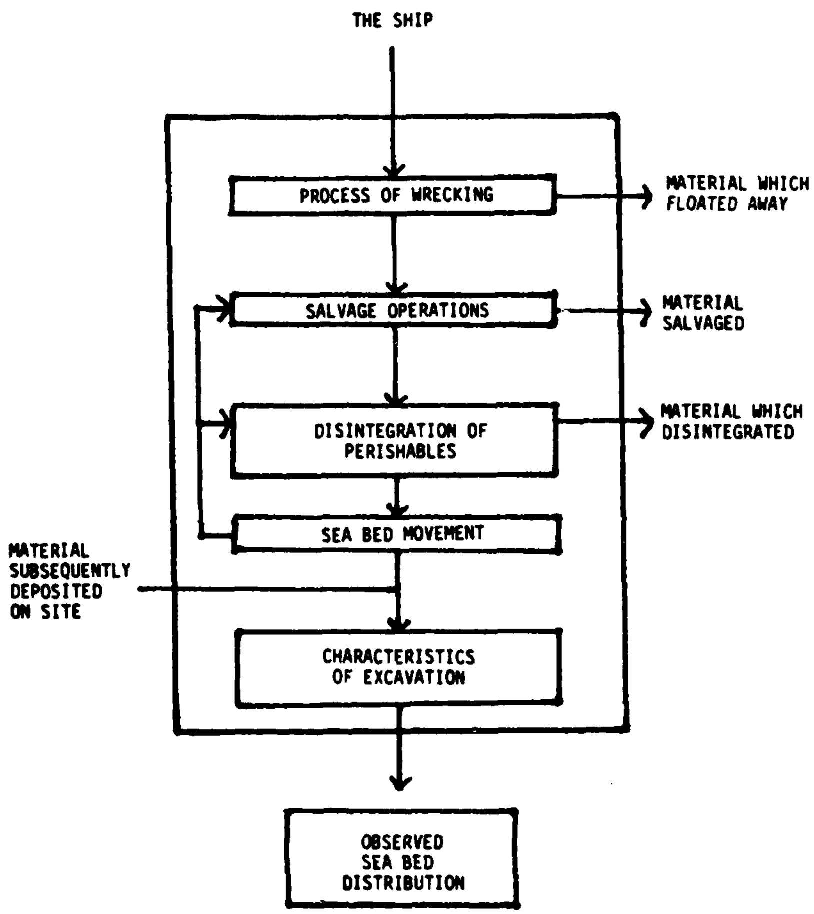
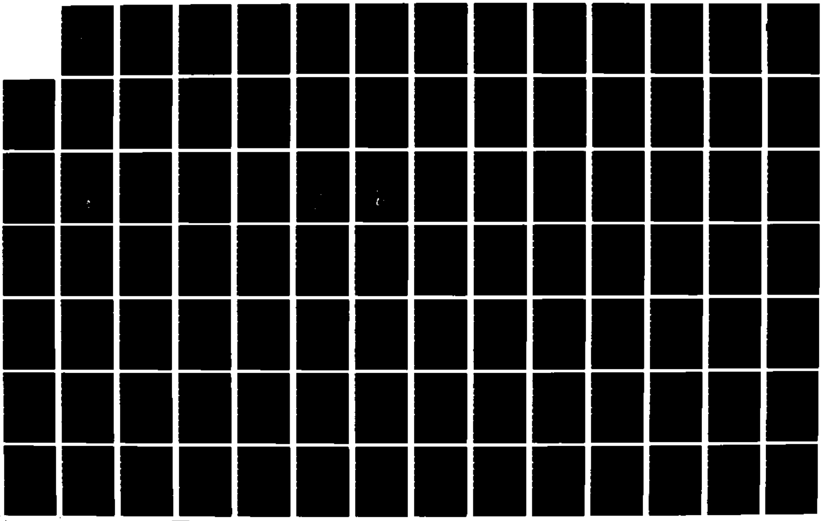
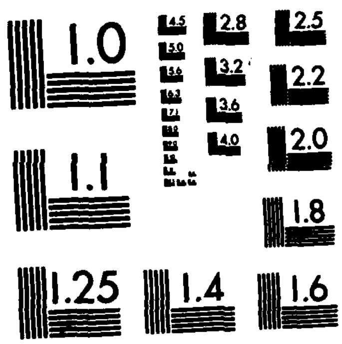


Figure 7.2. Flow Chart Representing the Evolution of a Shipwreck. Source: Redrawn from Muckelroy 1978, p. 458.

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981 5/7

UNCLASSIFIED F/G 5/1 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

1. Maximum offshore fetch, within 30 degrees of the perpendicular to the coast

2. Sea horizon from the site; i.e., sector within which there is more than 10 km of open water

3. Percentage of hours during which there are winds measuring Force 7 or more from directions within the sea horizon

4. Maximum speed of tidal streams across site

5. Minimum depth of site

6. Maximum depth of site

7. Depth of principal deposit onsite

8. Average slope of the seabed over the whole site

9. Underwater topography: the proportion of the site over which the seabed consists of geologically recent sedimentary deposits

10. Nature of the coarsest material within these deposits

11. Nature of the finest material within these deposits

In ordering sites according to attributes 10 and 11, Muckelroy initially ranked them according to broad categories of material and then according to the relative importance of these deposits on the different sites (Muckelroy 1978). Ranking the shipwrecks according to these eleven factors, Muckelroy compared the types of remains found in each situation. Using his analysis, he defined five classes of shipwrecks. These ranged from Class 1 sites, which had extensive structural remains and many organic and other remains within a coherent distribution, to Class 5 sites, which had few objects in a scattered or disorderly array. Table 7.4, describing relevant environmental attributes for each of the five classes of shipwreck sites, was developed by Muckelroy from these data.

Table 7.4 does not cover all contingencies, as Muckelroy himself pointed out. The important thing is the attempt to handle underwater archeological data quantitatively, with proper consideration for environmental variables and artifact distributions. The environmental variables relevant to Lake Erie can be specified after surveys have been conducted, and a similar analysis of shipwrecks can be made. The resulting correlations of class expectations for differing environmental zones could greatly enhance the cost effectiveness and efficiency of survey efforts during the development of the lake bottom for gas drilling and other activities.

7.3.4 Study of Submerged Archeological Sites Other Than Shipwrecks

The study of prehistoric sites is inherently more difficult than the investigation of shipwrecks because of the greater length of time that strong environmental forces have had to work upon them and because of the lack of recorded information about their location, size, and complexity. Discovery

Table 7.4. Relevant Environmental Attributes for Class 1-5 Shipwrecks[a]

Shipwreck Class	Topography (% of bottom sedimentary deposit)	Deposit (range of sediments)	Slope (average over whole site in degrees)	Sea Horizon (sector of open water for 10+ km in degrees)	Fetch (maximum offshore distance in km)
1	100	Gravel/silt	Minimal	<90	<250
2	>70	Boulders/silt	<2	<90	<250
3	>30	Boulders/silt	<4	<150	>250
4	>10	Boulders/sand	<8	>30	>250
5	<25	Boulders/gravel	>6	>120	>750

[a]Source: Muckelroy 1978:164.

techniques appropriate for submerged archeological sites are summarized in Table 7.5.

Work recently conducted by the National Reservoir Inundation Studies Project, sponsored by the National Park Service with additional support from the Corps and the Soil Conservation Service, has led to the attempt to formulate hypotheses and test implications that were designed to "enable federal land managers to realistically predict the impact of different models of freshwater inundation on different types of cultural resources" (Lenihan et al. 1977:10). This work will have considerable relevance for that performed in Lake Erie, since an understanding of the kinds of questions raised for reservoir-inundated sites should be extendable to submerged sites in general.

The specific questions asked by the Inundation Survey include the following (Lenihan et al. 1977:11-12):

1. What direct effects will the mechanical act of freshwater immersion have on the physical integrity of archeological sites?

2. Will chemical or other environmental changes that occur as a result of immersion cause differential preservation of those classes of cultural remains that are usually subjected to attribute analyses by archeologists (ceramics, bone, wood, glass, shell, etc.)?

3. Will the effects of immersion, permanent or periodic in nature, skew or make less valid the results obtained from specific dating and analytic techniques?

4. Will inundation adversely impact the potential a drainage area has for preliminary cultural-resource inventory efforts, standard survey techniques, and remote sensing?

Table 7.5. Archeological Discovery Techniques for Submerged Aboriginal Sites[a]

Probable Density of Archeological Site (i.e., area density)	Context	Remote Sensing	Recommended Spacing Interval (m)	Direct Search and Sampling
High	Lake floor	Vertical and side-scan sonar for fish weirs near river mouths	≤ 10	Scuba and habitat saturation diving with airlift or prop blower to remove surficial sediment; TV assist if necessary
	Buried	Bottom-penetrating radar or sonar as applicable		Coring or dredging with care to pinpoint the location of the core or dredge head as described in text
Intermediate	Lake floor Buried	Same as above	≤ 25	Same as above
Low	Lake floor	--		--
	Buried	--		Coring or dredging concurrent with operations, taking care to note artifacts brought up and exact head location as discussed in text

[a]Onsite conditions will dictate exact methods.

5. Will inundation impact those qualitative elements of archeological sites that are often used as indicators of natural and cultural features, such as soil color and texture?

The results generated by the research had not yet been published as this report was being prepared, but answers to the questions posed would certainly contribute greatly to future archeological research and data collection in Lake Erie.

7.3.5 Procedural Recommendations for Underwater Archeology in Lake Erie

Lake Erie contains two basic categories of submerged archeological sites: historic shipwrecks and aboriginal sites. A third category, historic debris, should also be noted. Various kinds of material items are expected to have been dragged from ships as they moved over the lake, with the greatest concentration of historic items within the major shipping lanes. Finding these items with currently available technologies would probably be a matter of chance.

The aboriginal sites can be subdivided into two classes: 1) aboriginal sites originally formed on dry land and 2) fishing facilities in the form of fish weirs. Procedures for locating the underwater sites are suggested in the following paragraphs.

Historic shipwrecks should be the easiest class of sites to locate. The areas likely to contain shipwrecks are those that have had regular shipping activities around them (e.g., ports, channels, shipping lanes) plus those that contain features dangerous to shipping (e.g., ridges, islands, points of land, and their peripheries in shallow water). Wrecks, however, may appear anywhere in the lake due to the nature of accidents caused by weather or technical malfunctions.

Whether or not a shipwreck exists in a specific area can be determined only by one or more of the survey technologies already outlined. Side-scan sonar would probably be the most suitable method to use in Lake Erie. First, the technique can be used to cover wide areas at relatively fast rates of search. Second, the large size and expected high state of preservation of the wrecks would probably make them readily detectable. Third, the relatively smooth nature of the lake bottom will make objects that stand upright easily distinguishable from their surroundings. Fourth, proven side-scan sonar systems are readily available. Although this survey technique is recommended for all sections of the lake, it is expected that, in some site-specific cases, the use of scuba divers may be more economical for investigating limited areas.

The prehistoric and ethnohistoric sites that formed on dry land but are now submerged will be the most difficult to locate. To minimize this problem, we recommend that searches be limited to the high sensitivity areas as defined in Section 6.2.6 and Table 7.5. Costs could be reduced if some construction activities were to be scheduled concurrently with the archeological sampling programs. For example, the real difference between sampling within an archeological research design and earth-moving operations during construction is the control over the context of artifacts discovered. It is possible that information about the location of artifacts can be determined during dredging and/or boring operations at the time of construction.

Preliminary sub-bottom profiling by sonar or radar should be used to map stratigraphy. As noted in Section 6.2.6, coarse surficial sediments in higher topographic positions characteristic of submerged and aboriginal sites should be observable in sub-bottom core profiles. Coupled with established rates of excavation by dredging, the site perimeter can be determined by the distribution of recovered artifacts. We are not suggesting that dredging should be used as the exclusive excavation technique on submerged sites, but it is suggested that this technique could be equivalent to backhoe testing in a terrestrial setting if it used in conjunction with pipeline construction or with other spatially confined construction work.

Boring devices could provide a better means of determining the physical structure of the stratigraphy remotely sensed by sonar. These devices are, however, limited in their ability to retrieve artifacts due to the generally small size of the cores recovered. Scuba and habitat saturation diving onto submerged terrestrial sites is suggested; but local conditions will have to dictate the actual value of this procedure.

Fishing weirs are a unique type of aboriginal site that may also be encountered. Like those located in the Atherley Narrows (Johnston and Cassavoy 1978), we can expect weirs to be linear features made of stones or wooden stakes. Their locations should occur, as previously noted, along both current and past streambeds and embayments. Another possible indicator would be the presence of nearby aboriginal fishin camps.

Where these weirs protrude from the bottom, they may be visible to side-scan sonar. Weirs under sediments should be distinguishable in sub-bottom profiles obtained by using either sonar or radar.

Although channel dredging may have destroyed central portions of prehistoric weirs, flanking sections may still exist. Weirs may also have been obscured by historic facilities. Despite this, every attempt should be made to verify their presence or absence.

7.4 COSTS

The costs of surveys for identifying cultural resources in different lease tracts depend largely on the size and complexity of the area to be studied and the technologies selected for these studies. As discussed earlier, the technologies for indirect surveys are now undergoing rapid development. As a result, costs associated with their use are dynamic and may increase or decrease for individual techniques in the future.

It is important to obtain enough technical data to make sound professional judgments about assessing particular construction and operational impacts without incurring excessive costs. In some cases, geological surveys will be made in the lease tracts prior to development; these surveys will utilize some of the same technologies for data collection as those described in this report. When this occurs, careful coordination of contractors can make the use of indirect survey methods more cost-effective by integrating the needs of both geological and archeological personnel.

Lessees should expect higher costs for underwater survey and retrieval of archeological remains than typically encountered for terrestrial studies.

This is in part due to the decrease in human physical performance in aquatic contexts resulting in longer task-completion times (Baddeley 1966; Muckelroy 1978), due in part to reduced visibility, disorientation, nitrogen narcosis, and other maladies that afflict divers; and in part to the greater need for reliance on high technology and heavy equipment in conducting underwater work. These factors are likely to produce direct costs of from three to five times more than those encountered for terrestrial studies.

A final aspect of the direct cost of archeological work, and underwater archeology in particular, is that of the curatorial maintenance of the artifacts retrieved from excavations. Sites found in fresh water can be expected to contain a number of artifacts, many of which will begin disintegrating, in whole or in part, upon exposure to air. For example, a recent exploration of the Atherly Narrows, Ontario, brought to light a fish weir some 4500 years old (Johnston and Cassavoy 1978). When several of the weir's wooden stakes were brought to the surface for dating, a drying process began; this caused the spongy, but otherwise well-preserved stakes, to split longitudinally and contract into wedge-shaped forms having no more than a quarter of their original volume.

In order to avoid the loss of significant archeological data, proper treatment must be afforded any artifacts removed, including cataloging, storage, evaluation, and conservation. It is necessary that all of these aspects of the conservation of artifacts be covered during the planning stages of a project. To underscore this point, Peterson (1974:63-65) observed that "if there are not sufficient monies to consider the conservation of the data from a site, then by definition there are not sufficient monies to adequately excavate that site."

7.5 DISCUSSION OF SURVEY METHODS

(Sue Ann Curtis, James W. Hatch, Christopher E. Hamilton, and Carl Bebrich)

Survey methods and two basic survey types were discussed in the previous section. An effort was made to review various indirect sensing techniques that should be considered for potential use in Lake Erie. Table 7.6 summarizes the techniques discussed and qualitatively evaluates each as to the kinds of contributions that can be made in terrestrial and aquatic contexts.

In reviewing the current state of the art, the visible light band still provides the greatest range of information about cultural resources in both terrestrial and aquatic environments. Increasing attention is, however, being given to sophisticated systems of remote sensing such as radar, resistivity, magnetometry, and sonar, which do not depend on the visible light band. Some of these techniques (e.g., sonar and magnetometry) have special importance for archeological reconnaissance of the lake bottom.

It should be noted that the application of both direct and indirect techniques of cultural-resource survey is a developing area in archeological methodology. New state-of-the-art approaches and developmental changes are constantly occurring, and in the years to come are likely to play an increasing role in the archeological study of the Lake Erie Basin. Consequently, regulatory agencies should keep abreast of state-of-the-art developments through periodic contacts with the research community, update their data collection guidelines accordingly, and make the updated guidelines available to lessees.

Preliminary sub-bottom profiling by sonar or radar should be used to map stratigraphy. As noted in Section 6.2.6, coarse surficial sediments in higher topographic positions characteristic of submerged and aboriginal sites should be observable in sub-bottom core profiles. Coupled with established rates of excavation by dredging, the site perimeter can be determined by the distribution of recovered artifacts. We are not suggesting that dredging should be used as the exclusive excavation technique on submerged sites, but it is suggested that this technique could be equivalent to backhoe testing in a terrestrial setting if it used in conjunction with pipeline construction or with other spatially confined construction work.

Boring devices could provide a better means of determining the physical structure of the stratigraphy remotely sensed by sonar. These devices are, however, limited in their ability to retrieve artifacts due to the generally small size of the cores recovered. Scuba and habitat saturation diving onto submerged terrestrial sites is suggested; but local conditions will have to dictate the actual value of this procedure.

Fishing weirs are a unique type of aboriginal site that may also be encountered. Like those located in the Atherley Narrows (Johnston and Cassavoy 1978), we can expect weirs to be linear features made of stones or wooden stakes. Their locations should occur, as previously noted, along both current and past streambeds and embayments. Another possible indicator would be the presence of nearby aboriginal fishing camps.

Where these weirs protrude from the bottom, they may be visible to side-scan sonar. Weirs under sediments should be distinguishable in sub-bottom profiles obtained by using either sonar or radar.

Although channel dredging may have destroyed central portions of prehistoric weirs, flanking sections may still exist. Weirs may also have been obscured by historic facilities. Despite this, every attempt should be made to verify their presence or absence.

7.4 COSTS

The costs of surveys for identifying cultural resources in different lease tracts depend largely on the size and complexity of the area to be studied and the technologies selected for these studies. As discussed earlier, the technologies for indirect surveys are now undergoing rapid development. As a result, costs associated with their use are dynamic and may increase or decrease for individual techniques in the future.

It is important to obtain enough technical data to make sound professional judgments about assessing particular construction and operational impacts without incurring excessive costs. In some cases, geological surveys will be made in the lease tracts prior to development; these surveys will utilize some of the same technologies for data collection as those described in this report. When this occurs, careful coordination of contractors can make the use of indirect survey methods more cost-effective by integrating the needs of both geological and archeological personnel.

Lessees should expect higher costs for underwater survey and retrieval of archeological remains than typically encountered for terrestrial studies.

This is in part due to the decrease in human physical performance in aquatic contexts resulting in longer task-completion times (Baddeley 1966; Muckelroy 1978), due in part to reduced visibility, disorientation, nitrogen narcosis, and other maladies that afflict divers; and in part to the greater need for reliance on high technology and heavy equipment in conducting underwater work. These factors are likely to produce direct costs of from three to five times more than those encountered for terrestrial studies.

A final aspect of the direct cost of archeological work, and underwater archeology in particular, is that of the curatorial maintenance of the artifacts retrieved from excavations. Sites found in fresh water can be expected to contain a number of artifacts, many of which will begin disintegrating, in whole or in part, upon exposure to air. For example, a recent exploration of the Atherly Narrows, Ontario, brought to light a fish weir some 4500 years old (Johnston and Cassavoy 1978). When several of the weir's wooden stakes were brought to the surface for dating, a drying process began; this caused the spongy, but otherwise well-preserved stakes, to split longitudinally and contract into wedge-shaped forms having no more than a quarter of their original volume.

In order to avoid the loss of significant archeological data, proper treatment must be afforded any artifacts removed, including cataloging, storage, evaluation, and conservation. It is necessary that all of these aspects of the conservation of artifacts be covered during the planning stages of a project. To underscore this point, Peterson (1974:63-65) observed that "if there are not sufficient monies to consider the conservation of the data from a site, then by definition there are not sufficient monies to adequately excavate that site."

7.5 DISCUSSION OF SURVEY METHODS

(Sue Ann Curtis, James W. Hatch, Christopher E. Hamilton, and Carl Bebrich)

Survey methods and two basic survey types were discussed in the previous section. An effort was made to review various indirect sensing techniques that should be considered for potential use in Lake Erie. Table 7.6 summarizes the techniques discussed and qualitatively evaluates each as to the kinds of contributions that can be made in terrestrial and aquatic contexts.

In reviewing the current state of the art, the visible light band still provides the greatest range of information about cultural resources in both terrestrial and aquatic environments. Increasing attention is, however, being given to sophisticated systems of remote sensing such as radar, resistivity, magnetometry, and sonar, which do not depend on the visible light band. Some of these techniques (e.g., sonar and magnetometry) have special importance for archeological reconnaissance of the lake bottom.

It should be noted that the application of both direct and indirect techniques of cultural-resource survey is a developing area in archeological methodology. New state-of-the-art approaches and developmental changes are constantly occurring, and in the years to come are likely to play an increasing role in the archeological study of the Lake Erie Basin. Consequently, regulatory agencies should keep abreast of state-of-the-art developments through periodic contacts with the research community, update their data collection guidelines accordingly, and make the updated guidelines available to lessees.

Table 7.6. Summary of Archeological Survey Techniques and Their Current Applications

Sensing Agent or Medium	Environmental Applicability and Techniques Used		Comments
	Terrestrial	Underwater	
X-Rays	None Reported	None Reported	No reported uses to date for survey work; useful for laboratory examination of objects
UV Light	None Reported	None Reported	No reported uses to date for survey work; tends to be easily absorbed and scattered; might be applied in areas of rough terrain for examining areas in deep shadow; may also be useful for determining the chemical composition of some artifacts
Visible Light	Aerial and ground surveys using photography and visual inspection Aerial; satellite imagery and multi-spectral scanning	Remote and direct survey using TV-video systems, photography, and visual inspection *Scuba*, *habitat saturation*, and towvane diving systems Flood and strobe light--assisted photography Aerial survey over shallow or clear-water areas	Limited in water by extreme turbidity, depth, microorganisms, and proximity to sediment laden runoff--i.e., factors that cause light to be absorbed, scattered or refracted in uncontrollable ways
IR Light	Increasing use for aerial terrestrial surveys using heat-sensing photography	None Reported	Extends range of visible light photography; useful for studying terrestrial ecology and land-use patterns
Microwave	Vertical and side-scanning radar for topographic mapping; ground-penetrating radar for locating subsurface features and mapping soil stratification	None Reported	Limited by presence of saline water
Electrical Currents	Resistivity survey for locating subsurface activity areas Magnetic inductance for locating metallic objects	Resistivity survey probably inapplicable in aquatic environments Magnetic inductance for locating metallic objects	Limited by the small area scanned by conventional metal detectors

Table 7.6. Continued

Sensing Agent or Medium	Environmental Applicability and Techniques Used: Terrestrial	Environmental Applicability and Techniques Used: Underwater	Comments
Gravity	None Reported (probably inapplicable)	*None* Reported (probably inapplicable)	
Magnetism	Magnetometry	Magnetometry	Inapplicable for non-magnetic materials; *potentially extensive* use in both terrestrial and aquatic environments for locating iron objects, kilns, furnaces, ovens, hearths, pits and ditches filled with rubbish and topsoil, wall foundations, roads, tombs, shipwrecks, etc.
Sound	*None* Reported	Vertical and side-scanning sonar for sensing and mapping topography	No reported uses for terrestrial archeology; some applications in the geosciences; most suitable for underwater contexts
		Penetrating sonar for strati-graphic profiling	*Limited* by *gas* bubbles at the surface being scanned

CHAPTER 8

SUMMARY AND DISCUSSION

Sue Ann Curtis and James W. Hatch

8.1 GENERAL STATEMENTS

There has been increasing interest in developing the natural gas resources underlying the Central and Eastern basins of Lake Erie over the past several years. Because the lake currently has many uses, including fishing, transportation, recreation, and water supply, the Corps has entered into an interagency agreement with USEPA to evaluate the impacts of natural gas development, including their compatibility with other uses of the lake. Among the impacts that may result from natural gas development projects is the disturbance and/or destruction of cultural resources of historic and scientific value.

The overall objective of this study has, therefore, been to assess the cultural resources potential of the Lake Erie Basin and to provide guidelines for managing these resources. The data gathered for this study indicate that both the one-mile wide lakeshore corridor and the lake bottom have significant potential for yielding cultural resources of scientific and historical importance. These resources may span some 13,000 years of human settlement in the area and include prehistoric and ethnohistoric archeological sites as well as historic structures and shipwrecks.

While the lakeshore, taken as a whole, was found to have a high potential for yielding prehistoric and historic cultural resources, the lake bottom presented a more variable picture. The overall cultural resource potential of the study area was found to be sufficiently high to warrant the conclusions that 1) a well-designed cultural resource management program must be made an integral part of environmental base conditions and 2) that such program would be both feasible and compatible with natural gas development procedures as outlined in the "Draft Programmatic Environmental Impact Statement: U.S. Lake Erie Natural Gas Resource Development."

The text of this report has been structured around three basic themes: 1) the presentation of the substantive findings resulting from a review of the cultural-historical and environmental literature; 2) recommendations concerning the management of cultural resources in the Lake Erie Basin based on federal and state regulatory controls; and 3) use of a conceptual framework -- the cultural-ecological approach -- to structure the collection and presentation of substantive findings and to provide a scientific basis for cultural resource management.

The conceptual framework of cultural ecology has had broad and productive applications for both ethnographic and archeological studies. The framework views humanity as an integral part of the total ecosystem. The creation of cultural objects, structures, sites, and settlement systems is seen as adaptation reflecting the interaction of societies with one another and with the natural environment.

Interactions with the natural environment are achieved principally through the techno-economic and settlement subsystems of a culture. Food, shelter, and raw materials are basic human needs, the fulfillment of which is strongly structured by the spatial and temporal distribution of resources in the natural environment. Spatial and temporal settlement distribution is thus directly linked to the uneven availability of the resources required.

Sites and settlement systems constitute the means for segmenting societies into social units that can optimally exploit natural resources while maintaining other essential cultural functions. The availability of natural resources can best be understood through the study of five basic variables: geology (including geomorphology and hydrography), climate, soils and their productivity, vegetation, and fauna (terrestrial and aquatic). These variables largely determine the spatial-temporal distributions and abundance of subsistence resources, as well as the suitability of the landscape for human settlement.

The discovery of relationships among these cultural and environmental variables is essential for predicting where, or at least under what circumstances, cultural resource sites are likely to be found. The development and presentation of these relationships, and their application to the study, is the central focus of this report.

Protection and preservation of cultural resources is achieved only through careful environmental management by industry and regulatory support. In this report, it was pointed out that cultural resources are likely to be numerous in the study area and that surveys for locating sites can be technically executed in a timely manner. Surveys can be followed by avoidance of known sites or by salvage excavations of such sites.

In order for industry to execute well-planned cultural resource surveys and to anticipate the kinds of construction and/or operational contingencies needed to avoid impacts to sites, prospective lessees must be informed. The regulatory agency responsible for lease management can establish useful guidelines for survey requirements and a research design to meet such requirements in a technically acceptable manner. Such guidelines and their implementation can be made a lease condition.

The information provided in this study will contribute to developing such guidelines. Terrestrial and submerged areas with known sites and those that have a high probability of containing sites have now been identified. It was determined that such sensitive locations require intensive study using one or more of the field methods discussed in Chapter 7. Areas expected to contain fewer sites are submerged. Areas with less sensitive designations would require less intensive survey efforts.

In addition to the sources identified in this document, there exist other local, state, and federal organizations and agencies concerned with cultural resource management. Specialized groups can provide information on specific sites and can aid in site evaluations; they can also contribute to methods selection and implementation. Many of these agencies have been listed in Appendix J. Lessees and regulators should be aware of these groups and should contact them as appropriate.

8.2 CHAPTER SUMMARIES

The substantive findings of this study were presented in Chapters 2 through 6. Chapter 2 focused on characterization of the natural environment during the time humans are believed to have occupied the study area. It also focused on reconstructing vegetational and climatic conditions through time. Chapters 3, 4, and 5 dealt with the cultural history of the Lake Erie Basin from prehistoric times through the ethnohistoric and historic periods, with emphasis on recognition of developmental trends in regional settlement patterns. Chapter 6 focused on establishing guidelines to determine the probability of locating prehistoric archeological sites in specific areas of the study area.

Chapter 2 presented a description of the environmental makeup of the project area and focused on five environmental factors: geology, climate, soils, vegetation, and fauna. Because technologies associated with Euro-American colonization and development of the area led to extensive environmental changes, a base datum of A.D 1800 was selected for the description provided (see Section 2.5). An attempt was then made to project major geohydrological, climatic, and vegetational changes back through time in order to visualize the adaptive milieus with which prehistoric societies were faced. The shoreline changed over time; almost all of the present lake bottom was dry land at one time or another. Substantial areas of the current lake bottom would thus have been available for settlement by some prehistoric populations. As the lake expanded over previously occupied areas, the mechanics of wave action removed soil in some areas depositing it in others. It was concluded, therefore, that some well-preserved archeological sites may still exist in areas of deposition.

Section 2.3.2 summarized available data for eastern and western Lake Erie, noting that parts of the eastern climatic-vegetation sequence lagged behind the western sequence. Climate and vegetation changes also affected the nature of the soils developing from the parent material in a micro-geographic setting. Soils were identified and characterized using a catena approach to distinguish important soil patterns. It was demonstrated that these patterns could be adjusted for various environmental factors and that the micro-environmental productivity of the soils could be assessed for producing two major subsistence resources: nuts and maize. Terrestrial and aquatic environments were also assessed as to their suitability for supporting fauna. Due to its shallowness, Lake Erie was characterized as highly suitable for supporting aquatic resources, including a wide variety of northern and southern species with high productivity, particularly in the Western Basin. Terrestrial areas included marsh, prairie, and woodland environments; such major game animals as waterfowl could be found in swamps, and deer, rabbit, and other game in woodlands.

Chapter 3 provided a review of the literature concerning prehistoric settlement patterns in the Lake Erie Basin. This was used to determine where prehistoric cultural sites are most likely to be located. The chapter was divided into three main sections: 1) a chronological discussion of five-geographic subregions covering the periods from Early Paleo-Indian to Terminal Late Woodland--emphasis was placed on describing site types and functions and on identifying associations between these factors and such environmental variables as soils, topography, and hydrology; 2) construction of twelve settlement modes that relate major site types and functions to an adaptive strategy used to exploit a specified environmental setting; and 3) an evaluation of these modes using available site file data from Ohio, Pennsylvania, and New York.

Several observations were made. First, different sociocultural patterns appear to have existed in the western and eastern portions of the lake basin, and the regionalism in the cultural components of these areas seems to have increased with time. Second, prehistoric use of the lake basin appears to have been greatest overall in the Western Basin where a larger number of sites and relatively more complex cultural components are recognized. Post Paleo-Indian adaptations throughout the area appear to represent the extension and intensification of subsistence-settlement patterns established at the beginning of the Archaic. These patterns involved the exploitation of terrestrial game and flora (particularly oak, hickory, and walnut) as well as aquatic (lacustrine/riverine) resources. Change over time appears to have been manifested by increasing efficiency through the exploitation of new niches in more effective ways. Concomitant with this evolving subsistence pattern was evidence for increasing population density, as indicated by increasing numbers of components with each successive time period. It was hypothesized that scheduling of subsistence resources played a progressively more important role in shaping subsistence-settlement activities as population density increased. It was further suggested that settlement systems in the vicinity of Lake Erie included three ecozones: 1) the lake and mouths of major rivers, 2) the lakeshore plain and piedmont, and 3) uplands. These three zones could have provided a diversity of resources, which, under the pressure of increasing population density, could then be optimally exploited only through careful personal scheduling of activities.

Not until well into the Late Woodland Period did agriculture become established as a part of the subsistence base and have a significant impact on settlement patterns. Endemic warfare was probably equally important in reshaping the patterns associated with continued population density increases.

The twelve settlement modes used to characterize Lake Erie Basin settlement systems were presented in Section 3.3. They were tested using site file data and reconstructed environmental data derived from Chapter 2. Based on the cultural and environmental information available for the area, three major environmental factors were identified as associated with site locations: 1) productive soil types associated with oak-hickory and walnut and/or maize agricultures, 2) proximity to water (100 m) and other riverine/ lacustrine resources, and 3) topographic relief that provided dry and/or easily defended settlement locations.

Settlement modes I, II, and IV could not be tested with site file data because of the paucity of sites found to date. Modes VII, X, and XII could be associated with scattered and unsystematic site file data, but the data were inadequate for an evaluation against reconstructed environments. Mode VII was tested with site and environmental mapping, but correlations were poor.

Modes III, V, VI, IX, and XI compared well with the site file data and environmental maps and included most of the regional culture sequence. A high degree of association was found between sites in Mode III and productive nut-tree soils (approximately 70 to 90% of the sites were located on these soils). Moreover, Mode III had broad temporal application (ranging from 10,000 to 3,500 B.P.). Modes V, VI, and IX included sites that ranged in time from 3,000 to 1,500 B.P. Mode XI applied only to the end of the Late Woodland, from 1,000 B.P. to historic contact; it emphasized associations with both nut-tree and agricultural soils. Using these modes, prehistoric settlement patterns were summarized for each cultural-historical time period (see Sections 3.3 and 3.4).

Chapter 4 characterized the ethnohistoric resources that may exist in the study area. It was noted that limited information is available for the environmental zones of the study area concerning site descriptions, chronology, and ethnic identity. The paucity of historical accounts and the general lack of published data about ethnohistoric sites thus require that verification of known sites and identification of unknown sites be accomplished through the use of state-of-the-art archeological reconnaissance methods.

The site lists and cultural-historical facts about ethnohistoric groups that are likely to have occupied various parts of the study area can contribute to the identification of cultural resource locations that may need special lease management considerations. In addition, data provided in this chapter contribute to interpreting archeologically recovered materials. The recognition of rare or unique remains at a site or group of sites ethnographically described and archeologically recovered may make the site or site group eligible for inclusion in the National Register.

Since it is possible that the study area contains locations of importance to Native Americans living in the area, a number of Native Americans were interviewed. Locations such as the Cattaraugus Creek drainage were identified as having particular importance as natural resource sites; at these sites, raw materials are collected for native crafts, medicines, and other needs. Some informants expressed concern over resources located on other properties previously owned by Iroquoian groups (see Fig. 4.8). It should be noted that the kinds and importance of these natural resource sites appears to vary among individuals and that the locations of known sites seem to be confidential. Thus, although some resources may be located in areas that will be affected by lease projects, an individual or group may feel culturally compelled not to divulge the site's location, even though such an action may lead inadvertantly to the site's destruction.

The sociocultural climate of Native American communities in the study area is dynamic, and issues and positions of individuals, groups, and communities are changing. Thus, studies of properties, particularly in New York State, under consideration for leases and locations of onshore facilities should include the collection of ethnographic data relevant to mitigating potential impacts to locations and resources that are valued by Native American groups residing nearby.

Chapter 5 presented an overview of historic cultural resources in the Lake Erie Basin. Two classes of resources were distinguished: lakeshore architectural remains and shipwrecks. These resources are associated with the mid-eighteenth century Euro-American colonization of the area. A list of historic structures and places entered in federal, state, and local registers and a compilation of known shipwrecks can be found in Appendixes G and H.

Population centers were identified as having the greatest number of and most varied historic architectural remains. Rural areas were also recognized as often having structures and places of historic interest and, because of greater genealogical continuity, they may constitute a rich source of information. It was suggested that surveys in rural areas should include a review of local histories, contact with local historical groups, and interviews with older residents to obtain oral histories. These activities can provide information essential for evaluating the importance of specific structures and locations.

Shipwrecks were found to be among the most numerous of cultural resources to be found in the Lake Erie Basin. Their importance lies in dating innovations in maritime technology and changing economic patterns in the Great Lakes area.

Chapter 6 focused on establishing guidelines as to where prehistoric archeological sites are more or less likely to be found on the modern lakeshore and submerged in the lake bottom. The discussion was organized by terrestrial and submerged subareas within the Lake Erie Basin. Each subarea was examined with respect to probable site-density distribution, which was scaled on a relative basis as high, intermediate, or low. The sensitivity ratings assigned to each subarea reflect the relative densities of sites expected to be found within specified environmental settings; these ratings were based on associations between site types and environmental factors such as soil, topography, and hydrology as defined, modeled, and tested in Chapter 3.

Predictive statements concerning probable site densities for the submerged areas must be viewed with considerable caution because the geomorphological history of the lake bottom is not as well understood as that of the surrounding terrestrial environment. Filling and leveling have occurred to varying degrees and over varying lengths of time in different areas of the lake. These processes led to the destruction of some prehistoric archeological sites (resulting in the redistribution of remains) and to the preservation of others in sediments that may be tens of meters thick. The discovery of these latter sites is a challenge and, given present state-of-the-art survey techniques, is likely to be as much a matter of chance as of planning and execution. Nevertheless, the importance of discovering these sites cannot be overemphasized; they are likely to provide new and substantial insights, especially concerning the earliest adaptations to the Lake Erie Basin. In a more general way, they will also help to enlarge our understanding of all phases of human adaptation to the area.

The likelihood of chance discovery of archeological remains raises one final issue, namely that of lessees being prepared to incorporate and make adequate allowances for archeological salvage work along with ongoing construction activities. In some cases, no other mitigative alternative exists. In this context, archeologists and lessee representatives will undoubtedly be faced with conflicting interests; data recovery and salvage of remains could conflict with project development timetables and costs. It would behoove both interests to recognize the legitimate needs of and constraints on the other in order to achieve a workable and timely solution equitable to both parties.

Chapter 7 presented a review of survey techniques and methods appropriate for locating both terrestrial and submerged sites. For four reasons, particular attention was devoted to techniques suitable for underwater use. First, the environmental analysis presented in Chapter 2 concluded that variable portions of the area submerged by modern Lake Erie would have been suitable for, and available to, human settlement between roughly 13,000 and 1,000 B.P. Second, many of the techniques are relatively new, have not been widely used, and are undergoing rapid technical development. As a result, archeologists used to exclusively terrestrial studies are often not familiar with these techniques. Third, the study of submerged prehistoric sites is inherently more difficult than the investigation of terrestrial sites, partly because of the greater inaccessibility of these sites and partly because of the unique environmental forces to which the sites have been subjected. Fourth, the study of lake bottom cultural resources is likely to have a profound effect on our understanding of prehistoric human adaptations in the Lake Erie Basin. Table 7.6 summarized survey techniques and current applications for both terrestrial and underwater environments.

The problem of meaningful sampling of archeological remains was recognized as a crucial feature of all survey methodology, and an attempt was made to provide parameters that should prove useful in conducting both terrestrial and underwater surveys under a variety of conditions. These parameters are summarized in Tables 7.1-7.5.

While the site constitutes the basic unit of observation and discovery, it can be fully understood only in the context of the settlement system of a society. Societies distribute themselves on the land so as to optimize the satisfaction of both sociocultural and biological needs. Size alone is no indication of a site's historical or scientific importance, since both factors play a vital role in societal maintenance. Understanding how social systems work and how they adapt to differing and changing physical and sociocultural environments requires that each site type be systematically sampled and studied.

Special attention was also given to the National Reservoir Inundation Studies Project (Lenihan et al. 1977), which is trying to show the impacts of freshwater inundation on different types of cultural resources. The kinds of questions posed by this project have a bearing on the physical integrity of inundated sites, preservation of remains, dating and dating methods, survey techniques, and the quality of indicators traditionally used to distinguish natural and cultural features. The results of these investigations should prove of great value to the study of archeological sites submerged in Lake Erie.

Shipwrecks were given special attention in Chapter 7, since they are likely to constitute one of the most commonly encountered types of cultural resource sites in offshore Lake Erie. Their value lies in the information they can provide about the history of Great Lakes economics and maritime technology. Discussion centered on the transformational process from ship to shipwreck and on the factors that determine the kinds and condition of remains. It was suggested that Muckelroy's (1978) study of the subject may have important applications for Lake Erie, ones that could enhance the cost-effectiveness of shipwreck survey projects.

The final topic dealt with in Chapter 7 was the costs associated with locating and curating cultural resources, particularly those that are presently submerged. It was indicated that survey costs depend largely on the size and complexity of the area to be studied, on the kinds of techniques to be employed, and on whether the cultural resources to be located are submerged or terrestrial. Costs associated with underwater work can be expected to run three to five times those for comparable terrestrial work.

Curatorial costs, which are often overlooked, are important, particularly when they involve perishable artifacts recovered from submerged contexts. The methods and techniques of archeological analysis are continually undergoing development and refinement; this means that new information can frequently be extracted from the artifacts and records of older excavations. In a very real way, these remains and records are the site itself, especially when all or nearly all of the physical deposit containing the site has been removed. Proper curatorial handling of these materials must, therefore, be assured.

8.3 LIMITATIONS

A number of problems were encountered in developing the substantive results reported in this study. This discussion is intended to caution the reader as to the limitations inherent in the information presented and to suggest new directions for future studies. Most of the limitations center on Chapters 2, 3, and 6, which dealt with paleoenvironmental and cultural-historical reconstruction and with establishing guidelines concerning the possible locations of prehistoric cultural resources.

8.3.1 Paleoenvironmental Reconstruction

The reconstruction of past environments was based largely on extant pollen cores. These cores are not numerous, nor are they optimally distributed relative to the area with which this study is concerned. Moreover, chronometric dating controls are less than desirable, particularly for the earliest periods of human settlement in the Lake Erie Basin. The paleoenvironmental reconstructions presented in Chapter 2 must, therefore, be regarded as tentative and somewhat generalized. The overall effect of inaccuracies would be to lower apparent associations between site distributions and environmental variables.

8.3.2 Modeling Subsistence-Settlement Systems

Because the locations of many, if not most, ethnohistoric and prehistoric cultural resources are not known, an alternative approach had to be developed for specifying where, or at least under what circumstances, sites are more or less likely to be found. The alternative selected was to model probabilities of site locations based on available archeological and environmental data and the modern theoretical foundations of both. These data have several deficiencies.

Archeological data from Ohio, Pennsylvania, and New York have, for the most part, been unsystematically acquired over the years. Few surveys incorporating a thorough research design have been performed, and, where surveys have been done, the total area involved has generally been small. For the most part, data have been opportunistically collected and tend to represent the more easily found sites (those lying near or at the surface where there is little or no vegetation cover) as well as the unsystematic artifact collecting by amateurs.

It should also be noted that the availability of data is very uneven across the study area, particularly in Pennsylvania and New York. Some time periods and regions are poorly represented, and it is unlikely that any have been representatively sampled. Thus, variability in the distribution of data is probably more a function of unsystematic archeological investigation than of real variation in the distribution of sites.

Finally, it should be noted that there are no archeological surveys of the lake bottom that this study has identified as likely rich in archeological information. Paleoenvironmental reconstructions indicated that some portions of the lake bottom probably would have been highly suited to human settlement at some time. Because the lake and river mouths represent a distinct ecological zone having rich subsistence potential, the lack of data can only be regarded as a major deficiency in this attempt to construct subsistence-settlement models for the area, a deficiency that natural gas development projects could be instrumental in eliminating.

Because of these deficiencies, the data used in this study surely include some substantial errors of sampling reconstructions and estimations. The extent to which these errors distort the subsistence-settlement models developed in Chapter 3 is difficult to assess. In some cases, the biases have unavoidably led to a degree of circularity in the model formulation, since some data used to generate the models were also used to test them. In other cases, the available data were insufficient to test some of the models.

Variations in the availability of site-distribution data also made it difficult or impossible to assign numerical values to site-density probabilities. As a result, a best-effort attempt was made to formulate a scale of high, intermediate, and low archeological potential. It was thought better to have a limited approximation to help solve an important problem than no approximation at all.

8.3.3 Determinants of Prehistoric Site Placement

The potential sociocultural and environmental factors that determine site placement within a subsistence-settlement system are in theory without limit. For any given site, the number of major controlling factors is normally quite small once investigated and understood, and may, for convenience, be considered the critical factors.

One school of archeological thought tends to disproportionately emphasize subsistence activities. However, in this review the critical factors used to model potential site placement were 1) environmental variables that structure the availability of subsistence resources and 2) physical features of the landscape that favor site placement. While these factors are known to be of major importance in the site placement of technologically simple societies, they are not the only factors, and they fail to account for sites termed residuals in this report (e.g., cemeteries and ceremonial sites).

Moreover, the critical factors identified in this study are broad in scope. While they can be used to generate types of locations favorable to site placement, they are inadequate for precisely predicting site locations. More refined modeling of site placement is clearly needed and could significantly reduce survey costs. Such detailed modeling would be difficult prior to actual field investigation of the lake given the difficulties in grossly modeling the lake due to the absence of empirical archeological data.

8.4 GENERAL STANDARDS FOR HISTORIC PRESERVATION PROJECTS

The following general standards apply to all treatment undertaken on historic properties listed in the National Register:

1. Every reasonable effort shall be made to provide a compatible use for a property that requires minimal alteration of the building structure, or site and its environment, or to use a property for its originally intended purpose.

2. The distinguishing original qualities or character of a building, structure, or site and its environment shall not be destroyed. The removal or alteration of any historic material or distinctive architectural features should be avoided when possible.

3. All buildings, structures, and sites shall be recognized as products of their own time. Alterations which have no historical basis and which seek to create an earlier appearance shall be discouraged.

4. Changes which may have taken place in the course of time are evidence of the history and development of a building, structure, or site and its environment. These changes may have acquired significance in their own right, and this significance shall be recognized and respected.

5. Distinctive stylistic features or examples of skilled craftsmanship which characterize a building, structure, or site, shall be treated with sensitivity.

6. Deteriorated architectural features shall be repaired rather than replaced, wherever possible. In the event replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual qualities. Repair or replacement of missing architectural features should be based on accurate duplications of features, substantiated by historical, physical, or pictorial evidence rather than on conjectural designs or the availability of different architectural elements from other buildings or structures.

7. The surface cleaning of structures shall be undertaken with the gentlest means possible. Sandblasting and other cleaning methods that will damage the historic building materials shall not be undertaken.

8. Every reasonable effort shall be made to protect and preserve archeological resources affected by, or adjacent to, any acquisition, protection, stabilization, preservation, rehabilitation, restoration, or reconstruction project.

Appendix A

English Equivalents for Commonly Used Metric Units

English Equivalents for Commonly Used Metric Units

Metric Unit	English Equivalent (Approximate)
meter (m)	39.4 inches (in.)
centimeter (cm)	0.4 inches
square kilometer (km^2)	0.39 square miles (mi^2)
hectacre (ha)	2.5 acres
liter (L)	1.06 quarts (qt)
kilogram (kg)	2.2 pounds (lb)
gram (g)	0.04 ounces (oz)

Appendix B. USGS Topographic Map Arrangement Lake Erie

1. Toledo
2. Oregon
3. Reno Beach
4. Genoa
5. Metzger Marsh
6. Oak Harbor
7. Lacarne
8. Port Clinton
9. Vickery
10. Put-in-Bay
11. Gypsum
12. Castalia
13. Kelley's Island
14. Sandusky
15. Huron
16. Milan
17. Vermillion West
18. Berlin Heights
19. Vermillion East
20. Lorain
21. Avon
22. North Olmstead
23. Lakewood
24. Cleveland North
25. Cleveland South
26. East Cleveland
27. Eastlake
28. Mayfield Heights
29. Mentor
30. Perry
31. Painesville
32. Madison
33. Geneva
34. Astabula North
35. Astabula South
36. North Kingsville
37. Conneaut
38. Fairview Southwest
39. East Springfield
40. Fairview
41. Swanville
42. Erie North
43. Erie South
44. Harborcreek
45. North East
46. Ripley
47. South Ripley
48. Westfield
49. Brocton
50. Hamburg
51. North of Dunkirk
52. Dunkirk
53. Silver Creek
54. Angola
55. Farnham
56. Eden
57. Buffalo Northeast
58. Buffalo Southeast
59. Hamburg
60. Buffalo Northwest

Appendix C

SEQUENCE OF GLACIAL CHANGES ON THE GREAT LAKES

Source: Hough, Jack L., Geology of the Great Lakes, University of Illinois Press, Urbana, 1958:284-296.

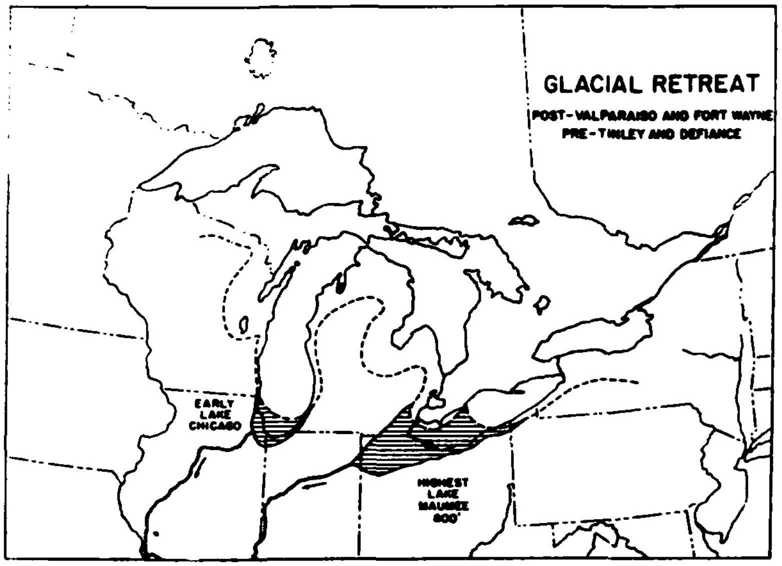


Fig. C.1 Lake Maumee I (Highest Lake Maumee) and Early Lake Chicago. Occurred during the glacial retreat between the Valparaiso-Fort Wayne advance and the Tinley-Defiance advances. Position of ice front conjectural.

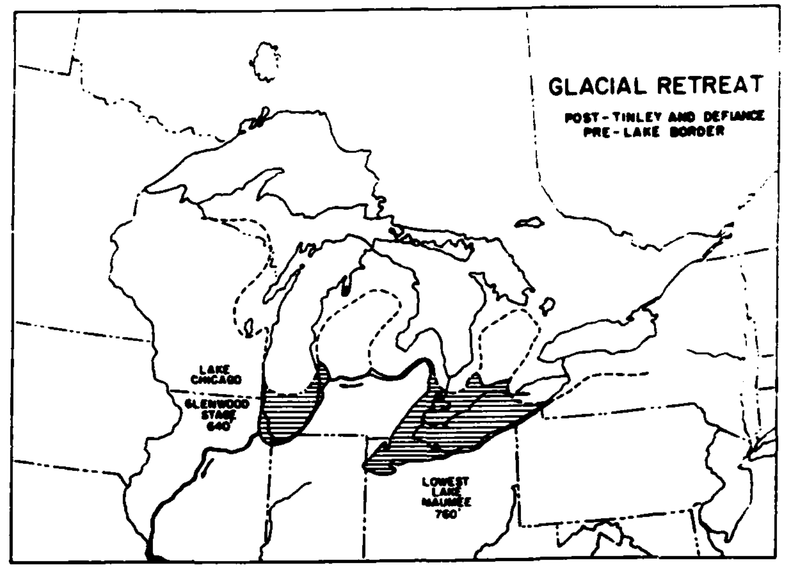


Fig. C.2 Lake Maumee II (Lowest Lake Maumee) and Glenwood I stage of Lake Chicago. Occurred during the glacial retreat between the Tinley and Defiance advances and the Lake Border advances. Position of ice front conjectural.

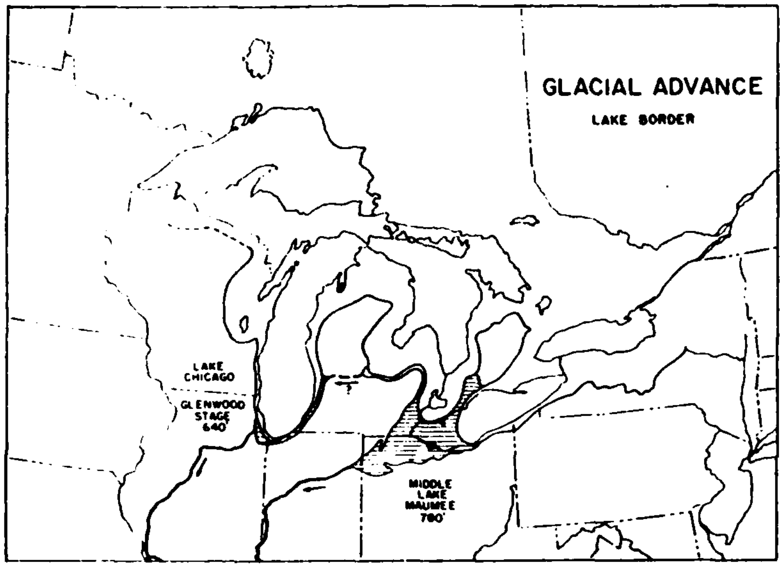


Fig. C.3 Lake Maumee III (Middle Lake Maumee) and Glenwood I stage of Lake Chicago. Advance of ice to Lake Border moraines constricted Lake Chicago and returned the discharge of the Erie Basin to the Fort Wayne Outlet (discharge down the Grand River was probably eliminated).

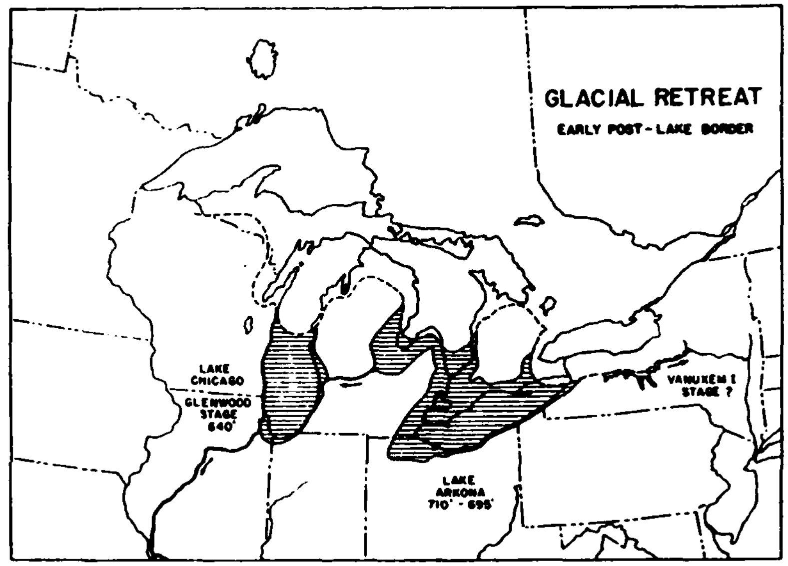


Fig. C.4 Lake Arkona I-III (Highest Lake Arkona) and Glenwood I stage of Lake Chicago. Occurred during the glacial retreat from the Lake Border moraines.

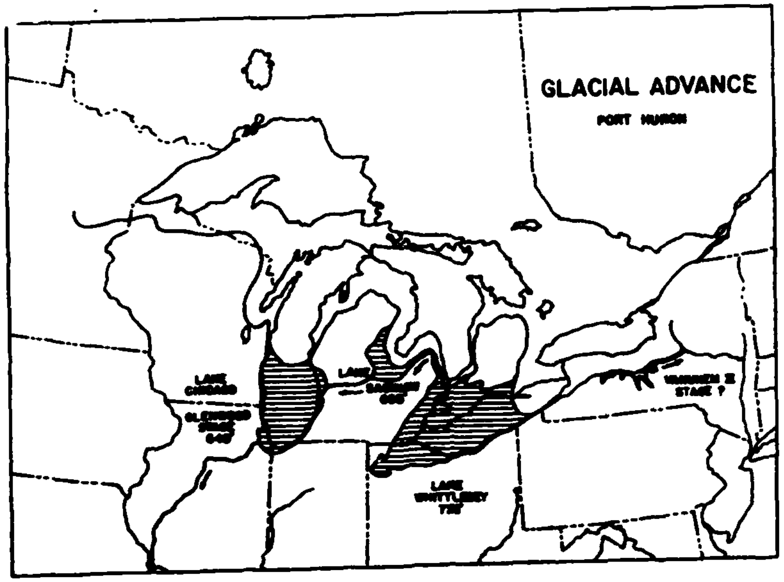


Fig. C.5 Lake Whittlesey, Lake Saginaw, and Glenwood II stage of Lake Chicago. Occurred at the time of maximum extent of the Port Huron (Mankato) glacial substage.

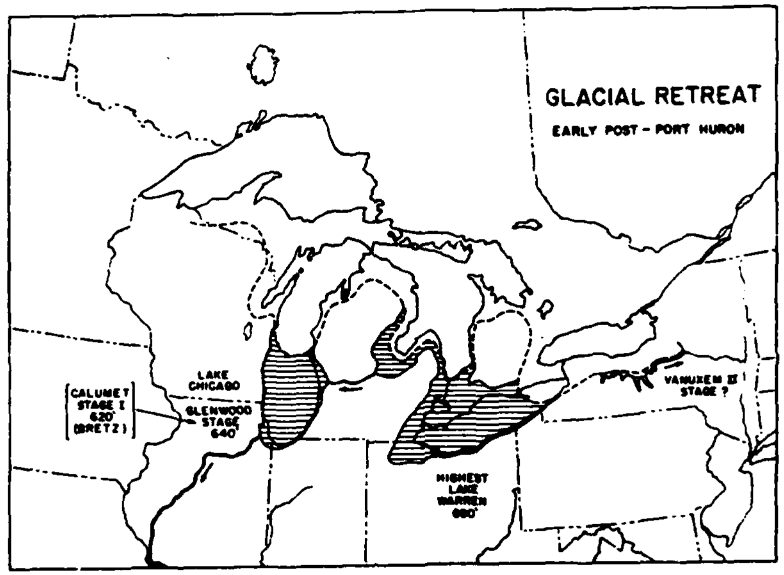


Fig. C.6 Lake Warren I and II (Highest Lake Warren) and Glenwood II stage of Lake Chicago. Occurred during the glacial retreat from the Port Huron maximum position.

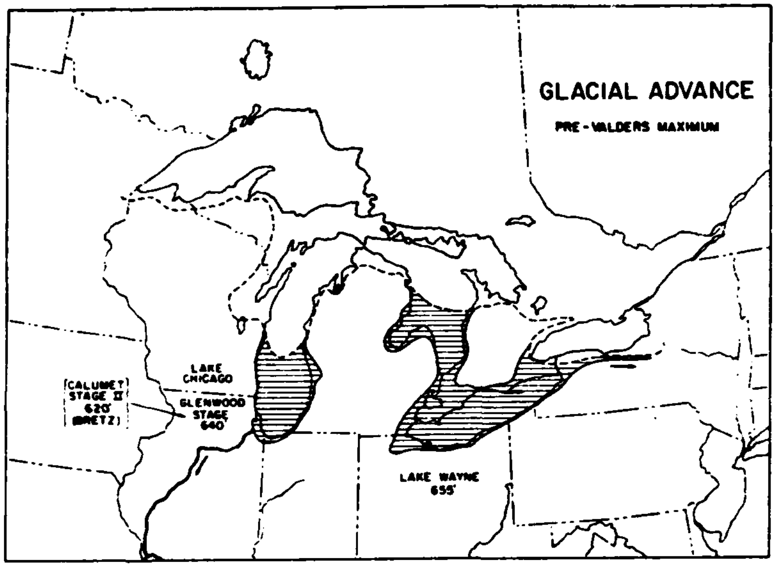


Fig. C.7 Lake Wayne and Glenwood III stage of Lake Chicago. Occurred during the advance of the Valders glacial sub-stage ice.

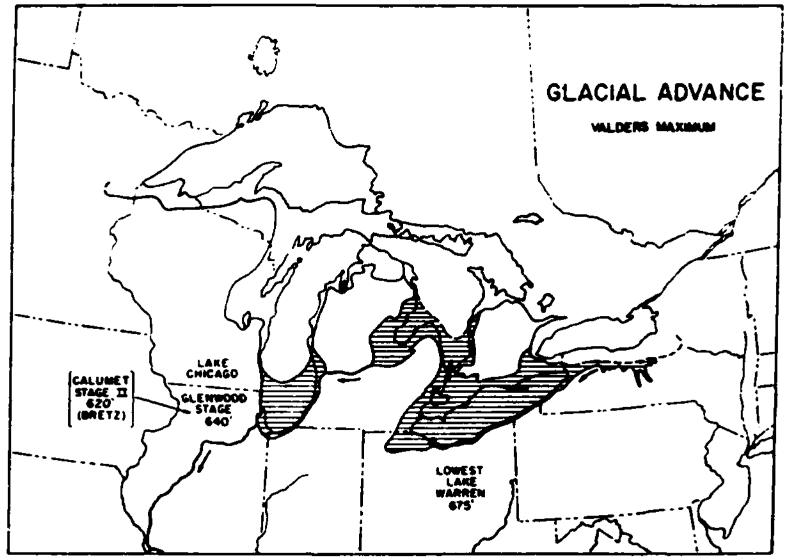


Fig. C.8 Lake Warren III (Lowest Lake Warren) and Glenwood III stage of Lake Chicago. Occurred at the time of the Valders glacial substage maximum.

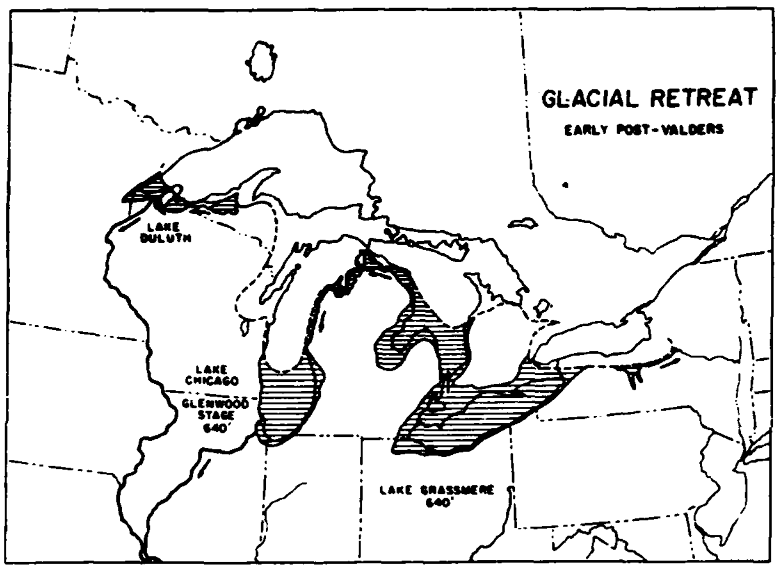


Fig. C.9 Lake Grassmere and Glenwood III stage of Lake Chicago. Occurred early in the retreat of the Valders ice.

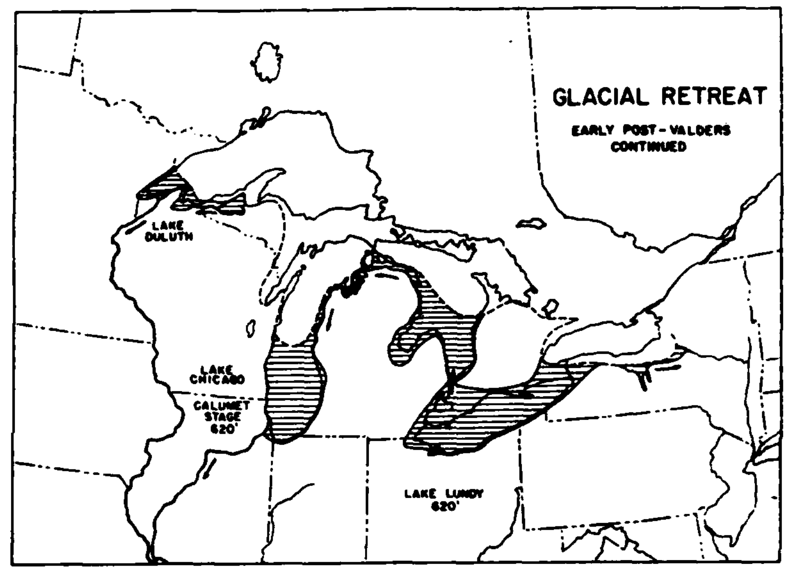


Fig. C.10 Lake Lundy and Calumet stage of Lake Chicago. Occurred during the continued retreat of the Valders ice.

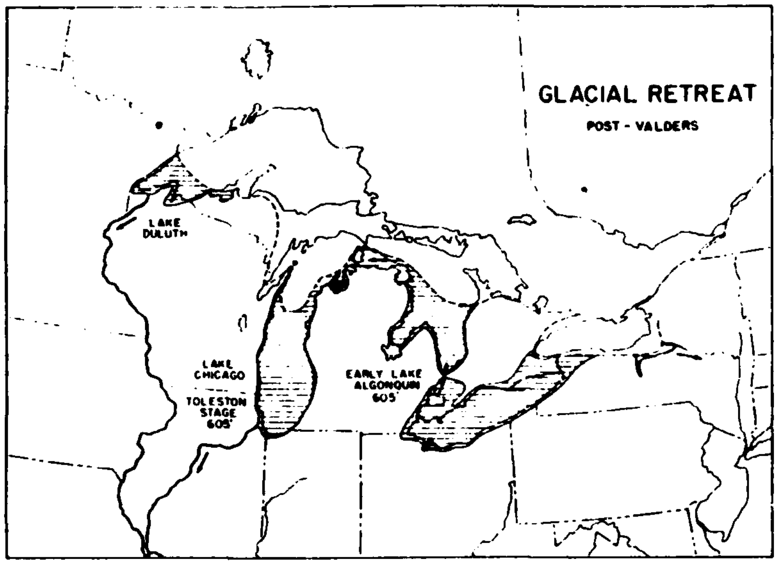


Fig. C.11 Lake Algonquin and Toleston stage of Lake Chicago.

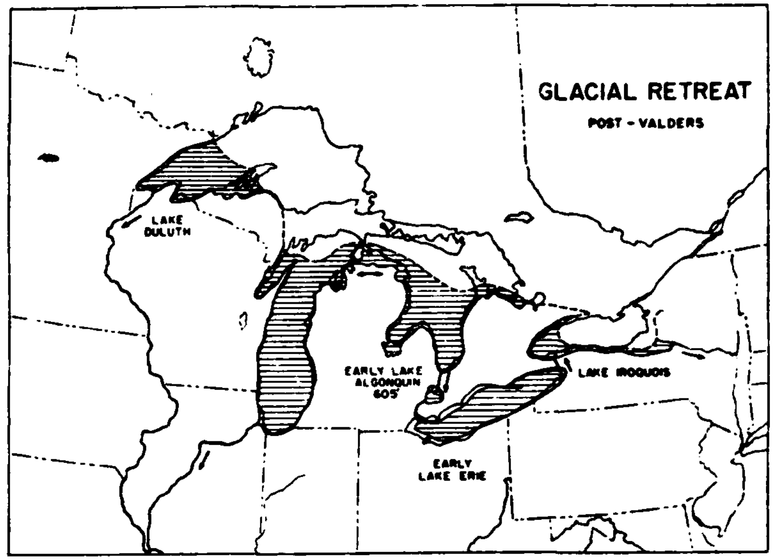


Fig. C.12 Early Lake Erie, Early Lake Algonquin, and Lake Duluth.

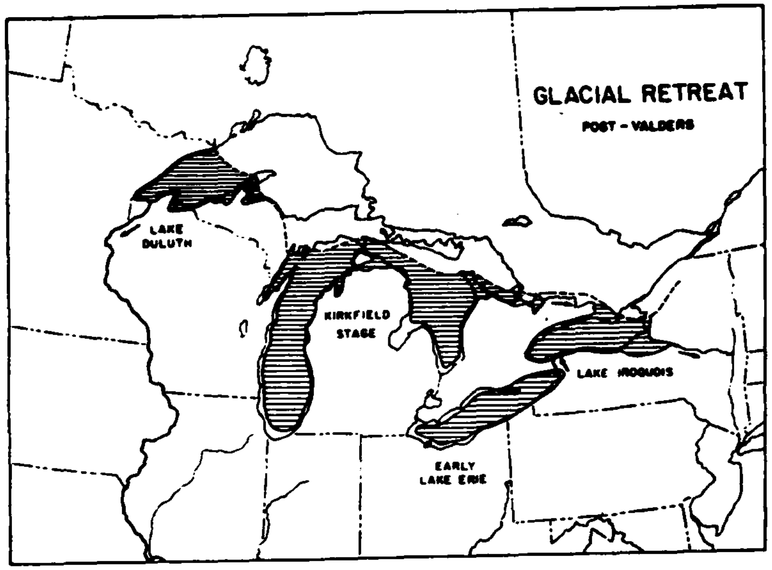


Fig. C.13 Kirkfield Stage of Lake Algonquin, Early Lake Erie, Lake Iroquois, and Lake Duluth.

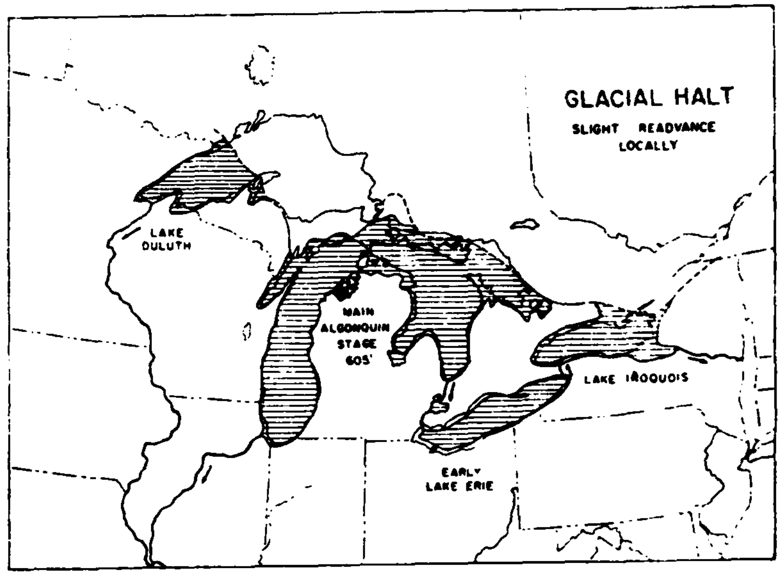


Fig. C.14 Main Lake Algonquin, Early Lake Erie, Lake Iroquois, and Lake Duluth.

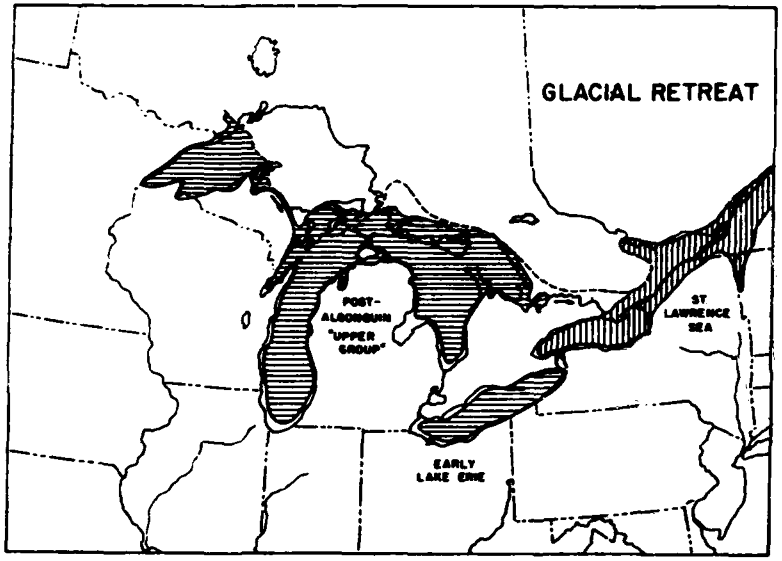


Fig. C.15 Final Ice Retreat, Post-Algonquin "Upper Group" Lake Stages.

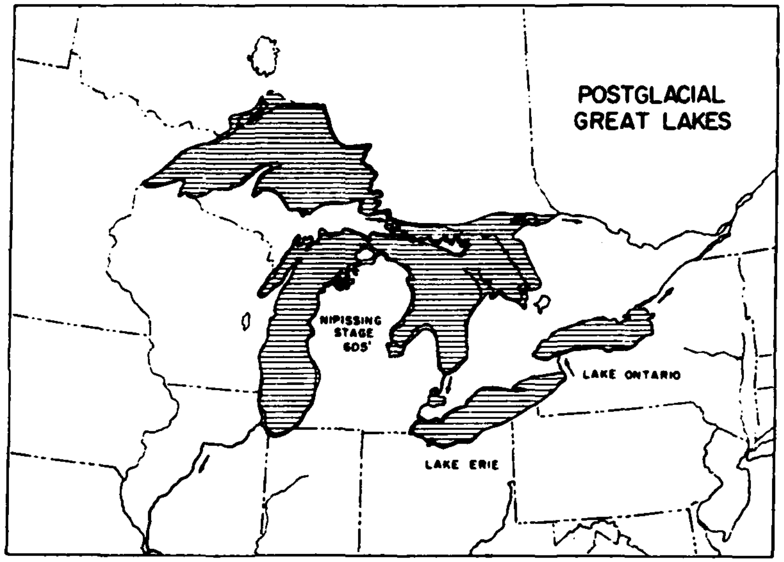


Fig. C.16 Lake Nipissing, Lake Erie, and Early Lake Ontario.

Appendix D

Glossary of Soil Terms

Argillic horizon: an illuvial horizon in which layer-lattice clays have accumulated by illuviation to a significant extent (2)

AWC (Available water capacity): the capacity of soils to hold water available for use by most plants. AWC is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer, is expressed as

Very low	0-3 in.	
Low	3-6 in.	
Moderate	3-9 in.	
High	more than 9 in.	(3)

Base saturation: the degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity (3)

Drainage class: refers to the frequency and duration of periods of saturation during soil formation (see Table 3) (3)

Fragipan: a loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay, but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly (3).

Horizon, soil: a layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon--an organic layer
A horizon--the mineral horizon, formed near the surface in which an accumulation of humified organic matter is mixed with the mineral soil B horizon--the mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon C horizon--the mineral horizon, excluding indurated bedrock that is little affected by soil-forming processes R layer--consolidated bedrock beneath the soil (paraphrased from Reference 3)

Phase, soil: a segment of a soil type, a subdivision made along any characteristic significant to the use or management of the soil (1)

Profile, soil: a vertical section of the soil extending through all its horizons and into the parent material (3)

Residuum: soil parent material derived from the weathering of consolidated rock in place (1)

Series, soil: a group of soils having soil horizons similar in differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and developed from a particular type of parent material (1)

Solum: the upper part of a soil profile, above the C horizon, in which the processes of soil formation are active (3)

Subgroup: the fourth level in the Soil Taxonomic hierarchy, indicating subordinate as well as dominant marks of soil-forming processes (2)

Texture, soil: the relative proportions of sand, silt, and clay particles in a mass of soil (3)

Tilth, soil: the condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure (3)

Type, soil: a subdivision of the soil series based on the texture of the surface soil. The soil-type name consists of the series name plus the textural class name (1).

Key to references for definitions:

(1) USDA 1951 (2)- USDA 1975 (3)- USDA 1978b

Appendix E

An Inventory of Tree Species

Present in the Lake Erie Shore Area ca. 1800

Tree Species within the Survey Area[a]

Common Names	Scientific Names
Alder	*Alnus sp.*
White ash	*Fraxinus americana*
Black ash	*F. nigra*
Blue ash	*F. quadrangulata*
Quaking aspen (Poplar)	*Populus tremuloides*
Bigtooth aspen (Poplar)	*P. grandidentata*
Basswood (Linden)	*Tilia americana*
American beech	*Fagus grandifolia*
Yellow birch	*Betula allegheniensis*
Sweet birch	*B. lenta*
Box-elder	*Acer negundo*
Ohio buckeye	*Aesculus glabra*
Butternut (white walnut)	*Juglans cinerea*
Northern white cedar	*Thuja occidentalis*
Eastern red cedar	*Juniperus virginiana*
Black cherry	*Prunus serotina*
Pin cherry	*P. pennsylvanica*
Chestnut	*Castanea dentata*
Common chokecherry	*Prunas virginiana*
Eastern cottonwood	*Populus deltoides*
Cucumbertree (Magnolia)	*Magnolia acuminata*
Flowering dogwood (boxwood)	*Cornus florida*
American elm	*Ulmus americana*
Red elm (slippery elm)	*U. rubra*
Balsam fir	*Abies balsamea*
Hackberry	*Celtis occidentalis*
American hazel	*Corylus americana*
Eastern hemlock	*Tsuga canadensis*
Shagbark hickory	*Carva ovata*
Shellbark hickory (Big shagbark)	*C. laciniosa*
Mockernut hickory	*C. tomentosa*
Pignut hickory	*C. glabra*
Bitternut hickory	*C. cordiformis*
Eastern hop hornbeam	*Ostrya virginiana*
American hornbeam	*Carpinus caroliniana*
Common juniper	*Juniperus communis*
Honey-locust	*Gleditsia tiracanthos*
Sugar maple (hard maple)	*Acer saccharum*
Black maple	*A. nigrum*
Red maple (soft maple)	*A. rubrum*
Silver maple (soft maple)	*A. saccharinum*
Red mulberry	*Morus rubra*
White oak	*Quercus alba*
Burr oak	*Q. macrocarpa*
Chestnut oak	*Q. prinus*
Swamp white oak	*Q. bicolor*
Chinkapin oak	*Q. muehlenbergii*

Tree Species within the Survey Area (continued)

Common Names	Scientific Names
Northern red oak	*Quercus rubra*
Black oak	*Q. velutina*
Scarlet oak	*Q. coccinea*
Pin oak	*Q. palustris*
Eastern white pine	*Pinus strobus*
Jack pine	*P. banksiana*
Red pine	*P. resinosa*
Pitch pine	*P. rigida*
Yellow poplar (Tuliptree)	*Liriodendron tulipfera*
Sassafras	*Sassafras albidum*
Sourwood (Sourgum)	*Oxydendrum arboreum*
Black Spruce	*Picea mariana*
Red Spruce	*P. rubens*
White Spruce	*P. glauca*
American sycamore	*Platanus occidentalis*
Tamarack	*Larix laricina*
Black tupelo (gum)	*nyssa sylvatica*
Black walnut	*Juglans nigra*
Black willow	*Salix nigra*
Sandbar willow	*S. interior*
Witch-hazel	*Hamamailis virginiana*

[a]Scientific names taken from Brockman (1968); names in parentheses are alternate or colloquial names.

Appendix F

Native Fishes of Lake Erie

Native Fishes of Lake Erie[a]

Common Name	Scientific Name	Habitat
Silver lamprey	*Ichthyomyzon unicuspis*	lake & tributaries
N. brook lamprey	*I. fossor*	tributary (?)
Am. brook lamprey	*Lampetra lamottei*	tributary
Lake sturgeon	*Acipenser fulvescens*	lake & trib (spawn)
Paddlefish	*Polyodon spathula*	W. Lake Erie
Spotted gar	*Lepisosteus oculatus*	W. Basin
Longnose gar	*L. osseus*	trib & shallow water
Bowfin	*Amia calva*	trib & shallow water
Gizzard shad	*Dorosoma cepedianum*	lake & trib
Brook trout	*Salvelinus fontinalis*	E. cold trib
Lake trout	*S. namaycush*	C. & E. deep lake
Cisco or lake herring	*Coregonus artedii*	shallow water
Longjaw cisco	*C. alpenae*	E. basin
Lake whitefish	*C. clupeaformis*	
Mooneye	*Hiodon tergisus*	shallow; big trib
Central mudminnow	*Umbra limi*	shallow & marsh
Grass pickerel	*Esox americanus vermiculatus*	shallows; marsh
Northern pike	*E. lucius*	W. Basin; marsh
Muskellunge	*E. masquinongy*	W. Basin; trib.
Golden shiner	*Notemigonus crysoleucas*	marshes
Hornyhead chub	*Hybopsis biguttata*	tributaries
River chub	*H. micropogon*	tributaries
Silver chub	*H. storeriana*	W. Basin; large trib.
Bigeye chub	*H. a. amblops*	S. tribs.
Blacknose dace	*Rhinichthys atratulus meleagris*	cold tribs.
Longnose dace	*R. cataractae*	C. & E. Basin
Creek chub	*Semotilus a. atromaculatus*	tributaries
Pearl dace	*S. m. margarita*	cold tribs.
Southern redbelly dace	*Chrosomus erythrogaster*	S. tribs.
Redside dace	*Clinostomus elongatus*	tributaries
Pugnose minnow	*Opsopoeodus emiliae*	tribs; islands
Numerous species of shiners	*Genus Notropis*	
Silverjaw minnow	*Ericymba buccata*	tributaries
Fathead minnow	*Pimephales p. provelas*	S. tribs.
Bluntnose minnow	*P. notatus*	shallow; islands
Stoneroller	*C. mpostoma anomalum*	tribs
Bigmouth buffalo	*Ictiobus cyrrinellus*	W. & C. Basins
Quillback	*Carpiodes cyprinus*	lake & tribs.
Silver redhorse	*oxostoma anisurum*	lake & tribs.
Black redhorse	*M. duquesnei*	tribs.
Golden redhorse	*M. erythrurum*	shallow; islands
Northern redhorse	*M. m. macrolepidotum*	lakes; tribs
Harelin sucker	*Lagochila lacera*	Maumee R.
Northern hog sucker	*Hypentelium nigricans*	tributaries
White sucker	*Catostomus c. commersoni*	trib; shallow
Longnose sucker	*C. c. catostomus*	lake
Spotted sucker	*Minytrema melanops*	lake; tribs
Lake chubsucker	*Erimyzon sucetta kennerlyi*	trib; marsh; shallow
Creek chubsucker	*E. oblongus claviformis*	tributaries
Channel catfish	*Ictalurus punctatus*	lake; tribs.
Yellow bullhead	*I. natalis*	shallow; tribs
Brown bullhead	*I. nebulosus*	shallow; W. Basin
Black bullhead	*I. melas*	shallow; tribs
Flathead catfish (?)	*Pylodictis olivaris*	Huron R.
Stonecat	*Noturus flavus*	lake; tribs
Brindled madtom	*M. Mimrus*	W. Basin; tribs
Tadpole madtom	*N. gyrinus*	Tribs; marshes
Banded killifish	*Fundulus diaphanus menona*	tribs; marshes
Blackstripe topminnow	*F. notatus*	tribs
Burbot	*Lota lota lacustris*	deep lake
Brook stickleback	*Culaea inconstans*	veget. bays
Trout-perch	*Percopsis omiscomaycus*	lake
Pirate perch	*Aphredoderus sayanus*	Maumee system
White bass	*Morone chrysops*	lake; tribs
White crappie	*Pomoxis annularis*	shallow; marshes

Native Fishes of Lake Erie (continued)

Common Name	Scientific Name	Habitat
Black crappie	*P. nigromaculatus*	shallow; marshes
Rock bass	*Ambloplites rupestris*	shallow; tribs
Smallmouth bass	*Micropterus d. dolomieui*	W. Basin; lake
Largemouth bass	*M. s. salmoides*	shallow; marshes
Warmouth	*Chaenobryttus gulosus*	tribs W. Ohio
Green sunfish	*Lepomis cyanellus*	tribs
Bluegill	*L. m. macrochirus*	shallow; marshes
Longear sunfish	*L. megalotis peltastes*	W. tribs.
Pumpkinseed	*L. gibbosus*	veget. shallow
Sauger	*Stizostedion canadense*	lake; W. Basin
Walleye (yellow blue pike)	*S. vitreum*	W. Basin C. & E. Basin
Yellow perch	*Perca flavescens*	lake
Blackside darter	*Percina maculata*	tribs
River darter	*P. shumardi*	islands; bay
Channel darter	*P. copelandi*	shores; islands
Gilt darter	*P. evides*	Maumee R.
Logperch	*P. caprodes*	shores; bays
Eastern sand darter	*Ammocrypta pellucida*	sandy shores
Johnny darter and other darters of *genus Etheostoma*		
Freshwater drum	*Aplodinotus grunniens*	lake
Mottled sculpin	*Cottus bairdi*	lake; tribs
Slimy sculpin	*C. cognatus*	deep eastern Basin
Brook silverside	*Labidesthes s. sicculus*	shallow; islands

[a]Following Van Meter and Trautman 1970.

APPENDIX G. INVENTORY OF HISTORIC PROPERTIES

OHIO--Lucas County

1. Toledo. BERDAN BUILDING, 601 Washington St., 1902 (5-29-75)

   George S. Mills, architect. Brick, terra-cotta trim; 5 stories, rectangular, large first-story delivery doors; 2-4-story windows set in tall round arches and separated by paneled spandrels, small round-arched fifth-story windows. Excellent example of early twentieth-century commercial style architecture; built as warehouse for wholesale grocery company whose developers included the pioneer Ketcham, Secor, and Berdan families, including John Berdan, first mayor of Toledo. Private.

2. Toledo. BRAND, R., AND COMPANY (WESTERN SHOE COMPANY), 120-124 St. Clair St., c. 1874 (5-27-75)

   Brick, dressed stone front facade; 4 stories, rectangular, flat roof, center double-door entrance flanked by storefront windows separated by cast-iron engaged columns, rectangular and round- and segmental-arched windows separated by small piers, bracketed cornice. Italianate. Excellent example of city's late nineteenth century commercial architecture; built for R. Brand and Co., firm founded by Adolph Brand and Guido Marx, a mayor of Toledo, 1849. Private.

3. Toledo. BURT'S THEATER, 719-723 Jefferson St. (11-1-77)

4. Toledo. EAST SIDE COMMERCIAL BLOCK, 107-117 Main St., c. 1880s (5-3-76)

   Brick, painted; 3 stories, rectangular, flat roof with pedimented parapet, commercial entrances, two-story center round-arched recess, third-story polygonal oriels, denticulated frieze with engaged colonettes and brick panels. Eclectic. One of only remaining nineteenth century commercial structures in downtown E. Toledo; developed because of cheap land, natural gas, river frontage, and railway facilities. Private.

5. Toledo. FORT INDUSTRY SQUARE, 19th century (7-23-73)

   Block of commercial brick buildings all 4 stories, but in various shapes and heights, in Victorian styles; ground-level windows modernized. Site of Fort Industry's stockade and blockhouse, 1795; development as waterfront and industrial area began early 1900s with advent of Erie Canal and continued through the nineteenth century. Multiple private.

6. Toledo. LUCAS COUNTY COURTHOUSE AND JAIL, 1896 (5-11-73)

   David L. Stine, architect. Government buildings on six-acre courthouse square; three-story Neo-Classical Revival courthouse with low central dome over colonnaded drum, rusticated first floor, and monumental porticos with Corinthian columns on center and end pavilions; and three-story Second Renaissance Revival jail building with hipped roof, center porch, and third-floor triple arched loggia. Jail and courthouse replaced earlier structures. County.

7. Toledo. MANHATTAN BUILDING, 518 Jefferson Ave., 1903 (6-10-75)

Edward O. Fallis, architect. Steel frame, brick, reinforced concrete; 6 stories, rectangular, flat roof, street-level commercial entrances, elaborate sixth-floor bracketed cornice, third-sixth story terra-cotta garland enframement, ribbon windows with transoms. Commercial. Unusual Sullivanesque ornamentation. Private.

8. Toledo. MONROE STREET COMMERCIAL BUILDINGS, 513-623 Monroe St., 1870s-1880s (2-12-76)

Eight two- to four-story commercial brick buildings, some with stone trim, characterized by bracketed cornices, curved and rectangular pediments, corbeling; rectangular, round and elliptical-arched windows, some entrances retain wooden and cast-iron columns; street-level storefronts altered. Victorian. Greatest construction of commercial structures built during city's period of economic prosperity, and one of few such remaining early groups in Toledo. Multiple private.

9. Toledo. NEUKOM, ALBERT, HOUSE, 301 Broadway, 1888 (3-4-71)

Sandstone, 2½ stories, modified rectangle, hipped roof sections, small Ionic entrance portico with balustraded deck, carved stone panels above front first-story windows, prominent string course, round arched windows in front wall gable. Renaissance Revival with Chateauesque elements. Built for Albert Neukom with stone from his cut stone company which also provided materials for public buildings in OH, MI, and IL. Private; not accessible to the public.

10. Toledo. OLD CENTRAL POST OFFICE, 13th St. between Madison and Jefferson Aves., 1909-1911 (2-23-72)

James Knox Taylor, architect. Ashlar limestone, 2 stories, rectangular, hipped roof sections, engaged Doric colonnade beneath full entablature balustrade, pedimented entrance pavilions with paired columns and large fanlights over entrances, first-floor window architraves with keystones, blind panels and consoles beneath windows; recessed attic clerestory section with round arched windows and antifixae; interior alterations. Neo-Classical Revival. Monumental federal buildings by the Treasury Architect; now converted for use as education building. Muncipal.

11. Toledo. OLD WEST END DISTRICT, Late 19th to early 20th century (3-14-73)

District of large detached mansions on landscaped lots, illustrating Chateauesque, Georgian Revival, Richardsonian Romanesque, Queen Anne, Second Renaissance Revival, Jacobean Revival, and High Victorian Italianate styles, among others. Unusually diverse collection of grand houses. Area settled and developed by prosperous merchants and industrialists in late nineteenth century; later building included location of Neo-Classical Revival municipal art museum here. Multiple public/private.

12. Toledo. PHILIPPS, HENRY, HOUSE, 220 Columbia St., 1866 (2-23-72)

Brick, 2 stories, irregular shape, overhanging gabled roof sections, large brackets under eaves, three-story entrance tower with large bracketed hood over entrance, ornate hoods over tall windows, elaborate iron-work porch, belt course with foliate panels; side bay. One of few examples of Italian villa style in the West End; built for Henry Philipps, owner of seed and implement company, who was active in public affairs. Private; not accessible to the public.

13. Toledo. PYTHIAN CASTLE (BLECKNER MUSIC COMPANY), 801 Jefferson Ave., 1889-1890 (4-30-72)

Bacon and Huber, architect. Rockfaced sandstone, 5½ stories, rectangular, mansard-type roof, second-fourth floor windows grouped beneath round arched bays, corbeled arcading at cornice line, corner tower with complex roof and turrets, hipped wall dormers with oculi along attic, smooth stone trim. Eclectic elements. Typical bold hybrid building of the period; built for five lodges of Knights of Pythias. Private.

14. Toledo. ST. CLAIR STREET HISTORIC DISTRICT. Both sides of St. Clair St., from Perry St. to south side of Lafayette St., 1855-1880s (5-29-75)

Commercial district with six significant masonry, two- to three-story structures; notable are Martin Evoy's saloon with cast-iron street-level elements, the C. N. Dixon Building with elaborate window hoods, and the Hinery and Sons modified Romanesque Revival building. Examples of Italianate and Romanesque Revival styles. Only group of nineteenth century commercial buildings remaining in dock area of Toledo; developed as rail terminus for lake shipping. Private.

15. Toledo. SECOR HOTEL, 413-423 Jefferson Ave., 1908 (4-30-76)

George S. Mills, architect. Brick, stone trim and first- and second-story facing; 10 stories, rectangular, flat roof, rusticated first and second floors with large segmental-arched reinforced concrete entrance, flanking segmental-arched windows, small frieze windows and decorative panels, ornate cornice; end bays flanked on each side by stone banding, surmounted by cartouches. Second Renaissance Revival. Described as Toledo's leading hotel in 1915; viewed during early twentieth century as a symbol of the city's progress. Private.

16. Toledo. SECOR, JOSEPH K., HOUSE, 311 Bush St. (6-11-79)

17. Toledo. STANDART-SIMMONS HARDWARE COMPANY, 36 S. Erie St., 1906 (5-29-75)

Brick, 7 stories, modified triangle, flat roof, centered round-arched side entrances; rectangular, segmental- and round-arched windows; seventh-story windows set in arched panels, belt course between sixth and seventh stories, corbeled cornice. Vernacular Commerical Style. Good example of Toledo's early twentieth century commercial architecture; built for the Standart-Simmons Hardware Co., wholesale distributors. Private.

18. Toledo. SUCCESSFUL SALES COMPANY (OLIVER HOUSE), 27 Broadway, 1959 (5-6-71)

Isaiah Rogers, architect. Brick, 3 stories, polygonal, flat roof, wooden cornice, arched windows encircle lower floor of rounded center bay, stone lintels; interior cast iron columns on lower floor. Elegant block with restrained neo-classical elements. Private.

19. Toledo. TOLEDO CITY MARKET, 237 S. Erie St., 1908 (2-23-72)

Edward O. Fallis, architect. Reinforced concrete, 1 story, rectangular, flat and arched roof sections, open building with broad arched entrances into vaulted market spaces; center and end pavilions with square corner turrets, center parapet, and rectangular entrances beneath open fanlights with mullions; large rear auditorium wing added 1928. Monumental Mission Style building with starkly contrasting voids and solids. No longer serves market purposes. Municipal.

20. Toledo. TOLEDO CLUB, 14th St. and Madison Ave. (12-1-78)

21. Toledo. TOLEDO NEWS-BEE BUILDING, 604 Jackson St., 1912 (2-23-72)

Brick, 2 stories, rectangular, flat roof, two-story square brick pilasters with stone bases and ornate terra cotta capitals dividing bays of unornamented windows, stone sills under window groups, decorative terra cotta panels above pilasters and at corners, end entrances with decorated broken pediments, slightly corbeled cornice, sparse geometric ornamentation in brickwork bands. Prairie School. Restrained, nicely detailed building constructed for newspaper which resulted from consolidation of three Toledo papers. Private.

22. Toledo. TOLEDO YACHT CLUB, Bay View Park, 1908 (12-12-76)

A. Burnside Sturges, architect; H. J. Speiker Co., builder. Steel frame, concrete; 2½ stories over high basement. L-shaped, gabled roof, three false curvilinear front gables, full-width one-story arcaded front porch with two-story center section, side three-story tower with open third story and pyramidal roof. Unusual area Mission Style structure; area's oldest yacht club (1865), eleventh oldest in U.S. Private/municipal.

23. Toledo. WHEELER BLOCK, 402 Monroe St., 1896 (5-29-75)

Brick, cast-iron trim; 3½ stories, modified rectangle, flat roof with parapet, recessed double-door entrance at rounded dormer articulated by cast-iron columns and pilasters, flanking display windows, flat and round-arched openings, attic-level roundels in frieze, denticulated modillion cornice. Eclectic. Good example of city's late nineteenth century commercial architecture. Multiple private.

24. Toledo. WRIGHT, DR. JOHN A., HOUSE, Detroit Rd. (10-5-78)

OHIO--Ottawa County

25. Danbury. JOHNSON ISLAND CIVIL WAR PRISON AND FORT SITE, East shore area of Johnson Island, 1862 (3-27-75)

Earthworks of fort and cemetery on site of federal Civil War prison that contained 100 structures, including commissary, barracks, school, carpenter shop, lime kiln, stables, and two forts. One of largest Civil War forts built in the North, holding an average of 2,600 prisoners; forts added, 1963; buildings and equipment transferred or auctioned at conclusion of war. Private.

26. Gibraltar Island. COOKE, JAY, HOUSE, Put-in-Bay, Lake Erie, 1864-1865 (11-13-66)

Sandstone, 2½ stories; rectangular with four-story octagonal crenelated tower on one side, wing on other; hipped roof and dormers, label window scroll moldings, bracketed cornice. Italianate. Summer home of financier, Jay Cooke, whose sales of bonds during the Civil War helped stabilize the national economy. State; not accessible to the public: NHL.

27. Marblehead. MARBLEHEAD LIGHTHOUSE, OH 163, 1821 (12-17-69)

Stone, stuccoed; circular, 25-foot-diameter base, truncated concical elevation with cupola and balustrade above. Greek Revival elements. Second lighthouse on the Great Lakes. Federal/USCG.

28. Mineyahta-on-the-Bay. WAR OF 1812 BATTLE SITE, East Bay Shore Re., 1 mile west of junction with T-142, 1858 (2-23-72)

Stone marker on site of state's first action during War of 1812, in which Ohio volunteers repulsed attack by pro-British Indians; battle later recounted by abolitionist Congressman Joshua Giddings, who erected the monument. Believed to be state's first battle marker. Private.

29. Port Clinton. OTTAWA COUNTY COURTHOUSE, W. 4th and Madison Sts., 1898-1901 (5-3-74)

Wing and Mahurin, architects. Rock-faced stone, 3½ stories, Greek cross shape, intersecting hipped and gabled roof sections, large central square clock tower with hipped roof and gabled clock dormers and round-arched windows and arcade, center gabled entrance section with segmental-arched doorway and tall-round arched window area on each facade, round-arched and rectangular windows; interior central stairwell under vaulted area containing paintings depicting county's livelihoods. Chateauesque and Richardsonian Romanesque elements. County.

30. Port Clinton vicinity. MO-JOHN, BETSY, CABIN, About 4 miles east of Port Clinton off OH 53, c. 1853 (5-6-76)

Henry Cuckert, builder. Log construction, concrete block foundation; 1 story, rectangular, gabled roof, center entrance; moved 1967. Vernacular. Believed to be the only log building in the United States constructed with dovetailed notching; home of Betsy Mo-John, the last Ottawa Indian living in Ottawa County. Private; not accessible to the public.

31. Put-in-Bay, South Bass Island. PERRY'S VICTORY AND INTERNATIONAL PEACE MEMORIAL, 1813 (battle); 1912-1915 (monument) (10-15-66)

Joseph H. Freedlander and A. D. Seymour, architects. Twenty-one-acre featuring 352-foot granite Doric column topped with bronze urn. Monument to Comdr. Oliver Hazard Perry's victory over the British in the Battle of Lake Erie, Sept. 10, 1813, which gave the United States control of Lake Erie, and helped the United States hold the Old Northwest; also commemorates 1817 Rush-Bagot Agreement which led to permanent disarmament of U.S./Canadian border. Federal/NPS/non-federal.

32. Put-in-Bay vicinity. INSELRUHE, Northeast of Put-in-Bay at junction of Bayview Ave. and Chapman Rd. on South Bass Island, 1875 (12-12-76)

James Young, architect; George E. Gascoyne, builder. Frame, board-and-batten siding; 2½ stories, rectangular, truncated hipped roof with cresting, interior chimneys, front off-center double-door entrance, front and side wraparound porch, side entrance porch, polygonal front corner tower with mansard roof, bracketed sawtooth cornice, paneled frieze broken by attic lights, window and door architraves; lavish ten-room interior; outbuildings include two-story cottage with square tower. Italianate with Second Empire elements. Elaborate summer house complex built for railroad magnate James Monroe; later residence of John J. Hunker, well-known naval commander during Spanish-American War. Private; not; accessible to the public.

OHIO--Erie County

33. Kelley's Island. KELLEY'S ISLAND SOUTH SHORE DISTRICT, Water St., South side of Kelley's Island, Mid-late 19th century (3-27-75)

Mixed-use district of thirty significant brick, frame, and stone 2-3½-story structures; notable are the Italian Villa Addison Kelley mansion, the Stick Style Water Street Hotel with its 1½-story Second Empire tower, and the 1½-story Gothic Revival cottage with traceried bargeboards and porch fasciae; other examples of Queen Anne and High Victorian Italianate. Area settled by Irad and Datus Kelley after purchase from Connecticut Land Co. 1833-1836; noted for production of red cedar, limestone, and wines; remains a homogenous late nineteenth century community. Multiple public/private.

34. Sandusky. ADAMS STREET DOUBLE HOUSE, 106-108 E. Adams St., 1840s (10-10-75)

Brick, 2 stories over high stone basement, rectangular, gabled roof with stepped end parapets; front center one-story flat roof porch with paired entrances, round-arched brackets, denticulated cornice, and balustraded side stairs; twin basement entrances under porch, stone lintels and sills, rear entrances with rounded and gabled hoods; interior woodwork intact. Greek Revival. Rare city example of double row house construction. Private; not accessible to the public.

35. Sandusky. BALTIMORE AND OHIO RAILROAD COMPANY DEPOT, Washington and Warren Sts. (9-13-78)

36. Sandusky. BEECHER, LUCAS, HOUSE, 215 W. Washington Row (5-7-79)

37. Sandusky. CARNEGIE LIBRARY, Adams and Columbus Ave., 1901 (11-12-75)

D'Oench and Yost, architects. Rock-faced ashlar limestone, 1½ stories over high basement, modified rectangle, gabled roof sections, center bay with recessed entrance porch and wall dormer, flanking polygonal twin towers with corbeled tables and flared pavilion caps, cross-gable end bays with triangular wall dormers and polygonal window bays, dressed stone window surrounds, sandstone inscription panels. Jacobean Revival elements. Financed under the Andrew Carnegie Library Program. Private.

38. Sandusky. ENGELS AND KRUDWIG WINE COMPANY BUILDINGS, 220 E. Water St., 1863 (7-30-76)

Stone, brick, and frame; 2 stories, irregular shape, gabled and shed roof sections, front center double-door entrance with vertical boards and blind fan numerous entrances, stone stills and lintels; many original fixtures; 1885, 1900, and 1934 additions; planned adaptation of 1934 sections into apartments and shops. Vernacular and Italianate elements. The largest and one of the most well-known of area wineries established by German immigrants. Private.

39. Sandusky. ENGINE HOUSE NO. 3, Meigs St. and Sycamore Lane, 1894 (4-1-75)

C. N. Biehl, builder. Ashlar limestone, 2½ stories, rectangular, gabled roof sections, paired one-story round-arched vehicular entrances, second-story belt course and arcaded windows; cross gable with louvered opening, dentils, and rosette ornamentation; side elevation with asymmetrical fenestration and intersecting gable with decorative shingling and quarter-round lights. Interesting and well-preserved adaptation of Richardsonian Romanesque styling to small firehouse structure; still in use. Municipal.

40. Sandusky. ERIE COUNTY OFFICE BUILDING, 1202 Sycamore Lane, 1899 (11-20-74)

Rock-faced limestone, 1½-2½-story sections over high basement, T-shaped; gambrel, gabled, and hipped roof sections; interior chimneys, modillion cornice on central gambrel roof block with Palladian windows in gable ends, Ionic portico, parapeted end pavilions with interior front chimneys; contrasting dark stone belt course, sills, and lintels. Eclectic elements. County.

41. Sandusky. EXCHANGE HOTEL, 202-204 E. Water St., 1885 (7-30-75)

Brick, 2-2½ stories, rectangular, flat roof sections, interior side chimneys; main facade with recessed corner entrance, one-story pilasters, flat-arched openings, and decorative cornice with triangular parapet; side elevation with stepped parapet, original three-story block (1817) with gabled entrance porch; two-story lobby wing added, twentieth century. Eclectic. Visited by Charles Dickens during his American travels (1842) and described in his American Notes; in continuous use as hotel since construction. Private.

42. Sandusky. FOLLETT-MOSS-MOSS RESIDENCES, 404, 414, 428 Wayne St., Mid-19th century. (12-31-74)

Block with three stone residences including Greek Revival house with balustraded roof deck and portico, rock-faced Italianate structure with label molded windows, and 2½ story house with scalloped bargeboards and pendants. Group of three representative structures built for prominent local businessmen and politicians. Museum. Multiple public/private.

43. Sandusky. LAKE SHORE AND MICHIGAN SOUTHERN RAILROAD DEPOT, N. Depot at Carr St., c. 1891 (7-17-75)

Shepley, Rutan and Coolidge, architects; A. Feick and Brothers, master builders. Rock-faced ashlar limestone, 1½ stories, main block with platform loggia and baggage shed, flared slate hipped roof, interior chimneys, multiple trackside entrances, openings with square transoms, front and rear triangular Palladian-motif dormers, conical roof projections, wide eaves with angle brackets. Richardsonian Romanesque elements. Constructed by the Lake Shore and Michigan Southern RR.; typifies late nineteenth century small railroad passenger depot. Private; not accessible to the public.

44. Sandusky. MAD RIVER BLOCK, 1002-1018 W. Adams St., c. 1849 (10-16-75)

Brick, 2 stories, rectangular, gabled roof; Block of nine continuous row houses with stepped parapet at each gable end, interior chimneys, stone lintels over all windows and doors, continuous stone water table and cut stone foundation; rear additions. Greek Revival. Built to house railroad employees. Private; not accessible to the public.

45. Sandusky. SLOANE, RUSH R., HOUSE, 403 E. Adams St., Early 1850s (2-24-75)

Stone, stuccoed; 2 stories over high basement, irregular shape, low hipped roof, elaborate interior chimneys; front off-center entrance porch with fluted columns, scroll brackets, dentils, and ornamental stairway;

corner tower with arcaded windows, brackets, and truncated flared hip cap; ornate window molds, elaborate cornice brackets separated by frieze lights and panels, second-story balustraded balcony with canopy, quoins; alterations 1860s. Italian Villa Residence of Rush R. Sloane, town mayor, county probate judge, and railroad president; house reputedly served as underground railroad station during Sloane's residence. Private.

46. Sandusky. ST. MARY'S CATHOLIC CHURCH, 429 Central Ave., 1873-1880 (10-10-75)

Ashlar limestone, sandstone trim; 2½ stories, cross-shaped, gabled and hipped roof sections, projecting front center entrance bay with two-stage tower and flared octagonal spire; flat-arched entrance with curvilinear transom, pointed-arched frontispiece, tall traceried Gothic openings, buttresses, ridge cresting, small fleche, polygonal apse with flanking one-story chancel rooms; groin vaulting and supporting stone columns. Exemplifies High Victorian Gothic ecclesiastical architecture; constructed by the German Catholic congregation of Sandusky. Private.

47. Sandusky. SYCAMORE SCHOOL, 3rd and Sycamore Sts., 1876 (11-19-74)

Coursed rusticated stone, 2½ stories over full basement, square, hipped roof, interior chimneys; slightly projecting pedimented center entrance sections on front and sides, round-arched entrances; slightly recessed sections containing round- and segmental-arched windows, elaborately carved brackets. Italianate elements. Formerly the First Ward School; town's second oldest operative school. Private.

48. Sandusky. WATER STREET COMMERCIAL BUILDINGS, 101-165 E. Water St. and 101-231 W. Water St., 1855-1890 (3-18-75)

Commercial district of fifteen masonry, 3-4-story buildings; notable are the Romanesque Revival structure at 231 W. Water St., the Renaissance Revival Hubbards granite block, and the Second Empire Fisher's Hall. Additional examples of High Victorian Italianate. Original mercantile center of flourishing nineteenth century Great Lakes port; quality of buildings influenced by abundance of local limestone, retains nineteenth century character. Multiple private.

49. Sandusky. WHITE, SAMUEL M., HOUSE, 304 E. Adams St., 1838 (6-16-76)

Local limestone ashlar, 2 stories, modified rectangle, flat and gabled roof sections with paired bracketed and paneled cornice, interior end chimneys, front center entrance with sidelights and transom, polygonal side section with round-arched windows, dressed stone lintels and sills; one-story section and rear wing added, mid-nineteenth century. Area example of Greek Revival house with Italianate elements; built by area carpenter Samuel M. White. Private; not accessible to the public.

50. Sandusky vicinity. OHIO SOLDIERS' AND SAILORS' HOME, Northeast of Sandusky between U.S. 250 and S. Columbus Ave., 1888 (9-13-76)

Veterans' community with residential, medical, and support facilities; includes vernacular Richardsonian Romanesque buildings, all of blue limestone quarried on site. Established by the state legislature; still serving original use. State.

51. Vermilion. FRANCIS, JOSEPH, IRON SURF BOAT, 480 Main St. (9-13-79)

52. Vermilion. VERMILION TOWN HALL, 736 Main St., 1883 (11-20-74)

Brick, 2½ stories, rectangular, hipped roof, square corner tower, center gabled pavilions with large oriels in gables, stone belt course and label molds, hooded round-arched entrance; spire removed; two-story auditorium inside. High Victorian Gothic. Municipal.

OHIO--Lorain County

53. Lorain. LORAIN LIGHTHOUSE, Lorain Harbor (12-29-78)

54. Lorain. PALACE THEATRE BUILDING, Broadway and 6th St. (3-30-78)

55. Lorain. ROOT, WILLIAM H., HOUSE, 3535 E. Erie Ave. (9-20-78)

56. Lorain. SEHER, WILLIAM, HOUSE, 329 W. 9th St., 1909 (6-17-76)

Brick, stone trim; 2½ stories, L-shaped, tile hipped roof with elaborate dormers, interior chimneys, first- and second-story front center entrances with semielliptical fanlight and sidelights, slightly projecting center pavilion, one-story full-width arcaded entrance porch with engaged columns, front center Palladian motif dormer with broken swan's neck pediment; one-story rear wing. Georgian Revival. Built for William Seher, prominent local businessman and civic leader. Private.

57. Lorain vicinity. BURRELL, JABEZ AND ROBBINS, HOUSE AND CHEESE FACTORY, North of Lorain off OH 301, c. 1828 (1-1-76)

HOUSE: brick, 2 stories, modified rectangle, gabled roof, front center entrance with small latticework vestibule, flat-arched windows, boxed cornice with end returns; rear additions. Federal. FACTORY: stone foundation, frame, board-and-batten siding; 1 story, rectangular, gabled roof. House built for Capt. Jabez Burrell, one of two original proprietors who purchased entire Sheffield Township in 1815; farm operated in 1836 as part of manual labor program of Oberlin College, whose original 1834 incorporators included Jabez Burrell, Jr.; factory operation dates unknown. County; not accessible to the public.

58. Sheffield Lake. 103RD OHIO VOLUNTEER INFANTRY ASSOCIATION BARRACKS, 5501 E. Lake Rd. (7-14-78)

59. Vermillion vicinity. MILL HOLLOW HOUSE, THE, Southeast of Vermillion on N. Ridge Rd., c. 1845 (6-29-76)

Frame, lapped siding; 1-2 stories, modified rectangle, gabled roof sections with front chevron-patterned pediment, interior chimneys, front off-center entrance with sidelights and lintel with center and corner blocks, one-and-a-half-story wing with front bay window, off-center recessed entrance; one-story summer kitchen added; additions 1870; alterations 1900. One of area's few remaining Greek Revival houses; home of early local settler Benjamin Bacon. County.

OHIO--Cuyahoga County

60. Bay Village. ALDRICH, AARON, HOUSE, 30663 Lake Rd. (12-4-78)

61. Bay Village. BAY VIEW HOSPITAL, 23200 Lake Rd., 1898 (8-27-74)

Colburn and Barnum, architects. Concrete, steel, and brick veneer; 2½ stories, modified rectangle; hipped, gabled, and pyramidal roof sections;

octagonal two- and three-story towers with pyramidal roof sections at each end of front facade, triple arched loggia on squat columns at entrance, numerous gables in tile roof, large lintels over all openings, string courses. Large modern hospital addition at rear. Eclectic elements. Private.

62. Bay Village. HUNTINGTON, JOHN, PUMPING TOWER, 28600 Lake Rd. (2-27-79)

63. Bratenahl. GWINN ESTATE (WILLIAM G. MATHER HOUSE), 12407 Lake Shore Blvd., 1908 (10-1-74)

Charles A. Platt, architect; Warren Manning, landscape architect. Stucco, 2 stories, rectangular, flat balustraded roof, interior chimneys; lakeshore front with semicircular two-story Ionic portico, terraced stairs, and fountain; circular colonnaded gazebo; slightly projecting central southern section opening onto formal sixteenth century style garden; eclectic interior. Second Renaissance Revival. Estate of important industrial and civic leader, William Gwinn Mather. Museum. Private.

64. Bratenahl. HANNA, HOWARD M., JR., HOUSE. 11505 Lake Shore Blvd., 1909-1910 (7-24-74)

McKim, Mead and White, architects. Brick, 2½ stories, T-shaped, gabled roof, three interior chimneys, dormers, slightly projecting center gable section flanked by two smaller flush gable sections and hipped dormers, enclosed stone arched porch, Tudor arched windows, stone trim; W covered pergola, one-story east wing; central hall plan. Jacobean Revival. Home of wealthy industrialist Howard M. Hanna, Jr. Private; not accessible to the public.

65. Bratenahl. PICKANDS, JAY M., HOUSE, 9619 Lake Shore Blvd. (8-24-79)

66. Cleveland. BINGHAM COMPANY WAREHOUSE, 1278 W. 9th St., 1915 (11-2-73)

Walker and Weeks, architects. Steel, concrete and brick; 8 stories, L-shaped, flat roof, windows grouped in vertical ranks with vertical piers emphasized and spandrels recessed. One of Cleveland's finest examples of commercial architecture. Bingham Co., founded 1841, was one of the city's pioneer hardware companies. Private; not accessible to the public.

67. Cleveland. CAXTON BUILDING, 812 Huron Rd., SE., 1903 (10-30-73)

Frank S. Barnum, architect. Steel frame with brick, stone, and terra cotta facing; 8 stories, rectangular, flat roof, round-arched Romanesque entrance, upper stories of front facade Sullivanesque with piers emphasized, spandrels recessed. Commercial style. Built for Caxton Co., commercial printing and graphic arts business. Private.

68. Cleveland. CLEVELAND ARCADE, 401 Euclid Ave., 1888-1890 (3-20-73)

John Eisenmann and George H. Smith, architects. Brick, iron framing; 9 stories with ten-story center pavilion, gabled roof sections, rectangular, wide round-arched entrance with rock-faced stone on Superior Ave., third-sixth-story round-arched window bays, rectangular and round-arched windows; interior five-level arcade beneath iron and glass skylight 290-foot long, 104-foot high; iron galleries; ornate iron stairs, balustrades, and details; roof trusses constructed by Detroit Bridge Co. Commercial Style. Arcades were a notable nineteenth century architectural form, and this is one of the finest arcades built for a consortium of prominent

Cleveland businessmen as a major shopping and office center. Private: HABS.

69. Cleveland. CLEVELAND GRAYS ARMORY, 1234 Bolivar Rd., 1893-1894 (3-28-73)

Fenimore C. Bate, architect. Brick, rusticated rock-faced stone foundation and trim; 3 stories, rectangular, flat and gabled roof sections, five-story circular corner tower with vertical "loopholes" in top flared section, Syrian arched entrance with iron tympanum, corner turrets; extended rear section with drill hall. Richardsonian Romanesque. Built for local military organization that flourished during late nineteenth century; became municipal recreation center in later years. Municipal.

70. Cleveland. CLEVELAND HARBOR STATION, U.S. COAST GUARD, New West Pier, 1940 (1-1-76)

J. Milton Dyer, architect. Reinforced concrete, 2 stories with 60-foot observation tower, irregular shape, simple windows and entrances, decks; three boat slips, garages. Unusual modernistic design evocative of a ship; reflects the versatility and eclecticism of Dyer's work. Federal/USDOT.

71. Cleveland. CLEVELAND MALL, Roughly T-shaped mall area between E. 9th and W. 3rd Sts. and Superior Ave. and RR. tracks, 1903-1935 (6-10-75)

T-shaped district including seven significant Beaux-Arts and Second Renaissance Revival civic structures adjoining formal mall area with memorial fountain; sculpture by Daniel Chester French and Marshall Fredericks. Area planned according to directives of Cleveland's Group Plan Commission composed of architects Daniel Burnham, John Carrere, and Arnold Brunner; the group stressed classical symmetry and detailing and uniformity of building style for maximum effect through minimum expense; one of the more elaborate formal building complexes constructed in early twentieth century. Multiple public/private: HABS.

72. Cleveland. CLEVELAND PUBLIC SQUARE, Superior Ave. and Ontario St., 1796 (12-18-75)

Herman N. Matzen, J. C. Hamilton, and Levi T. Scolfield, artists. Square park divided into quadrants, three of which contain statues--one of city founder Gen. Moses Cleveland, one of Mayor Tom L. Johnson, and the large Soldiers' and Sailors' Monument with groupings of infantry, artillery, cavalry and naval men surrounding central shaft terminated by statue of Liberty. Park represents early town planning efforts and contains some impressive late Victorian statuary by noted local artists. Municipal.

73. Cleveland. CLEVELAND TRUST COMPANY, 900 Euclid Ave. at E. 9th St., 1905-1908 (11-26-73)

George B. Post and Sons, architects. Steel frame, granite; 3 stories, trapezoidal, flat roof with balustrade, central dome, thirteen recessed two-story rectangular windows framed by paired and single Corinthian engaged columns, three-bay entrance section with pediment sculpture by Karl Bitter; 1973 renovations and restoration. Excellent example of Beaux-Arts Classicism. Private.

74. Cleveland. CUYAHOGA BUILDING, 216 Superior Ave. NE., 1892-1893 (12-31-74)

Daniel Burnham, architect. Steel frame, brick; 8 stories, rectangular, flat roof, shop windows on first floor, banded second floor topped by cornice, second-eighth-floor three-sided window bays between other windows grouped under seventh-floor round arches, rectangular corner windows, stone and terra cotta trim, large round-arched two-story entrance. Commercial. First steel-frame building in Cleveland, by noted Chicago architect. Private.

75. Cleveland. DETROIT-SUPERIOR HIGH LEVEL BRIDGE, Over Cuyahoga River Valley, between Detroit Ave. and Superior Ave., 1917 (1-18-74)

A. B. Lea and Frank R. Lander, engineers. Tweleve reinforced concrete arches carrying vertical piers which support a double-decked roadway; central steel arch of 591-foot span. Largest double-deck reinforced concrete bridge in world at time of its completion. County.

76. Cleveland. DIVISION AVENUE PUMPING STATION, Division Ave., at the foot of W. 45th St., 1918 (station), 1914-1917 (engines) (1-18-74)

Brick, 5 stories, T-shaped, hipped roof, round-arched ground-floor windows, two tall freestanding brick chimneys; original hardware and fixtures. Second Renaissance Revival. Three vertical, triple-expansion steam engines by Allis-Chalmers pumped 25 million gallons per day for municipal water system; still maintained on standby basis in the event of power failure. Such well-preserved pumping engines and station are rare in OH, and becoming so nationally. Municipal.

77. Cleveland. FEDERAL RESERVE BANK OF CLEVELAND, E. 6th St. and Superior Ave., 1922-1923 (10-8-76)

Walker and Weeks, architect. Steel frame, masonry; 9 stories plus penthouse, rectangular, truncated hipped roof, front center entrance with architrave in round-arched recess; rusticated ground story with prominent voussoirs, lettered frieze, and surmounting balustrade; flanking sculptured figures, prominent modillion cornice; interior features shallow central dome, coffered ceilings, wrought iron and Sienna marble. Second Renaissance Revival. Example of the work of prominent Cleveland architects Walker and Weeks; designed to harmonize with D. H. Burnham's Beaux-Arts Classical Cleveland Mall Plan of 1903. Federal.

78. Cleveland. HOYT BLOCK, 608 W. St. Clair St., 1875 (1-18-74)

Red sandstone, 4 stories, rectangular, flat roof, high stone cornice with scrolled brackets, segmental- and round-arched windows grouped in vertical divisions. Only remaining example of stone commercial block in High Victorian Italianate style in city's main nineteenth century commercial district; built for prominent lawyer and real estate dealer James M. Hoyt. Private.

79. Cleveland. MAY COMPANY, 158 Euclid Ave. at Public Sq., 1914-1931 (1-18-74)

D. H. Burnham and Co., architects. Metal frame, terra cotta; 8 stories, rectangular, flat roof, six stories with Chicago windows; series of acroteria, scrolled pediment, and clock at the roofline; two later recessed stories (1930-1931) designed by Graham, Anderson, Probst and White. Characteristic example of the Commercial style and one of four buildings by Burnham in Cleveland. Private.

80. Cleveland. MILES PARK HISTORIC DISTRICT (NEWBURGH PUBLIC SQUARE), Miles Park Ave. around Miles Park, 19th and 20th century (5-17-74)

Small community area containing two churches, library, and eight houses in various nineteenth and twentieth century styles. Settled as Newburgh Village in 1798; incorporated 1850. Retains late-nineteenth century character within heavily urbanized area. Multiple public/private.

81. Cleveland. OHIO CITY PRESERVATION DISTRICT, Bounded by W. 26th, Clinton, W. 38th, and Carroll Sts., 19th-early 20th century (10-9-74)

District composed of 250 buildings including houses, commercial structures, churches, and a library. Houses range from generally simple treatment of common styles to more elaborate buildings including some fine Italianate structures; public buildings in High Victorian Gothic and Second Renaissance Revival styles. On the west bank of the Cuyahoga River, Ohio City was incorporated in 1836, before Cleveland, with which it merged in 1854. Multiple public/private.

82. Cleveland. OLD FEDERAL BUILDING AND POST OFFICE, 201 Superior Ave., NE., Early-20th century (5-3-74)

Arnold W. Brunner, architect. Granite, 5 stories, rectangular, flat balustraded roof, interior chimneys, rusticated ground floor with round-arched openings, pedimented second-story windows, corner pavilions, window bays articulated by engaged Corinthian columns and piers, sculptural groups by Daniel Chester French. Second Renaissance Revival. Central feature of two adjacent public spaces, one of which was designed by Daniel H. Burnham. Federal/GSA: HABS.

83. Cleveland. PERRY-PAYNE BUILDING, 740 Superior Ave., 1888 (7-16-73)

Cudell and Richardson, architects. Stone, 8 stories, square, flat roof with monitor; front paneled facade with first-floor storefronts, pilasters and columns framing each first- and second-story panel; bracketed stone cornices above the fourth and seventh floors, fourth- and sixth-floor bracketed balconies, central section extends an extra floor; replacement of all original windows. Excellent commercial structure. Private.

84. Cleveland. PLAYHOUSE SQUARE GROUP, 2067 E. 14th St.; 1422, 1501, 1515, 1621 Euclid Ave. (10-5-78)

85. Cleveland. ROCKEFELLER BUILDING, 614 Superior Ave., 1903-1905 (6-4-73)

Knox and Elliott, architects. Steel frame, brick; 16 stories, U-shaped, flat roof, lower three floors, with cast iron facade ornamented with elaborate Sullivanesque detail, fourth through sixteenth floors with continuous vertical pilasters between bays of paired windows, corner piers continuous from ground to top horizontal frieze, plain spandrels beneath windows; 1910 four-bay addition with similar treatment; altered interior. First steel frame building of this size in city, featuring straight-forward appearance of the Commercial Style; built for John D. Rockefeller. Private: HABS.

86. Cleveland. ROCKEFELLER PARK BRIDGES, Rockefeller Park (9-27-77)

87. Cleveland. SUPERIOR AVENUE VIADUCT, Superior Ave. (6-9-78): HAER.

88. Cleveland. UNION TERMINAL GROUP, Public Sq., 1919-1934 (3-17-76)

James Westmore, Walker and Weeks, and Philip Small, architects. Commercial district including seven office and public buildings constructed of steel frame and masonry veneer in the Beaux Arts and Modernistic styles. Design incorporates the Beaux-Arts concept of a "city within a city" and an unprecedented use of air rights over a railroad; constructed under the leadership of railroad entrepreneurs O. P. and M. J. Van Sweringen, developers of the nearby suburb of Shaker Heights. Private.

89. Cleveland. WEST SIDE MARKET, W. 24th St. and Lorain Ave., c. 1912 (12-18-73)

Hubbell and Benes, architects. Brick and Stone 1 story high, rectangular, vaulted roof with clerestory; front corner square tower with modified dome, diamond-patterned patterned brick detailing on tapered shaft, and four clock faces set in alternating bands of brick and stone. Market contains one of best column-free brick vaulted ceilings in OH. Municipal.

90. Cleveland vicinity. LORAIN-CARNEGIE BRIDGE, Spans Cuyahoga River between Lorain and Carnegie Aves., 1927-1932 (10-8-74)

Frank R. Walker, architect; Wilbur J. Watson, engineer; Lowensohn Construction Co. and Mt. Vernon Bridge Co., contractors. Steel and concrete; fourteen cantilever truss spans and one simple truss span at east end, 3,610 feet long; 93 feet above river, 60-foot-wide roadway; designed as two-deck bridge, lower deck never completed; pair of sandstone pylons at each end with sculpted faces of Art Deco figures holding transportation symbols. Third high-level bridge to connect city's residential west side with downtown east side; pylons are city's only major sculptural monuments in Art Deco idiom; received award from American Institute of Steel Construction, 1936. County.

91. Lakewood. CLIFTON PARK LAKEFRONT DISTRICT, Roughly bounded by Clifton Blvd., Rocky River, Lake Erie, and Webb Rd., Late 19th-early 20th century (11-20-74)

Residential area containing 103 structures; the majority present sophisticated examples of those building styles prevalent at the turn of the century. Developed as a cohesive upper class residential neighborhood. Multiple private.

92. Lakewood. HONAM, JOHN, HOUSE, 14710 Lake Ave. (4-13-77): HABS.

93. Lakewood. NICHOLSON, JAMES, HOUSE, 13335 Detroit Ave. (8-24-79): HABS.

94. Rocky River-Lakewood. DETROIT AVENUE BRIDGE (ROCKY RIVER BRIDGE), Detroit Ave. at Rocky River, 1907-1910 (2-23-73)

A. M. Felgate, engineer. Unreinforced concrete, 280-foot arched central span with multiarched approaches of about 220 feet each, 56 feet wide, concrete abutments and piers 95 feet above river; built for two lanes of highway traffic, double tracks for interurban railway cars, and sidewalks; slightly altered. Modeled after a 1903 stone bridge in Luxembourg. Once the longest unreinforced concrete main span in the world. County.

OHIO--Lake County

95. Fairport Harbor. FAIRPORT MARINE MUSEUM, 129 2nd St., 1871 (11-5-71)

Lightkeeper's house and round stone lighthouse; building is brick, 1½ stories, rectangular, with gabled roof, interior end chimneys, and segmental- arched windows; recent side addition of pilot house for display purposes. Light marks Lake Erie site where a lighthouse has stood since 1825. Museum. Municipal.

96. Painesville. ADMINISTRATION BUILDING, LAKE ERIE COLLEGE (COLLEGE HALL), 391 W. Washington St., 1859 (3-20-73)

Charles W. Heard, architect. Brick, 4 stories, modified L shape, low hipped roof sections, off-center five-story entrance tower with tripartite round-arched windows; large end pavilions with center gables, arcaded porch with balustrade between tower and pavilions, modillion cornice, label molded segmental- and round-arched windows, stone belt courses and foundations; some cast iron interior columns; rear wing 1872. Italian Villa. Built for Lake Erie Female Seminary when fire destroyed county's only institution of higher education for women. Private.

97. Painesville. CASEMENT HOUSE, 436 Casement Ave., 1870-1873 (7-30-75)

Charles W. Heard and Walter Blythe, architects. Brick, 2 stories, modified rectangle, hipped roof with mansarded cupola, interior chimneys, slightly projecting front center pedimented entrance bay with paired second-story round-arched windows, full-width one-story entrance porch with projecting pedimented entrance, segmental- and round-arched entrance, rear two-story gabled wing, modillion cornice; interior modified for office use. Italianate. Designed by prominent northeast Ohio architectural firm of Heard and Blythe. Private.

98. Painesville. LUTZ'S TAVERN (RIDER TAVERN), 179 Mentor Ave., c. 1810s (4-23-73)

Frame, clapboarding; 2 stories, L-shaped, gabled and flat roof sections, two-story full-width loggia with giant square Doric columns, off-center entrance beneath entablature, pedimented gable ends; one-story structure expanded 1832 by Jonathon Goldsmith; 1922 side addition; presently aluminum siding. Greek Revival. Tavern served as stage stop until popularity of railroads led to its conversion into a residence in 1865. Again a commercial operation. Private. HABS.

99. Painesville. MATHEWS HOUSE, 309 W. Washington St., 1829 (4-23-73)

Jonathan Goldsmith, builder-architect. Frame, clapboarding with flush-sided facade; 2 stories, cross-shaped, gabled roof sections, pedimented front gable on main block with four Doric pilasters across facade, entablature with triglyphs and guttae; off-center entrance with transom and side lights, Ionic columns, and consoles; fine wood carving in interior and at entrance. Good Greek Revival house by local man, Jonathan Goldsmith, whose carving inside and out illustrates the retention of Federal elements along with the more contemporary Greek Revival. Private; not accessible to the public.

100. Painesville. MENTOR AVENUE DISTRICT, Wood St. and Mentor Ave. from Liberty to Washington St. (8-3-78)

101. Painesville. MORLEY, LEWIS, HOUSE, 231 N. State St. (3-30-78)

102. Painesville. PAINESVILLE CITY HALL (OLD LAKE COUNTY COURTHOUSE), 7 Richmond St., 1840 (7-24-72)

Brick, 2 stories, rectangular, gabled and flat roof sections, tetrastyle pedimented two-story portico with robust fluted Doric columns, center entrance, dome on octagonal drum with circular lantern, two-story Doric pilasters and full entablature along one side; Italianate extension on side and rear with label molded round-arched windows and corbeled arched cornice; long rear wing added 1961. Greek Revival. Example of provincial courthouse in contemporary style with later nineteenth century additions. Municipal.

103. Painesville. ST. JAMES EPISCOPAL CHURCH, 141 N. State St., 1865-1868 (7-7-75)

Charles W. Heard and Walter Blythe, architects. Brick, stone foundation and trim; 1 story with choir loft, modified rectangle, gabled roof; front gable end three-story tower with ogee-arched entrance, pinnacles, and spire; tall narrow pointed-arched windows; rear bay apse, buttresses; northwest addition. Gothic Revival. Designed by prominent northeast OH architectural firm of Heard and Blythe. Private.

104. Painesville. SEELEY, URI, HOUSE, 969 Riverside Dr., c. 1830 (8-14-73)

Frame, clapboarding; 2 stories, rectangular, gable roof with two interior chimneys, pilasters dividing five-bay front facade into three sections, center doorway flanked by colonnettes supporting transom with center fanlight and radiating mullions. Greek Revival elements. Private; not accessible to the public.

105. Painesville. SESSIONS HOUSE (TUSCAN HOUSE), 157 Mentor Ave., c. 1870 (8-14-73)

Attributed to Charles Wallace Heard, designer. Brick, 2 stories, T-shaped, hipped roof, one interior chimney, slightly projecting section with dripstoned doors, second-story Palladian window moldings, bracketed pediment above cornice, bracketed and denticulated cornice. High Victorian Italianate. Private; not accessible to the public.

106. Painesville. SMEAD HOUSE, 187 Mentor Ave., 1875 (11-21-74)

Frame, clapboarding; 1½ stories, rectangular, mansard-type roof with bracketed pent at base, gabled dormers breaking through pent and frieze of vertical siding; decorated center porch with jigsaw work, flanked by bracketed projecting bays with floor-length windows; center gambrel cross-gable motif in roof, polygonal side bays; rear alterations. Second Empire ornamented with Stick Style elements. Illustrates late nineteenth century combination of a variety of forms and elements into a lively, hybrid work. Private; not accessible to the public.

107. Painesville vicinity. SOUTH LEROY MEETINGHOUSE, NE of Painesville at OH 86 and Brakeman Rd. (5-8-79)

108. Perry. GREEN, LUCIUS, HOUSE, 4160 Main St., 1878-1894 (7-12-76)

Frame, clapboarding; 2½ stories, irregular shape, steep truncated hipped roof with small decorative dormers, front off-center glazed entrance, one-story front and side wraparound porch, one-story projecting front bay with surmounting gabled porch, carved window surrounds, paneled frieze, bracketed cornice, three-and-a-half-story corner tower with balconied opening and shed dormers; interior alterations. Unusual example of High Victorian Eclectic; built for Lucius Green, prominent local agriculturalist. Private; not accessible to the public.

109. Ashtabula. ASHTABULA HARBOUR COMMERCIAL DISTRICT. Both sides of W. 5th St. from 1200 block to Ashtabula River. c. 1870-1910 (9-5-75)

A one-and-a-half block long commercial district comprised of predominantly brick and frame one- and two-story Italianate structures with supplementary examples of Queen Anne, Eastlake, and Neo-Classical Revival. Area developed in late nineteenth century as important commercial and shipping center at mouth of Ashtabula River; has maintained considerable nineteenth century character despite development of surrounding city. Multiple public/private use.

110. Ashtabula. HARMON, FRANCIS E., HOUSE, 1641 E. Prospect Rd., mid-19th century (2-24-75)

Brick, 2½ stories, L-shaped, gabled roof, interior chimneys, one-story front center gabled entrance porch with balustraded arcade and cornice brackets, tripartite entrance motif employing fanlight and round-arched sidelight, front center cross gable with octagonal attic light, rear ell with side frame addition; interior renovated for apartments. Well-preserved local adaptation of Italian Villa style. Private; not accessible to the public.

111. Ashtabula. HUBBARD, COL. WILLIAM, HOUSE, Corner of Lake Ave. and Walnut Blvd., 1834 (3-20-73)

Brick, 2 stories, rectangular, gabled roof, interior end chimneys, wooden window surrounds with sawtooth lintel and sill ornamentation; later front porch with square columns; altered. Greek Revival elements. Built for local businessman and abolitionist, William Hubbard, who helped escaped slaves en route to Canada. Municipal; not accessible to the public.

112. Conneaut. CUMMINS, DAVID, OCTAGON HOUSE, 301 Liberty St., c. 1863 (9-9-74)

Board construction, board and batten siding; 2 stories, octagonal, pyramidal roof, octagonal cupola, bracketed cornice, alternating one- and two-window facades, raked lintels; porch and rear wing added. Built for important Conneaut manufacturer, David Cummins; with solid board construction recommended in Orson Fowler's A Home for All. Private; not accessible to the public.

113. Conneaut. HARWOOD BLOCK, 246, 250, 256 Main St. (3-21-78)

114. Conneaut. KLIPI HALL, 1025 Buffalo St., 1899 (12-12-76)

Frame, asphalt siding, stone foundation; 2½ stories, Greek cross shape, intersecting hipped roof sections, front center recessed arched entrance, arched window and shingled gable with diamond-paned window, cupola and platform removed; rear addition and siding to be removed in planned restoration. Vernacular Queen Anne. Social hall typical of those built by Finnish temperance societies in late nineteenth century in northern Ohio and Great Lakes region. Private.

115. Conneaut. LAKE SHORE AND MICHIGAN SOUTHERN PASSENGER DEPOT, 342 Depot St., 1900 (3-27-75)

Stone, brick; 1 story, rectangular, hipped roof with wide bracketed eaves, interior chimney, similar front and rear facades each with twin entrances, rock-faced ashlar skirting and dressed corner and window quoins, track facade embellished by polygonal telegraph window bay and Palladian wall dormer. Jacobean elements. Exemplified rapidly disappearing small railroad passenger depot; constructed for Lake Shore and Michigan Southern RR; adapted to museum 1966. Private.

116. Eagleville vicinity. PECK, L. W., HOUSE, 2646 Eagleville Rd., c. 1848 (1-1-76)

Adobe brick, stuccoed; 2½ stories, rectangular, gabled roof, exterior end chimney, flat-arched entrance and window; one-story south end porch added in early twentieth century. Vernacular. Rare example of use of adobe brick in Western Reserve section of northeast Ohio. Private; not accessible to the public.

117. Geneva vicinity. SHANDY HALL, 6333 Ridge Rd., 1818-1828 (6-28-74)

Frame, clapboarding; 1½ stories, modified rectangle, gabled roof, side shed wings with open porches and rear extension, two interior chimneys, entrance with four light transom; altered. Construction begun by Robert Harper, state and local politician. Private: HABS.

PENNSYLVANIA--Erie County

118. Erie. CASHIER'S HOUSE, 413 State St., c. 1839 (1-13-72)

Brick, plastered; 3 stories, rectangular, flat roof, four interior chimneys; recessed off-center entrance with transom, pilasters, and heavy entablature; ornate Egyptian Revival interior. Greek Revival and Egyptian Revival elements. Built for Peter Benson, first cashier for the Erie branch of the United States Bank. State: HABS.

119. Erie. ERIE LAND LIGHTHOUSE, Dunn Blvd., Lighthouse Park (3-30-78): HABS

120. Erie. MAIN LIBRARY, 3 S. Perry St. (4-26-79)

121. Erie. OLD CUSTOMHOUSE, 409 State St., 1839 (1-13-72)

William Kelly, architect. Brick, marble front facade; 2 stories, rectangular, gabled roof, two interior chimneys, center double-door entrance with full-width hexastyle Doric portico with full entablature and simple pediment, facade marble secured with hand-forged dowels instead of mortar; interior contains plastered walls with egg-and-dart decoration. One of the earliest regional examples of Greek Revival. Built as Erie branch of United States Bank; later served as post office and customhouse. State: HABS.

122. Erie. U.S.S. NIAGARA, State St. at Lake Erie, 1813 (4-11-73)

Wooden square-rigged brig, 110-foot length, 17-foot beam; two masts, two long guns; reconstructed 1913 with some original timbers after being salvaged from lake bottom. One of six ships built at Erie to challenge British on lake during War of 1812; ship on which Comdr. Oliver Hazard Perry defeated the British following the sinking of his flagship, Sept. 10, 1813; Perry reported of the battle, "We have met the enemy and they are ours"; victory gave United States control of Lake Erie and renewed American threat to Canada. Museum. State.

NEW YORK--Chautauqua County

123. Westfield. BARCELONA LIGHTHOUSE AND KEEPER'S COTTAGE, East Lake Rd., 1829 (4-13-72)

Lighthouse complex includes conical stone lighthouse approximately 50 feet high with octagonal lantern and detached 1½-story stone cottage. Reputedly oldest existing lighthouse on Great Lakes; first public building to be lighted by natural gas; in use until 1859. Private.

NEW YORK--Erie County

124. Buffalo. ALBRIGHT-KNOX ART GALLERY, 1285 Elmwood Ave., in Delaware Park, 1900-1905 (5-27-71)

Edward B. Green, architect. Partially marble faced, 2 stories, modified H shape, gabled roof sections; east pedimented Ionic entrance portico flanked by colonnaded wings ending in pavilions, each with caryatids by Augustus Saint Gaudens; west semielliptical Ionic porch flanked by colonnaded sections; interior sculpture courtyard. Neo-Classical Revival. Built to permanently house the collections of the Buffalo Fine Arts Academy. Private.

125. Buffalo. BUFFALO GAS LIGHT COMPANY WORKS, 249 W. Genesee St., 1859 (9-1-76)

John L. Selkir, architect. Gasworks complex of five masonry, two- and three-story structures; includes dressed stone retort house with Gothic and Romanesque Revival elements, the brick office building, a brick stable and coal shed; alterations. Excellent example of well-designed nineteenth century industrial complex using Italianate and fortresslike Gothic and Romanesque Revival elements; built by Buffalo Gas Light Co., first to supply illuminating gas to Buffalo. Private.

126. Buffalo. BUFFALO STATE HOSPITAL, 400 Forest Ave., 1871-1890 (11-12-73)

Henry Hobson Richardson, architect. Random rough ashlar sandstone, brick; 3½ stories above high basement, main block with five west wards and two east wards, gabled and hipped roof sections, gabled and flared hipped dormers, front entrance recessed under three-bay arcade flanked by projecting pavilion; two main-block towers with steeply hipped roofs, shed dormers, and corner turrets; machicolations, rectangular and segmental-arched windows, wings with projecting cross-gable sections; three wards removed 1960s; four service buildings; site plan by Frederick Law Olmsted. Richardsonian Romanesque elements. Early development example of Henry Hobson Richardson's work. State: HABS.

127. Buffalo. GUARANTY BUILDING (PRUDENTIAL BUILDING), Church and Pearl Sts., 1894-1895 (3-20-73)

Louis Sullivan, architect. Steel frame, terra cotta sheathing; 12½ stories, U-shaped, flat roof; front and side entrances, each with large lunette at second-story level; first two stories topped by narrow cornice form base for upper levels, upper-story fenestration organized in vertical bands under round arches; oculi in coved section below cornice, decorative terra cotta ornament in low relief covers entire building; interior lobby with cast iron and leaded glass skylight, mosaic frieze and cast iron stairway; first-story store windows altered 1970 to form flat plane behind piers. Sullivanesque. A milestone in modern skyscraper development by Louis Sullivan, building successfully integrates structural clarity with ornamentation. Private: NHL, HABS.

128. Buffalo. MACEDONIA BAPTIST CHURCH, 511 Michigan Ave., 1845 (2-12-74)

Brick, 1 story, rectangular, gabled roof, enclosed entrance vestibule flanked by round-arched windows in recessed rectangular panels, rounded and inscribed stone plaque above entrance; modified meetinghouse plan with apse; twentieth century alterations. Social and religious center for Black community for 125 years. Parish of Dr. J. Edward Nash, a founder of the Buffalo Urban League and the local branch of the NAACP. Private.

129. Buffalo. PIERCE ARROW FACTORY COMPLEX, Elmwood and Great Arrow Aves., 1906 (10-1-74)

Albert Kahn, architect. Factory complex containing fourteen major buildings mainly of reinforced concrete steel with brick and glass curtain walls; saw-tooth roof sections, large spans up to 60 feet; some Arts and Crafts decorative elements on Administration Building front. Represents synthesis of trends foreshadowing developments in factory design; owned and operated by Pierce Arrow Co. until 1938; buildings later converted for diversified commercial use. Multiple private.

130. Buffalo. SHEA'S BUFFALO THEATER, 646 Main St., 1925 (5-6-75)

C.W. and George L. Rapp, architects; John Gill and Sons, builder. Steel, concrete, terra cotta; 1½ and 3-story sections, L-shaped, flat roof; five front bronze double-door entrances with suspended steel marquee surmounted by a large recessed segmental-arched window with flanking decorative terra-cotta panels; Baroque interior decorations intact; Wurlitzer organ. Substantially unaltered Baroque theater design by Rapp Brothers; in continuous use as theater and entertainment center. Public.

131. Buffalo. ST. PAUL'S EPISCOPAL CATHEDRAL, 125 Pearl St., 1850-1851 (3-1-73)

Richard Upjohn, architect. Sandstone ashlar, 1 story, irregular shape, gabled roof sections; cornice sections, some with modillions, some with trefoil arcading; front three-stage tower with tall spire, entrance porch, transept chapel with entrance and adjacent three-stage bell tower with spire, nave lancet windows with label molds, buttresses; towers completed 1870s; 1888 fire destroyed interior; new interiors designed by English architect, Robert Gibson; clerestory added. Fine example of Gothic Revival building adapted to unusual triangular site. Private.

132. Buffalo. THEODORE ROOSEVELT INAUGURAL NATIONAL HISTORIC SITE, Delaware Ave., 1838 (11-26-66)

Site includes Ansley Wilcox house, brick, 2½ stories, modified rectangle; gabled roof sections, some with end returns; interior end chimney; front full-width two-story pedimented portico, center entrance with fanlight, Palladian window in tympanum; 1863 remodeling, portico moved; 1890s additions; twentieth century interior alterations; restored. Greek Revival. Built for officers' quarters as part of Poinsett Barracks; site of Theodore Roosevelt's inauguration Sept. 14, 1901, after William McKinley's assassination. Museum. Federal/NPS.

133. Buffalo. U.S. POST OFFICE, 121 Ellicott St., 1897-1901 (3-16-72)

James Knox Taylor, architect. Rock-faced granited base, granite ashlar; 4½ stories over high basement, modified rectangle, gabled and pyramidal roof sections, numerous gabled and dormers, modillion cornice; front center tall tower with corner turrets, gargoyles, and spire with crockets and finial; front three entrances recessed under three-bay entrance porch with elaborate Gothic detailing, each side with three-bay entry and one to three entrances; rear cast iron portecochere, string courses, windows grouped under pointed arches; molded and carved detail including foliate capitals and buffalo heads; four-story-high central courtyard above first floor with steel and glass roof surrounded by galleries with rectangular, segmental, and pointed arched openings; 1936 remodeling included roofing of first floor of courtyard and skylight. Later Gothic Revival. Excellent example of late nineteenth century dual-nature architecture combining revivalist style with technological innovations; designed by James Knox Taylor, Supervising Architect of the U.S. Treasury. Federal/GSA: HABS.

134. Irving. THOMAS INDIAN SCHOOL, NY 438 on Cattaraugus Reservation, 1900 (1-25-73)

Barney and Chapman, architects. Educational complex consisting of nine principal brick Georgian Revival buildings and twenty-five dependencies; notable is the elaborate Administration Building with its ornate stone trim and decorative use of Indian related motifs and subject matter. Built by New York on reservation as a self-sufficient educational facility; school began mid-eighteenth century as the Thomas Asylum of Orphan and Destitute Indian Children and developed into a successful, accredited educational institution; in operation until 1958 when closed a result of centralization of the public school system. Tribal.

APPENDIX H. AN INVENTORY OF LAKE ERIE SHIPWRECKS*

(symbols are defined on pp. 5-27 of this report)

Wrecks in Area A (Michigan State Line to Sandusky Light)

Time Period 1: to 1865

Exact location "a"

1. 1A1ao Crocker, I.B.: Schooner. Stranded on Carpenter's Point, Kelley's Island, September 1864. Cargo: stone.
2. 2A1ao Empire: Bark. Wrecked May 4, 1857, at Marblehead Point.
3. 3A1ao Rainbow: Schooner. Wrecked August 24, 1837, at Put-in-Bay.
4. 4A1a* St. Louis: Sidewheel steamer. Wrecked one mile northeast of Kelley's Island, November 8, 1852. 618 tons. Built at Perrysburg, Ohio, in 1844. 185x27x12. Square engine from Sandusky.
5. 5A1a* Wisconsin: Sidewheel steamer. Sank August 1853; one mile east of West Sister Island. 490 tons. Built at Conneaut in 1838.

Approximate location "b"

6. 1A1b+ Acorn: Schooner. Collided with schooner Troy near West Sister Island and lost on July 28, 1849.
7. 2A1b+ Adair, W.A.: Schooner. Stranded May 7, 1849, off West Sister Island. 61 tons. Built in Black River, Ohio, in 1845.
8. 3A1b+ Borneo: Brig. Foundered August 28, 1852, near Cedar Point.
9. 4A1b+ California: Schooner. Foundered June 5, 1859, off Niagara Reef, north of Port Clinton. Built in 1853 at Black River.
10. 5A1b+ Essex: Schooner. Wrecked September 29, 1848, off North Bass Island.
11. 6A1b+ Lake Serpent: Schooner. Foundered October 1, 1829, near Sandusky Bay.
12. 7A1b+ Moses & Elias: Schooner. Wrecked April 1851 west of Middle Bass Island. Cargo: general.

*Base data derived with the assistance of Robert MacDonald who provided much of the information included in this Appendix.

13. 8A1b+ Seymour, H.R.: Schooner. Sank November 1854 at Rattlesnake Island. Cargo: wheat and whiskey.

14. 9A1b+ Sylph: Schooner. Wrecked May 14, 1824, off North Bass Island. Cargo: whiskey and wooden dishes.

15. 10A1b+ Uncle Sam: Schooner. Wrecked December 1847 on east side of Kelley's Island. Cargo: lumber.

16. 11A1b+ Visitor: Schooner. Foundered May 16, 1855, off West Sister Island. Cargo: general.

General location "c"

17. 1A1c+ Ashtabula: Schooner. Foundered June 20, 1848, near Kelley's Island.

18. 2A1c+ Cocquette: Schooner. Wrecked August 1858 near South Bass Island.

19. 3A1c+ Falcon: Scow/schooner. Foundered December 1856 off Kelley's Island.

20. 4A1c+ Florence: Schooner. Wrecked off Kelley's Island in 1854. Built in 1848 at Black River.

21. 5A1c+ Homen: Schooner. Wrecked December 4, 1854, off South Bass Island.

22. 6A1c+ Lafayette: Schooner. Wrecked August 1830 off South Bass Island.

23. 7A1c+ Marengo: Schooner. Foundered May 18, 1856, off Middle Sister Island.

24. 8A1c+ Matthews, Wm.: Scow. Foundered 1861 at Kelley's Island.

25. 9A1c+ Ohio: Sidewheel steamer. Burned 1842 off Toledo. 157 tons. Built in 1830 at Sandusky.

26. 10A1c+ Texas: Schooner. Wrecked May 1845 at South Bass Island.

Time Period 2: 1866-1890

Exact location "a"

27. 1A2ao Advance: Schooner. Foundered July 1871 off Green Island.

28. 2A2ao Escanaba: Foundered June 18, 1883, at Gull Island. 414 tons. Built 1866 at Vermilion by Nicholas. Cargo: iron ore.

29.* 3A2ao Gillmore, A.: Schooner. Wrecked June 1881 at Gull Island Shoal.

---

*Entry 29a. The schooner William Hunter was stranded October 25, 1875, on Niagara Reef.

30. 4A2aO Plummer, C.N.: Schooner. Burned and sank November 1888 on south side of Kelley's Island off Captain Hamilton's home. Cargo: none.

31. 5A2a+ Relief: Tug. Burned and beached off Carpenter's Point, Kelley's Island, June 1884.

32. 6A2ao King Sisters: Schooner. Wrecked October 1884 on Gull Island Schoal. 286 tons. Built by Rogers at Toledo in 1862.

Approximate location "b"

33. 1A2bo Exchange: Schooner. Wrecked November 28, 1874, on south side of Kelley's Island.

34. 2A2bo Gould: Scow/schooner. Wrecked August 1878 off Cedar Point.

35. 3A2b+ Handy Boy: Steamer. Burned August 4, 1888, off Sandusky.

36. 4A2bo Isabella: Barge. Wrecked off Put-in-Bay in 1878.

37. 5A2bo McLane, Louis: Schooner. Foundered August 1872 at anchor off Marblehead.

38. 6A2bo Mary Ann: Schooner. Wrecked June 1870 off Marblehead.

39. 7A2bo Mayflower: Schooner. Foundered August 17, 1875, off Kelley's Island.

40. 8A2bo Star of Hope: Schooner. Stranded October 1886 off Kelley's Island and broke up. 267 tons. Built by Quale and Martin at Cleveland in 1856.

41. 9A2bo Walter, Pitt: Propeller. Foundered June 20, 1887, near Marblehead.

42. 10A2bo Williams, H.G.: Scow/schooner. Foundered 1872 off Cedar Point.

General location "c"

43. 1A2co Grand Army: Scow. Capsized near Kelley's Island in July 1877.

44. 2A2co Hanna, H.R.: Schooner. Foundered and pounded to pieces off Kelley's Island in October 1886.

45. 3A2co Michigan: Propeller. Burned December 3, 1888, at Kelley's Island. 354 tons. Built in Ohio City in 1852.

Time Period 3: since 1891

Exact location "a"

46. 1A3ao Barlum, John J.: Schooner/barge. Foundered September 18, 1922, 1½ miles north-northeast of Marblehead Light. Built in 1890 at Toledo. 222x40x16. Wood, three masts. Cargo: coal.

47. 8A3ao Boyce, Isabella J.: Sand steamer. Burned to water's edge off the east end of Middle Bass Island on June 6, 1917. Crew escaped to Put-in-Bay, 3 miles to the southeast.

48. 2A3ao Chicago Board of Trade: Schooner. Stranded November 19, 1900, on Niagara Reef during heavy weather; became a total loss. 424 tons. Built in 1863 at Manitowoc by Rand.

49. 3A3ao Constitution: Schooner. Sank September 29, 1906, near West Dock, Kelley's Island. 422 tons. Built by Jones at Milwaukee in 1861. Cargo: stone.

50. 4A3ao Custodian: Tug. Burned east end of West Sister Island on June 23, 1925.

51. 5A3a+ Dunbar, George: Steamer. Foundered 4 miles east-northeast of Kelley's Island on June 29, 1902.

52. 6A3ao Erie: Schooner. Sank off west side of South Bass Island, November 1929.

53. 7A3ao Eddy, John F: Barge. Foundered November 13, 1920, about 5½ miles northwest of West Sister Island. Cargo: coal.

54. 9A3ao Keepsake: Scow. Wrecked on Gull Island Shoal in August 1911.

55. 10A3ao Lucille: Steamer. Foundered August 8, 1906, about one mile east of Turtle Island Light. Cargo: none.

56. 11A3ao Mosher, Amaretta: Schooner. Stranded off Starve Island on November 23, 1902. Cargo: coal.

57. 12A3ao Red Cloud: Tug. Wrecked September 1899 when she struck Cedar Point Jetty. 20 tons. Built by S. Gibson at Buffalo in 1883.

58. 13A3ao Richards, May: Schooner. Foundered in 1906 on the north side of North Bass Island. 511 tons. Built by J. Richard in 1871.

59. 14A3ao Roberta: Yacht. Burned July 27, 1900, off the south side of West Sister Island.

60. 15A3co Toledo: Dredge. Foundered November 19, 1924, one mile west-northwest of Rattlesnake Island; 6,000 feet northwest from the northwest end of Rattlesnake Island and about 2 7/8 miles north of Green Island Light.

61. 16A3co Willard, Julia: Schooner. Sank December 20, 1895, off West Sister Light. Built at Ashtabula in 1865.

Approximate location "b"

62. 1A3bo Adventure: Steamer. Burned October 7, 1903, at North Bay, Kelley's Island. Cargo: lime.

63. 2A3bo Argo: Barge. Foundered October 20, 1937, 3 miles from north side of Kelley's Island.

64. 3A3bo Barkalow, M.P.: Schooner. Foundered April 1902 off South Bass Island. 115 tons. Built in 1871 by O. Harper at Peru.

65. 4A3bo <u>Benson, J.R.</u>: Schooner. Foundered June 22, 1899, near Cedar Point.

66. 5A3bo <u>Exilda</u>: Tug. Foundered November 27, 1916, about four miles off West Sister Island.

67. 6A3bo <u>Edith</u>: Tug. Burned April 1894 off Mouse Island.

68. 7A3bo <u>Grace M</u>: Tug. Sank due to collision in June 1905 about six miles off Middle Bass Island.

69. 8A3bo <u>John Mark</u>: Schooner. Wrecked October 23, 1903, southeast of Kelley's Island. 319 tons. Built at Trenton in 1870. Cargo: stone.

70. 9A3b+ <u>Lorene</u>: U.S. 207088. Foundered off Port Clinton in September 1945. Built in Buffalo in 1886 by Bell. Hull #31.

71. 10A3bo <u>Maggie, Jessie</u>: Schooner. Foundered May 10, 1904, off Sandusky.

72. 11A3bo <u>Marblehead</u>: Gas-engined boat. Foundered June 14, 1920, off Kelley's Island.

73. 12A3bo <u>Minch, Philip</u>: Propeller. Burned November 20, 1904, about eight miles off Marblehead.

74. 13A3bo <u>Prince, F.H.</u>: Steamer (originally package freighter converted into sand and gravel steamer). Caught fire August 12, 1911, near Kelley's Island.

75. 14A3bo <u>Point Abino</u>: Steamer. Wrecked December 1899 near Ballast Island. 130 tons. Built in Buffalo in 1872.

76. 15A3bo <u>Roland</u>: Propeller. Foundered October 1892 off Green Island. 124 tons. Built in 1885 at Sandusky. Cargo: stone.

77. 16A3bo <u>Root, H.D.</u>: Schooner. Foundered April 3, 1894, off South Bass Island. 110 tons. Built 1874 at Black River by H.D. Root.

78. 17A3bo <u>Spademan, Charles</u>: Schooner. Foundered near Put-in-Bay on December 11, 1909.

<u>General location "c"</u>

79. 1A3co <u>Fulton</u>: Schooner. Foundered July 7, 1908, off Toledo.

80. 2A3co <u>Lucille</u>: Passenger steamer. Sank August 9, 1906, off Toledo.

81. 3A3co <u>Miller, Laura</u>: Schooner. Foundered October 8, 1899, near Toledo.

Wrecks in Area B (Sandusky Light to Rocky River, Ohio)

<u>Time Period 1: to 1865</u>

<u>Exact location "a"</u>

None located.

Approximate location "b"

82. 1B1bo Anawan: Schooner. Foundered off Huron River in December 1851.

83. 2B1bo Commander Lawrence: Schooner. Foundered August 29, 1849, off Vermilion.

84. 3B1b+ Emigrant: Propeller altered to brig in 1845. Lost off Avon Point in 1845. 249 tons. Built Cleveland 1843.

85. 4B1b+ Euphrates: Propeller. Wrecked May 1862 off Sandusky Bar. 587 tons. Built at Buffalo in 1856.

86. 5B1bo Illinois: Schooner. Foundered July 1865 near Vermilion. Wrecked Lake Erie 1851. Built at Sackett's Harbor in 1834.

87. 6B1bo Independence: Schooner. Wrecked off Black River on November 15, 1818.

88. 7B1bo Ivanhoe: Schooner. Sank due to collision on October 4, 1855, about 10 miles west of Cleveland. Commissioned in 1849.

89. 8B1bo Lexington: Schooner. Foundered with all hands on November 19, 1846, about 5 to 10 miles off Huron, OH. Cargo: gold and whiskey.

90. 9B1bo Lyons, E.M.: Schooner. Sank due to collision on June 12, 1855, off Black River.

91. 10B1bo Mary: Schooner. Foundered October 25, 1856, off Vermilion.

92. 11B1bo Monarch: Schooner. Foundered November 1862 off Sandusky Bar.

93. 12B1bo Phoenix: Schooner. Foundered June 5, 1864, off Avon Point.

94. 13B1bo Ploughboy: Scow. Wrecked 1861 off Lorain.

95. 14B1bo Reindeer: Schooner. Capsized June 23, 1838, off Huron. Built at Clayton, Lake Ontario.

96. 15B1bo Republic: Schooner. Sank July 31, 1895, off Lorain. 314 tons.

97. 16B1bo Scott, A.: Schooner. Wrecked near Black River on April 26, 1859.

98. 17B1bo Sea Bird: Schooner. Sank off Vermilion on December 7, 1850.

99. 18B1b* Wayne, Anthony: Sidewheel steamer. Lost by explosion on April 28, 1850, off Vermilion. 400 tons. Built in 1849 at Trenton, MI.

General location "c"

100. 1B1c* Beaver: Schooner. Stranded May 17, 1771, about ten leagues* below Sandusky. Historical significance based on time period.

101. 2B1co Lily: Scow. Wrecked 1862 off Vermilion.

102. 3B1co Meyers: Schooner. Wrecked November 1852 off Cedar Point.

---

*A league is a unit of distance that can vary from 2.4 to 4.6 miles.

103. 4B1co Plymouth: Schooner. Lost due to collision on June 23, 1852, about thirty-five miles west of Cleveland.

104. 5B1co Republic: Propeller. Burned near Sandusky on October 3, 1857. 460 tons. 170x25x11. Built at Cleveland in 1848.

Time Period 2: 1866-1890

Exact location "a"

105. 1B2a* Morning Star: Steamer. U.S. 16463. Sank 21 miles north-northeast of Vermilion due to collision with bark Cortland on June 20, 1868. 1,075 tons. Built at Trenton, MI, by A.A. Turner in 1862. 243x34x14. Vertical beam engine from Ocean, 60" x 11".

106. 2B2ao Hawley, R.K.: Tug. Foundered one mile east-northeast of Huron Pier.

Approximate location "b"

107. 1B2bo Eclipse: Propeller. Foundered 1874 off Avon Point. 620 tons. Built at Buffalo in 1857.

108. 2B2bo Griffon, F.R.: Foundered June 20, 1887, off Lorain.

109. 3B2bo Henry, Patrick: Tug. Foundered August 11, 1887, about four miles off Vermilion.

110. 4B2bo Vulcan: Tug. Burned June 7, 1883, off Vermilion.

111. 5b2bo White, Ellen: Scow/schooner. Burned September 20, 1870, off Avon Point. Cargo: staves.

Time Period 3: since 1891

Exact location "a"

112. 1B3ao State of Ohio: Barge. Stranded December 17, 1929, east of Lorain entrance channel, opposite the foot of California Avenue and about 550 feet from shore.

113. 2B3ao Penelope: Tug. Burned December 19, 1909, at Lorain. 54 tons. Built as steam yacht. 74x13.7x8.7.

114. 3B3a+ Sand Merchant: Steamer. Foundered October 17, 1936, about seventeen miles northwest of Cleveland. Lies off Avon Point 13½ miles 288° from Cleveland West Pierhead Light.

Approximate location "b"

115. 1B3bo Admiral: Tug. Foundered December 2, 1942, off Avon Point.

116. 2B3bo Alva: Tug. Foundered November 1, 1917, off Avon Point.

117. 3B3bo Black Marlin: Tug. Foundered November 29, 1958, off Avon Point.

118. 4B3bo Buckeye: Fishing tug. Foundered June 29, 1924, off Lorain.

119. 5B3b+ City of Concord: Propeller. Sank September 27, 1906, off Sandusky. Built in 1868.

120. 6B3bo Col. Cook: Schooner. Foundered September 23, 1895, near Lorain.

121. 7B3bo Comet: Fishing tug. Foundered December 22, 1924, off Avon Point.

122. 8b3bo Duff, Nellie A: Schooner. Lost October 14, 1895, off Lorain. Built in 1885 at Port Clinton. Cargo: gravel.

123. 9B3bo Hickory Stick: Dredge. Foundered November 29, 1958, off Avon Point.

124. 10B3bo McKerchey, John M: Propeller. Foundered October 16, 1950, about one mile from Lorain.

125. 11B3b+ Mecosta: Steamer. Foundered October 29, 1922, near Rocky River. Built in 1888 at West Bay City. 281x40.

126. 12B3b+ Olwill, Margaret: Steamer. Foundered June 1899 about 8 miles off Lorain.

127. 13B3bo Pelton: Schooner. Wrecked July 7, 1896, east of Lorain. 129 tons. Built in 1891 at Vermilion.

128. 14B3bo Restless: Yacht. Foundered July 30, 1908, off Rocky River.

129. 15B3bo Sprankle, J.R.: Tug. Foundered November 21, 1956, west of Rocky River.

130. 16B3bo Woods, Kate: Schooner. Lost due to collision on September 22, 1899, about 12 miles off Huron.

General location "c"

131. 1B3co Beaubion #6: Scow. Foundered April 15, 1932, near Sandusky.

132. 2B3co Fellowcraft: Barge. Foundered in 1928 between Cleveland and Southeast Shoal.

133. 3B3c+ 104: Steel barge; whaleback. Sank in 1898 near Cleveland. 1,295 tons. Built in 1890 at Duluth.

Wrecks in Area C (Rocky River, OH, to Pennsylvania State Line)

Time Period 1: to 1865

Exact location "a"

134. 1C1ao American Eagle: Schooner. Stranded November 25, 1820, at mouth of Grand River. 48 tons. Built in Cleveland.

135. 2C1a* Caspian: Sidewheel steamer. Wrecked off Cleveland Pier in July 1852. 921 tons. Built at Newport in 1851.

136. 3C1a* Hudson, Hendrik: Sidewheel steamer. Burned May 21, 1860, off Cleveland. 750 tons. Built at Cleveland in 1846.

137. 4C1a* Indiana: Sidewheel steamer. Burned at Conneaut on November 23, 1848. 534 tons. Built at Toledo in 1842.

138. 5C1a* Lady of the Lake: Propeller. Wrecked by explosion on March 26, 1859, at Fairport, OH. 326 tons. Built at Cleveland in 1846.

139. 6C1a+ Manchester: Canadian brig. Totally wrecked at Madison, OH, on April 23, 1859. Built at Wolf Island, Lake Ontario, before 1852.

140. 7C1a* North American: Sidewheel steamer. Burned January 14, 1847, near Conneaut. 361 tons. Built at Conneaut in 1834.

141. 8C1a+ North Star: Sidewheel steamer. Burned on February 20, 1862, at Cleveland. 1,106 tons. Built at Cleveland in 1854.

142. 9C1ao Olive Branch: Sloop. Wrecked October 1831 at mouth of Grand River.

143. 10C1a+ Petrel: Propeller. Drifted ashore about 100 feet below piers at Ashtabula on October 3, 1850. 237 tons. Built at Port Huron in 1848. Cargo: flour.

144. 11C1a* St. Joseph: Propeller. Stranded 6 miles below Fairport on November 4, 1856. 460 tons. Built at Buffalo in 1846.

145. 12C1ao Toledo: Schooner. Wrecked about one mile below Grand River on November 7, 1838. 130 tons. Built at Buffalo in 1836.

146. 13C1a* Wood, James: Propeller. Stranded on September 12, 1854, off Ashtabula. 400 tons. Built in 1846.

Approximate location "b"

147. 1C1bo Alps: Schooner. Capsized off Ashtabula on May 5, 1851. 108 tons. Built in 1840.

148. 2C1bo Barton, Agnes: Schooner. Sank off Conneaut on August 8, 1855. 110 tons. Built at Buffalo in 1835.

149. 3C1bo Brewster, William: Schooner. Sank off Ashtabula in 1852. 70 tons. Built on Lake Superior in 1838.

150. 4C1bo Chesapeake: Sidewheel steamer. Sank due to collision with propeller General Porter on June 10, 1847, off Conneaut. 412 tons. Built at Maumee in 1838. Operated by Read of Erie. 172x25x10.

151. 5C1b* City of Oswego: Propeller. Sank due to collision with America on July 12, 1852, off Willowick, OH. 357 tons. Built at Buffalo in 1852.

152. 6C1bo Clay, Henry: Schooner. Lost off Ashtabula on May 14, 1851. 59 tons. Built at China, MI, in 1844. 83x20'5"x9'2½".

153. 7C1bo <u>Commercial</u>: Schooner. Lost due to collision on June 22, 1840, off Conneaut.

154. 8C1bo <u>Convoy</u>: Schooner. Foundered December 4, 1854, off Conneaut.

155. 9C1bo <u>Darlie, C.J.</u>: Schooner. Wrecked May 1847 off Conneaut.

156. 10C1bo <u>Dolphin</u>: Schooner. Foundered July 1, 1854, off Cleveland. 75 tons. Built at Milwaukee in 1841.

157. 11C1bo <u>Emily</u>: Schooner. Lost due to collision on September 1, 1842, off Cleveland.

158. 12C1bo <u>Franklin</u>: Schooner. Lost October 11, 1820, off Grand River, OH.

159. 13C1bo <u>Gazette</u>: Schooner. Stranded December 13, 1852, off Cleveland.

160. 14C1b* <u>Griffith, G.P.</u>: Sidewheel steamer. Burned off Mentor, OH, on June 18, 1850. 587 tons. Built at Maumee in 1848.

161. 15C1bo <u>Hudson</u>: Schooner. Sank about one mile off Conneaut on August 26, 1854. 125 tons. Built at Oswego in 1836.

162. 16C1bo <u>Hunt Merritt</u>: Schooner. Foundered November 12, 1850, near Grand River.

163. 17C1bo <u>Johnson, R.R.</u>: Schooner. Foundered with all hands off Fairport, OH, on December 4, 1854.

164. 18C1bo <u>King, J.G.</u>: Schooner. Wrecked off Conneaut in 1843. 154 tons. Built at Dunkirk in 1836.

165. 19C1b* <u>Lexington</u>: Sidewheel steamer. Sank August 1, 1850, near Conneaut. 363 tons. Built at Black River in 1838.

166. 20C1bo <u>Mackinaw</u>: Schooner. Sank due to collision on June 4, 1851, off Euclid, OH.

167. 21C1bo <u>Oregon</u>: Schooner. Foundered November 5, 1852, off Conneaut. 145 tons. Built at Three Mile Bay, Lake Ontario, in 1843.

168. 22C1bo <u>Porter, John</u>: Schooner. Lost due to collision on June 10, 1847, off Conneaut.

169. 23C1bo <u>St. Nicholas</u>: Steamer. Lost due to collision in August 1848 off Fairport, Ohio.

170. 24C1bo <u>Scioto</u>: Schooner. Sank due to collision with brig <u>Quebec</u> on October 20, 1851, off Ashtabula. 130 tons. Built at Cleveland in 1841.

171. 25C1bo <u>Walker, Gitt</u>: Schooner. Wrecked at Madison Dock on October 28, 1853. Cargo: lumber.

172. 26C1bo <u>War Eagle</u>: Schooner. Wrecked at Ashtabula in 1856.

173. 27C1bo <u>Whittlesey, Elisha</u>: Schooner. Capsized and sank in squall off Ashtabula on October 5, 1832. Built at Ashtabula in 1831.

174. 28C1bo <u>William, Mary</u>: Schooner. Wrecked October 22, 1862, about 16 miles east of Cleveland.

General location "c"

175. 1C1co Alabama: Schooner. Total loss near Fairport in 1843.

176. 2C1co Atlantic: Schooner. Lost on September 5, 1840, about 7 miles below Cleveland. 119 tons.

177. 3C1co Ceres: Schooner. Foundered August 23, 1837, about 4 miles from Chagrin River.

178. 4C1co Commodore: Schooner. Wrecked near Cleveland on November 9, 1845.

179. 5C1co Courier: Brig. Sank by brig Monteith between Erie and Conneaut on September 20, 1847. 219 tons. Built at Cleveland in 1847.

180. 6C1co Eddy, H.M.: Scow. Foundered July 1, 1850, about 15 miles off Cleveland.

181. 7C1co Elizabeth: Schooner. Lost near Conneaut on October 11, 1820.

182. 8C1co Equator: Schooner. Lost due to collision in September 1843 near Conneaut. 132 tons. Built at Charleston.

183. 9C1co Houston, General: Schooner. Total wreck near Fairport on June 3, 1859.

184. 10C1c+ Ogdensburg: Propeller. Sank due to collision with schooner Snow Bird near Fairport on September 30, 1864. 352 tons. Built in 1852 at Ohio City.

185. 11C1co Owen, Garry: Schooner. Foundered July 1, 1869, off Ashtabula. 333 tons.

186. 12C1co Rough and Ready: Scow. Lost near Conneaut on June 9, 1847.

187. 13C1c+ Sandusky: Propeller. Stranded on October 20, 1856, near Conneaut. 370 tons. Built at Buffalo in 1849.

188. 14C1c+ Southerner: Sidewheel steamer. Stranded October 18, 1853, near Ashtabula. 550 tons. Built at Monen, MI, in 1847. 170x28x11. High pressure engine from General Wayne, 27"x8'.

Time Period 2: 1866-1890

Exact location "a"

189. 1C2ao Arabian: Bark. Stranded June 17, 1866, off Cleveland.

190. 2C2a+ Wahnipitac: Schooner. Wrecked off Cleveland on October 26, 1890. 1,431 tons. Built in 1886 at Bay City, MI. 260x51x11.9.

191. 3C2ao Walbridge, Sarah C.: Brig. Wrecked December 20, 1866, off Euclid Creek. Built at Conneaut.

Approximate location "b"

192. 1C2bo Andes: Schooner. Sunk off Madison in October 1868. 360 tons.

193. 2C2bo Bates, Eli: Schooner. Foundered November 1871 between Conneaut and Ashtabula. June 22, 1872, discovered off Conneaut in 14 feet of water. 365 tons. Built by George Hardison 137x26x11. Launched at Erie on May 2, 1857. Cargo: wheat.

194. 3C2bo Darien: Schooner. Foundered June 17, 1866, off Euclid. Built in 1858.

195. 4C2bo Gale, Stephen F.: Brig. Lost November 28, 1876, near Cleveland. 266 tons. Built at Chicago in 1846.

196. 5C2bo Grover, Alice: Schooner. Wrecked off Cleveland on June 18, 1866.

197. 6C2bo Hill, John J.: Schooner. Foundered 1885 near Fairport.

198. 7C2bo Jones, Fannie L.: Schooner. Foundered in a heavy sea a half mile from Cleveland Harbor, and sank August 1890. 112 tons. Built in 1867 at Black River.

199. 8C2b+ Joy, James F.: Schooner. Sank off Ashtabula in 1887. 554 tons. Built in 1866.

200. 9C2bo Juliette: Schooner. Sank off Madison in 1871. Built in 1834 at Black River.

201. 10C2b+ Leo: Steam yacht. Lost due to explosion in 1889 off Cleveland.

202. 11C2bo New Lisbon: Schooner. Capsized off Fairport on September 10, 1871.

203. 12C2bo Oakland: Propeller. Foundered off Conneaut. Sank at Ashtabula in 1878. 311 tons. Built at Erie, PA, in 1867.

General location "c"

204. 1C2co Gilmore, General: Dredge. Foundered 1888 off Fairport.

205. 2C2co Maple Leaf: Schooner. Foundered November 21, 1899, 25 miles off Cleveland. 141 tons. Built in 1867.

206. 3C2co Mills, Philena: Schooner. Wrecked June 20, 1866, below Cleveland.

207. 4C2co Susquehanna: Schooner. Sank August 1865 off Conneaut, Ohio. 270 tons.

Time Period 3: since 1891

Exact location "a"

208. 1C3ao Cleveco: Oil barge (U.S. 211035). Foundered December 3, 1942, about nine miles northeast of Cleveland. All hands lost. Raised and sunk in deep water in 1961. Built at Lorain in 1913. 250x43x26. Moved to position approximately 16 7/8 miles, 010½° from Cleveland East Entrance Light. Sank keel up in 71 feet of water.

209. 2C3ao Dixie: Barge. Foundered December 4, 1964, about four miles north-northwest of Ashtabula Harbor in 43 feet of water; 20,000 feet 066° from Ashtabula Harbor East Breakwater Light.

210. 3C3ao Gregory, John: Tug. Foundered November 13, 1904, at entrance to Cleveland Harbor.

211. 4C3ao Gulnare: Schooner. Came ashore July 15, 1892, at Woodland Beach Park, east of Ashtabula Harbor. Remains are inside the breakwall. Built in 1873 at Port Robinson. Cargo: grindstone.

212. 5C3ao Pelican: Schooner. Foundered May 16, 1893, in 48 ft. of water off Ashtabula; distance also given as 1 mile off Ashtabula. 813 tons. Built in 1872 off Detroit.

213. 6C3ao Queen of the West: Steamer. Foundered August 20, 1903, about 7 3/4 miles northwest of Fairport. 818 tons. Built by Crosthwaite at Bay City, MI, in 1881.

214. 7C3ao Sonsmith, Rosa: Schooner. Stranded November 5, 1900, at Ashtabula Pier during heavy weather. Became a total loss.

Approximate location "b"

215. 1C3bo Algeria: Schooner. Foundered May 9, 1906, about 3 miles northwest of Cleveland.

216. 2C3bo Cleveland, H.G.: Schooner. Foundered August 10, 1899, off Cleveland.

217. 3C3bo Cornell: Tug. Foundered December 21, 1922, off Fairport.

218. 4C3bo Davis, Charles H.: Propeller. Foundered June 13, 1903, off Cleveland.

219. 5C3bo Dundern: Barge. Foundered July 15, 1919, outside Ashtabula Harbor.

220. 6C3bo Fishing Queen: Tug. Foundered December 17, 1897, off Cleveland.

221. 8C3bo Foster, David: Barge. Foundered October 17, 1936, off Conneaut.

222. 9C3bo King, C.G.: Schooner. Burned off Cleveland on July 23, 1913.

223. 10C3bo North Carolina: Tug. Foundered December 9, 1968, about 1½ miles north of Mentor-on-the-Lake.

224. 11C3bo Pacific: Barge. Stranded near Cleveland on October 13, 1896.

225. 12C3bo Peck, W. I.: Schooner. Foundered off Ashtabula in 1891. 361 tons. Built in 1873 at Carrollton.

226. 13C3bo Pensaukee: Tug. Foundered December 1, 1902, off Cleveland.

227. 14C3bo Reindeer: Schooner. Foundered July 8, 1896, at Ashtabula. 191 tons. Built in 1860 at Clayton, NY.

228. 15C3bo Riverside: Schooner. Lost off Cleveland on October 19, 1893. 278 tons. Built in 1870 at Oswego.

229. 16C3bo Sawyer, J. D.: Schooner. Stranded west of Cleveland on October 29, 1891; abandoned as a total loss.

230. 17C3bo Stewart, David: Schooner. Stranded near Fairport October 29, 1891. Abandoned after attempts to release failed. 545 tons. Built at Cleveland by Peck in 1867.

231. 18C3bo Two Fannies: Schooner. Sank off Cleveland in 1890.

232. 19C3bo Wilson, Mable: Schooner. Foundered May 28, 1906, about two miles off Cleveland.

233. 20C3bo Winnie M.: Fishing tug. Foundered January 15, 1918, off Conneaut.

234. 21C3bo Yukon: Schooner. Foundered October 20, 1905, about 3 miles north of Ashtabula Harbor.

235. 22C3bo Monitor: Propeller. Foundered September 15, 1901, near Grand River.

General location "c"

236. 1C3co Dundee: Schooner. Foundered September 12, 1900, about 11 miles west of Cleveland.

237. 2C3co Keepsake: Schooner. Foundered September 17, 1898, about 50 miles east of Cleveland. 268 tons. Built in 1864 at Marine City, MI.

238. 3C3co Lockwood, C.B.: Steamer. Lost in 1902 about 15 miles off Ashtabula. Cargo: wheat.

239. 4C3co Pridgeon, John Jr.: Steamer. Wrecked in storm on September 18, 1909, about 14 miles from Cleveland. 1212 tons. Built at Detroit by Clark in 1875. Cargo: lumber.

240. 5C3co Wonder: Steamer. Ran aground on September 6, 1908, near Ashtabula; was released on September 10. While being towed to dock, sank again in 20 feet of water. Total loss.

Wrecks in Area D (Pennsylvania State Line to Silver Creek, NY)

Time Period 1: to 1865

Exact location "a"

241. 1D1a+ Cataract: Propeller. Burned on June 16, 1861, at Erie, PA. 393 tons. Built at Buffalo in 1852.

242. 2D1ao Celeste: Schooner. Wrecked at Barcelona, NY, in 1840.

243. 3D1ao Elmira: Scow. Sank at Erie in 1855. 52 tons. Built in 1852 at Black River.

244. 4D1ao Eudora: Schooner. Wrecked at Dunkirk in 1851. 133 tons. Built in Charleston, OH, in 1843.

245. 5D1a+ Golden Gate: Sidewheel steamer. Burned at Erie on November 29, 1856. 771 tons. Built at Buffalo in 1852.

246. 6D1ao Jenkins, Louisa: Schooner. Wrecked at Dunkirk in September 1841.

247. 7D1ao Josephine: Schooner. Wrecked at Dunkirk in 1848. 175 tons. Built at Oswego, NY, in 1845.

248. 8D1a+ Marcy, Gov.: Sidewheel steamer. Stranded June 4, 1847, near Dunkirk. 161 tons. Built at Black Rock in 1834.

249. 9D1ao Paugasset: Propeller. Burned on August 23, 1856, near Dunkirk, NY. 325 tons. Built at Ohio City in 1847.

250. 10D1ao Peerless: Bark. Wrecked off Dunkirk in 1859.

251. 11D1ao Sizer, H.H.: Brig. Sank off Dunkirk in 1851. 242 tons. Built in 1845.

252. 12D1ao Troy: Propeller. Burned off Erie in 1850.

Approximate location "b"

253. 1D1bo Bogart, D.D.: Schooner. Wrecked near Erie in 1851. 80 tons. Built at Three Mile Bay, Lake Ontario, in 1843.

254. 2D1bo Brandywine: Sloop. Lost off Barcelona in 1846.

255. 3D1bo California: Schooner. Wrecked near Barcelona on November 29, 1851.

256. 4D1b+ Charter Oak: Schooner converted to steamer in 1848. Lost near Erie on October 28, 1855. 184 tons.

257. 5D1bo Colt, Thomas G.: Schooner. Capsized and sank off Barcelona on July 3, 1859. Built in 1846 at Black River.

258. 6D1b* Detroit: Sloop. Sank in 1797 about 3 miles north of Erie. Cargo: military equipment.

259. 7D1bo Dousman, M.: Schooner. Sank near Dunkirk, NY, in 1852. 86 tons. Built at Milwaukee in 1843.

260. 8D1bo Grank, John: Schooner. Capsized near Erie in 1845. 93 tons. Built in 1836.

261. 9D1bo Harlequin: Schooner. Lost off Erie during her first season with all hands. Built at Erie in 1800 by Beebe.

262. 10D1bo Honore: Schooner. Wrecked near Dunkirk in 1851.

263. 11D1b+ Indian Queen: Paddlewheel steamer. Foundered November 19, 1846, near Battery Point (Dunkirk). 112 tons. Built at Buffalo in 1844.

264. 12D1bo Java: Schooner. Lost off Dunkirk in 1858.

265. 13D1bo Mills, Francis: Brig. Sank off Erie in 1847. 116 tons. Built at Michigan City in 1841.

266. 14D1bo Monarch: Scow. Lost near Erie in 1835.

267. 15D1b+ Ohio: Propeller. Exploded and sank off Erie in November 1859. 441 tons. Built at Black River in 1848.

268. 16D1bo Ohio: Schooner. Lost off Dunkirk in 1856. 127 tons. Built at Cleveland in 1841.

269. 17D1b+ Oneida: Propeller. Foundered November 7, 1852, off Van Buren Point. 345 tons. Built at Cleveland in 1846.

270. 18D1bo Pacific: Schooner. Wrecked and destroyed near Dunkirk in 1844.

271. 19D1b* Princeton: Propeller. Lost in ice on April 20, 1854, about 3 miles below Barcelona. 455 tons. Built at Perrysburg in 1845. Cargo: stoves, hardware, and agricultural implements.

272. 20D1bo Rainbow: Scow. Wrecked near Barcelona in 1848. 15 tons. Built in 1836.

273. 21D1bo Rochester: Barge. Wrecked west of Erie in 1852. 472 tons. Built as steamer near Fairport in 1837.

274. 22D1b+ Scioto: Propeller. Lost September 2, 1864, off Dunkirk. 389 tons. Built in 1848 at Huron, OH.

275. 23D1bo Watchman: Schooner. Wrecked near Dunkirk in 1858.

276. 24D1bo Wood, Robert: Schooner. Lost off Dunkirk in 1854. 152 tons. Built at Clayton, NY.

277. 25D1b+ Young Lion: Schooner. Wrecked off Walnut Creek (near Erie) in July 1836. 50 tons. Built at Black River in 1827.

General location "c"

278. 1D1co South American: Schooner. Lost between Buffalo and Toledo in November 1843. 100 tons. Built at Vermilion in 1841.

279. 2D1co Salina (formerly Canadian schooner Catherine): Captured at Mackinaw in June 1812. Caught in ice and abandoned. Drifted down lake and burned near Erie. Built in May 1809.

280. 3D1c+ Strong, Helen: Sidewheel steamer. Stranded west of Barcelona. Sank in November 1846. 253 tons. Built in 1845 at Monroe, MI, by J.M. Keating.

281. 4D1co Wright, Silas: Schooner. Wrecked between Barcelona and Dunkirk on September 13, 1860. Built at Cape Vincent.

Time Period 2: 1866-1890

Exact location "a"

282. 1D2ao City of Port Huron: Propeller, U.S. 5392. Lost September 9, 1876, at Dunkirk. 411 tons. Built in 1867 at Port Huron.

283. 2D2ao Frost, George: Steamer. Burned at Erie in 1879.

284. 3D2a+ Owego: Propeller, U.S. 18926. Stranded in November 1867 at Van Buren, NY. 483 tons. Built in 1853 at Cleveland.

285. 4D2ao Resolute: Schooner. Sank at Erie in June 1871. 339 tons. Built in 1856 at Black River. 125.4x26.2x11.2.

286. 5D2ao Richmond, C.T.; Schooner. Wrecked off Dunkirk in 1870. 230 tons.

Approximate location "b"

287. 1D2bo British Lion: Schooner. Foundered in southwesterly gale off Erie. Sank in 1888. 80 tons. Built in 1868.

288. 2D2b+ Brunswick: Steamer. Sank off Dunkirk in 1881. Built at Detroit in 1881.

289. 3D2bo Correspondent: Schooner. Wrecked off Dunkirk in 1878.

290. 4D2bo Dorr, Anna P.: Tug. Sank near Dunkirk on November 26, 1888. 44 tons. Built in 1870.

291. 5D2bo Eldorado: Barge. Foundered near Erie on November 20, 1880.

292. 6D2bo Golden Fleece: Schooner. Lost near Dunkirk in 1890. 434 tons. Built at Cleveland by Peck & Master in 1862.

293. 7D2bo Logan, Eliza: Schooner. Foundered about 12 miles off Erie on October 19, 1871. 369 tons. Built in 1856 at Buffalo.

294. 8D2bo Manzanilla: Canadian schooner. Sank October 13, 1887, off Dunkirk. 400 tons. Built in 1873 at St. Catherines.

295. 9D2bo Post Boy: Schooner. Lost near Dunkirk in 1862.

296. 10D2bo Tillinghast, Thos.: Tug. Burned near Erie in 1876.

General location "c"

297. 1D2c+ Acme: Propeller. Sank about 20 miles off Dunkirk on November 4, 1867. 762 tons. Built at Buffalo in 1856.

298. 2D2co Carlingford: Schooner. Sank in collision with Brunswick in 1881 off Dunkirk. 638 tons. Built at Port Huron in 1869.

299. 3D2c+ Lyon, John B.: Steamer. Foundered on September 11, 1900, between Conneaut and North Girard. 1,710 tons. Built in 1881.

300. 4D2co Mitchell, Belle: Schooner. Foundered east of Erie in southwesterly gale on October 14, 1886. 320 tons. Built at Olgonac, MI, by Navagh in 1870.

301. 5D2c+ Sheridan, Phil: Sidewheel steamer, U.S. 20301. Burned on December 31, 1875, about 30 miles west of Buffalo. 711 tons. Built in 1867 at Detroit.

Time Period 3: since 1891

Exact location "a"

302. 1D3ao Armour, Philip D.: Steamer. Sank November 1915 after striking shore off Waldameer.

303. 2D3ao City of Rome: Steamer. Burned off Ripley, NY, on May 7, 1914.

304. 3D3ao Gerkin, Howard S.: Steamer (ex T.P. Phalen). Sank August 21, 1896, about 4 miles north by east of Erie.

305. 4D3ao Isolde: Barge (ex steamer City of Paris). Wrecked on rocks off Five Mile Creek, east of Erie. Sank in April 1933.

306. 5D3ao S.K. Martin: U.S. 12 6125 (ex City of St. Joseph). Went down off Twelve Mile Creek east of Erie on October 12, 1912. 464 tons. Built in 1883 at Benton Harbor by J. H. Randall.

307. 6D3ao Mautenee: Schooner/barge. Total wreck about 1½ miles inside New York state line on October 20, 1905.

308. 7D3ao Rob Roy: Barge. Sank September 16, 1916, about four miles northeast of Erie. Built in 1868 at Perry, OH. 98x22x7.

309. 8D3a+ Whalen, George J.: Steamer. Foundered July 29, 1930, in 120 feet of water six miles north of Dunkirk. Built in 1901 at Toledo.

310. 9D3a+ Oneida: Propeller. Burned August 20, 1893, off North East, PA, (between Freeport and McCord's Point). 887 tons. Built in 1862 at Buffalo.

Approximate location "b"

311. 1D3bo American Sailor: Scow. Sank off Westfield, NY, in November 1937.

312. 2D3bo American Scout: Scow. Sank off Westfield in November 1937.

313. 3D3b+ Boland, John: Steamer. Foundered on October 5, 1932, about 10 miles off Barcelona.

314. 4D3bo Burton, Charles H.: Schooner. Lost off Barcelona in October 1905.

315. 5D3bo Kelderhouse, John: Tug. Beached near Dunkirk April 25, 1907; total loss.

316. 6D3bo Van Straubenzie, Sir C.T.: Canadian schooner. Sank after collision with City of Erie off Dunkirk on September 27, 1909. 317 tons. Built at St. Catherines in 1875.

317. 7D3bo Wilson, Annabell: Barge. Foundered off Dunkirk on July 12, 1913.

Wrecks in Area E (Silver Creek, NY, to Buffalo, NY)

Time Period 1: before 1865

Exact location "a"

318. 1E1a+ Alabama: Sidewheel steamer. Sank about 1½ miles from Buffalo Light on August 28, 1854. 799 tons. Built at Detroit in 1849.

319. 2E1a+ Bunker Hill: Sidewheel steamer. Burned off Tonawanda, NY, on September 2, 1851. 457 tons. Built at Black River in 1837.

320. 3E1a+ Fulton, Robert: Sidewheel steamer. Wrecked off Sturgeon Point, NY, on October 23, 1844. 368 tons. Built at Cleveland in 1835.

321. 4E1ao Lady Washington: Schooner. Wrecked off Sturgeon Point on October 29, 1828.

322. 5E1ao Marion: Schooner. Wrecked near Buffalo in 1852. 140 tons. Built at Charleston, OH, in 1841.

323. 6E1ao Sampson: Propeller. Stranded on November 12, 1852, at Buffalo. 250 tons. Built in 1842 at Perrysburg.

324. 7E1a+ Starr: Sidewheel steamer. Burned in 1845 off Buffalo. 128 tons. Built at Belvidere, MI, in 1837.

325. 8E1a+ Tecumseh: Sidewheel steamer. Stranded on November 14, 1850, off Buffalo. 259 tons. Built in 1844 at Algonac.

326. 9E1ao Two Brothers: Schooner. Wrecked at Buffalo in 1835.

327. 10E1ao Utica: Bark. Wrecked near Buffalo in 1854. 334 tons. Built at Chicago in 1846.

Approximate location "b"

328. 1E1bo Birmingham: Schooner. Wrecked near Buffalo in 1854. 138 tons. Built at Vermilion in 1843.

329. 2E1b+ Dacotah: Sidewheel steamer. Stranded on November 23, 1860, about 18 miles west of Buffalo. 698 tons. Built in 1857 at Cleveland by L. Moses.

330. 3E1bo Florida: Schooner. Wrecked near Buffalo in 1836.

331. 4E1bo Freeman: Schooner. Lost off Buffalo in 1861. 190 tons. Built at Charleston in 1845.

332. 5E1bo Hudson, Sarah E.: Schooner. Sank in collision with propeller Eclipse near Buffalo in October 1863.

333. 6E1bo Lady of the Lake: Schooner. Went to pieces near Buffalo in 1838.

334. 7E1bo Myers, Mary A.: Schooner. Capsized near Silver Creek in April 1848. Built at Buffalo in 1847.

335. 8E1bo Powell, Linnie: Canadian schooner. Wrecked near Buffalo in 1859.

336. 9E1bo Ruggles, S.B.: Brig. Lost near Buffalo in 1851. 184 tons.

337. 10E1bo Sparrow: Schooner. Wrecked near Buffalo in 1855. 50 tons. Built at China, MI, in 1845.

338. 11E1b* Walk-in-the-Water: Sidewheel steamer. Stranded near Buffalo on November 1, 1821. 338 tons. Built in 1818 at Black Rock, NY. First steamer above the Niagara.

339. 12E1b+ Washington: Steamer. Burned on her first voyage on June 16, 1838, off Silver Creek. 380 tons. Built at Ashtabula in 1838.

Time Period 2: 1866-1890

Exact location "a"

340. 1E2ao Hutchinson, Charles L.: Barge. Broke in two and went down while anchored 5 miles above the breakwater at Buffalo on October 4, 1887. 297 tons. Built at Cleveland by Eaton and Church in 1866; rebuilt in 1881.

General location "b"

341. 1E2b+ Cushman, Govenor: Propeller. Exploded on May 1, 1868, while leaving Buffalo. 384 tons. Built at Cleveland in 1857.

342. 2E2bo Ellington: Schooner. Wrecked at Buffalo on November 1, 1873. 190 tons.

343. 3E2bo Falmouth: Schooner. Foundered at Buffalo in 1880.

344. 4E2bo Iron City: Barge. Foundered and sank in September 1872 near Sturgeon Point, about 18 miles from Buffalo. 607 tons. Built at Cleveland in 1856.

345. 5E2bo Puritan: Schooner. Wrecked at Buffalo in 1866.

Time Period 3: since 1891

Exact location "a"

346. 1E3ao Ada Medora: Schooner. Ran on north breakwater at Buffalo on October 7, 1906.

General location "b"

347. 1E3b+ Passaic: Propeller. Foundered on October 31, 1891, off Silver Creek. 654 tons. Built in 1862 at Buffalo.

Appendix I

Correlation Factors

Correlation Coefficient = .91 p < 0.5

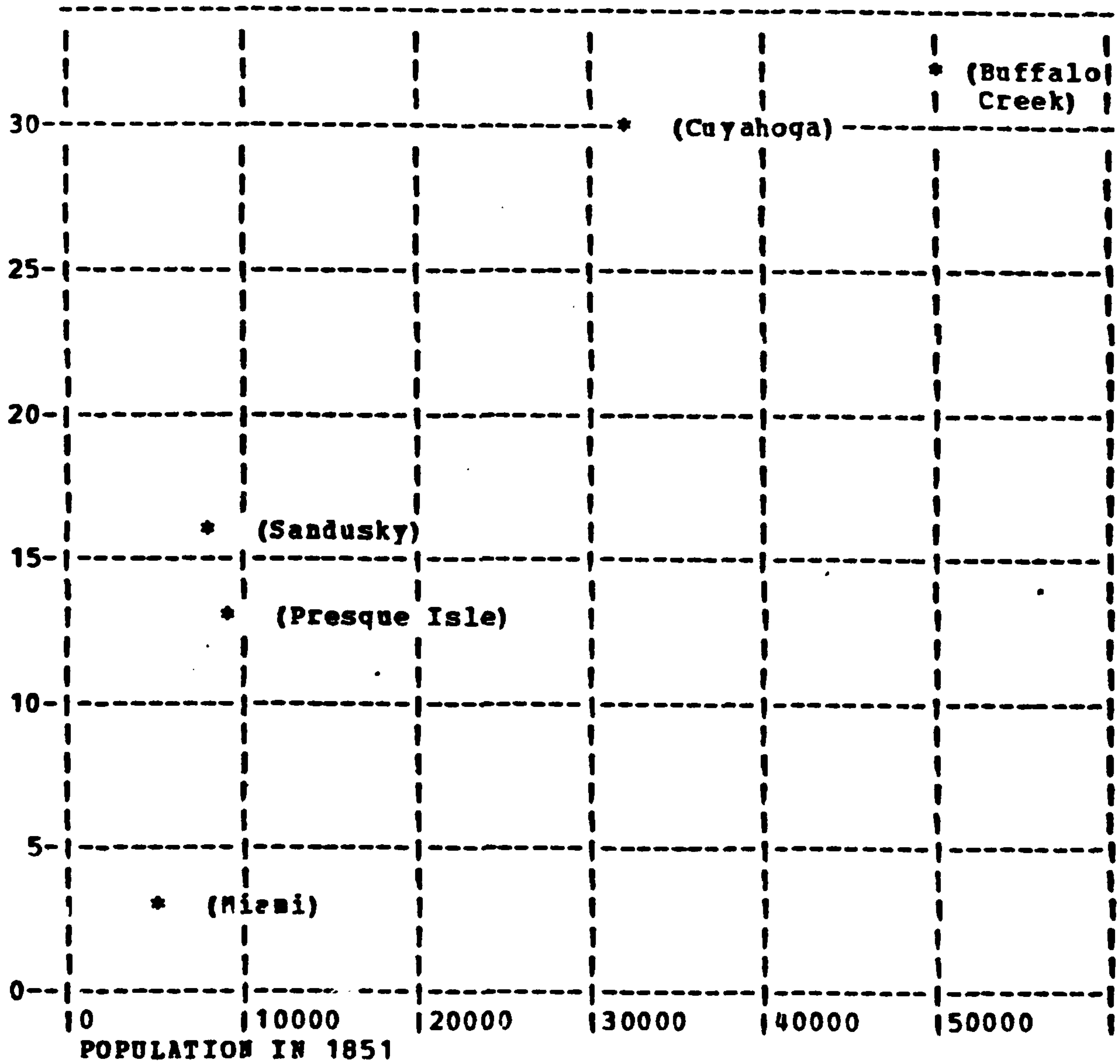


Fig. I.1. Cumulative Wrecks in 1851

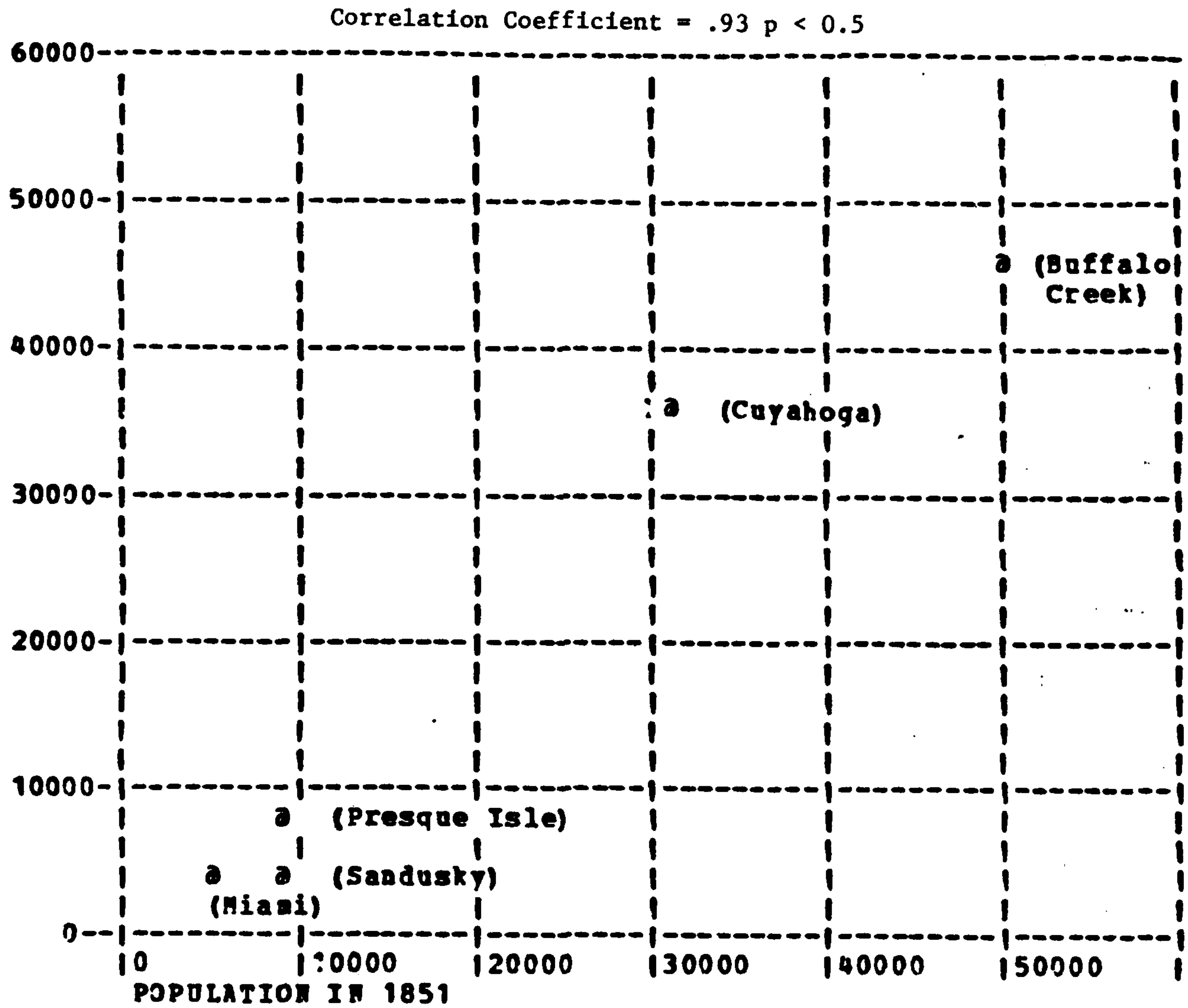


Fig. I.2. Tons Enrolled in 1851

Correlation Coefficient = .79 $p < 0.10$

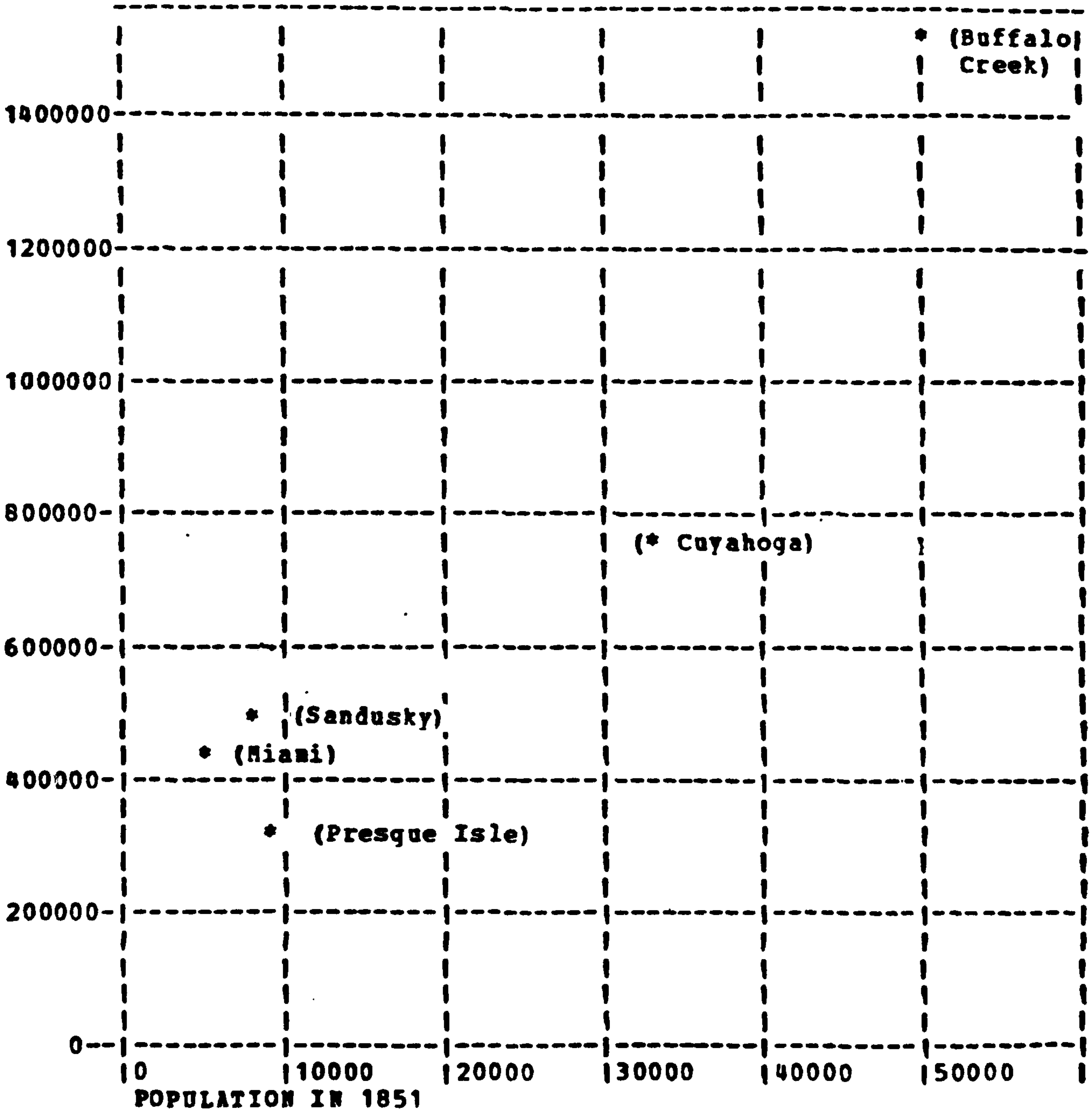


Fig. I.3. Tons Entered in 1851

Correlation Coefficient = .56 p < .2

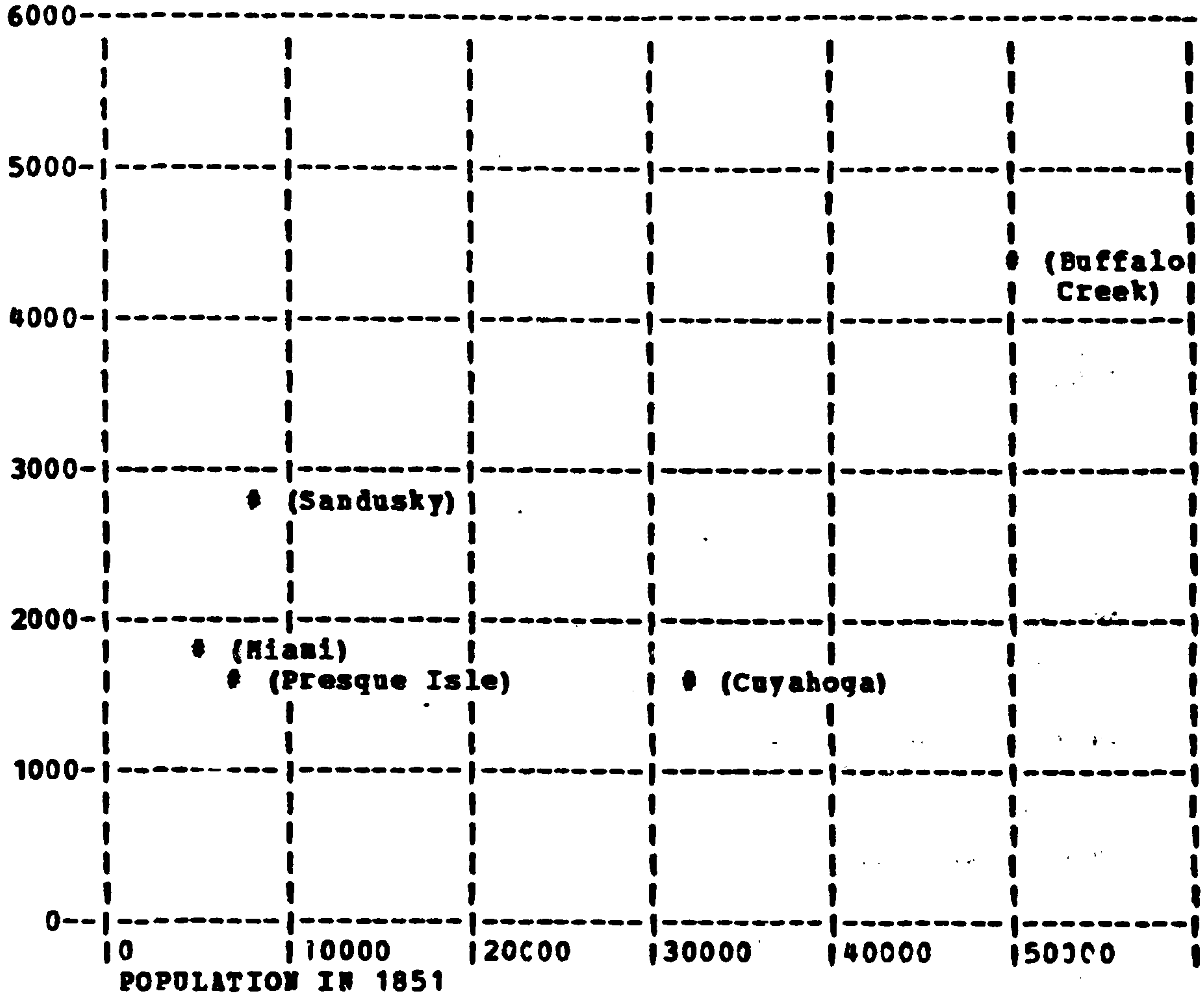


Fig. I.4. Number Entered in 1851

Correlation Coefficient = .944 p < .2

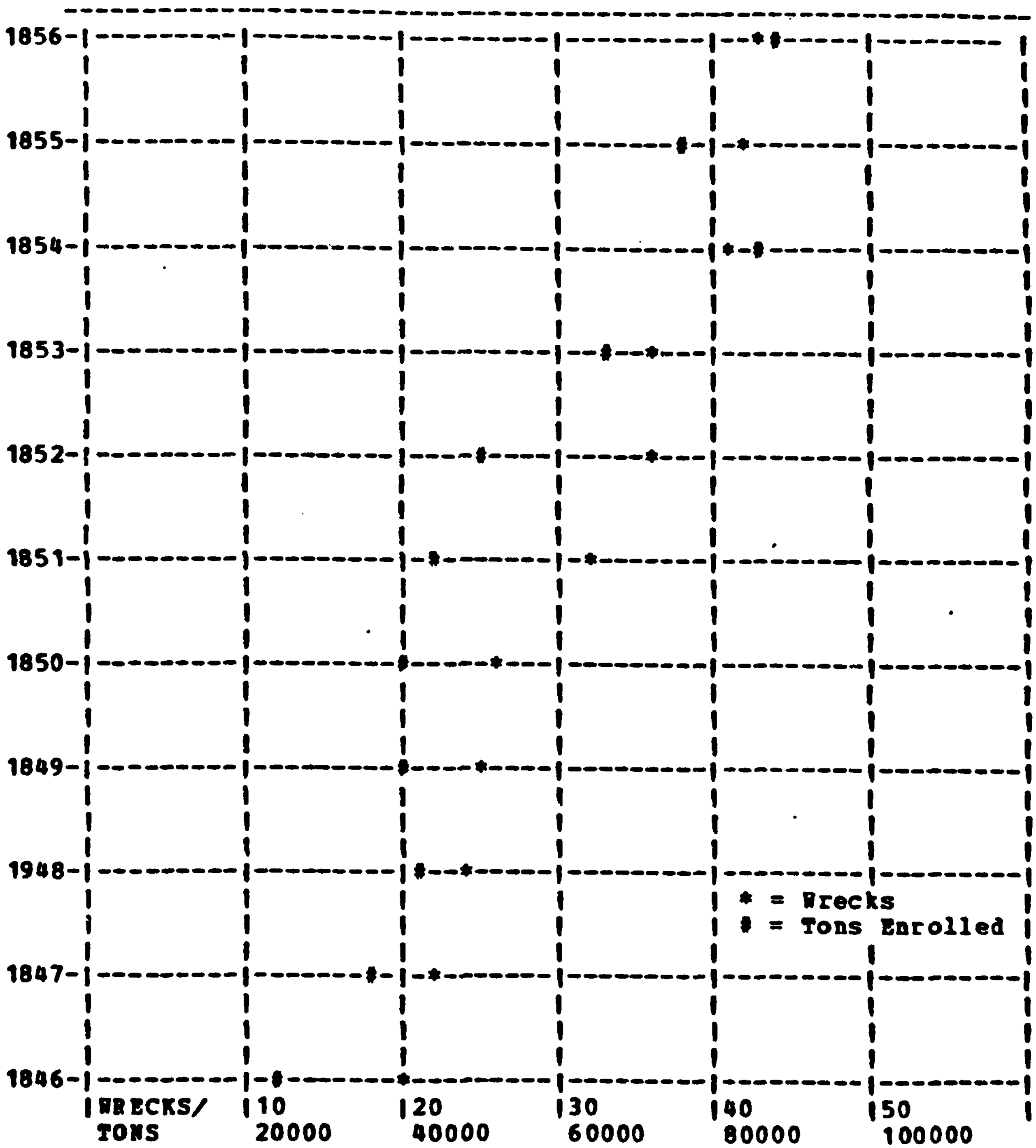


Fig. I.5. Wreck/Tons Enrolled by Year, Buffalo

Correlation Coefficient - .776 p < .001

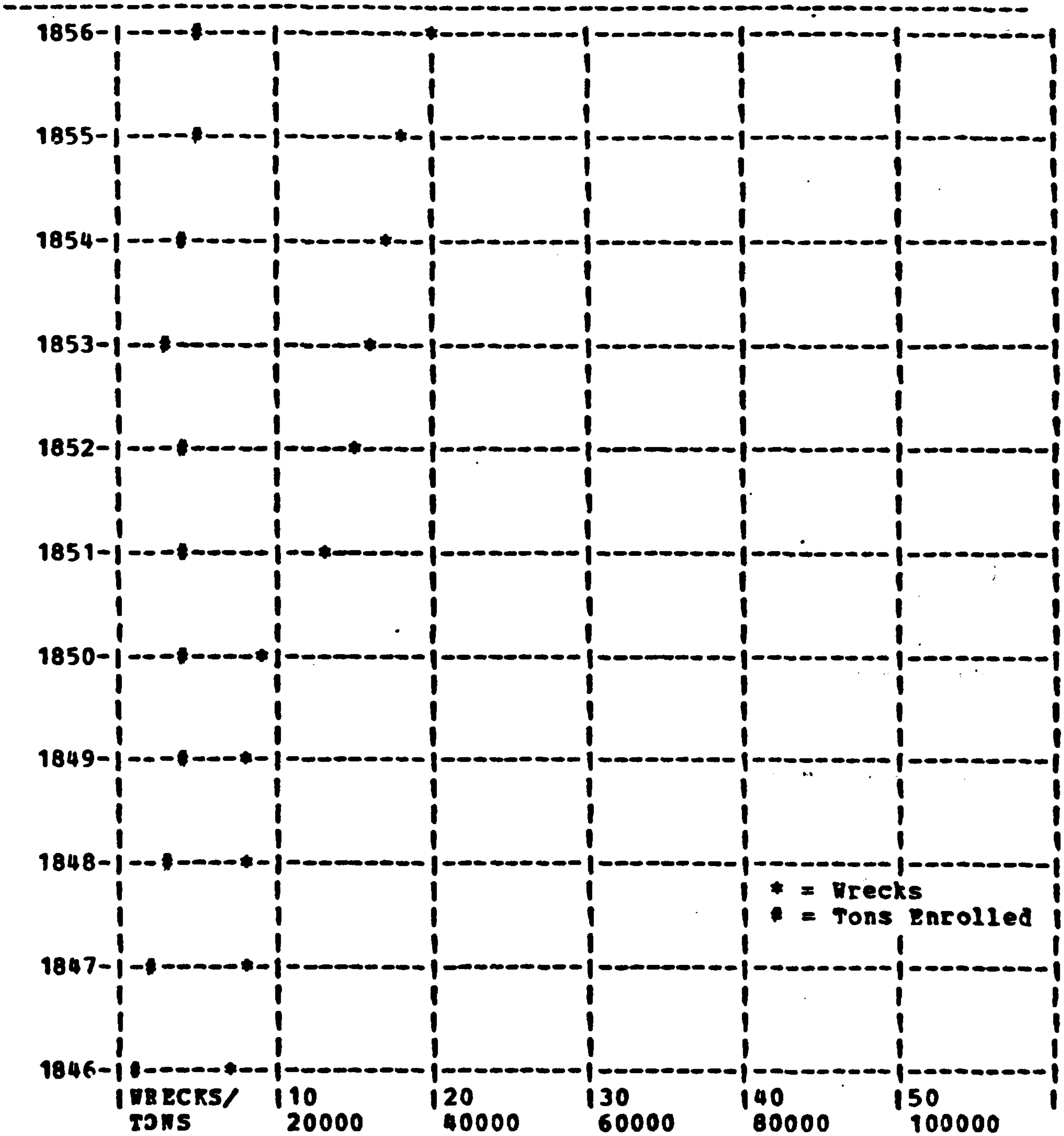


Fig. I.6. Wreck/Tons Enrolled by Year, Presque Isle

Correlation Coefficient - .977 p < .001

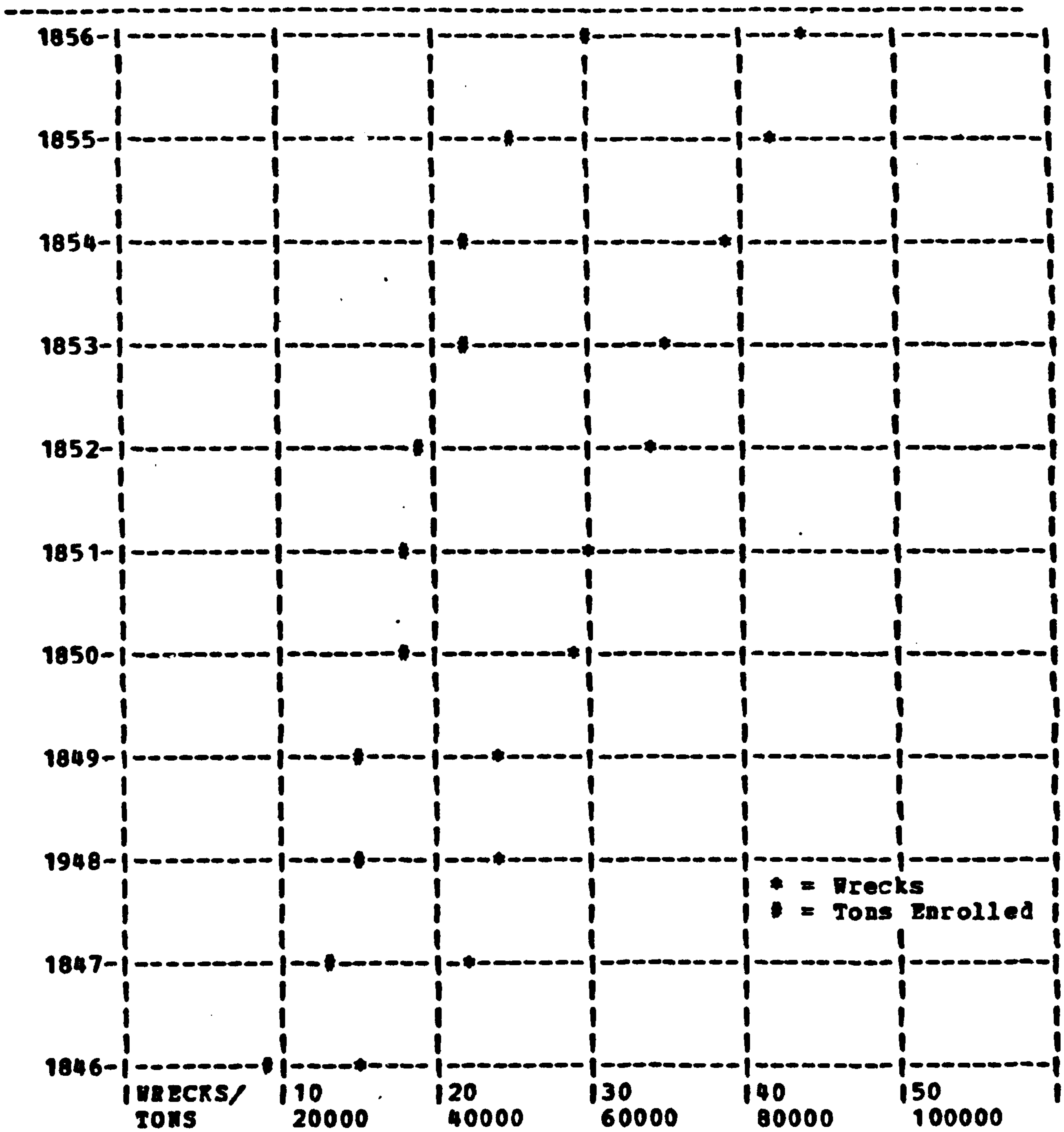


Fig. I.7. Wreck/Tons Enrolled by year, Cuyahoga

Correlation Coefficient = .610 $p < .05$

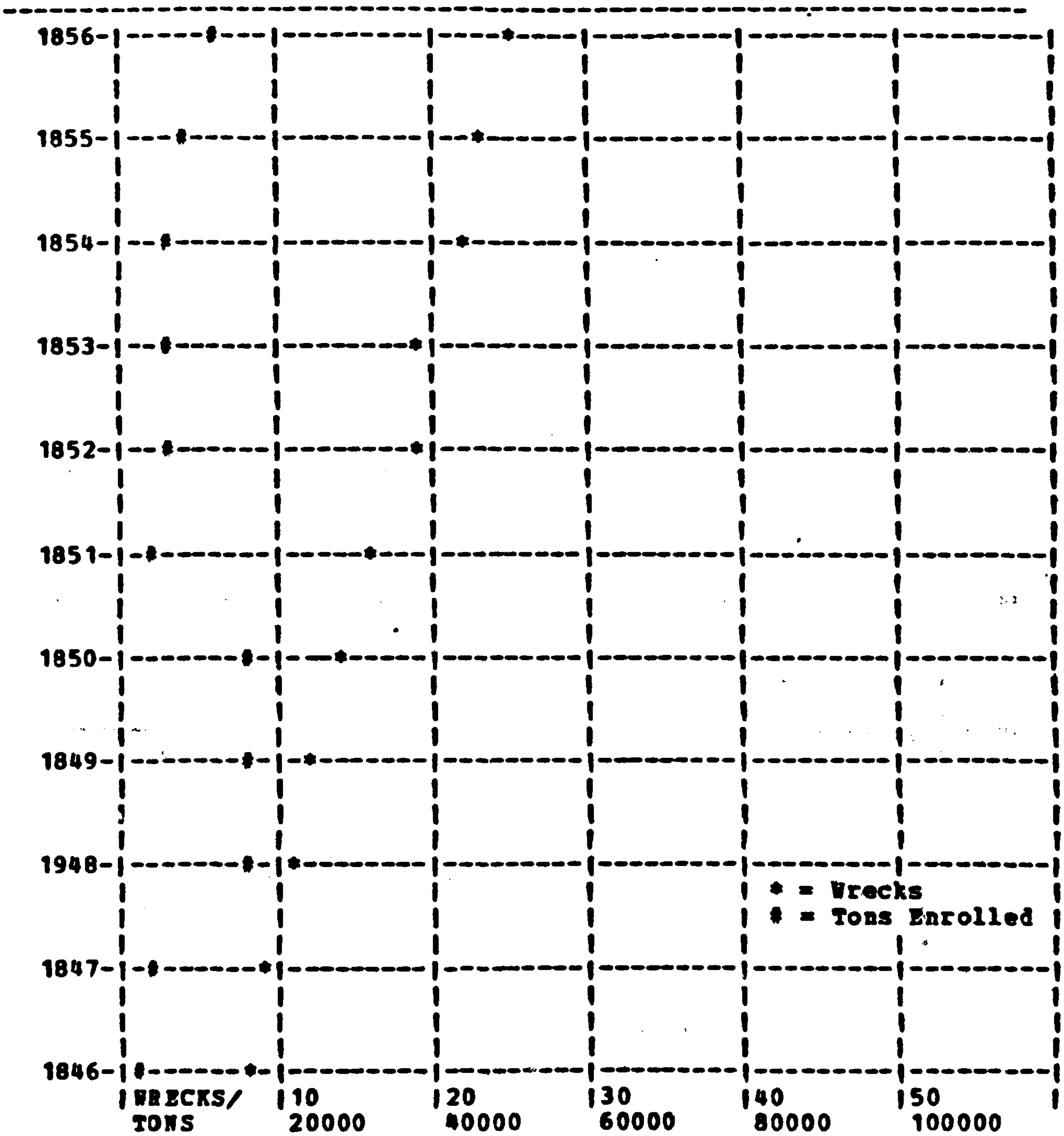


Fig. I.8. Wreck/Tons Enrolled by Year, Sandusky

Correlation Coefficient = .998 p < .0001

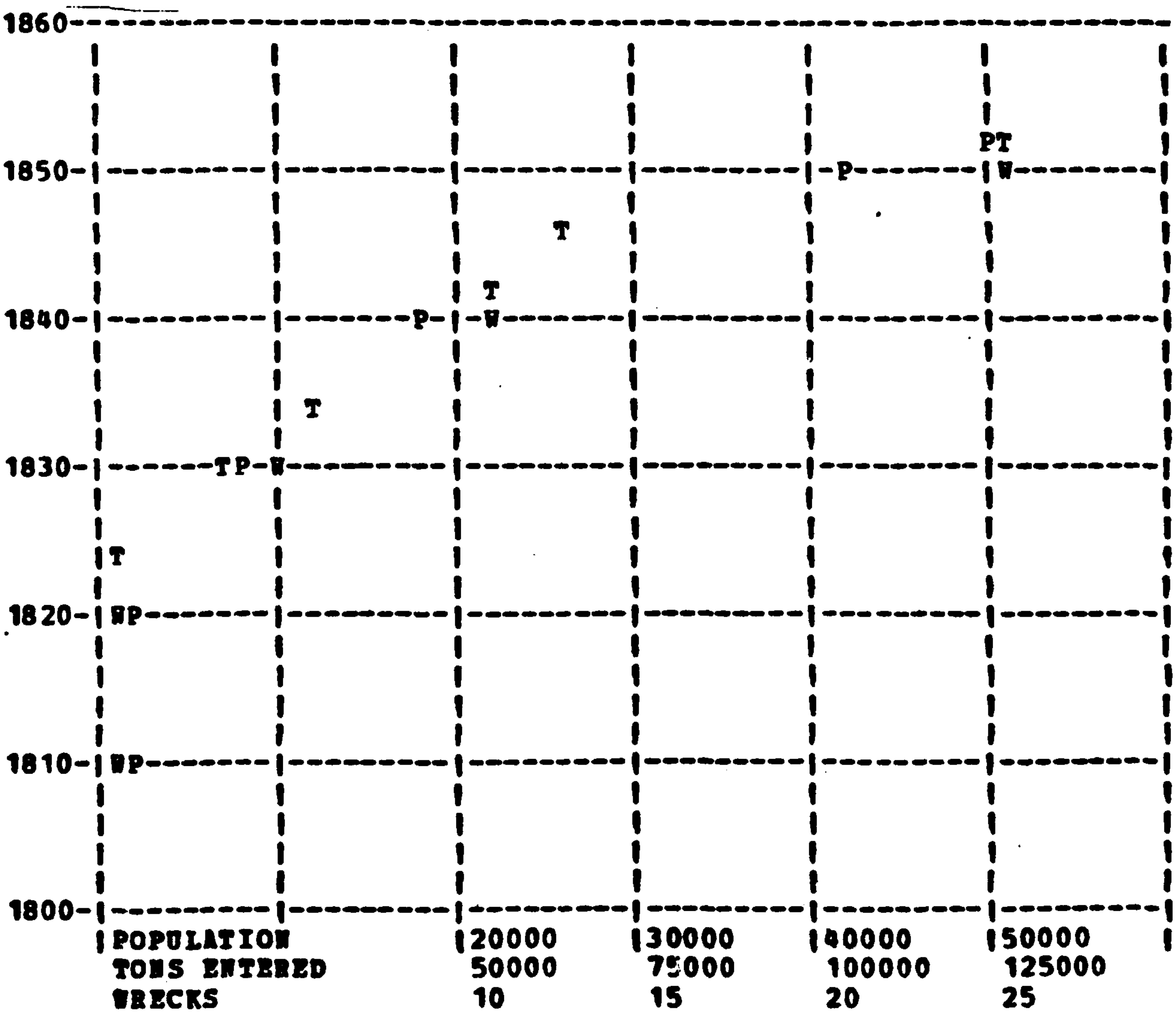


Fig I.9. Population/Tons Entered/Wrecks by Year, Buffalo Creek (Correlation on W/P only)

Correlation Coefficient = .515 p < .2

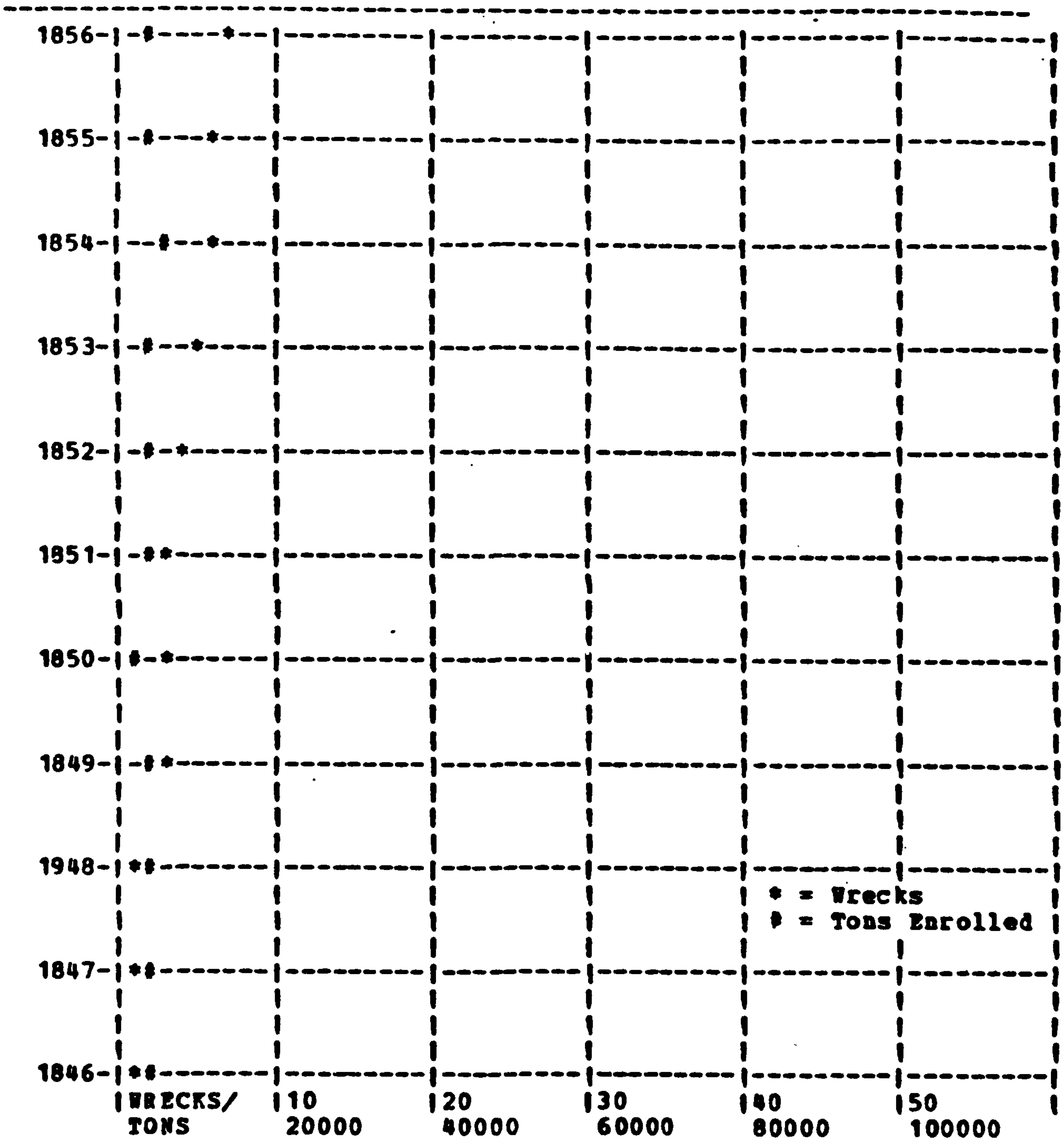


Fig. I.10. Wreck/Tons Enrolled by Year, Miami

APPENDIX J

FEDERAL AND STATE AGENCIES AND NATIONAL ORGANIZATIONS CONCERNED WITH HISTORIC PRESERVATION

INTRODUCTION

The preservation of cultural resources from direct and indirect impacts of the construction and operation of natural gas facilities is important at the federal, state, and local levels. Interest in preservation is reflected in the federal laws discussed in Chapter 1 and in various organizations that were developed in response to implementing these laws. This Appendix lists the major organizations concerned with preservation. Parts 1, 2, and 3 of this appendix list federal and state agencies and national organizations, respectively. Each agency or organization included is described as to its service functions, associated publications, and general goals. The mailing address and main office telephone number of each agency and organization are also provided.

These three lists can be used by developers as an index for obtaining sources of expertise in the evaluation of specific cultural resource sites as well as guidance in selecting the best available mitigation and preservation methods. The literature and publications provided by some agencies, notably those associated with the U.S. Department of the Interior, outline various kinds of specific information.

PART I: FEDERAL AGENCIES CONCERNED WITH HISTORIC PRESERVATION*

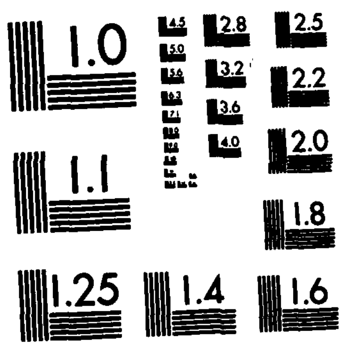
Advisory Council on Historic Preservation
Executive Secretary
1522 K Street, N.W.
Washington, DC 20005
202-254-7788

The Advisory Council on Historic Preservation is an independent agency that was created by the National Historic Preservation Act of 1966 to advise Congress and the president on historic preservation, to encourage public interest in preservation, to recommend studies relating to state and local preservation legislation, and to encourage training and education. Under Section 106 of the National Historic Preservation Act, the Council reviews and comments upon the impact of federally assisted projects included or eligible for inclusion in the National Register of Historic Places; this review process is carried out in cooperation with the states. The Council issues a publication, Report, which features special studies and information on federal preservation legislation. The Council also coordinates U.S. membership in the International Center for the Study of the Preservation and Restoration of Cultural Property, an international organization that sponsors technical assistance programs, publication, and training courses.

*Much of the information in this section appeared originally in Preservation News, published by the National Trust for Historic Preservation, and in 11593, published by the U.S. Department of the Interior.

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981 6/7

UNCLASSIFIED F/G 5/1 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Geological Survey
U.S. Department of the Interior
National Center
Reston, VA 22092
703-860-7444

The Geological Survey prepares and sells topographic maps that are useful for conducting surveys of historic resources and which are required as part of National Register documentation. If copies of the desired quadrangles are not available locally, they may be ordered from the Geological Survey.

Historic American Buildings Survey

Chief, Historic American Buildings Survey
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5754

Since 1933, HABS has gathered drawings, photographs, and documentation for a national architectural archive. The program is administered by the National Park Service in cooperation with the American Institute of Architects and the Library of Congress, which is the repository of the records. Recording projects are carried out on a shared-cost basis in cooperation with state and local governments and private organizations. Buildings are recorded by detailed studies that include measured drawings, photographs, and architectural and historical data. HABS's aim of preservation through documentation is of particular importance for historic buildings threatened by demolition or alteration; priority is given to recording such buildings whenever possible. Other criteria for inclusion in HABS are listed in a brochure called HABS. Copies of HABS records may be ordered from the Photoduplication Service, Library of Congress, Washington, DC 20540. A new series of state catalogs is being prepared.

Historic American Engineering Record
Chief, Historic American Engineering Record
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5460

The purpose of HAER is to record a complete summary of engineering technology by surveying significant examples of engineering solutions demonstrating the accomplishments of all branches of the engineering profession. State and local governments and private organizations may sponsor a HAER project on a shared-cost basis. HAER is a cooperative program with the Library of Congress and the American Society of Engineers. The program operates primarily through two types of comprehensive surveys: the regional survey, determined by geographic factors, and the industrial survey, determined by the type of industry. HAER also records individual structures and systems of particular merit. Engineering recording teams record sites threatened with demolition. Criteria for inclusion in HAER is listed in a free brochure, HAER. The actual recording is accomplished primarily during the summer by student architects and engineers and faculty supervisors. The National Park Service and other sponsoring organizations periodically publish state catalogs and documentary reports on some of the surveys.

Interagency Archeological Services
Director, Interagency Archeological Services Program
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5454

This office is responsible for conducting a nationwide program for the salvage of archeological remains. It develops policies, standards, and procedures for professional conduct and archeological research methods and advises governmental agencies, historical and archeological societies and commissions on archeological matters. The office issues permits for archeological exploration on federally controlled lands.

National Historic Landmarks Program
Chief, Historic Sites Survey
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5464

The Historic Sites Act of 1935 authorizes the secretary of the interior to survey historic sites and buildings to identify those of national significance. The program began in 1960. Potential landmarks are evaluated by the Advisory Board on National Parks, Historic Sites, Buildings and Monuments, and are recommended to the secretary of the interior. Sites and structures found to be nationally significant by the secretary are eligible for designation as National Historic Landmarks. All NHLs are included in the National Register of Historic Places. Upon the owner's agreement to adhere to accepted preservation precepts, this designation is recognized by the award of a bronze plaque and a certificate. Properties eligible for landmark designation are listed in a booklet entitled National Parks and Landmarks. Studies leading to the selection of National Historic Landmarks are published in a series of books. The booklet and the books are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

National Register of Historic Places
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5483

The National Register is a list of the nation's properties officially designated as worthy of preservation. Such properties may include archeological or historical sites, districts, buildings, and objects. Properties are usually nominated to the Register by the states. Listing in the Register makes a property eligible for matching Historic Preservation Grants-in-Aid and provides certain protection from federally financed, licensed, or assisted projects. Properties in the Register also qualify for special federal tax benefits under the Tax Reform Act of 1976 and for special FHA Title I loans.

Cemeteries, birthplaces, or graves of historical figures; properties owned by religious institutions or used for religious purposes; structures that have been moved from their original locations; reconstructed historic buildings; properties primarily commemorative in nature; and properties that have achieved significance within the past fifty years are usually not considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria.

Technical Preservation Services
Chief, Technical Preservation Services Division
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, DC 20240
202-523-5891

Technical Preservation Services is responsible for developing and disseminating technical information on the preservation and restoration of cultural properties, for advising federal agencies on the preservation and maintenance of such properties, for reviewing the transfer of surplus federal property for historic monument purposes, and for evaluating and advising preservation grantees on preservation methods. This office publishes a series of free technical leaflets, called Preservation Briefs, on building conservation as well as bibliographies on such subjects as early building technology and maintaining historic properties.

PART 2: STATE AND LOCAL AGENCIES AND ORGANIZATIONS CONCERNED WITH PRESERVATION

OHIO

Ohio Historic Preservation Office
Ohio Historical Center
I71 & 17th Avenue
Columbus 43211

Regional Preservation Offices of the Ohio Historic Preservation Office

History-Architecture Offices

Region 1Ha Ted Ligibel & Cynthia Barclay, Center for Archival Collections of Bowling Green State University, 5th floor, University Library, Bowling Green 43403, 419-372-2411. Counties: Defiance, Fulton, Henry, Lucas, Ottawa, Sandusky, Williams and Wood.

Region 2HA Eric Johannesen, Western Reserve Historical Society, 10825 East Boulevard, Cleveland, 44106, 216-721-5722 or -721-5723. Counties: Ashtabula, Cuyahoga, Erie, Geauga, Huron, Lake, Lorain, Mahoning, Medina, Portage, Summit, and Trumbull.

Archeological Offices

Region 1A G. Michael Pratt, University of Toledo, Department of Anthropology, Room 10, Bancroft Avenue, Toledo, 43606, 419-537-2364. Counties: Erie, Huron, Lucas, Ottawa, Sandusky, Seneca, and Wood. Assistant: John Stidham.

Region 2a David Bush, Cleveland Museum of Natural History, Wade Oval, University Circle, Cleveland, 44106, 216-231-4600. Counties: Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit, and Trumbull.

Historical Societies

Ohio Association of Historical Societies and Museums
Paul A. Goudy, Secretary-Treasurer
P.O. Box 97
New Philadelphia 44663
216-339-6448

Great Lakes Historical Society
480 Main Street
Vermilion 44089

Ashtabula County Historical Society
P.O. Box 193
Jefferson 44047

The Avon Lake Historical Society
c/o Mrs. W. O. Handy
33393 Electric Boulevard, E-2
Avon Lake 44012

Bay Village Historical Society
Lake-Cahoon Road
Bay Village 44140

Canal Society of Ohio
40 Valley & Co.
502 Investment Insurance Building
601 Rockwell Avenue
Cleveland 44114

Cuyahoga County-Inter-Museum Council
c/o William R. Vanaken
1028 National City Bank Building
Cleveland 44114

Erie County Historical Society
629 East Market Street
Sandusky 44870

Fairport Harbor Historical Society
129 Second Street
Fairport Harbor 44077

Lake County Historical Society
8059 Mentor Avenue
Mentor 44060

Lorain County Historical Society, Inc.
509 Washington Avenue
Elyria 44035

Ohio Historical Society
Ohio Historical Center
1982 Velma Avenue
Columbus 43211

Ottawa County Historical Society
4392 East Ledge Avenue
Port Clinton 43451

Sandusky County Historical Society
1337 Hayes Avenue
Fremont 43420

Steamship Historical Society of America
c/o Mr. Charles D. Bieser
11720 Edgewater Drive, No. 419
Cleveland 44107

Western Reserve Architectural Historians
10825 East Boulevard
Cleveland 44106

Western Reserve Historical Society
10825 East Boulevard
Cleveland 44106

Western Lake Erie Historical Society
c/o Mr. Harry C. Archer
5902 Swan Creek Drive Toledo 43614

PENNSYLVANIA

Office of Historical Preservation
Pennsylvania Historical and Museum Commission
William Penn Memorial Museum Building
Box 1026
Harrisburg 17120
717-787-4363

John R. Claridge
Erie County Historical Society
417 State Street
Erie 16501
814-454-1813

NEW YORK

Bureau of Historic Sites
Division for Historic Preservation
New York State Office of Parks and Recreation
Peebles Island
Waterford 12188
518-237-8643

Coastal Zone Management Program
Division of State Planning
New York State Department of State
162 Washington Avenue
Albany 12231
518-474-7210

Historical Research and Statewide Services Bureau
Division of Historical Services
New York State Education Department
99 Washington Avenue
Albany 12230
518-474-5353

Highway Salvage Archeology Program
New York State Science Service
New York State Education Department
Albany 12224
518-474-5813

New York State Sea Grant Institute
99 Washington Avenue
Albany 12230
518-474-5787

Statewide Inventory of Historic Resources
Field Services Bureau
Division for Historic Preservation
New York State Office of Parks and Recreation
Agency Building 1
Empire State Plaza
Albany 12238
518-474-0479

State Board of Historic Preservation
c/o Deputy Commissioner for Historic Preservation
New York State Office of Parks and Recreation
Agency Building 1
Empire State Plaza
Albany 12238
518-474-0468

New York State Historical Association
Lake Road
Cooperstown 13326

Preservation League of New York State
13 Northern Boulevard
Albany 12210
518-462-5658

Chautauqua County Historical Society
P.O. Box 173
Westfield 14787
Roderick A. Nixon, Treasurer
716-326-2977

The Historical Society of Dunkirk, New York
536 Central Avenue
Dunkirk 14048
Louise V. Nowak, Secretary
716-366-2511

Seneca Indian Historical Society
c/o Cattaraugus Indian Reservation
R.F.D. #1
Irving 14081

Buffalo and Erie County Historical Society
25 Nottingham Court
Buffalo 14216
Walter S. Dunn, Jr., Director
716-873-9644

Erie County Historical Federation
11 Danforth Street
Cheektowaga 14227
Julia Boyer Reinstein, President
716-683-2269

Historical Society of the Tonawandas
113 Main Street
Tonawanda 14150
Willard B. Dittmar, Curator

PART 3: NATIONAL ORGANIZATIONS CONCERNED WITH PRESERVATION

American Association for State and Local History
1400 Eighth Avenue, S.
Nashville, TN 37203
615-242-5583

AASLH is a nonprofit educational organization dedicated to advancing knowledge and appreciation of local history in the United States and Canada. The Consultant Service Program provides professional consultants to assist museums with such problems as conservation, management, documentation, and cataloguing; fees are determined by museum budgets.

American Institute of Architects
1735 New York Avenue, N.W.
Washington, DC 20006
202-785-7300

The AIA Committee on Historic Resources meets three times a year to consider various preservation issues such as the certification of institutions offering preservation programs and professional programs and professional standards; the committee takes public stands on issues of more than local concern.

American Society of Civil Engineers
345 East 47th Street
New York, NY 10017
212-644-7496

ASCE publishes a monthly journal, a monthly newsletter, technical journals, reports, and the ASCE Guide to History and Heritage Programs. ASCE has drawn up a list of National Historic Civil Engineering Landmarks and is actively involved with their preservation. The program was developed by the Committee on the History and Heritage of American Civil Engineering, which also selects the recipient of the History and Heritage Award, sponsors and edits the publication of a civil engineering historical series, and cooperates with the Smithsonian Institution to encourage civil engineers to contribute historical materials to the Smithsonian.

American Society of Landscape Architects
1750 Old Meadow Road
McLean, VA 22101
703-893-3140

American Society of Planning Officials
1313 East 60th Street
Chicago, IL 60637
312-947-2575

Association for Preservation Technology
Box-C.P. 2487
Station D
Ottawa Ontario,
Canada K1P 5W6

APT was founded in 1968 as a Canadian-American association to promote the research, collection, and publication of technical information in all aspects of historic preservation. APT publishes a bimonthly newsletter, Communique, and a quarterly journal.

Committee for the Preservation of Architectural Records
15 Gramercy Park S.
New York, NY 10003
212-533-0711

The Committee for the Preservation of Architectural Records is concerned with the preservation of records of architecture and the building arts. The committee endeavors to locate, record, and index the contents of collections of such records, including both written and graphic material, and to work toward a nationwide information center and uniform system of recording.

National Trust for Historic Preservation
740-748 Jackson Place, N.W.
Washington, DC 20006
202-638-5200

The National Trust is a private, nonprofit organization chartered by Congress to facilitate public participation in the preservation of sites, buildings, and objects significant in American history and culture. It is the primary function of the Office of Preservation Services to provide professional advice on preservation problems through correspondence and field visits; inquiries should be addressed to the Mid-Atlantic Field Office at the Washington headquarters. The Trust's programs also include a speakers bureau, an extensive preservation library, an audiovisual library, annual meetings, conferences, tours, and awards.

Preservation Action
2101 L Street, N.W.
Washington, DC 20037
202-466-8960

Preservation Action is a lobbying organization that works for the protection and enhancement of the built environment; it directs its efforts toward the enactment of legislation and appropriation of funds for preservation.

Society for Industrial Archeology
Room 5020
National Museum of History and Technology
Smithsonian Institution
Washington, DC 20560
202-381-5294

SIA promotes the study of the physical survivals of America's technological, engineering, and industrial past. It encourages and sponsors field investigation, research, and education programs on the advantages of preservation through continued or adaptive use.

Urban Land Institute
1200 18th Street, N.W.
Washington, DC 20036
202-331-8500

The Urban Land Institute is a nonprofit organization concerned with improving the quality of land use planning and development and with historic preservation and adaptive use. ULI conducts research projects on private development activities in preservation, sponsors workshops, and publishes a monthly magazine as well as quarterly case study reports called Project Reference File.

PART 4: THE SECRETARY OF THE INTERIOR'S STANDARDS FOR HISTORIC PRESERVATION PROJECTS*

The Secretary of the Interior's Standards for Historic Preservation Projects are the required basis for State Historic Preservation Officers and the Heritage Conservation and Recreation Service to evaluate Historic Preservation Fund grant-assisted acquisition and development project work proposals for properties listed in the National Register of Historic Places.

The Secretary of the Interior's Standards for Historic Preservation Projects are used as the basis for advising other Federal agencies under Executive Order 11593, and evaluating reuse proposals submitted with State and local government applications for the transfer of federally-owned surplus properties listed in the National Register.

The Secretary of the Interior's Standards for Historic Preservation Projects (Standards for Rehabilitation) are also the program regulations used by State Historic Preservation Officers and the Heritage Conservation and Recreation Service to determine if a rehabilitation project for a certified historic structure qualifies as a "certified rehabilitation," pursuant to the Tax Reform Act of 1976 and the Revenue Act of 1978.

---

*U.S. Department of the Interior, Standards for Historic Preservation Projects (Washington, DC: U.S. Government Printing Office, 1979), pp. 1-3.

Definitions for Historic Preservation Project Treatments

The following definitions are provided for treatments that may be undertaken on historic properties listed in the National Register of Historic Places:

Acquisition is defined as the act of process of acquiring fee title or interest other than fee title of real property (including the acquisition of development rights or remainder interest).

Protection is defined as the act or process of applying measures designed to affect the physical condition of a property by defending or guarding it from deterioration, loss or attack, or to cover or shield the property from danger or injury. In the case of buildings and structures, such treatment is ge rally of a temporary nature and anticipates future historic preservation treat t; in the case of archeological sites, the protective measure may be tempor or permanent.

Stabilization is defined as the act or process of applying measures desi to reestablish a weather resistant enclosure and the structural stabilit an unsafe or deteriorated property while maintaining the essential form a. t exists at present.

Preservation is defined as the act of process of applying measures to sustain the existing form, integrity, and material of a building or structure, and the existing form and vegetative cover or a site. It may include initial stabilization work, where necessary, as well as ongoing maintenance of the historic building materials.

Rehabilitation is defined as the act or process of returning a property to a state of utility through repair or alteration which makes possible an efficient contemporary use while preserving those portions or features of the property which are significant to its historical, architectural, and cultural values.

Restoration is defined as the act or process of accurately recovering the form and details of a property and its setting as it appeared at a particular period of time by means of the removal of later work or by the replacement of missing earlier work.

Reconstruction is defined as the act or process of reproducing by new construction the exact form and detail of a vanished building, structure, or object, or a part thereof, as it appeared at a specific period of time.

General Standards for Historic Preservation Projects

The following general standards apply to all treatment undertaken on historic properties listed in the National Register:

1. Every reasonable effort shall be made to provide a compatible use for a property that requires minimal alteration of the building structure, or site and its environment, or to use a property for its originally intended purpose.

2. The distinguishing original qualities or character of a building, structure, or site and its environment shall not be destroyed. The removal or alteration of any historic material or distinctive architectural features should be avoided when possible.

3. All buildings, structures, and sites shall be recognized as products of their own time. Alterations which have no historical basis and which seek to create an earlier appearance shall be discouraged.

4. Changes which may have taken place in the course of time are evidence of the history and development of a building, structure, or site and its environment. These changes may have acquired significance in their own right, and this significance shall be recognized and respected.

5. Distinctive stylistic features or examples of skilled craftsmanship which characterize a building, structure, or site, shall be treated with sensitivity.

6. Deteriorated architectural features shall be repaired rather than replaced, wherever possible. In the event replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual qualities. Repair or replacement of missing architectural features should be based on accurate duplications of features, substantiated by historical, physical, or pictorial evidence rather than on conjectural designs or the availability of different architectural elements from other buildings or structures.

7. The surface cleaning of structures shall be undertaken with the gentlest means possible. Sandblasting and other cleaning methods that will damage the historic building materials shall not be undertaken.

8. Every reasonable effort shall be made to protect and preserve archeological resources affected by, or adjacent to, any acquisition, protection, stabilization, preservation, rehabilitation, restoration, or reconstruction project.

APPENDIX K. EVALUATION OF SOURCE MATERIALS FOR ETHNOHISTORY OF THE RESEARCH AREA

APPENDIX K. EVALUATION OF SOURCE MATERIALS FOR ETHNOHISTORY OF THE RESEARCH AREA

The source materials utilized in writing the ethnohistoric summary consisted of three major types: archeological, ethnohistoric, and early historic. Ethnohistoric research is at the interface between archeology and colonial history and must make use of these resources as well as those specific to ethnohistory. The emphasis of ethnohistory, as previously mentioned, is on the non-European, Native American societies or tribes that were reported to inhabit any portion of the research region for the 280-year period (1570-1850). The tabulations in Tables K.1-K.3 will give some idea as to the quantity of the source materials consulted. Since archeological reports, ethnohistoric studies, and early historic documents and syntheses are written using modern state and county designations, Table K.1 will use these parameters. Table K.2 lists archeological sources by zone, and Table K.3 quantifies ethnohistoric/ethnographic sources by Native American tribe.

Source evaluation, cross-checking, verification, and correlation of data required enormous amounts of time, and the verification often yielded surprising inconsistencies and errors, especially in county histories. Archeological data was taken at face value, but the "ethnic" or societal interpretations were scrutinized. For example, many Late Woodland and Late Prehistoric sites were given unjustified ethnographic interpretations. Numerous sites along the Lake Erie shore from Ripley, New York, and west as far as Toledo, Ohio, were inferred to be the villages or campsites of the Erie/Eries/Eriez Indians. No verification of this inference is possible. The archeological Whittlesey Focus in Ohio, which was once considered to be ethnographically Erie, is no longer believed to be so (Brose 1976b; Kolb 1977a, 1979).

In terms of quality, ethnohistoric sources ranged downward from excellent. Accounts or field reports written by Jesuit priests objectively trained in the scientific method were politically and religiously tinged or motivated. These reports by Jesuit missionaries to New France also dealt with the Native Americans of what is today New York State and those in the vicinity of Detroit, Michigan. The Jesuit Relations and Allied Documents (73 vols.) covered the period from 1610 to 1791 (a modern edition that includes the original French, Latin, and Italian texts as well as an English translation was edited by Reuben Gold Thwaites (1896-1901, 1959). Donnelly (1967) has published errata and addenda to the Jesuit Relations. These volumes include especially useful materials on the Huron, Miami, Neutral, Ottawa, and Seneca.

Bibliographies on the archeology, ethnohistory, ethnology, and colonial/early history were consulted. Among these thirty-three references were the annotated archeological bibliographies on Ohio (Morgan and Rodabaugh 1947; Murphy 1977) and the northeastern United States (Rouse and Goggin 1947; Guthe and Kelly 1963; Moeller 1977). Among the more useful ethnohistoric bibliographies were those of Hoffman (1961), Karpinski (1931), and Prucha (1977a, 1977b). Good early historic bibliographies for New York included O'Callaghan

Table K.1. Number of Source Materials Consulted

	Archeological (See Table K.2)	Ethnohistoric (See Table K.3)	Historic
Michigan			
General	1	19	10
Monroe County	--	13	2
Ohio			
General	30	49	28
Lucas County	--	12	9
Ottawa County	--	16	2
Seneca County	--	15	3
Sandusky County	--	18	12
Huron County	--	16	6
Erie County	--	12	11
Lorain County	--	15	6
Summit County	--	6	3
Cuyahoga County	--	23	8
Geauga County	--	14	5
Lake County	--	11	9
Ashtabula County	--	12	10
Pennsylvania			
General	9	41	18
Erie County	--	27	14
New York			
General	3	42	8
Chautauqua County	--	19	10
Erie County	--	18	10
TOTAL	43	398	184

Table K.2. Major Archeological Sources Consulted

Zone	Number of Sources
Ia	19
Ib and IIa	11
Ic and IIb	68
Id and IIc	48
Ie and IId	15

Table K.3. Major Ethnohistoric/Ethnographic Sources Consulted

Tribe	Number of Sources
Cayuga	5
Chippewa	6
Delaware	15
Erie/Eries/Eriez	28
Fox	7
Huron	21
"Iroquois" (general)	63
Kickapoo	6
Mascouten	5
Miami	4
Missisaugua/Missisauga	4
Mohawk	6
Neutral	15
Oneida	5
Onondaga	6
Ottawa	7
Petun/Khionontateronon	5
Potawatomi	6
Seneca	30
Shawnee	8
Susquehannock/Andaste	7
Tionontati/"Tobacco"	4
Wenro/Wenroe	13
Wyandot	6

and Fernow (1856-1887); for Pennsylvania, the Pennsylvania and Historical Museum Commission (1957, 1976), Schaeffer and Roland (1941), and Wilkinson, Stevens, and Kent (1957). For Ohio, the multiple publications of Howe (1847, 1854, 1875, 1889-1891, 1900) were useful; for Michigan, a work by Streeter (1921) was most helpful. A listing of county histories for all 3111 counties in the forty-eight coterminous states was an important resource (Peterson 1946, 1963).

Murdock and O'Leary's Ethnographic Bibliography of North America (1975), although useful, had limitations. For example, only twenty-one sources were listed for the Erie Indians, whereas Kolb (1979) reported 212 in archeology, ethnohistory, and colonial/early historic sources which had increased to a compendium of 449 by 1981 (Kolb 1981).

Brose's The Late Prehistory of the Lake Erie Drainage Basin (1976) delineated the terminal Late Woodland in the research area. However, no synthesis of the ethnohistory of the area was attempted in the Handbook of North American Indians, Vol. 15: Northeast, edited by Bruce Trigger (1978). In this latter volume, Upper Great Lakes ethnohistory has been synthesized;

Lower Great Lakes ethnohistory has not. Nonetheless, the Handbook has articles on all of the societies or "tribes" listed in Table K.3, with the exception of the Missisauga and the Tionontati/Tobacco Indians, who, with Huron remnants, became the Wyandot (ca. 1657). An elaborate four-volume compendium edited by Washburn, The American Indian and the United States: A Documentary History (1973), contains boundary information and reproduces treaties between the United States and various Native American tribes, including most of the tribes listed in Table K.3.

State histories, written for the most part by professional historians, proved useful for background information, especially as to initial Euro-American contact and colonial viewpoints about the aboriginal inhabitants.

Sources for the state of Michigan included Bald (1961), Cooley (1905), Dunbar (1971), Fuller (1916, 1939), Goodrich (1940), Quaife and Glazer (1948), Santer (1977), Vexler (1978), and the Writer's Program (1941).

Sources for Ohio included Atwater (1838), Baldwin (1875), Bond (1941), Downes (1952), Hatcher (1945, 1947, 1949, 1966), Havighurst (1962, 1976), Howe (1847, 1854, 1875, 1889-1891, 1900), Howells (1897), Lindsey (1960, 1962), Randall and Ryan (1912), Rosenbloom and Weisenburger (1967), Smith (1977), Stewart (1935), Upton (1910), Utter (1942), Weisenburger (1965), Winter (1917), Wittke (1941-1944), and the Writer's Program (1940).

Sources for Pennsylvania included Bolles (1899), Brewster (1954), Cochran (1978), Day (1843), Doddridge (1912), Donehoo (1926), Dunaway (1948), Egle (1876), Illick (1976), Jenkins (1903-1907), Keith (1917), Klein and Hoogenboom (1973), Murphy and Murphy (1937), Secor (1975), Stevens (1956, 1964), Wallace (1962), and the Writer's Program (1940).

Sources for New York were Brodhead (1853, 1871), Ellis et al. (1967), Flick (1933-1937), Horton et al. (1947), Kammen (1975), Lossings (1888), Sullivan (1927), and the Writer's Program (1940).

General summaries of North American ethnology and ethnohistory normally included materials on the Iroquoian and Algonkian-speaking tribes of the northeastern United States and Great Lakes region. However, such sources usually did not present the specific information needed for a research focus such as this one. Indeed, the southern Lake Erie shore and adjacent uplands were rarely considered in such works. Typical of these works are Underhill's Red Man's America (1953), Driver's Indians of North America (1969), Spencer et al.'s (1977) volume The Native Americans, and Gabarino's Native American Heritage (1976). Such comparative works as Driver and Massey (1957) and summaries with an emphasis on selected tribes also provide ethnographic data. The Iroquois, especially the Seneca, are often selected for inclusion in such summaries, e.g. Leacock and Lurie (1971) contains a review by Fenton (1971:129-168), as does Oswalt (1978:415-456).

The major source on the Seneca remains Lewis Henry Morgan's League of the Ho-dé-no-sau-nee (1851). Morgan, a pioneer ethnologist, conducted interviews among members of Iroquoian-speaking tribes of New York State during the 1840s. The use of participant observation, structured and unstructured interviews, and questionnaires marked a major departure into modern anthropology. Unfortunately, Morgan's visitations among the Seneca did not take him into Pennsylvania, and he relied on Ely S. Parker, of Tonawanda, a native Seneca, for much of his data on this tribe. Morgan's maps of Seneca, Oneida, Onondaga, Cayuga, and Mohawk tribal territories ended at the New York-Pennsylvania border.

Wallace's and Steen's The Death and Rebirth of the Seneca (1969) deals with the late colonial and early reservation history of the Seneca, and particularly the prophet Handsome Lake and his moral and religious revitalization movement. Much of Wallace's information came from interviews with Deardorff, Fenton, and Paul A. W. Wallace. The research for his book, conducted between 1951 and 1956, utilized ethnohistoric, ethnographic, and archival documents. Deardorff was the only "informant" cited although a number of Seneca were consulted.

Although Barbara Graymont's The Iroquois in the American Revolution (1972) covers primarily the Mohawk Valley, it also depicts the composition of the Iroquois League and the diplomatic negotiations between the Six Nations and Britain and the United States. Her research, conducted ca. 1968-1971, employed ethnohistoric, ethnographic, and archival material.

K.1 SOURCES FOR ZONE 1a

Zone Ia, the Glacial Till Plain, extends eastward from Toledo to Pipe Creek near Sandusky, Ohio. This zone has no upland to the south as it is the former bed of Lake Warren. Although the zone is artificially defined as beginning at the present Michigan-Ohio boundary, the ethnohistory of the zone was influenced by events in Monroe and Wayne counties, Michigan, particularly those in what is now the City of Detroit. For this reason, this enthnohistoric investigation includes parts of present-day Monroe County, Michigan, and Lucas, Ottawa, Seneca, Sandusky, Huron, and Erie counties, Ohio.

The important state of Michigan sources consulted were Bald (1961), Dunbar (1971), Santer (1977), Vexler (1978), and the Writer's Program (1940). The primary state of Ohio sources consulted were Atwater (1838), Bond (1941), Randall and Ryan (1912), Utter (1962), Winter (1917), Wittke (1941-1944), and the Writer's Program (1940).

Specific sources for Monroe County were Buckley (1913a) and Wing (1890). Sources for Lucas County, Ohio, were Downes (1954), Evans (1967), Frohman (1969), Hardesty (1882), Killits (1923), Andreas and Baskin (1875), Uhl Bros. (1901), and Waggoner (1888).

Sources consulted for Ohio counties are as follows: for Ottawa County, Goodman (1900) and Hardesty (1874); for Seneca County, Lang (1880), Leeson (1886), and Lewis Publishing Co. (1902); for Wood County, Evers (1897, 1910); for Sandusky County, Broekhoven (1904-1905), Everett (1878, 1882), Frohman (1965, 1968), Keeler (1904), Meek (1909, 1915), Sandusky County (1874, 1882), Beers (1896), and Wiggins (1897-1898); for Huron County, Baughman (1909), Cherry (1934), Beers (1894), Lake (1873, 1874b), and Williams (1879); and for Erie County, Aldrich (1889), Stewart and Page (1874), Frohman (1965, 1968, 1971), Hills (1925), Huntington (1863), Keeler (1904), Peeke (1916, 1925), and Ryall (1913).

The primary Native American tribes in this region during the 1570-1850 period were as follows:

Chippewa (Hyde 1962, Kinietz 1940; Ritzenthaler and Ritzenthaler 1970; Swanton 1952)

Delaware (Goddard 1978a; Kinietz 1946; Speck 1946; Swanton 1952; Weslager 1942, 1978b; Witthoft 1965)

Erie/Eries/Eriez (Hewitt 1907; Hyde 1962; Lupold 1975; Potter 1968; Swanton 1952; Vietzen 1945, 1965; White 1956, 1958, 1961, 1971, 1976, 1978a; Witthoft 1965)

Fox (Callender 1978a; Hyde 1962; Kinietz 1940; Ritzenthaler and Ritzenthaler 1970; Swanton 1952)

Huron (Heidenreich 1978; Hodge 1913; Tooker 1963, 1964, Trigger 1960, 1962, 1969; White 1956, 1958, 1961, 1963, 1967, 1971, 1976)

Kickapoo (Callender, Pope, and Pope 1978; Gibson 1963; Hyde 1962; Swanton 1952)

Mascouten (Goddard 1978b; Hyde 1962; Swanton 1952)

Miami (Callender 1978b; Swanton 1952)

Missisauga (Hodge 1913; Swanton 1952)

Neutral (Hodge 1913; Noble 1978; Swanton 1952; White 1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b; Wright 1963)

Ottawa (Feest and Feest 1978; Greening 1961; Hodge 1913; Kinietz 1940; Swanton 1952)

Potowatomi (Clifton 1978; Hyde 1962; Kinietz 1940; Swanton 1952)

Seneca (Abler and Tooker 1978; Morgan 1851; Swanton 1952; Tooker 1963; Trelease 1962; Trigger 1960; White 1956, 1958, 1961, 1963, 1967, 1971, 1976)

Shawnee (Callender 1978c; Swanton 1952; Witthoft 1965)

"Tobacco"/Tionontati (Hodge 1913; Swanton 1952)

Wenro/Wenroe (Hodge 1913; Swanton 1952; White 1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b)

Wyandot (Hodge 1913; Hyde 1962; Schlup 1906; Swanton 1952; Tooker 1978d)

K.2 SOURCES FOR ZONES Ib AND IIa

Zone Ib, the Western Ohio Lowlands, extends from Pipe Creek near Sandusky eastward to the Cuyahoga River at Cleveland, Ohio. This zone is a lowland area bordering upon the Glacial Till Uplands (IIa), which lie to the south. This ethnohistoric investigation includes, from west to east, the following areas in Ohio: the eastern two-thirds of Erie County, all of Lorain County, the western three-fourths of Cuyahoga County, and the northern half of Summit County.

The important state of Ohio sources consulted were Atwater (1838), Bond (1941), Randall and Ryan (1912), Stewart (1935), Utter (1942), Winter (1917), Wittke (1941-1944), and the Writer's Program (1940).

Specific sources for Erie County were Aldrich (1889), Stewart and Page (1874), Frohman (1965, 1968, 1971), Hills (1925), Huntington (1863), Keeler (1904), Peeke (1916, 1925), and Ryall (1913). Sources for Lorain County were Boynton (1892), Lake (1874c), Lawrence (1912), Williams (1879b), Stranahan (1896), and Wright (1916). Specific sources for Cuyahoga County were Chapman (1964), Cleave (1875), Coates (1924), Lewis Publishing Co. (1894), Ellis (1966), Johnson (1879), Kennedy (1896), and the U.S. Department of the Interior (1977). Sources for Summit County were Grant (1891), Lake (1892), and Perrin (1881).

The primary Native American tribes in this region during the period from 1570 to 1850 were as follows:

Chippewa (Hyde 1962; Kinietz 1940; Ritzenthaler and Ritzenthaler 1970; Swanton 1952)

Delaware (Goddard 1978a; Kinietz 1946; Speck 1946; Swanton 1952; Weslager 1942, 1978b; Witthoft 1965)

Erie/Eries/Eriez (Hewitt 1907; Hyde 1962; Lupold 1975; Potter 1968; Swanton 1952; Vietzen 1945, 1965; White 1956, 1958, 1961, 1971, 1976, 1978a; Witthoft 1965)

Miami (Callender 1978b; Swanton 1952)

Ottawa (Feest and Feest 1978; Greening 1961; Hodge 1913; Kinietz 1940; Swanton 1952)

Seneca (Abler and Tooker 1978; Morgan 1851; Swanton 1952; Tooker 1963; Trelease 1962; Trigger 1960; White 1956, 1958, 1961, 1963, 1967, 1971, 1976)

Wyandot (Hodge 1913; Hyde 1962; Schlup 1906; Swanton 1952; Tooker 1978d)

K.3 SOURCES FOR ZONES Ic AND IIb

Zone Ic, the Eastern Ohio Lowlands, extends eastward from the Cuyahoga River at Cleveland, Ohio, to Mill Creek (locally Millcreek) at Erie, Pennsylvania. It is a very narrow band of land and provides a sublinear pattern of stream drainage. Zone IIb, the Allegheny Plateau Upland, is the formerly glaciated segment of the Allegheny Plateau. This ethnohistoric investigation includes, from west to east, what are now the eastern one-fourth of Cuyahoga County, Ohio; Geauga, Lake and Ashtabula counties, Ohio; and the western half of Erie County, Pennsylvania.

The important state of Ohio sources consulted were Atwater (1838), Bond (1941), Randall and Ryan (1912), Stewart (1935), Utter (1942), Winter (1917), Wittke (1941-1944), and the Writer's Program (1940). The important Commonwealth of Pennsylvania sources consulted were Bolles (1898), Day (1843), Donehoo (1926), Illick (1976), Klein and Hoogenboom (1973), Stevens (1956, 1964), Wallace (1962), and the Writer's Program (1941).

Specific sources for Cuyahoga County, Ohio, were Chapman (1964), Cleave (1875), Coates (1924), Lewis Publishing Co. (1894), Ellis (1966), Johnson (1879), Kennedy (1896), and the U.S. Department of the Interior (1977). Sources for Geauga County, Ohio, were Biographical (1893a), Cleave (1895), Historical Society of Geauga County (1880), Stranahan (1900), and Williams Brothers (1878). Specific sources for Lake County, Ohio, were Biographical (1893a), Cleave (1895), Gault (1957), Lake (1874b), New Century. . .(1915), Lake County Historical Society (1976), Lupold (1974), Williams (1878), and the Writer's Program (1941). Sources for Ashtabula County, Ohio, were Ashtabula County (1905), Biographical (1893a, 1893b), Cleave (1895), Hall (1856), Howells (1927), Lake (1874a), Large (1924), Talcott (1906), and Williams (1878).

Specific sources for Erie County, Pennsylvania, were Bates (1884), Day (1843), Erie Metropolitan Planning Commission (1975), Lechner (1975), Miller (1909), Moorehead (1876), Reed (1925), Riesenman (1943), Robbins (1894), Sanford (1862, 1894), Spencer (1962), Whitman (1896), Whitman and Russell (1884), and the U.S. Army Corps of Engineers (1979).

The primary Native American tribes in this region during the 1570-1850 period were as follows:

Chippewa (Hyde 1962; Kinietz 1940; Ritzenthaler and Ritzenthaler 1970; Swanton 1952)

Delaware (Goddard 1978a; Kinietz 1946; Speck 1946; Swanton 1952; Weslager 1942, 1978b; Witthoft 1965)

Erie/Eries/Eriez (Hewitt 1907; Hyde 1962; Lupold 1975; Potter 1968; Swanton 1952; Vietzen 1945, 1965; White 1956, 1958, 1961, 1971, 1976, 1978a; Witthoft 1965)

Ottawa (Feest and Feest 1978; Greening 1961; Hodge 1913; Kinietz 1940; Swanton 1952)

Seneca (Abler and Tooker 1978; Morgan 1851; Swanton 1952; Tooker 1963; Trelease 1962; Trigger 1960; White 1956, 1958, 1961, 1963, 1967, 1971, 1976)

Shawnee (Callender 1978c; Swanton 1952; Wallace 1961; Wallower 1956; Witthoft 1965)

Wyandot (Hodge 1913; Hyde 1962; Schlup 1906; Swanton 1952; Tooker 1978d)

K.4 SOURCES FOR ZONES Id AND IIc

Zone Id, the Southwestern New York Lowlands, extends eastward from Mill Creek at Erie, Pennsylvania, to Silver Creek, New York. The zone is wider than the Eastern Ohio Lowlands (Ic) and has a subdendritic stream pattern. Zone IIc, the Allegheny Plateau Upland, is the formerly glaciated segment of the Allegheny Plateau. This ethnohistoric investigation includes, from west to east, what are now the eastern half of Erie County, Pennsylvania, and most of Chautauqua County, New York, the exception is a 120-km^2 portion at the extreme northeast that abuts the Lake Erie littoral (Zone Id).

The important Commonwealth of Pennsylvania sources consulted were Bolles (1899), Day (1843), Donehoo (1926), Illick (1976), Klein and Hoogenboom (1973), Stevens (1956, 1964), Wallace (1962), and Writer's Program (1940). The important State of New York sources consulted were Brodhead (1853, 1871), Flick (1933-1937), Kammen (1975), Sullivan (1927), and the Writer's Program (1940).

Specific sources for Erie County, Pennsylvania, were Bates (1884), Day (1843), Erie Metropolitan Planning Commission (1975), Lechner (1975), Miller (1909), Moorehead (1876), Reed (1925), Riesenman (1943), Robbins (1894), Sanford (1862, 1894), Spencer (1962), Whitman (1896), Whitman and Russell (1884), and the U.S. Army Corps of Engineers (1979). Sources for Chautauqua County, New York, were Dilley (1891), Doty (1925), Downs and Hedley (1921), Edson and Merrill (1894), McMahon (1938, 1958), Merrill (1894), Ripley (1966), Warren (1846), and Young (1895).

The primary Native American tribes in this region during the 1570-1850 period were as follows:

Delaware (Goddard 1978a; Kinietz 1946; Speck 1946; Swanton 1952; Weslager 1942, 1978b; Witthoft 1965)

Erie/Eries/Eriez (Hess 1978; Hewitt 1907; Hyde 1962; Kolb 1977a, 1977b, 1979; MacNeish 1952; Swanton 1952; Vietzen 1945, 1965; Wallace 1961; White 1956, 1958, 1961, 1971, 1976, 1978a; Witthoft 1965)

Seneca (Abler and Tooker 1978; Conover 1889; Hayes 1979; MacElwain 1978; MacNeish 1952; Morgan 1851, 1959; Parker 1926a, 1926b; Swanton 1952; Tooker 1963; Trelease 1962; Trigger 1960; Wallace 1978; Wallace with Steen 1973; White 1956, 1958, 1961, 1963, 1967, 1971, 1976; Wray and Schoff 1953)

Shawnee (Callender 1978c, Swanton 1952, Witthoft 1965)

K.5 SOURCES FOR ZONES Ie AND IId

Zone Ie, the Western New York Lowlands, extends eastward from Silver Creek to Buffalo, New York; it is wider than the Southwestern New York Lowlands (Id). Zone IId, the Allegheny Plateau Upland, is the formerly glaciated segment of the Allegheny Plateau. This ethnohistoric investigation includes, from west to east, a 120-km^2 section at the extreme northeast of Chautauqua County that abuts the Lake Erie littoral (Zone Ie), an 85-km^2 northeastern area in Chautauqua County (Zone IId), and all of Erie County, New York, including the present-day city of Buffalo.

The important State of New York sources consulted were Brodhead (1853, 1871), Flick (1933-1937), Kammen (1975), Sullivan (1927), and the Writer's Program (1940).

Specific sources for Erie County, New York, and for Buffalo were Boots (1942), Doty (1925), Dunn (1971), Hall and Patterson (1867), Johnson (1876), Ketchum (1864), Retter (1932), Smith (1884), Sweetney (1920), and White (1898).

The primary Native American tribes in this region during the period 1570-1850 were as follows:

Erie/Eries/Eriez (Hess 1978; Hewitt 1907; Hyde 1962; Kolb 1977a, 1977b, 1979; MacNeish 1952; Swanton 1952; Vietzen 1945, 1965; Wallace 1961; White 1956, 1958, 1961, 1971, 1976, 1978a; Witthoft 1965)

Fox (?) (Callender 1978a; Hunter 1978; Swanton 1952)

Huron (Heidenreich 1978; Hodge 1913; Tooker 1963, 1964; Trigger 1960, 1962, 1969; White 1956, 1958, 1961, 1963, 1967, 1971, 1976)

Neutral (Hodge 1913, Noble 1978; Swanton 1952; White 1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b; Wright 1963)

Seneca (Abler and Tooker 1978; Conover 1889; Hayes 1979; MacElwain 1978; MacNeish 1952; Morgan 1851, 1959; Parker 1926a, 1926b; Swanton 1952; Tooker 1963; Trelease 1962; Trigger 1960; Wallace 1978; Wallace with Steen 1973; White 1956, 1958, 1961, 1963, 1967, 1971, 1976; Wray and Schoff 1953)

Wenro/Wenroe (Hodge 1913; Swanton 1952; White 1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b)

Appendix L

Protohistoric Site Inventory and Sources for Ethnohistoric Data

Appendix L

Protohistoric Site Inventory and Sources for Ethnohistoric Data

Five tables that integrate available information on the major protohistoric sites (ca. 1600-contact) in the study area have been compiled (Tables L.1-L.5). Emphasis was placed on sites in the Lakeshore Plain and Maumee River drainage. The following information is included in these tables: Site Name, Site Type (when known), Location (county), Chronology (when known and reported in the literature), Affiliation (assumed cultural or tribal affiliation as reported in the literature), and References. The primary "working list" was based on the 1976 work edited by Brose and on maps and discussions contained in his volume The Late Prehistory of the Lake Erie Drainage Basin.

Ethnohistoric documentation and intensive archeological investigations in western New York yielded the best chronological data for the Protohistoric Period and the study region. Hence, White (1961, 1971, 1976, 1978a) appears to be on safe ground in assigning Erie and/or Seneca affiliations. None of the assigned affiliations for Pennsylvania, Ohio, or Michigan can be verified by ethnohistoric or archeological data, although some early authors (notably Greenman, Mayer-Oakes, Morgan, and Ellis, attempted to make such assignments. Brose (1976c, 1978a) and Kolb (1977a, 1979) commented on the lack of validity in these assignments. Early authors assumed that the Whittlesey Focus was the archological representation of the Erie Indians, known from ethnohistoric documentation, but Brose effectively rejected this speculation (1978a:582). He correctly stated that there is no direct relationship between archeological sites and ethnohistoric cultures, and that the specific ethnic identification of any lake archeological manifestation is entirely speculative. Therefore, the New York State data (12 Protohistoric sites) is the best, the Pennsylvania data (3 Protohistoric sites) is poor, the Ohio (73 Protohistoric sites) and the Michigan (13 Protohistoric sites) data is weakest, as one attempts to assign "cultural" affiliations to archeological complexes. It is an exercise fraught with danger.

Table L.1. Protohistoric Sites: New York State, Erie and Chautauqua Counties (Littoral)

Site Name	Site Type	Location (County)	Chronology	Affiliation	References[a]
Buffalo Creek	Village	Erie Co.	ca. 1625	Erie?, Seneca	1, 6, 25, 26, 27, 13, 20, 24
Clarence	Village/Camp?	Erie Co.	ca. 1625	Erie?, Seneca	25, 26
Nursery	Camp?	Erie Co.		Erie?, Seneca	25, 26
Ellicott Creek	Village	Erie Co.	ca. 1625	Erie?, Seneca	25, 26
Buffam Street	Village, Cemetery	Erie Co.	ca. 1625	Erie, Seneca	1, 6, 25, 26, 27
Buffam Street		Erie Co.	ca. 1580-1600	Wenro?	13
Kleis	Village	Erie Co.	ca. 1625, 1644	Erie, Seneca	25, 26, 27, 28
High Banks (UB887)	Village	Chautauqua Co.	ca. 1625	Erie, Seneca	21, 25, 26, 27, 20, 24
Silverheels (UB787)	Cemetery/Ossuary	Chautauqua Co.	ca. 1625	Erie, Seneca?	12, 17, 21, 25, 26, 27, 28, 20, 24
Burning Spring	Camp/Village	Chautauqua Co.		Seneca?	21
Sheridan	Village	Chautauqua Co.	ca. 1625	Seneca	6, 21
Westfield	Village	Chautauqua Co.	ca. 1600-1656	Erie, Seneca	6, 12, 14, 25, 26
Ripley	Village, Cemetery	Chautauqua Co.	ca. 1644 ff.	Erie, Seneca	6, 12, 17, 25, 26, 27, 28, 14

[a]Key to References
1 Abler and Tooker 1978
2 Brose 1973
3 Brose 1976b
4 Brose 1976c
5 Brose 1978a
6 Brose 1976
7 Brose et al. 1976
8 Greenman 1935a
9 Greenman 1937
10 Greenman 1937
11 Johnson 1976
12 Kolb 1979
13 MacNeish 1976
14 Mayer-Oakes 1955
15 Morgan and Ellis 1943
16 Murphy 1971
17 Parker 1907
18 Prahl, Brose, and Stothers 1976
19 Prufer and Shane 1976
20 Ritchie 1969
21 Schock 1976
22 Sturtevant 1978
23 Tooker 1978
24 Trigger 1978
25 White 1961
26 White 1971
27 White 1976
28 White 1978a
29 McKenzie and Blank 1976

Table L.2. Protohistoric Sites: Pennsylvania, Erie County (Littoral)[a]

Site Name	Site Type	Location (County)	Chronology	Affiliation	References
East 28th Street	Camp, Cemetery	Erie Co.	ca. 1644 ff.	Erie?, Seneca?	6, 11, 12, 14, 24, 25, 26, 27, 28
Wintergreen Gorge or Behrend	Camp?, Village?	Erie Co.	?	?	11, 12
Wesleyville	Village?	Erie Co.	ca. 1644 ff.	Erie?	11, 12, 14

[a]For key to references, see Table L.1.

Table L.3. Protohistoric Sites: Ohio, Ashtabula, Lake, Cuyahoga Counties (Littoral)[a]

Site Name	Site Type	Location (County)	Chronology	Affiliation	References
Kantola	Village?	Ashtabula Co.	?	?	6
Eastwall	Village?	Ashtabula Co.	?	?	6
Kaiser Fort	Village (Palisaded)	Ashtabula Co.	?	?	6
Sauro Farm	Village, Camp?	Ashtabula Co.	?	?	6
Conneaut Fort	Village (Palisaded)	Ashtabula Co.	"Middle Mississippian"		8
Conneaut Fort	Village (Palisaded)	Ashtabula Co.	?	?	5, 6, 7, 12, 4
Linesville Earthwork	Village (Palisaded)	Ashtabula Co.	?	?	6, 12
Thunderbolt	Camp?	Ashtabula Co.	?	?	6, 12
County Fairgrounds	Camp, Village?	Ashtabula Co.	?	?	5, 6, 7, 12
Ahlstrom	Camp	Ashtabula Co.	ca. 1450	?	5, 6, 12
Kaiser	Camp?	Ashtabula Co.	?	?	5, 6
Mentor Headlands	Village?, Camp	Lake Co.	?	?	4, 5, 6
Fairport Harbor	Village, Cemetery	Lake Co.	1000-1640	Erie	14, 15
Fairport Harbor	Village, Cemetery	Lake Co.	1000-1640	not Erie-Seneca	2, 3, 4, 5, 6, 12, 16
Eveport	?	Lake Co.	?	?	4, 5, 6
Lyman	Village	Lake Co.	?	?	2, 3, 4, 5, 6, 16
Little Mountain	Village?	Lake Co.	?	?	6
Reeve	Camp/Village	Lake Co.	1000-contact	Erie, Seneca	9, 10
Reeve	Camp/Village	Lake Co.	1000-contact	?	4, 5, 6, 12
White City Beach	?	Lake Co.	?	?	6
Garfield Estate	Camp?	Lake Co.	?	?	6
Euclid Creek	?		?	?	6
Gordon Park	?		?	?	6
Nike Site 2	Camp	Cuyahoga Co.	?	?	6
Terminal Tower	?	Cuyahoga Co.	?	?	6
Bay Village Yacht Club	?	Cuyahoga Co.	?	?	6
Offut	Village	Cuyahoga Co.	ca. 1400-contact	?	5, 6
Bay Village Hospital	?	Cuyahoga Co.	?	?	6
Cahoon Creek	?	Cuyahoga Co.	?	?	6
South Park I	Village (Palisaded)	Cuyahoga Co.	1100-1760	Erie, Seneca	10
South Park I	Village (Palisaded)	Cuyahoga Co.	1100-1760	?	2, 3, 4, 5, 6, 12
South Park II	Village (Palisaded), Cemetery	Cuyahoga Co.	1540-1760	?	2, 3, 4, 5, 6, 12
South Park III	Camp	Cuyahoga Co.	1625-contact	?	2, 5, 6, 12
Boice Fort	Village (Palisaded)	Cuyahoga Co.	1625-contact	?	5, 6
Greenwood	Village, Cemetery	Cuyahoga Co.	1100-1640	?	2, 6
Tuttle Hill	Camp, Village	Lake Co.	1250-1760	Erie, Seneca	10
Tuttle Hill	Camp, Village	Lake Co.	1250-1760	not Erie or Seneca	2, 4, 5, 6, 12

[a]For key to references, see Table L.1.

Table L.4. Protohistoric Sites: Ohio, Lorain, Erie, Sandusky, Lucas Counties (Littoral)[a]

Site Name	Site Type	Location (County)	Chronology	Affiliation	References
CEI Avon	Camp?	Lorain Co.	?	?	5, 6, 7
White Fort	Village (Palisaded)	Lorain Co.	"Middle Mississippian"	?	8
White Fort	Village (Palisaded)	Lorain Co.	?	?	5, 6, 7
Burrell Orchard	Village?	Lorain Co.	"Middle Mississippian"	?	8, 10
Eiden	Village	Lorain Co.	"Middle Mississippian"	?	8
Eiden	Village	Lorain Co.	1400-contact	?	3, 5, 6, 29
Burrell Fort	Village (Palisaded)	Lorain Co.	?	Erie, Seneca	10
Burrell Fort	Village (Palisaded)	Lorain Co.	?	?	6, 7
National Tube Co. Site	Camp?	Lorain Co.	"Middle Mississippian"		8
National Tube Co. Site	Camp	Lorain Co.	?	?	6, 7
Leimbach	Village	Lorain Co.	750-ff.	?	5, 6, 19
Frank	?	Lorain Co.	?	?	6
Morrow	?	Erie Co.	?	?	6
Mixter	Village	Erie Co.	1400-contact	?	5, 6, 19
Taylor	?	Erie Co.	?	?	6
Esch	?	Erie Co.	?	?	6
Fort Island	?	Erie Co.	?	?	5
Windsor Fort	Village (Palisaded)	Erie Co.	?	?	5
North Bass Mound	Camp, Ossuary?	North Bass Island	?	?	6
Bretz	?	Middle Bass Island	?	?	6
South Bass #1	?	South Bass Island	?	?	6
Whittlesey Mount	Camp, Ossuary	Kelleys Island	?	?	6
Libben	Village	Sandusky Co.	1400-contact	?	5, 6, 19, 22
Libben	Village	Sandusky Co.	?	Wyandot?	23
Squaw Island	?	Sandusky Co.	?	?	6
Peters	?	Sandusky Co.	?	?	6
Peterson	?	Sandusky Co.	?	?	6
Silica Quarry	Quarry	Lucas Co.	?	?	6
Doctors	?	Lucas Co.	?	?	6
Morin	?	Lucas Co.	?	?	6
Point Place	?, Camp?	Lucas Co.	?	?	6
Waterworks Mound	?.	Lucas Co.	?	?	6
Ten Mile Creek	?	Lucas Co.	?	?	6
Montri	?	Lucas Co.	?	?	6
Willson	?	Lucas Co.	?	?	6
Johnoff #1 and #2	?	Lucas Co.	?	?	6
Patyi-Dowling	?	Lucas Co.	?	?	6
Cufr	?	Lucas Co.	?	?	6
Albon	?	Lucas Co.	?	?	6
Indian Hills	?	Lucas Co.	?	?	6
Dodge	?	Lucas Co.	?	?	6
McNichols	?	Lucas Co.	?	?	6
Fort Meigs	Village	Lucas Co.	1400-contact	?	5, 6
Williams	?	Lucas Co.	?	?	5, 6
Biggers	?	Lucas Co.	?	?	5
Heckleman	?	Lucas Co.	?	?	5

[a]For key to references, see Table L.1.

Table L.5. Protohistoric Sites: Michigan, Monroe County (Littoral)[a]

Site Name	Site Type	Location (County)	Chronology	Affiliation	References
Bay Creek	?	Monroe Co.	post 1650	"Iroquois"	6, 18
Indian Point	Camp	Monroe Co.	1250-1640	?	2
Rocky River	Village	Monroe Co.	1250-1450	?	2
Woodtick Peninsula	?	Monroe Co.	?	?	6
Sterling Park	?	Monroe Co.	?	?	6
Point Mouille	?	Monroe Co.	?	?	6
Ottinger	?	Monroe Co.	?	?	6
"No Name"	?	Monroe Co.	?	?	6
Hospital	?	Monroe Co.	?	?	6
Academy	?	Monroe Co.	?	?	6
St. Mary's Vineyard	?, Camp	Monroe Co.	post 1655	"Iroquois"	6, 18
Sisson	?	Monroe Co.	?	?	6
Indian Trails	?	Monroe Co.	?	?	6

[a]For key to references, see Table L.1.

TRIBAL SOURCES DATA BASE

Cayuga
Kubiak (1970); MacNeish (1952); Murdock and O'Leary (1975); Swanton (1952); White, Englebrecht, and Tooker (1978)

Chippewa Hyde (1962), Kinietz (1940), Kubiak (1970), Murdock and O'Leary (1975), Ritzenthaler and Ritzenthaler (1970), Swanton (1952)

Delaware Goddard (1978a), Hunter (1956), Kinietz (1946), Murdock and O'Leary (1975), Newcomb (1956), Speck (1946), Swanton (1952), Wallace (1961), Wallower (1956), Weslager (1941, 1942, 1978a, 1978b), Witthoft (1949, 1965)

Erie/Eries/Eriez Braden (1928); Edson (1935); Hess (1978); Hewitt (1907); Hyde (1962); Kolb (1977a, 1977b, 1979); Kubiak (1970); Lupold (1975); MacNeish (1952); Murdock and O'Leary (1975); Potter (1968); Schmitz (1878); Swanton (1952); Vietzen (1945, 1965); Wallace (1961); Wallower (1956); White (1956, 1958, 1961, 1971, 1976, 1978a); Witthoft (1949, 1965); Wolynec, et al. (1978)

Fox Callender (1978a), Hyde (1962), Kinietz (1940), Kubiak (1970), Murdock and O'Leary (1975), Ritzenthaler and Ritzenthaler (1970), Swanton (1952)

Huron Gendron (1868), Heidenreich (1978), Hodge (1913), Hunter (1907), Kubiak (1970), Murdock and O'Leary (1975), Sagard-Theodat (1939), Swanton (1952), Tooker (1963, 1964), Trigger (1960, 1962, 1969), White (1956, 1958, 1961, 1963, 1967, 1971, 1976)

"Iroquois" Bailey (1938), Beauchamp (1904, 1905), Carpenter (1942b), Colden (1958), Emerson (1968), Englebrecht (1971, 1974a and b), Fenton (1940, 1941, 1971, 1978), Fenton (ed.) (1968), Graymont (1972), Griffin (1944), Harrington (1922c), Hertzberg (1966), Kubiak (1970), MacNeish (1972, 1976), Morgan (1851, 1959), Murdock and O'Leary (1975), Oswalt (1978), Quain (1937), Ridley (1957), Scheele (1947), Skinner (1921), Snyderman (1948), Speck (1945, 1955), Spencer et al. (1977), Stites (1905), Sulte (1899), Swanton (1952), Tooker (1963, 1970a, 1970b, 1978a, 1978b, 1978c), Tooker (ed.) (1967), Trelease (1962), Trigger (1963, 1978), Trigger and Pendergast (1978), Tuck (1978a), Underhill (1953), Wallace (1956, 1961), Wallower (1956), Whallon (1968), White (1956, 1958, 1961, 1963, 1967, 1971, 1976), Witthoft (1951), J.V. Wright (1964)

Kickapoo Callender, Pope and Pope (1978); Gibson (1963); Kubiak (1970); Murdock and O'Leary (1975); Swanton (1952).

Mascouten Goddard (1978b), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Miami Callender (1978b), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Missisaugua/Missisauga Hodge (1913), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Mohawk Fenton and Tooker (1978), Kubiak (1970), MacNeish (1952), Morgan (1851), Murdock and O'Leary (1975), Swanton (1952)

Neutral Harris (1913), Hodge (1913), Kubiak (1970), Murdock and O'Leary (1975), Noble (1978), Swanton (1952), White (1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b), Wright (1963)

Oneida Campisi (1978), Kubiak (1970), MacNeish (1952), Murdock and O'Leary (1975), Swanton (1952)

Onondaga Blau, Campisi and Tooker (1978); Kubiak (1970); MacNeish (1952); Murdock and O'Leary (1975); Swanton (1952); Tuck (1971)

Ottawa Feest and Feest (1978), Greening (1961), Hodge (1913), Kinietz (1940), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Petun/Khionontateronon Garrad and Heidenreich (1978), Murdock and O'Leary (1975), Ritzenthaler and Ritzenthaler (1970), Swanton (1952)

Potawatomi Clifton (1978), Kinietz (1940), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Seneca Abler and Tooker (1978); Conover (1889); Curtin (1923); Hayes (1979); Kubiak (1970); Lane (1977, 1978); MacElwain (1978); MacNeish (1952); Morgan (1851); Murdock and O'Leary (1975); Parker (1926a, 1926b); Swanton (1952); Tooker (1963); Trelease (1962); Trigger (1960); Wallace (1978); Wallace with Steen (1973); Wallace (1961); Whallon (1968); White (1956, 1958, 1961, 1963, 1967, 1971, 1976); Wolynec et al. (1978); Wray and Schoff (1953)

Shawnee Callender (1978c), Donehoo (1924), Murdock and O'Leary (1975), Swanton (1952), Wallace (1961), Wallower (1956), Witthoft (1949, 1965)

Susquehannock/Andaste Jennings (1978), Murdock and O'Leary (1975), Swanton (1952), Wallace (1961), Wallower (1956), Witthoft (1949, 1965)

"Tobacco"/Tionontati Hodge (1913), Kubiak (1970), Murdock and O'Leary (1975), Swanton (1952)

Wenro/Wenroe Hodge (1913), Kubiak (1970), Murdock and O'Leary (1975), Silver (1923), Swanton (1952), White (1956, 1958, 1961, 1963, 1967, 1971, 1976, 1978b)

Wyandot Hodge (1913), Hyde (1962), Murdock and O'Leary (1975), Schlup (1906), Swanton (1952), Tooker (1978d)

LIST OF INFORMANTS

George Abrams (Seneca), Director/Curator, Seneca-Iroquois National Museum, Salamanca, New York.

Richard (Rick) Hill (Tuscarora), Secretary/Treasurer, Native American Center for the Living Arts, Inc., Niagara Falls, New York.

Robert Hoag (Seneca), President, Seneca Nation of Indians, Salamanca, New York.

Neville Spring (Seneca), Director, Native American Center for the Living Arts, Inc., Niagara Falls, New York.

REFERENCES

Abler, T.S. 1969. Factional dispute and conflict in the political system of the Seneca Nation (1845-1895): An ethnohistorical analysis. Ph.D. dissertation, University of Toronto.

Abler, T.S., and Tooker, E. 1978. Seneca. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 505-517. Washington: Smithsonian Institution.

Abrams, J.P., and Taft, C.E. 1971. A bibliography of research conducted at the Franz Theodore Stone Laboratory, and its predecessor, of the Ohio State University, from 1895 to 1968. Ohio Journ. Sci. 71(2): 81-105.

Acrelius, I. 1759. Beskrifning om de Swenska Forsamlingars forna och Norwarande Tilstand, uti det so Kallade Nya Swerige [Description of the Swedish Parishes, former and present condition, in the so-called New Sweden]. Stockholm.

Adams, W., ed. 1893. Historical gazetteer and biographical memorial of Cattaraugus County, N.Y. Syracuse, N.Y.: Lyman, Horton and Co.

Adams, W.H. 1979-1980. Historical archaeology: Science and humanism. North American Archaeologist 1(1):85-96.

Addison, L.G. 1888. Ohio boundary, or the Erie War. Ohio Archaeological and Historical Publications 2:340-344.

Adovasio, J.M.; Gunn, J.D.; Donahue, J.; and Stuckenrath, R. 1977. Meadowcroft Rockshelter: Retrospect 1976. Pennsylvania Archaeologist 47(2-3):1-93.

Agnew, D. 1887. A history of the region of Pennsylvania north of the Ohio and west of the Allegheny River. Philadelphia: Kay and Brother.

Aitken, M.J.

1961 Physics and archaeology. New York: Interscience Publishers, Inc.

1970 Magnetic location. In Science and archaeology: A survey of progress and research, D. Brothwell and E. Higgs, eds. New York: Praeger.

Aldrich, J.W. 1943. Biological survey of the bogs and swamps in northeastern Ohio. Am. Mid. Nat. 30(2):346-402.

Aldrich, L.C. 1889. History of Erie County, Ohio. Syracuse, N.Y.: Mason and Co.

Allin, A.E. 1929. Seining records and food of the intermediate stages of Lake Erie fishes. In Preliminary report on the cooperative survey of Lake Erie, season of 1928. Buffalo Soc. Nat. Sci., Bull. 14(3):188-194.

Andahazy, W.J.; Everstine, D.G.; and Hood, B.R. 1976. Magnetometer search for shipwrecks from the Battle of Yorktown. Sea Technology (November).

Andreas and Baskin. 1875. An illustrated historical atlas of Lucas and part of Wood counties, Ohio. Chicago.

Andrews, I.D. 1853. Trade and commerce of the British North American colonies and upon the Great Lakes and rivers. Executive Document no. 112, Robert Armstrong, Washington.

Anuskiewicz, R.J. 1978. The exorbitant cost of underwater remote sensing and research: A public and federal government cultural resource management dilemma. In Beneath the waters of time: The proceedings of the 9th Conference of Underwater Archaeology, ed. J.B. Arnold III. Texas Antiquities Committee Pub. no. 6.

Applegate, V.C., and VanMeter, H.D. 1970. A brief history of commercial fishing in Lake Erie. Bur. Comm. Fisheries, Fishery Leaflet 630. Washington: USGPO.

1930. Archeological survey of Erie County [Pennsylvania]. Pennsylvania Archaeologist 1(2):10.

Armson, K.A. 1977. Forest soils: Properties and processes. Toronto: University of Toronto Press.

Arnold, J.B. III

1976 An underwater archeological magnetometer survey and site test excavation project off Padre Island, Texas. Texas Antiquities Committee Pub. no. 3.

1977 Site test excavations underwater, the sequel to the magnetometer survey. I.J.N.A.U.E. 6.1:21-36.

1978 Underwater site testing: Results of the Texas Antiquities Committee 1977 Field Season. Paper presented at the 9th Conference of Underwater Archeology, San Antonio.

1979a An Airborne magnetometer survey for shipwrecks and associated underwater test excavations. Paper presented at the 10th Conference of Underwater Archaeology, Nashville.

1979b Personal communication.

Arnold, J.B. III, and Clausen, C.J.

1975a A magnetometer survey with electronic positioning control and calculator-plotter system. I.J.N.A.U.E. 4.2:353-366.

1975b Shipwreck sites found by magnetometer survey. Sea Technology (August) pp. 20-22.

Arnold, J.B. III, and Kegley, G.B. III. 1977. Results of a magnetometer survey at Hueco Tanks, a prehistoric Mogollon village in western Texas. Texas Journal of Science vol. 28, nos. 1-4 (March) pp. 201-207.

Asch, D.L., and Asch, N. 1977. Chenopod as cultigen. Midcontinental Journal of Archaeology vol. 2, no. 1, pp. 33-46.

Asch, N.B.; Ford, R.I.; and Asch, D.L. 1972. Paleoethnobotany of the Koster Site: The Archaic horizons. Ill. State Mus., Rept. of Invest. no. 24.

Ashtabula County Historical Society. 1905. Ashtabula County Atlas. Ashtabula, Ohio: Sill, Tucker and Co.

Atwater, C. 1838. A history of the state of Ohio, natural and civil. 2d ed. Cincinnati: Glazer and Shepard.

Atwater, W.O. 1892. The chemical composition and nutritive values of food-fishes and aquatic invertebrates. Rept. U.S. Comm. Fish. Part 16, pp. 679-868.

Auten, J.T. 1945. Some soil factors associated with site quality for planted black locust and black walnut. Journ. Forestry 43:592-598.

Baby, R.S. 1971. Prehistoric architecture: A study of house types in the Ohio Valley. Ohio Journ. Sci. 71(4):193-197.

Baby, R.S., and Potter, M.A. 1965. The Cole Complex: A preliminary analysis of the Late Woodland ceramics in Ohio and their relationship to the Ohio Hopewell Phase. Ohio Historical Society Papers in Archaeology 2.

Baddeley, A.D. 1966. The influence of depth on the manual dexterity of free divers. Journal of Applied Psychology 50(1):81-85.

Baerreis, D.A., and Bryson, R.A. 1965. Climatic episodes and the dating of the Mississippian Cultures. The Wisconsin Archeologist n.s., 46(4):203-220.

Bailey, J.H. 1938. An analysis of Iroquoian ceramic types. American Antiquity 3(4):333-338.

Baker, F.S. 1921. Black walnut: its growth and management USDA Bull. 933.

Bald, F.C. 1961. Michigan in four centuries. Rev. ed. New York: Harper.

Baldwin, C.C.

1875 Early maps of Ohio and the west. Western Reserve Historical and Archaeological Society Tract 25:1-25.

1879 Early Indian migration in Ohio. American Antiquarian and Oriental Journal 1:227-239.

Baldwin, L.D. 1941. The keelboat age on western waters. Pittsburgh: University of Pittsburgh Press.

Baldwin, N.S., and Saalfield, R.W. 1962. Commercial fish production in the Great Lakes, 1867-1960. Great Lakes Fish. Comm. Tech. Rept. no. 3.

Banfield, A.W.F. 1962. Notes on the mammals of Pelee Island. Nat. Mus. of Can., Dept. Northern Affairs and Nat. Res. Bull. 183, pp. 118-122.

Barber, C.R., sponsor. 1938. Erie: A guide to the city and county. Philadelphia: William Penn Association of Philadelphia. American Guide Series written and compiled by the Erie County Unit of the Federal Writers' Project of the Works Progress Administration for the Commonwealth of Pennsylvania.

Barzun, J. 1972. Cultural history as a synthesis. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 387-402. New York: Random House.

Barzun, J., and Graff, H.F. 1977. The modern researcher. 3rd ed. New York: Harcourt, Brace, Jovanovich.

Bascom, W. 1976. Deep water, ancient ships. Garden City, N.Y.: Doubleday & Company, Inc.

Bass, G. F.

1966 Archaeology under water. New York: Frederick A. Praeger.

1972 Submersibles in underwater search and photogrammetric mapping. In Underwater archaeology: A nascent discipline. UNESCO. Paris.

Bates, S.P. 1884. History of Erie County, Pennsylvania. Chicago: Warner, Beers and Co. [Reprinted Evansville, Ind.: Unigraphic, Inc., 1976.]

Baughman, A.J.

1909 History of Huron County, Ohio. 2 vols. Chicago: S.J. Clarke Publishing Co.

1911 History of Seneca County, Ohio. 2 vols. Chicago and New York: Lewis Publishing Co.

Bean, T.H.

1892 The fishes of Pennsylvania, with description of the species and notes on their common names, distribution, habits, reproduction, rate of growth, and mode of capture. Pa. State Comm. Fish.

1903 Catalogue of the fishes of New York. NY State Mus. Bull. 60, Zool. 9.

Beardslee, C.S., and Mitchell, H.D. 1965. Birds of the Niagara frontier region. Buffalo Soc. Nat. Sci. Bull. 22.

Beardsley, R.K.; Holder, P.; Krieger, A.D.; Meggers, B.J.; Renaldo, J.B.; and Kutsche, P. 1956. Functional and evolutionary implications of community patterning. In Seminars in archaeology: 1955, ed. R. Wauchope. Society for American Archaeology Memoirs, vol. 11, pp. 129-157.

Beasley, N. 1930. Freighters of fortune. New York: Harper & Brothers.

Beattie, H.M. 1950. The location of British Fort Sandusky. Inland Seas 4(4):226-233.

Beauchamp, W. M.

1904 A history of the New York Iroquois. NY State Mus. Bull. 78, Archeology 9 [Reprinted Port Washington, N.Y.: Ira J. Friedman].

1905 A history of the New York State Iroquois, now commonly called the Six Nations. University of the State of New York Bulletin 329; NY State Mus. Bull. 78, Archeology 9:125-461.

Bednarik, K.E. 1953. An ecological and food habits study of the muskrat in the Lake Erie marshes. M.Sc. thesis, Ohio State University.

Beers (J.H.) and Co.

1894 Commemorative biographical record of the counties of Huron and Lorain, Ohio. Chicago.

1896 Commemorative biographical record of the counties of Sandusky and Ottawa, Ohio. Chicago.

Beeton. 1963. Limnological survey of Lake Erie, 1959 and 1960. U.S. Fish and Wildlife Service.

Bender, E. 1978. New techniques advance geophysical survey. Sea Technology (September).

Bendler, E. 1962. Exploration for natural gas in Ohio. Inland Seas 18(4):280-290.

Benedict, A.L. 1901. Mound Builder remains on Cattaraugus Creek, Erie County, New York. American Antiquarian and Oriental Journal 23:99-105.

Bernabo, J.C., and Webb, T. III. 1977. Changing patterns in the Holocene pollen record of northeastern North America: A mapped summary. Quaternary Res 8(1):64-96.

Bevan, B. 1979. Personal communication.

Bevan, B., and Kenyon, J. 1975. Ground-penetrating radar for historical archaeology. MASCA Newsletter vol. 11, no. 2.

Bidwell, P.W., and Falconer, J.I. 1925. History of agriculture in the northern United States. Washington: Carnegie Institution of Washington.

Bierce, L.V. 1854. Historical reminiscences of Summit County [Ohio]. Akron, Ohio: T. and G.H. Canfield.

Biggar, H.P., ed. 1929. The works of Samuel de Champlain. 3 vols. Toronto: Champlain Society.

Binford, L. R.

1963 "Red ochre" caches from the Michigan area: A possible case of cultural drift. Southwestern Journal of Anthropology 19:89-108.

1971 Mortuary practices: Their study and their potential. In Social dimensions of mortuary practices, ed. J.A. Brown. Society for American Archaeology, Memoirs, no. 25.

1972 An archaeological perspective. New York: Seminar Press.

Black, G.A. 1954. The historic Indian of the Ohio Valley: An archaeologist's view. Ohio State Archaeological and Historical Quarterly 63:155-165.

Blair, E.H., ed. 1911. The Indian tribes of the Upper Mississippi Valley and region of the Great Lakes. 2 vols. Cleveland.

Blank, J.E. 1970. The Archaic component of the Welling Site, 33Co3, Coshocton County, Ohio. Ohio Archaeologist 20:269-281.

Blau, H.; Campisi, J.; and Tooker, E. 1978. Onondaga. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 491-499. Washington: Smithsonian Institution.

Bloomster, E.L. 1969. Sailing and small craft down the ages. U.S. Naval Institute, Annapolis.

Bolles, A.S. 1899. Pennsylvania, province and state: A history from 1609 to 1790. 2 vols. Philadelphia: John Wanamaker.

Bolsenga, S.J. 1967. Snow depth probability in the Great Lakes Basin. Proc. 10th Conf. Great Lakes Res., Int. Assoc. Great Lakes Res. 1967:162-170.

Bond, B.W., Jr. 1941. The foundations of Ohio: History of the State of Ohio, ed. C. Wittke, vol. 1. Columbus, Ohio: Ohio State Archaeological and Historical Society.

Boots, J.F. 1942. Reminiscences of Niagara and Erie counties, New York. Riverside, Calif. Printed by the author.

Bowen, D.T. 1952. Shipwrecks of the lakes. Daytona Beach, Fla.

Bowen, J.

1976 The Appalachian Archaic of the Upper Green Creek drainage. Ohio Archaeologist 26(4):8-10.

1978 The Eiden Phase component of Pearson Village. Ohio Archaeologist 28(3):12.

Bowen, J. (Cont.)

1979 Wolf-like Late Woodland remains at Pearson Village. Paper presented at the American Anthropological Association Annual Meeting, Cincinnati, Ohio.

Boynton, W.W. 1892 (1876). The early history of Lorain County, Ohio: An address delivered July 4, 1876, at Elyria, Ohio. Western Reserve Historical Society Tract 83, 3:300-367.

Braden, J.A. 1928. Little brother of the Hudson. New York: Harper and Brothern.

Bradford, T.L. 1907-1910. The bibliographer's manual of American history. Revised and edited by S. V. Henkels. Philadelphia: Stan V. Henkels.

Bradt, G.W. 1939. Breeding habits of beaver. Journ. Mammology 20:486-489.

Braudel, F. 1972. Time, history, and the social sciences. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 403-429. New York: Random House.

Braun, E.L.

1916 The physiographic ecology of the Cincinnati region. Ohio Biol. Surv. Bull. 7.

1934 A history of Ohio's vegetation. Ohio Journ. Sci. 34(4):247-257.

1950 Deciduous forests of eastern North America. New York: Hafner.

Bray, W.L. 1930. The development of the vegetation of New York State. NY State Coll. Forestry, Tech. Publ. 29, 2nd ed.

Brewington, M.V., and Brewington, D. 1968. Marine paintings and drawings in the Peabody Museum. Salem, Mass.: The Peabody Museum of Salem, Mass.

Brewster, W. 1954. Pennsylvania and New York frontier: From 1720 to the close of the Revolution. Philadelphia: G.S. MacManus.

Broadfoot, W.M. 1973. Raised water tables affect southern hardwood growth. U.S. Forest Service, Research Note, Southern Forest Experiment Station SO-168.

Brockman, C.F. 1968. Trees of North America. New York: Golden.

Brodhead, J.R.

1853 History of the State of New York, Vol. 1: 1609-1664. New York: Harper and Brothers.

1871 History of the State of New York, Vol. 2: 1664-1871. New York: Harper and Brothers.

Broecker, W.S. 1966. Glacial rebound and the deformation of the shorelines of proglacial lakes. Journ. Geophys. Res. 71(20):4777-4783.

Broekhoven. 1904-1905. Broekhoven's Fremont City and Sandusky County Directory. Columbus, Ohio: P.J. Broekhoven.

Brooks, P. 1969. Research in archives: The use of unpublished primary sources. Chicago: University of Chicago Press.

Brose, D.S.

1970 The early Indians of Ohio. The Explorer 12(1):20-29. Cleveland Museum of Natural History.

1971 The early historic Indians of northern Ohio. The Explorer 13(1):21-29. Cleveland Museum of Natural History.

1972 An initial summary of the Late Prehistoric Period in northeastern Ohio. Paper presented at the Central States Anthropological Society Annual Meeting, Cleveland, Ohio. Mimeographed.

1973 A preliminary report on recent excavations at the South Park Site, Cuyahoga County, Ohio. Pennsylvania Archaeologist 43(1):25-43.

1975a Archaeological survey of the Cuyahoga Valley Interceptor Project. Cleveland Regional Sewer District report.

1975b Botanical archaeology at the Norman P. Site in Ohio. Journal of Field Archaeology 2(4):293-306.

1975c Preliminary result of an archaeological reconnaissance of the area of Lower Tinker Creek Valley. Report of the Cuyahoga Valley Park Board Federation.

1975d Squaw Rockshelter: Early Archaic occupation in northeastern Ohio. Paper presented at the annual meeting of the Eastern States Archaeological Foundation, Columbus, Ohio.

1976a The Hillside Road Site (33Gu3): Fort Ancient influence in a Middle Whittlesey component. Ohio Archaeologist 26(4):25-27.

1976b The Hospital and Academy Sites (20 Mr 19, 121 & 123): Archaic occupations in Monroe County, Michigan. TAARB.

1976c An initial summary of the Late Prehistoric Period in northeastern Ohio. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 25-47. Scientific Papers of the Cleveland Museum of Natural History.

1976d Locational analysis in the prehistory of northern Ohio. In Papers in honor of James B. Griffin, ed. C. Cleland, pp. 3-18. New York: Academic Press.

1976e Squaw Rock Shelter: An Early Archaic campsite in northeast Ohio. Paper presented at the Society for American Archaeology Annual Meeting, St. Louis, Mo.

1977 Archaeological reconnaissance and sub-surface investigation of the proposed United States Steel Corporation Greenfield Steel Plant, Ashtabula County, Ohio; Erie County, Pennsylvania. Cleveland Museum of Natural History.

Brose, D.S. (Cont.)

1978a Comment to Stoltman: Temporal models in prehistory. Current Anthropology 19:729-731.

1978b Late Prehistory of the Upper Great Lakes Area. In Handbook of North American Indians, Vol. 8, ed. B. G. Trigger, pp. 569-582. Washington: Smithsonian Institution.

1978c A model of changing subsistence technology in the Late Woodland of northeast Ohio. In Lithics and subsistence, ed. D.D. Davis, pp. 87-115. Vanderbilt University Publication in Anthropology no. 20.

n.d.(a) Late Woodland prehistoric occupation at the Hale Farm, Summitt County, Ohio. Bulletin of the Western Reserve Historical Society (in press).

n.d.(b) Recent salvage excavations at two village sites near Cleveland, Ohio: Redating the occupation of the Tuttle Hill and Reeve Site. Ohio Archaeologist (in press in 1978).

n.d.(c) South Park: A stratified Whittlesey Site in Cuyahoga County, Ohio. Scientific Papers of the Cleveland Museum of Natural History (in press in 1976).

Brose, D.S., ed. 1976. The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised. Scientific Papers of the Cleveland Museum of Natural History.

Brose, D.S., and Essenpreis, P.S. 1973. A preliminary report on archaeological survey of Monroe County, Michigan. Michigan Archaeologist 19(1-2):1-238.

Brose, D.S., and Lee, A. 1975. A summary report on the archaeological survey and testing of the Perry Nuclear Power Plant area, Lake County. Ohio Archaeologist 25(2):7-10.

Brose, D.S., and Scarry, J.F. 1976. The Boston Ledges Shelter: Comparative spatial analyses of early Late Woodland occupations in Summit County, Ohio. Midcontinental Journal of Archaeology 1(2):179-228.

Brose, D.S.; Wentzel, G.; Bluestone, H.; and Essenpreis, P. 1976. Conneaut Fort: A prehistoric village in Ashtabula, Ohio. Pennsylvania Archaeologist 46(4):29-77.

Brose, D.S.; Werner, B.; and Wolynec, R. 1977. Final report on the secondary study area stochastic predictive archaeological analysis of Erie and Crawford counties, Pennsylvania, and Ashtabula County, Ohio. Cleveland Museum of Natural History.

Brose, D.S., and White, N.M. Seventeen prehistoric sites in northern Ohio. Cleveland: Case Western Reserve University, Department of Anthropology, Ms. on file.

Brown, F.B.H. 1917. The forest associations of Wayne County, Michigan. Ann. Rept. Mich. Acad. Sci. 19:209-217.

Brown, J.A. 1977. Current directions in Midwestern archaeology. Annual Review of Anthropology, 6:161-179.

Boyles, B.J.

1966 Preliminary report: The St. Albans Site (46Ka27), Kanawha County, West Virginia. The West Virginia Archaeologist 19:1-43.

1971 Second preliminary report: The St. Albans Site, Kanawha County, West Virginia. West Virginia Geological and Economic Survey, Report of Archeological Investigations no. 3.

Bruce, J.P.; Anderson, D.V.; and Rodgers, G.K. 1961. Temperature, humidity, and wind profiles over the Great Lakes. Proc. 4th Conf. Great Lakes Res., Univ. Mich., Great Lakes. Res. Div., Publ. 7:65-70.

Bruemmer, F. 1966. Lake Erie gull colony. Can. Audubon 28(1):13-17.

Bryson, R.A., and Wendland, W.M. 1967. Tentative climatic patterns for some Late Glacial and Post-glacial episodes in central North America. In Life, land, and water, ed. W.J. Mayer-Oakes, pp. 271-289. Winnipeg, Manitoba: University of Manitoba Press.

Buchanan, R.A. 1970. Industrial archaeology: Retrospect and prospect. American Antiquity 44:281-287.

Buchman, R.L. 1976. Introduction: Who and where were Ohio's Indian Peoples? In The historic Indian in Ohio, ed. R.L. Buchman, pp. 3-5. Columbus, Ohio: Ohio Historical Society.

Buchman, R.L., ed. 1976. The historic Indian in Ohio: A conference to commemorate the bicentennial of the American Revolution. Columbus, Ohio: Ohio Historical Society.

Buck, S.J., and Buck, E.H. 1939. The planting of civilization in western Pennsylvania. Pittsburgh: University of Pittsburgh Press.

Buckley, J.M.

1913a History of Monroe County [Michigan]. Chicago: Lewis Publishing Co.

1913b The early French settlements on the Great Lakes. Ohio Archaeological and Historical Publications 22:341-348.

Buehler, E.J., and Tesmer, I.H. 1963. Geology of Erie County, New York. Bull. Buffalo Soc. Nat. Sci. 21(3).

Buettner, H.J. 1965. Commercial fisheries of the Great Lakes 1879-1963. U.S. Fish. and Wildlife Serv. Statistical Dig. 57:444-466.

Buller, C.R. 1927. A treatise on the fish of Pennsylvania. Pa. Board Fish. Comm., Bull. 4.

Bunk, I.W. 1962. Precipitation estimates in the Great Lakes drainage basins. Monthly Weather Rev. 90(3):79-82.

Buol, S.W.; Hole, F.D.; and McCracken, R.J. 1973. Soil genesis and classification. Ames, Iowa: Iowa State University Press.

Burchard, J., and Bush-Brown, A. 1961. The architecture of America: A social and cultural history. Boston: Little, Brown and Company.

Burns, G.W. 1958. Wisconsin age forests in western Ohio, II: Vegetation and burial conditions. Ohio Journ. Sci. 58:220-230.

Burt, W.H. 1957. Mammals of the Great Lakes Region. Ann Arbor, Mich.: University of Michigan Press.

Bury, J.B. 1972. History as a science. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 209-223. New York: Random House.

Bush, D.R.

1976a An assessment of prehistoric and historical cultural resources within the proposed federal harbor improvements and local cooperator developments at Cleveland Harbor, Cuyahoga County, Ohio. Ohio Historical Society, Columbus.

1976b A cultural resource reconnaissance level literature search and records review for the Big Creek improvement project Cleveland, Cuyahoga County, Ohio. Ohio Historical Society, Columbus.

1979 The Valentine Cache Site, Lake County, Ohio. Ohio Archaeologist 29(1):21-24.

Butler, G.W. 1956. Glacial erosion: Kelleys Island and vicinity. Inland Seas 12(2):125-127.

Butler, M. 1936. Archaeological problems in Erie County, Pennsylvania. Pennsylvania Archaeologist 6(2):27-31.

Butzer, K. 1971. Environmental archaeology: An ecological approach to prehistory. Chicago: Aldine Press.

Byers, D.S. 1959. The Eastern Archaic: Some problems and hypotheses. American Antiquity 24:233-256.

Cadillac, A. de la M. 1947. The western country in the seventeenth century: The memoirs of Lamothe Cadillac and Pierre Liete, ed. M. Quaife. Chicago: Lakeside Press.

Cadzow, D.A.

1934 Pennsylvania Historical Commission's archaeological survey and excavation in northwestern Pennsylvania, Parts 1-9. Harrisburg: Pennsylvania Historical Commission, Ms.

1935a Report on archaeological explorations in western Pennsylvania 1934. Pennsylvania Historical Commission Bulletin 4.

1935b Report on archaeological investigations in western Pennsylvania. Harrisburg: William Penn Memorial Museum, Ms. on file.

1936 Progress of research in Pennsylvania. Pennsylvania Archaeologist 6(2):31-33.

Cadzow, D.A., et al. 1932. Archaeological excavations in the city of Erie, Erie County. Pennsylvania Historical and Museum Commission Archaeological Reports for 1932, Ms. 18-42. [Files of PHMC, Harrisburg.]

Cain, S.A., and Slater, J.V. 1948. Palynological studies at Soden Lake, Michigan, part III. The sequence of pollen spectral, profile I. Ecology 29(4):492-500.

Caldwell, J.R. 1958. Trend and tradition in the prehistory of the eastern United States. American Anthropological Association Memoir 88.

Caldwell, J.R., and Hall, R.L., eds. 1964. Hopewellian Studies. Illinois State Museum Scientific Papers, vol. 12.

Calkin, P.E. 1970. Strandlines of glacial Great Lakes in northwestern New York. Ohio Journ. Sci. 70:78-96.

Calkin, P.E., and McAndrew, J.H. 1969. Dating late glacial recession and vegetation in the Erie Basin, northwestern New York. (Abstr.) 4th Ann. Meeting, Northeast Sect., Geol. Soc. Amer. Abstr. Part 1, p. 5.

Calkin, P.E., and Miller, K.E. 1977. Late Quaternary environment and man in western New York. In Amerinds and their paleoenvironments in northeastern North America. W.S. Newman and B. Salwen, eds. Annals of the New York Academy of Sciences, vol. 288, pp. 297-315.

Callender, C.

1978a Fox. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 636-647. Washington: Smithsonian Institution.

1978b Miami. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 681-689. Washington: Smithsonian Institution.

1978c Shawnee. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 622-635. Washington: Smithsonian Institution.

Callender, C.; Pope, R.K.; Pope, S.M. 1978. Kickapoo. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 656-667. Washington: Smithsonian Institution.

Campbell, L.J. 1955. The late glacial and lacustrine deposits of Erie and Huron counties, Ohio. Ph.D. dissertation, Ohio State University.

Campbell, (Rev.) T.J. 1913. Pioneer priests of North America 1642-1710. 3 vols. New York: The America Press.

Campisi, J. 1978. Oneida. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 481-490. Washington: Smithsonian Institution.

Cantor, G. 1978. The Great Lakes guidebook, Vol. 1: Lakes Ontario and Erie. Ann Arbor, Mich.: University of Michigan Press.

Cantor, N.F., and Schneider, R.I. 1967. How to study history. Northbrook, Ill.: AHM Publishing Corp.

Carmack, R.M. 1972. Ethnohistory: A review of its development, definitions, methods and aims. Annual Review of Anthropology 1:227-246.

Carman, J.E. 1930. Drainage changes in the Toledo region. Ohio Journ. Sci. 30:187-193.

Carpenter, E. S.

1942a Archaeological reconnaissance in the Upper Ohio Valley. Pennsylvania Archaeologist 12(1):20-23.

1942b Iroquoian figures. American Antiquity 8(1):105-113.

1949 Wesleyville Site, Erie County. Pennsylvania Archaeologist 19(1-2):17.

1950 The Spartansburg Cairns [Crawford County]. Pennsylvania Archaeologist 20(1-2):40-46.

1962 A correction. [Spartansburg Cairns]. Pennsylvania Archaeologist 32(1):20.

Carpenter, E.S.; Pfirman, K.R.; and Schoff, H.L. 1949. The 28th Street Site. Pennsylvania Archaeologist 19(1-2):3-16.

Carpenter, E.S., and Schoff, H.L. 1951. The Nelson Mound, Crawford County, Penna. Pennsylvania Archaeologist 21(3-4):57-59.

Carr, C. 1977. A new role and analytical design for the use of resistivity surveying in archaeology. Midcontinental Journal of Archaeology.

Carrell, T.; Rayl, S.; and Lenihan, D. 1976. The effects of freshwater inundation of archaeological sites through reservoir construction: A literature search. U.S. Department of the Interior, National Park Service Cultural Resource Management Division. Washington.

Carter, C.H.

1976 Lake Erie shore erosion, Lake County, Ohio: Setting, processes, and recession rates from 1876 to 1972. Ohio DNR, Div. of Geol. Surv. Rept. Invest. no. 99.

1977 Sediment-load measurements along the United States shore of Lake Erie. Ohio DNR, Div. of Geol. Surv. Rept. of Invest. no. 102.

Carter, D.B. 1966. Climate. In Geography of New York State, ed. J.H. Thompson, pp. 54-78. Syracuse, N.Y.: Syracuse University Press.

Cederlund, C.O. 1977. Preliminary report on recording methods used for the investigation of merchant shipwrecks at Jutholmen and Alvsnabben in 1973-1974. I.J.N.A.U.E. 6.2:87-99.

Chapelle, H.I. 1935. The history of American sailing ships. New York: W.W. Norton & Company, Inc.

Chapman, E.H. 1964. Cleveland: Village to metropolis. Cleveland: Western Reserve Historical Society and Case Western Reserve University Press.

Chapman, J. 1977. Archaic period research in the Lower Little Tennessee Valley. University of Tennessee Department of Anthropology, Report of Investigation no. 18.

Chapman Publishing Co. 1895. Portrait and biographical record of the city of Toledo and Lucas and Wood counties, Ohio. Chicago.

Charlevoix, P.F.X. de. 1866-1872. History and general description of New France [1744]. 6 vols. ed. J.G. Shea. New York: John G. Shea.

Cheney, T.A. 1860. Ancient monuments in western New York. In New York State Museum 13th Annual Report, pp. 37-52.

Cherry, M.L. 1934. Blockhouses and military posts of the Firelands. Shippensburg, Pa.

Chorley, R.J. 1978. The hillslope hydrological cycle. In Hillslope Hydrology, ed. M.J. Kirkby, pp. 1-42. New York: Wiley.

Christie, W.J. 1974. Changes in the fish species composition of the Great Lakes. Journ. Fish. Res. Board Can. 31:827-854.

Clark, A. 1970. Resistivity surveying. In Science and archaeology: A survey of progress and research, 2d ed., D. Brothwell and E. Higgs, eds. New York: Praeger.

Clark, C.F.

1950 Observations on the spawning habits of northern pike, Esox luciens, in northwestern Ohio. Copeia 1950(4);285-288.

1956 Sandusky River Report. Ohio DNR, Div. Wildlife.

Clark, C.F., and Alleson, C. 1966. Fish population trends in the Maumee and Auglaize rivers. Ohio DNR, Div. Wildlife.

Clark, C.F., and Steinback, F. 1959. Observations of the age and growth of the northern pike, Esox luciens L., in East Harbor, Ohio. Ohio Journ. Sci. 59(3):129-134.

Clark, N.A.; Lantz, S.W.; and Robinson, W.J. 1960. The Danner Mound. Pennsylvania Archaeologist 30(3):37-45.

Clarke, J.M. 1909. Fifth report of the director of the science division. Education Department Bulletin no. 453. Museum Bulletin 133. Albany, N.Y.

Clausen, C.J. 1979. Little Salt Spring, Florida: A unique underwater site. Science vol. 203, no. 4381, (Feb. 16) pp. 609-614.

Clausen, C.J. and Arnold, J.B. III. 1976. The magnetometer and underwater archaeology, magnetic delineation of individual shipwreck sites, a new control technique. I.J.N.A.U.E. 5.2:159-169.

Cleator, P.E. 1973. Underwater archaeology. New York: St. Martin's Press.

Cleave, E. 1875. Cleave's biographical cyclopedia of the state of Ohio: Ashtabula, Geauga, Lake, Lorain, Lucas, Mahoning and Trumbull counties. Philadelphia: J.B. Lippincott and Co.; Cleveland: Fairbanks and Co.

Cleland, C.E.

1965 Barren ground caribou (Rangifer articus) from an early man site in southeastern Michigan. American Antiquity 30:350-351.

1966 Prehistoric animal ecology and ethnozoology of the Upper Great Lakes. Anthropological Papers, University of Michigan Museum of Anthropology no. 26.

Clemens, H.P. 1951. The food of the burbot, Lota lota macalosa (LeSueur), in Lake Erie. Trans. Am. Fish. Soc. 80:56-66.

Clifton, J.A. 1978. Potawatomi. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 725-745. Washington: Smithsonian Institution.

Cline, M.G. 1955. Soils and soil associations of New York. New York Coll. Agr. Ext. Bull. 930.

Coates, D.R. 1976. Quaternary stratigraphy of New York and Pennsylvania. In Quaternary stratigraphy of North America, ed. W.D. Mahaney, pp. 65-90. Stroudsburg, Pa.: Dowden, Hutchinson, & Ross.

Coates, W.R. 1924. A history of Cuyahoga County and the city of Cleveland. 3 vols. Chicago: American Historical Society.

Cochran, T.C. 1978. Pennsylvania: A bicentennial history. New York: Norton.

Cochran, T., and Hofstadter, R. 1972. History and the social sciences. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 347-370. New York: Random House.

Cockrell, W.A., and Murphy, L. 1978. 8 SL 17: Methodological approaches to a dual component marine site on the Florida Atlantic Coast. In Beneath the waters of time: The proceedings of the 9th Conference of Underwater Archaeology, ed. J.B. Arnold III. Texas Antiquities Committee Publication no. 6.

Coe, J.L. 1964. The formative cultures of the Carolina Piedmont. Transactions of the American Philosophical Society 54(5):1-130.

Cohn, B.S. 1968. Ethnohistory. In International encyclopedia of the social sciences, Vol. 6, pp. 440-448.

Colden, C. 1958. The history of the five Indian nations, depending on the province of New York in America. Ithaca, N.Y.: Cornell University Press. [Originally published 1727, 1747.]

Conant, R. 1938. The reptiles of Ohio. Am. Mid. Nat. 20(1):1 200.

Condit, C.W. 1964. The Chicago School of Architecture. Chicago: University of Chicago Press.

Cone, S.D. 1908. Indian attack on Fort Dunlap. Ohio Archaeological and Historical Publications 17:64-72.

Conover, G.S. 1889. Seneca villages: Principal settlements between Canadaigua and Seneca Lake. Geneva, N.Y.:n.p.

Converse, R.N. 1970. Ohio flint types. Columbus, Ohio: Archaeological Society of Ohio.

Cooley, T.M. 1905. Michigan: A history of governments. 5th ed. Boston: Houghton, Mifflin and Co.

Core, E.L. 1948. The flora of the Erie Islands. The OSU F.T. Stone Lab. Contrib. 9.

Cornplanter, J.J. 1938. Legends of the longhouse. Port Washington, N.Y.: Ira Friedman.

Cottingham, K.

1960a Erie--the record of a lake, Part I. Inland Seas 16(2):131-137.

1960b Erie--the record of a lake, Part II. Inland Seas 16(3):215-223.

Crawford, L.C. 1953. Hydrology of Lake Erie and tributaries. Ohio DNR, Div. Water, Lake Erie Pollution Surv. Final Rept., pp. 19-28.

Creer, K.M.; Anderson, T.W.; and Lewis, C.F.M. 1976. Late Quaternary geomagnetic stratigraphy recorded in Lake Erie sediments. Earth and Plan. Sci. Lett. 31:37-47.

Crouch, M., and Raum, H., comps. 1977. Directory of state and local history periodicals. Chicago: American Library Association.

Cultural Resource Management Survey. 1977. A cultural resource survey for the proposed small-boat harbor at Cattaraugus Creek, Erie and Chautauqua counties, New York. Prepared for the U.S. Army Engineering District, Buffalo.

Cunningham, W.M. 1948. A study of the Glacial Kame culture in Michigan, Ohio, and Indiana. University of Michigan Museum of Anthropology, Occasional Contributions 12:1-51.

Curtin, J. 1923. Seneca Indian myths. New York: E.P. Dutton.

Curtis, S.A.

1969 The preliminary report of the 1969 Venango County Archaeological Project. Report submitted to the Pennsylvania Historical and Museum Commission in partial fulfillment of Contract SP-54055. December 27, 1969.

1971 The cultural ecology of early Late Woodland Venango County, Pennsylvania. M.A. thesis, Pennsylvania State University.

1980 Personal communication.

Curtis, S.A., and Bebrich, C.A. 1971. A preliminary report on the 1971 excavation of the Robert S. Kerr Site, 36 Ve 4. Report submitted to the Western Pennsylvania Conservancy. September 6, 1971.

Curtis, S.A., and Berlin, A. 1980. A study of the cultural resources at the Argonne National Laboratory. Division of Environmental Impact Studies, Argonne National Laboratory.

Curwood, J.O. 1967. The Great Lakes and the vessels that plow through them. Archives of James Pugliese.

Cusick, D. 1961. Ancient history of the six nations. Niagara County Historical Society, Occasional Contributions no. 15. [Originally published 1825.]

Daiber, F.C.

1952 The food and feeding relationships of the freshwater drum, Aplodinotus grunniens Rafinesque, in western Lake Erie. Ohio Journ. Sci. 52(1):35-46.

1953 Notes on the spawning population of the freshwater drum (Aplodinotus grunniens Rafinesque) in western Lake Erie. Am. Mid. Nat. 50(1):159-171.

Dailey, P.W., Jr. 1971. Climates of the States--Pennsylvania. In Climatography of the United States, National Oceanic and Atmosph. Admin. no. 60-36. Washington: USGPO.

Darby, W. 1962. A tour from the city of New York to Detroit in the Michigan Territory: May 2 to Sept. 22, 1818. New York: Quadrangle Books.

Daubin, S.C. 1970. System requirements for underwater acoustic holographic mapping. IEEE Transactions on Geoscience Electronics, vol. GE-8, no. 4 (October).

Davis, C.C. 1969. Plants in Lake Erie and Ontario, and changes of their numbers and kinds. In Proceedings of the Conference on Changes in the Biota of Lake Erie and Ontario, ed. R.A. Sweeney. Buffalo Soc. Nat. Sci. Bull. 25(1):18-44.

Davis, D., ed. 1978. Lithic and Subsistence. Nashville, Vanderbilt Univ. Anthropology 20.

Davis, M.B.

1967a Pollen accumulation rates at Rogers Lake, Connecticut, during late- and postglacial time. Review of Palaeobotany and Palynology 2:219-230.

1967b Late glacial climate in northern United States: A comparison of New England and the Great Lakes region. In Quaternary paleoecology, E.J. Cushing and H.E. Wright, Jr., eds. New Haven, Conn.: Yale University Press.

Day, D.F. 1883. Plants of Buffalo and its vicinity. Buffalo Soc. Nat. Sci. Bull. 4:65-279.

Day, G.M.

1953 The Indian as an ecological factor in the northeastern forest. Ecology 34:329-346.

1978 Nippissing. In Handbook of North American Indians, Vol.15, ed. B. G. Trigger, pp. 787-791. Washington: Smithsonian Institution.

Day, P.C. 1926. Precipitation in the drainage area of the Great Lakes 1875-1924, with discussion of the levels of the separate lakes and their relation to the annual precipitation. Monthly Weather Rev. 54(3):85-106.

Day, S. 1843. Historical collections of the state of Pennsylvania; containing a copious selection of the most interesting facts, traditions, biographical sketches, anecdotes, etc. relating to its history and antiquities, both general and local, with topographical descriptions of every county and all the larger towns in the state. Port Washington, N.Y.: Ira J. Friedman.

Deason, H.J. 1933. Preliminary report on the growth rate, dominance, and maturity of the pike perches (Stizostedion) of Lake Erie. Trans. Am. Fish. Soc. 63:348-360.

de Borhegyi, S. F. 1964. The challenge, nature, and limitations of underwater archaeology. In Diving into the past: Theories, techniques, and applications of underwater archaeology, J.D. Holmquist and A.H. Wheeler, eds. The Minnesota Historical Society and the Council of Underwater Archaeology.

DeBrock, M. 1975. A comparative study of twelve Archaic components from northwest Ohio. Toledo Area Aboriginal Research Bulletin 4(2):10-30.

Deevey, E.S., and Flint, R.F. 1957. Postglacial hypsithermal interval. Science 125:182-184.

DeKay, J.E. 1842. Zoology of New York, or the New York fauna. Parts III, IV, V, and VI. Albany, N.Y.: Carrol and Cook.

Delanglez, J. 1943. Franquelin, mapmaker. Mid-America 25(1):29-74.

Dell, C.I., and Booth, W.G. 1977. Anthropogenic particles in the sediments of Lake Erie. Journ. of Great Lakes Res. 3:204-210.

Deller, D.B.

1976a The Heaman Site: A preliminary report on a Paleo-Indian site in Middlesex County, Ontario. Ontario Archaeologist 27:13-28.

1976b Paleo-Indian location on late Pleistocene shoreline, Middlesex County, Ontario. Ontario Archaeologist 26:3-20.

DeVisscher, J.; Wahla, E.J.; and Fitting, J.E. 1970. Additional Paleo-Indian campsite adjacent to the Holcombe Site. Michigan Archaeologist 16(1):1-25.

Diller, O.D. 1935. The relation of temperature and precipitation to the growth of beech in northern Indiana. Ecology 16:72-81.

Diller, O.D., ed. 1944. Ohio forest resources. Ohio Agr. Expt. Sta. Forestry Publ. 76. Wooster, Ohio.

Dilley, B.F., ed. 1891. Biographical and portrait cyclopedia of Chautauqua County, New York, with a historical sketch of the county. Philadelphia: John M. Gresham.

Dincauze, D.F.

1968 Cremation cemeteries in eastern Massachusetts. Papers of the Peabody Museum of Archaeology and Ethnology, vol. 31, no. 1.

1971 An Archaic sequence for southern New England. American Antiquity 36(2):194-198.

1976 The Neville Site: 8000 years at Amoskeag. Peabody Museum Monographs, no. 4. Cambridge, Mass.

Dobyns, H.F. 1976. Native American historical demography: A critical bibliography. Bloomington, Ind.: Indiana University Press.

Doddridge, J. 1912. Notes on the settlement and Indian wars of the western parts of Virginia and Pennsylvania from 1763 to 1783,inclusive. 2d ed. Pittsburgh: John S. Ritenour.

Dodge, R.J. 1964. The struggle for control of Lake Erie. Northwest Quarterly 36:10-30.

Donehoo, G.P.

1924 The Shawnee in Pennsylvania. Western Pennsylvania Historical Magazine 7(3):178-187.

1926 Pennsylvania: A history. 4 vols. New York: Lewis Historical Publishing Co.

1928 A history of the Indian villages and place names in Pennsylvania. Harrisburg, Pa.: Telegraph Press.

Donnelly, J.P.

1947 A tentative bibliography of the colonial fur trade in the American colonies, 1608-1800. St. Louis: St. Louis University.

1967 Thwaites' Jesuit Relations errata and addenda. Chicago: Loyola University Press.

Donohoe, R.W. 1961. Muskrat reproduction in areas of controlled and uncontrolled water level units. M.Sc. thesis, Ohio State University.

Dorr, J.A., and Eschman, D.F. 1970. Geology of Michigan. Ann Arbor, Mich.: University of Michigan Press.

Doty, L.R. 1925. History of the Genesee country: Comprising the counties of Allegany, Cattaraugus, Chautauqua, Chemung, Erie, Genesee, Livingstone, Monroe, Niagara, Ontario, Orleans, Schuyler, Stuben, Wayne, Wyoming and Yates. 4 vols. Chicago: S.J. Clarke Publishing Co.

Douglas, E.M. 1932. Boundaries, areas, geographic centers and altitudes of the United States and the several States, with a brief record of important changes in their territory and government. United States Department of the Interior, Geological Survey Bulletin 817. Washington: USGPO.

Downes, R.C.

1940 Council fires on the Upper Ohio: A narrative of Indian affairs in the Upper Ohio Valley until 1795. Pittsburgh: University of Pittsburgh Press.

1948 Lucas County historical series. 4 vols. Toledo: Historical

1951 Society of Northwestern Ohio.

1952 History of lake shore Ohio. 3 vols. New York: Lewis Historical Publishing Co.

Downs, J.P., and Hedley, F.Y. 1921. History of Chautauqua County, New York, and its people. 3 vols. Boston: American Historical Society.

Dragoo, D.W.

1956 Excavations at the Watson Site, 46 Hk 34, Hancock County, West Virginia. Pennsylvania Archaeologist 26(2):59-88.

1959 Archaic hunters of the Upper Ohio Valley. Carnegie Museum Anthropological Series, no. 3, pp. 139-246.

1963 Mounds for the dead: An analysis of the Adena culture. Annals of the Carnegie Museum, vol. 37. Pittsburgh.

1964 Archaeological investigations at Pymatuming town, Mercer County, Pennsylvania. Pennsylvania Archaeologist 34(2):47-52.

1971 Archaeological salvage of selected sites in the Allegheny Reservoir in Pennsylvania and New York, 1969-1971. Report to the U.S. National Park Service on Projects No. 14-10-5-950-28 and 14-10-5-950-48. Carnegie Museum, Pittsburgh.

1972 Prehistoric Iroquoian culture in the Upper Ohio Valley. Paper presented at the Central States Anthropological Association Symposium on the Archaeology of the Lake Erie Basin, Cleveland, Ohio.

1976 Prehistoric Iroquoian culture in the Upper Ohio Valley. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose. Scientific Papers of the Cleveland Museum of Natural History. pp. 76-78

1977 Prehistoric Iroquoian occupation in the Upper Ohio Valley. In Current perspectives in northern archaeology, R. Funk and C. Haynes III, eds. Researches and Transactions of the New York State Archaeological Association, vol. 17, no. 1. pp. 41-47

Dreimanis, A.

1957 Stratigraphy of the Wisconsin glacial stage along the northwestern shore of Lake Erie. Science 126:166-168.

1964 Lake Warren and the Two Creeks Interval. Journ. of Geol. 72(2):247-250.

1966 Lake Arkona-Whittlesey and post-Warren radiocarbon dates from "Ridgetown Island" in southwestern Ontario. Ohio Journ. Sci. 66(6):582-586.

1969 Late Pleistocene lakes in the Ontario and Erie basins. Proc. of the 12th Conf. on Great Lakes Res., Intn'l. Assoc. for Great Lakes Res., pp. 170-180.

1977 Late Wisconsin glacial retreat in the Great Lakes region, North America. In Amerinds and their paleoenvironments in northeastern North America, W.S. Newman and B. Salwen, eds. NY Acad. Sci. Publ. 288:70-89.

Driver, H.E. 1969. Indians of North America. 2d rev. ed. Chicago: University of Chicago Press.

Driver, H.E., and Massey, W.C. 1957. Comparative studies of North American Indians. American Philosophical Society, Transactions 47(2).

Du Creux, F. 1951-1952. History of Canada, or New France [1664]. 2 vols. trans. P.J. Robinson, ed. J.B. Conacher. Toronto: Champlain Society.

Duff, W.A. 1931. History of north central Ohio. 3 vols. Topeka and Indianapolis: Historical Publishing Co.

Dunaway, W.F. 1948. History of Pennsylvania. 2d ed. New York: Prentice-Hall.

Dunbar, W.F. 1971. Michigan: A history of the wolverine state. Grand Rapids, Mich.: W.B. Eerdmans Publishing Co.

Dunn, W.S., ed. 1971. History of Erie County [New York], 1870-1970. Buffalo, N.Y.: Buffalo and Erie County Historical Society.

Eccles, W.J. 1972. France in America. New York: Harper and Row.

Edgerton, H.E. 1970. Electronic flash, strobe. New York: McGraw-Hill Book Company.

Edson, O. 1875. History of Chautauqua anterior to its pioneer settlement. In History of Chautauqua County, ed. A.W. Young, pp. 36-49. Buffalo, N.Y.: Methews and Warren.

Edson, O., and Merrill, G.D. 1894. History of Chautauqua County, New York. Boston: W.A. Fergusson.

Edson, W.H. 1935. The Eries: The nation of the cat. New York State Historical Association Proceedings 33:36-44.

Egle, W.H., ed. 1876. An illustrated history of the Commonwealth of Pennsylvania, civil, political, and military, from its earliest settlement to the present time. Harrisburg, Pa.: DeWitt C. Goodrich and Co.

Eichenlaub, V.L. 1979. Weather and climate of the Great Lakes region. South Bend, Ind.: University of Notre Dame Press.

Elden, J., and Spencer, R.F. 1977. The eastern woodlands. In The Native Americans, R.F. Spencer and J.D. Jennings, eds., pp. 364-400. New York: Harper and Row.

Elfner, L.E., Stuckey; R.L.; and Melvin, R.W. 1973. A guide to the literature of Ohio's natural areas. Ohio Biol. Surv. Inf. Circ. no. 3.

Ellicott, A. 1803. Journal of Andrew Ellicott. Philadelphia: Budd and Bartram.

Ellicott, J. n.d. Notes on the Original Land Warrantee Survey of New York for the Holland Land Company, at the Erie County, N.Y. Clerk's Office.

Ellis, D.M., et al. 1967. A history of New York State. Rev. ed. Ithaca, N.Y.: Cornell University Press.

Ellis, W.D. 1966. The Cuyahoga. New York: Holt, Rinehart and Winston.

Emerson, J.N. 1968. Understanding Iroquois pottery in Ontario: A rethinking. Ontario Archaeological Society, Special Publication.

Enders, R.K. 1932. Food of the muskrat in summer. Ohio Journ. Sci. 32:21-31.

Englebrecht, W.E.

1971 A stylistic analysis of New York Iroquois pottery. Ph.D. dissertation, University of Michigan.

1974a Cluster analysis: A method for studying Iroquois prehistory. Man in the Northeast 7:57-70.

1974b The Iroquois: Archaeological patterning on the tribal level. World Archaeology 6(1):52-65.

Erie Metropolitan Planning Commission. 1975. Pennsylvania coastal zone resources analysis for Lake Erie: A preliminary report.

Estes, J.E. 1974. Imaging with photographic and nonphotographic sensor systems. In Remote sensing, techniques for environmental analysis, J. Estes and L.W. Senger, eds. Santa Barbara, Calif.: Hamilton Pub. Co.

Ethnohistory. 1961. Symposium on the concept of ethnohistory. Ethnohistory 8:12-92.

Evans, L. 1755. Geographical, historical, political, philosophical and mechanical essays, the first, containing an analysis of a general map of the middle British colonies in America: and of the country of the confederate Indians. Philadelphia: B. Franklin and D. Hall.

Evans, W.H. 1967. A history of Cedar Point. Inland Seas 23(2):114-120.

Everett, H. 1882. History of Sandusky County, Ohio. Cleveland: H.Z. Williams and Bro.

Evers, C.W.

1897 Commemorative historical and biographical record of Wood County, Ohio. Chicago: J.H. Beers and Co.

1910 Many incidents and reminiscences of the early history of Wood County [Ohio]. Bowling Green, Ohio: The Democrat.

Everts, H. 1874. Historical atlas of Sandusky County, Ohio. Chicago: Everts, Stewart and Co.

Everts, H., and Ensign, B.W. 1876. History of Seneca County, New York. Philadelphia: Everts, Ensign and Everts.

Fairchild, H.L. 1932. New York physiography and glaciology west of the Genesee Valley. Rochester Acad. Sci. Proc. 7:97-135.

Farrand, W.R. 1962. Postglacial uplift in North America. Amer. Journ. Sci. 260:181-199.

Farriss, N.M., and Miller, A.G. 1977. Maritime culture contact of the Maya: Underwater surveys and test excavations in Quintana Roo, Mexico. I.J.N.A.U.E. 6.2:141-151.

Faulkner, H.W. 1968. The decline of laissez faire, 1897-1917. New York: Harper Torchbooks.

Federal Council for Science and Technology, Interagency Committee on Marine Science and Engineering. 1976. 1976 Great Lakes directory of universities, research institutes, and agencies concerned with water and land resources in the Great Lakes Basin. Ann Arbor, Mich.

Feest, J., and Feest, C.F. 1978. Ottawa. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 772-786. Washington: Smithsonian Institution.

Fenneman, N.G. 1938. Physiography of eastern United States. New York: McGraw-Hill.

Fenton, W.N.

1936 An outline of Seneca ceremonies at Coldspring Longhouse. Yale University Publications in Anthropology 9.

1940 Problems arising from the historic northeastern positioning of the Iroquois. Smithsonian Miscellaneous Collections 100.

1941 Tonawanda longhouse ceremonies: Ninety years after Lewis Henry Morgan. Bureau of American Ethnology Bulletin 128:139-165.

1962 Ethnohistory and its problems. Ethnohistory 9:1-23.

1971 The Iroquois in history. In North American Indians in historical perspective, E.B. Leacock and N.O. Lurie, eds., pp. 129-168. New York: Random House.

1978 Northern Iroquoian culture patterns. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 296-321. Washington: Smithsonian Institution.

Fenton, W.N., ed. 1968. Parker on the Iroquois: Iroquois uses of maize and other food plants, the Code of Handsome Lake, the Seneca prophet, the Constitution of the Five Nations. Syracuse, N.Y.: Syracuse University Press.

Fenton, W.N., and Tooker, E. 1978. Mohawk. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 466-480. Washington: Smithsonian Institution.

Fischer, G.R.

1974a Underwater archeological survey of Monteguma Well. In Underwater archaeology in the National Park Service: A model for the management of submerged cultural resources, ed. D.J. Lenihan. U.S. Department of the Interior, National Park Service, Southwest Regional Office, Santa Fe.

1974b The potential of habitat diving in underwater archeology. In Underwater archaeology in the National Park Service, ed. D.J. Lenihan. U.S. Department of the Interior, National Park Service, Southwest Regional Office, Santa Fe.

Fish, C.J. 1929. Preliminary report on the cooperative survey of Lake Erie. Buffalo Soc. Nat. Sci. Bull. 14:7-220.

Fisher, D.W., et al. 1961. Geologic map of New York. NY State Mus. Sci. Service, Map Chart, Ser. 5.

Fitch, J.M. 1961. Architecture and the esthetics of plenty. New York: Columbia University Press.

Fite, G.C., and Reese, J.E. 1959. An economic history of the United States. Boston: Houghton Mifflin Company.

Fitting, J.E.

1963a An early post fluted point tradition in Michigan: A distributional analysis. Michigan Archaeologist 9:21-24.

1963b The Welti Site: A multicomponent site in southeastern Michigan. Michigan Archaeologist 9:34-40.

1964a Bifurcate-stemmed projectile points in the eastern United States. American Antiquity 30:92-94.

1964b Ceramic relationships of four Late Woodland sites in northern Ohio. Wisconsin Archaeologist 45(4):160-175.

1965a Late Woodland cultures of southeastern Michigan. University of Michigan Museum of Anthropology, Anthropological Papers no. 24.

1965b Observations on Paleo-Indian adaptive and settlement patterns. Michigan Archaeologist 11(3-4):103-109.

1966 Radiocarbon dating the Younge Tradition. American Antiquity 31(5):738.

1968 Environmental potential and the postglacial readaptation eastern North America. American Antiquity 33:441-445.

1969 Settlement analysis in the Great Lakes region. SWJA 25:360-377.

1970 The archaeology of Michigan: A guide to the prehistory of the Great Lakes region. Garden City, N.Y.: Natural History Press.

1978a Prehistory: Introduction. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 14-15. Washington: Smithsonian Institution.

1978b Regional cultural development, 300 B.C. to A.D. 1000. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 44-57. Washington: Smithsonian Institution.

Fitting, J.E., ed. 1971. The Schultz Site at Green Point: A stratified occupation area in the Saginaw Valley of Michigan. Memoirs of the Museum of Anthropology, University of Michigan, no. 4.

Fitting, J.E., and Brose, D.S. 1971. The northern periphery of Adena. In Adena: The seeking of an identity, ed. B.K. Swartz, pp. 29-55. Muncie, Ind.: Ball State University Press.

Fitting, J.E.; DeVisscher, J.; and Wahlo, E.J. 1966. The Paleo-Indian occupation of the Holcombe Beach. University of Michigan Museum of Anthropology, Anthropology Papers no. 27.

Fitting, J.E., and Zurel, R.L. 1976. The Detroit and St. Clair River area. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 214-250. Scientific Papers of the Cleveland Museum of Natural History.

Fitzhugh, W.

1972 The Eastern Archaic: Commentary and northern perspective. Pennsylvania Archaeologist 42(4):1-19.

1973 Environmental archaeology and cultural systems in Hamilton Inlet, Labrador: A survey of the Central Labrador Coast from 3000 B.C. to the Recent. Smithsonian Contributions to Anthropology, vol. 16.

Flagg, C.A., and Jennings, J.T. 1901. Bibliography of New York colonial history. New York State Library Bulletin 56, Bibliography 24.

Flannery, K.V. 1967. Vertebrate fauna and hunting patterns. In Environment and subsistence, ed. D.S. Byers, pp. 132-177. The prehistory of the Tehuacan Valley, vol. 1. Austin: University of Texas Press.

Fleming, R.F.

1945 Paul Kane: Painter of Great Lakes Indians. Inland Seas 1(3):37-41.

1952 The search for La Salle's brigantine Le Griffon, Part I. Inland Seas 8(4):223-226.

1953 The search for La Salle's brigantine Le Griffon, Part II. Inland Seas 9(1):19-26.

1977 Artist Paul Kane paints Indian life around the Great Lakes. Inland Seas 33(4):277-281.

Flick, A.C., ed. 1933-1937. History of the State of New York. 10 vols. New York: Columbia University Press.

Flint, R.F. 1947. Glacial geology and the Pleistocene Epoch. New York: J. Wiley and Sons.

Foos, K.A. 1971. A floristic and phytogeographic analysis of the fen elements at the Resthaven Wildlife Area (Castalia Prairie), Erie County, Ohio. M.S. thesis, Ohio State University.

Ford, R. 1974. Northeastern archaeology: Past and future direction. Annual Review of Anthropology 3:385-413.

Forsyth, J.L.

1959 The beach ridges of northern Ohio. Ohio Dept. Nat. Res., Div. of Geol. Surv., Inf. Circ. 25.

1961 Dating Ohio's glaciers. Ohio Dept. Nat. Res., Div. of Geol. Surv., Inf. Circ. 30.

1965a Water modified till of the Lake Plain of northwestern Ohio. Ohio Journ. Sci. 65(2):96-

1965b Contributions of soils to the mapping and interpretation of Wisconsin tills in western Ohio. Ohio Journ. Sci. 65(4): 220-227.

1969 Evidence for a pre-Maumee lake in northwestern Ohio--a progress report. Abstracts of the 12th Conf. on Great Lakes Res. Internat. p. 61.

1970 A geologist looks at the natural vegetation map of Ohio. Ohio Journ. Sci. 70(3):180-191.

1971a Linking geology and botany--a new approach. The Explorer 13(3):19-25. Cleveland Museum of Natural History.

1971b Geology of the Lake Erie Islands and adjacent shores. In Michigan Basin Geol. Soc. Annual Field Excursion Guidebook, pp. 1-18.

1973 Late glacial and post-glacial history of western Lake Erie. The Compass of Sigma Gamma Epsilon 51:16-26.

Foster, E.J. 1970. A diver-operated underwater metal detector. Archaeometry 12(2):161-166.

Fowells, H.A., ed. 1965. Silvics of forest trees of the United States. USDA Handbook 271. Washington: USGPO.

Fowke, G. 1902. Archaeological history of Ohio. Columbus, Ohio: Ohio Historical Society.

Fowler, M.L. 1959. Summary of Modoc Rock Shelter, 1952, 1953, 1955, 1956. Illinois State Museum, Report of Investigation no. 8.

Fowler, M.L., and Hall, R.L. 1978. Late prehistory of the Illinois Area. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 560-568. Washington: Smithsonian Institution.

Franquelin, J.B.L. 1684. Carte de la Louisiane ou des voyages du Sr. de la Salle...[Map]. Washington: Library of Congress.

Frederick, R.H.; Johnson, E.C.; and MacDonald, H.A. n.d. Spring and fall freezing temperatures in New York State. N.Y. State Coll. Agr., Cornell Misc. Bull. 33.

Freidel, F., ed., with Showman, R.K. 1974. Harvard guide to American history. 2 vols., rev. ed. Cambridge, Mass.: Harvard University Press, Belknap Press.

Friesner, R.C. 1952. Dendrometer studies of five species of broadleaf trees in Indiana. Butler Univ. Bot. Stud. 5:160-172.

Fritz, P.; Anderson, T.W.; and Lewis, C.F.M. 1975. Late Quaternary climatic trends and history of Lake Erie from stable isotope studies. Science 190:267-269.

Frohman, C.E.

1963 Fort Sandusky on Sandusky Bay. Inland Seas 19(1):12-25.

1965 A history of Sandusky and Erie County. Columbus: Ohio Historical Society.

1968 Sandusky's yesterdays. Columbus: Ohio Historical Society.

1969 Cedar Point's yesterdays. Columbus: Ohio Historical Society.

1971 Put-in-Bay, its history. Columbus: Ohio Historical Society.

1973 Burning of the steamship Erie, August 1841. Inland Seas 29(3):177-181.

1976 Searching for the forts and Indian villages of Sandusky Bay. Hayes Historical Journal 1(1):61-68.

Fuller, G.N. 1916. Economic and social beginnings of Michigan. Lansing: Wynkoop, Hallenbeck, Crawford Co., State Printers.

Funk, R.E.

1965 The Archaic of the Hudson Valley: New evidence and new interpretations. Pennsylvania Archaeologist 35(3-4):139-160.

1972 Early Man in the northeast and the Late Glacial environment. Man in the Northeast 4:7-39.

Funk, R.E., ed.

1976 Recent contributions to Hudson Valley prehistory. The University of the State of New York, The State Education Department, New York State Museum, Memoir 22.

1977 Early to Middle Archaic occupations in upstate New York. In Current perspectives in northeastern archaeology, R.E. Funk and C.F. Hayes III, eds., pp. 21-29. Researches and transactions of the New York State Archaeological Association, vol. 17, no. 1.

1978 Post-Pleistocene adaptations. In Handbook of North American Indians, Vol. 8, ed. B.G. Trigger, pp. 16-27. Washington: Smithsonian Institution.

Funk, R.E.; Fisher, D.W.; and Reilly, E.M., Jr. 1970. Caribou and Paleo-Indian in New York State: A presumed association. American Journal of Science 268:181-186.

Funk, R.E., and Rippeteau, B.R. 1976. Adaptation, continuity and change in upper Susquehanna prehistory. Occasional Publications in Northeastern Anthropology 3.

Funk, R.E., and Schanbach, F.F. 1964. Probable Plano Point in New York State. Pennsylvania Archaeologist 34(2):90-93.

Garbarino, M.S. 1976. Native American heritage. Boston: Little, Brown and Co.

Garrad, C., and Heidenreich, C.E. 1978. Khionontateronon (Petun). In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 394-397. Washington: Smithsonian Institution.

Garriott, E.B. 1903. Storms of the Great Lakes. USDA Weather Bur. Bull. K.

Garrity, R.G. 1977. Canal boatman. Syracuse, N.Y.: Syracuse University Press.

Gault, H.J., ed. 1957. History of Mentor Headlands and vicinity. Fairport Harbor, Ohio: Neal Printing Co.

Geauga County Historical and Memorial Society. 1953. Pioneer and general history of Geauga County. Columbus: Stoneham Press [reprint of 1880 edition].

Gendron, F. 1868. Quelques particularités du pays des Hurons en la Nouvelle France, remarquées par le Sieur Gendron, docteur en médecine qui a demeuré dans de pays-là fort longtemps [1660]. ed. I.B. de Rocoles. Albany: J. Munsell.

Gerrick, D.J. 1968. A contribution toward a bibliography of Ohio zoology. Ohio Biol. Surv. Bull. n.s. vol. 2, no. 4.

Gibson, A.M. 1963. The Kickapoos: Lords of the middle border. Norman, Okla.: University of Oklahoma Press.

Gillham, S. 1971. Ships along the seaway. Fonthill, Ontario: Stonehouse Publications.

Gillies, D.K.A. 1960. Wind and water levels on Lake Erie. Proc. 3rd Conf. Great Lakes Res., U. of Mich. Great Lakes Res. Div. Publ. 4:35-42.

Goddard, I.

1978a Delaware. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 312-339. Washington: Smithsonian Institution.

1978b Mascouten. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 668-672. Washington: Smithsonian Institution.

Goldthwaith, R.P.

1958 Wisconsin age forests in western Ohio. I. Age and glacial events. Ohio Journ. Sci. 58:209-220.

1976 Paleosols and Quaternary history of western Ohio. In Quaternary Stratigraphy of North America, ed. W.C. Mahaney, pp. 159-160. Stroudsburg, Pa.: Dowden, Hutchinson, and Ross.

Goldthwaith, R.P.; White, G.W.; and Forsyth, J.L. 1961. Glacial map of Ohio. USGS Misc. Geol. Invest. Map I-316.

Goldthwaith, R.P., et al. 1965. Pleistocene deposits of the Erie Lobe. In The Quaternary of the United States, ed. H.E. Wright, Jr., and D.G. Frey, pp. 85-97. Princeton, N.J.: Princeton University Press.

Goodman, H.J. 1900. Illustrated historical atlas of Ottawa County, Ohio. Port Clinton, Ohio: H.J. Goodman.

Goodrich, C. 1940. The first Michigan frontier. Ann Arbor, Mich.: University of Michigan Press.

Gordon, R.B.

1940 The primeval forest types of southwestern New York. NY State Mus. Bull. 321.

1966 Natural vegetation map of Ohio at the time of the earliest land surveys. Ohio Biol. Surv.

1969 The natural vegetation of Ohio in pioneer days. Ohio Biol. Surv. Bull. n.s. vol. 3, no. 2.

Gramly, R.M. 1977. Deerskins and hunting territories: Competition for a scarce resource of the northeastern woodlands. American Antiquity 44(4):601-605.

Granger, J.E., Jr. 1978. Meadowood phase settlement pattern in the Niagara frontier region of western New York State. Anthropological Papers, Museum of Anthropology, University of Michigan, no. 65.

Grant, C.R. 1891. Summit County [Ohio] illustrated. Akron: Akron Atlas Co.

Graustein, J.E., ed. 1950/51. Nuttall's travels into the Old Northwest: An unpublished 1810 diary. Waltham, Mass.: Chronica Botanica.

Graves, L. 1977. Reconstruction of the environmental conditions for human cultural development in the western Lake Erie Basin during Late Holocene time. M.S. thesis, Bowling Green State University.

Gray, W., et al. 1956. Historian's handbook: A key to the study and writing of history. 2d ed. Boston: Houghton Mifflin.

Graymont, B. 1972. The Iroquois in the American Revolution. Syracuse, N.Y.: Syracuse University Press.

Great Lakes Basin Commission. 1969. Great Lakes Basin library book catalogue. Ann Arbor, Mich.: Great Lakes Basin Commission.

Greber, N., and Brose, D. n.d. Principle component and analysis of the ecological factors influencing the location of Whittlsey Sites in northeastern Ohio. Cleveland: Case Western Reserve University, Ms. on file.

Greber, N., and Beemore, M. 1976. Within Ohio Hopewell: Analysis of burial patterns from several classic sites. Ph.D. dissertation, Case Western Reserve University.

Green, C.R.

1905a The Indians of Huron County, Ohio, 100 years ago. Lyndon, Kansas.

1905b The Indians of Huron County, Ohio, 100 years ago. The Firelands Pioneer n.s. 15:1052-1072. [Reprint of Green 1905.]

Green, C. M. 1965. The rise of urban America. New York: Harper & Row.

Green, J.N.; Baker, E.F.; Richards, B.; and Squire, D.M. 1971. Simple underwater photogrammetric techniques. Archaeometry 13(2):221-232.

Green, J.N.; Hall, E.T.; and Katzev, M.L. 1967. Survey of Greek shipwreck off Kyrenia, Cyprus. Archaeometry 10:47-56.

Greenberg, J.H. 1968. Culture history. In International encyclopedia of the social sciences, vol. 6, pp. 448-455.

Greenfield, R. 1980. Personal communication.

Greening, W.E. 1961. The Ottawa. Toronto: McClelland and Stewart.

Greenman, E.F.

1935a Excavation of the Reeve Village Site, Lake County, Ohio. Ohio State Archaeological and Historical Quarterly 44(1):2-64.

1935b Seven prehistoric sites in northern Ohio. Ohio State Archaeological and Historical Quarterly 44(2):220-237.

1937a Two prehistoric villages near Cleveland, Ohio. Ohio State Archaeological and Historical Quarterly 46(4):305-366.

1937b The Younge Site: An archaeological record from Michigan. University of Michigan, Museum of Anthropology, Occasional Contributions 6.

1939 The Wolf and Furton Sites; Macomb County, Michigan. University of Michigan, Museum of Anthropology, Occasional Contributions 8.

1958 An early historic cemetery at St. Ignace. Michigan Archaeologist 4(2):28-35.

Griffin, J.B.

1937 The chronological position and ethnological relationships of the Fort Ancient aspect. American Antiquity 2(4):273-276.

1944 The Iroquois in American prehistory. Papers of the Michigan Academy of Science, Arts, and Letters 29:357-374.

1952 The late prehistoric cultures of the Ohio Valley. Ohio State Archaeological and Historical Quarterly 51(2):186-195.

1967 Eastern North American archaeology: A summary. Science 156(3772):175-191.

1978 Late prehistory of the Ohio Valley. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 547-559. Washington: Smithsonian Institution.

Griffing, B.N. 1886. An atlas of Wood County, Ohio. Philadelphia: Griffing, Gordon and Co.

Guilday, J.E.

1967 The climatic significance of the Hosterman's Pit local fauna, Center County, Pennsylvania. American Antiquity 32(2):231-232.

1969 A possible Caribou-Paleo-Indian association from Dutches Quarry Cave, Orange County, N.Y. New York State Archaeological Bulletin 45:24-29.

Guilday, J.E.; Martin, P.S.; and McCrady, A.D. 1964. New Paris, No. 4: A Pleistocene Cave deposit in Bedford County, Pa. National Speleological Soc. Bull. 26(4):121-194.

Gutenberg, B. 1954. Postglacial uplift in the Great Lakes region. Archiv fur Meteor. Geophys. und Bioklimatologie. Ser. A. 7:243-251.

Guthe, A.K.

1953 The Westfield Site: Prehistoric Iroquois of western New York. Eastern States Archaeological Federation Bulletin 12:7.

1956 The late prehistoric occupation in southwestern New York: An interpretive analysis. Ph.D. dissertation, University of Michigan.

1958 The late prehistoric occupation in southwestern New York: An interpretive analysis. Researches and Transactions of the New York Archaeological Society 14(1):1-100.

Guthe, A.K., and Kelly, P.B., eds. 1963. An anthropological bibliography of the eastern seaboard. Vol. 2. Eastern States Archeological Federation, Research Publication 2. Trenton, N.J.

Hall, J. 1856. A history of the Township of Ashtabula, Ashtabula County, Ohio. Cleveland: Western Reserve Historical Society, Manuscript 603.

Hall and Patterson. 1867. History of Erie County [New York], from 1821 to 1867. Syracuse, N.Y.: Hitchcock and Smith.

Hamilton, E.S., and Forsyth, J.L. 1972. Forest communities of South Bass Island. Ohio Journ. Sci. 72(4):184-210.

Hamilton, W.J. 1934. The life history of the rufescent woodchuck, Marmota monax rufescens Howell. Ann. Carnegie Mus. 23:85-178

Hanna, C.A. 1911. The wilderness trail; or, the ventures and adventures of the Pennsylvania traders on the Allegheny Path, with some new annals of the old west, and the records of some strong men and some bad ones. 2 vols. New York and London: G.P. Putnam's Sons.

Hardesty, H.H. 1882. Historical hand-atlas, illustrated, accompanied by a general survey of the world, history of the United States, history of each state and territory of the United States, outline map and history of Lucas County, Ohio. Chicago and Toledo: H.H. Hardesty and Co.

Hardesty, L.Q. 1874. Illustrated historical atlas of Ottawa County, Ohio. Chicago: H.H. Hardesty.

Harrington, M. Raymond

1922a Double Wall Fort. In The archeological history of New York, Part I, ed. A.C. Parker. New York State Museum Bulletin 235-236:237-246.

1922b A midcolonial Seneca site in Erie County. In The archeological history of New York, ed. A.C. Parker. New York State Museum Bulletin 235-236:207-236.

1922c Notes on ancient semicircular earthwork in Chautauqua County. In The archeological history of New York, ed. A.C. Parker. New York State Museum Bulletin 235-236:307-309.

1922d Prehistoric Iroquoian sites in northern New York. In The archeological history of New York, ed. A.C. Parker. New York State Museum Bulletin 235-236:315-339.

Harris, W.R. 1913. The Attiwandarons, or Nation of the Neutrals: Primitive civilization of the American Indians. In Annual Archaeological Report, Ontario Provincial Museum, 1913. Toronto: Cameron.

Harrisburg. William Penn Memorial Museum. Ms. on file. Mound reports for northwestern Pennsylvania and New York.

Harter, R.C. 1973. The Early Archaic. Ohio Archaeologist 23(2):22-26.

Hartley, R.P.

1960 Sand dredging areas in Lake Erie. Ohio DNR, Div. Shoreline Erosion, Tech. Rept. 5

1961a Bottom deposits in Ohio waters of central Lake Erie. Ohio DNR, Div. Shoreline Erosion, Tech. Rept. 6.

1961b Bottom sediments in the island area of Lake Erie. Ohio Geol. Surv., Tech. Rept. 9.

Hartley, R.P. (Cont.)

1968 Bottom currents in Lake Erie. Internat. Assoc. Great Lakes Res., Proc. 11th Conf. Great Lakes Res. pp. 398-405.

Hatcher, H.

1944 The Great Lakes. New York: Oxford University Press.

1945 Lake Erie. Indianapolis: Bobbs-Merrill.

1947 Buckeye country, a pageant of Ohio. Rev. ed. New York: G.P. Putnam's Sons.

1949a Western Reserve: The story of New Connecticut in Ohio. Indianapolis: Bobbs-Merrill.

1966b Western Reserve: The story of New Connecticut in Ohio. Cleveland: World.

Hatcher, H., and Walter, E.A. 1963. A pictorial history of the Great Lakes. New York: Crown Publishers.

Hathaway, E.J. 1915. The story of the Hurons. Toronto: Ontario Historical Society.

Haugen, A.O. 1942. Home range of the cottontail rabbit. Ecology 23:354-367.

Havighurst, W.

1962 The heartland: Ohio, Indiana, Illinois. New York: Harper and Row.

1976 Ohio: A bicentennial history. New York: W.W. Norton.

Hayden, B. 1977. Corporate groups and the Late Ontario Iroquoian longhouse. Ontario Archaeologist no. 28.

Hayes, C.F. III. 1979. An overview of the current status of Seneca ceramics. Paper presented at the Iroquois Pottery Conference, Rochester, New York.

Hayes, F.R., and Anthony, E.H. 1964. Productive capacity of North American lakes as related to the quantity and the trophic level of fish, the lake dimension, and the water chemistry. Trans. Am. Fish. Soc. 93(1):53-57.

Headline, C., and Gallup, M.N., eds.

1962 The diary of an early fur trader, Part I. Inland Seas 18(4):300-305.

1963a The diary of an early fur trader, Part II. Inland Seas 19(1):30-39.

1963b The diary of an early fur trader, Part III. Inland Seas 19(2):113-122.

1963c The diary of an early fur trader, Part IV. Inland Seas 19(3):227-234.

Headline, C., and Gallup, M.N., eds. (Cont.)

1963d The diary of an early fur trader, Part V. Inland Seas 19(4):277-283.

Heden, R. 1966. Directory of shipwrecks on the Great Lakes.

Heidenreich, C.E. 1978. Huron. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 368-388. Washington: Smithsonian Institution.

Helvey, J.D., et al. 1972. Predicting soil moisture in the southern Appalachians. Soil Sci. Soc. Amer. Proc. 36:954-959.

Henderson, G. 1976. James Mathews Excavation, Summer 1974, Interim Report. I.J.N.A.U.E. 5.3:245-251.

Herbich, J.B. 1975. Coastal & deep ocean dredging. Houston: Gulf Publishing Co.

Herdendorf, C.E.

1964 Sedimentary processes at the mouth of Sandusky Bay. Ohio DNR, Div. Geol. Surv. Manuscript Rept.

1966a Geology of the Vermillion West and Berlin Heights Quadrangles, Ohio. Ohio DNR, Div. Geol. Surv. Rept. Invest. 60.

1966b A preliminary report on currents and water masses in Lake Erie. Ohio DNR, Div. Geol. Surv. Spec. Rept.

1968 Sedimentation studies in the south shore reef area of western Lake Erie. Proc. of the 11th Conf. on Great Lakes Res. pp. 188-205.

1970 Sand and gravel resources of the Maumee River Estuary, Toledo to Perrysburg, Ohio. Ohio DNR, Div. Geol. Surv. Rept. Invest. 76.

1972 Sedimentology of Lake Erie. In Limnology of lakes and embayments. Great Lakes Basin Commission. Great Lakes Framework Study 2, Draft 2, Append. 4, Section 4-972 to 4-991.

Herdendorf, C.E., and Bradeich, L.L. 1972. Physical characteristics of the reef area of western Lake Erie. Ohio DNR, Div. Geol Surv. Rept. Invest. 82.

Herdendorf, C.E., et al. 1974. Lake Erie bibliography in environmental sciences. Ohio Biol. Surv. Bull. n.s. vol. 4, no. 5.

Hertzberg, H.W. 1966. The great tree and the longhouse: The culture of the Iroquois. New York: Macmillan.

Hess, B.B. 1978. The historical geography of the aboriginal population of the southern shore of the Lake Erie Basin: A research paper. M.A. thesis, Gannon College.

Hewitt, J.N.B. 1907. Erie. In Handbook of Indians north of Mexico, ed. F.W. Hodge. Bureau of American Ethnology Bulletin 30(1):430-432.

Hexter, J.H. 1968. Historiography: The rhetoric of history. In International encyclopedia of the social sciences, vol. 6, pp. 368-394.

Hicks, L.E. 1934. The original forest vegetation and the vascular flora of northeastern Ohio--Ashtabula County. Abstr. of Doctoral Dissertations at Ohio State University, no. 13. Ohio State University Press.

Hill, H.W. 1923. Municipality of Buffalo, New York: A history, 1720-1923. 4 vols. New York and Chicago: Lewis Historical Publishing Co.

Hills, N.E. 1925. A history of Kelley's Island, Ohio. Toledo: Norman E. Hills.

Hilton, G.W.; Plummer, R.; and Jobe, J. 1976. The illustrated history of paddle steamers. Edita S.A. New York: The Two Continents Publishing Group.

Hirschberg, J.G.; Wouters, A.W.; and Byrne, J.D. 1974. LASAR measure of sea salinity, temperature and turbidity in depth. In Remote sensing, energy related studies, ed. T.N. Veziroglu. Washington: Hemisphere Publishing Corp.

Historical Society of Geauga County. 1880. Pioneer and general history of Geauga County. Burton, Ohio: Historical Society of Geauga County.

Hobson, G.D.; Herdendorf, C.E.; and Lewis, C.F.N. 1969. High resolution reflective seismic survey in western Lake Erie. Proc. 12th Conf. Great Lakes Res., Internat. Assoc. Great Lakes Res., pp. 210-224.

Hodge, F.W., ed. 1913. Handbook of Indians of Canada. Ottawa: Parmelee.

Hodge, W. 1976. A bibliography of contemporary North American Indians. New York: Interland.

Hoffman, B.G.

1961 Cabot to Cartier: Sources for a historical ethnography of northeastern North America 1497-1550. Toronto: University of Toronto Press.

1964 Observations of certain ancient tribes of the North Appalachian Province. Bureau of American Ethnology, Bulletin 191, Anthropological Papers no. 70, pp. 191-246, Pl. 26.

Holstein, H.O.

1973 Replication of Late Woodland ceramics from western Pennsylvania. Pennsylvania Archaeologist 43(3-4):75-87.

1979 Is the Middle Woodland Period within the Monongahela drainage a time of population decrease or simply a problem of ceramic temper confusion? Pennsylvania Archaeologist 49(1-2):47-51.

Honigmann, J.J., ed. 1973. Handbook of social and cultural anthropology. Chicago: Rand McNally.

Horr, D.A., ed. 1974. Indians of Ohio and Indiana, prior to 1795. 2 vols. New York and London: Garland Publishing Co.

Horsman, R.

1967 Expansion and American Indian policy, 1783-1812. East Lansing, Mich.: Michigan State University Press.

1976 United States Indian policy and expansion into Ohio. In The historic Indian in Ohio, ed. R.L. Buchanan, pp. 6-13. Columbus, Ohio: Ohio Historical Society.

Horton, J.T., et al. 1947. History of northwestern New York. 3 vols. New York: Lewis Historical Publishers.

Horton, J.W. 1959. Fundamentals of SONAR. United States Naval Institute, Annapolis.

Hough, A.F. 1936. A climax community on East Tionesta Creek in northwestern Pennsylvania. Ecology 17:9-28.

Hough, A.F., and Forbes, R.D. 1943. The ecology and silvics of forests in the high plateaus of Pennsylvania. Ecol. Monographs 13:299-320.

Hough, J.L.

1958 Geology of the Great Lakes. Urbana, Ill.: University of Illinois Press.

1963 The prehistoric Great Lakes of North America. Am. Scientist 51:84-109.

1966 Correlation of glacial lake stages in the Huron, Erie, and Michigan basins. Journ. of Geol. 74(1):62-77.

Houghton, F.

[1908] Indian village camp and burial sites on the Niagara frontier. Buffalo Society of Natural Science Bulletin 1909 9(3):261-274.

1916 The characteristics of Iroquois village sites of western New York. American Anthropologist 18(4):508-520.

1920 Are there evidences of an Iroquoian migration west of Lake Erie? American Anthropologist 22(2):293-297.

1922 The Indian inhabitants of the Niagara frontier. Journal of American History 16:213-228.

Hovart, G.L. 1972. Koster, a stratified Archaic site in the Illinois Valley. Illinois State Museum, Report of Investigation, no. 22.

Howe, H.

1847 Historical collections of Ohio. Cincinnati: Derby, Bradley and Co.

Howe, H. (Cont.)

1854 Historical collections of Ohio. Cincinnati: E. Morgan and Co.

1875 Historical collections of Ohio. Cincinnati: R. Clarke and Co.

1889-1891 Historical collections of Ohio. 2 vols. Columbus, Ohio: Henry Howe and Son.

1900 Historical collections of Ohio. 2 vols. Columbus, Ohio: State of Ohio, Centennial edition.

Howells, J.A. 1927. Pioneer life in Ashtabula County. Ohio Archaeological and Historical Quarterly 36:551-562.

Howells, W.D. 1897. The story of Ohio. New York: American Book Co.

Hudson, C. 1973. The historical approach in anthropology. In Handbook of social and cultural anthropology, ed. J.J. Honigmann, pp. 111-142. Chicago: Rand McNally.

Hulbert, A.B. 1900. The Indian thoroughfares of Ohio. Ohio Archaeological and Historical Publications 8:264-295.

Hulbert, A.B., and Schwarze, W.N.

1910 David Zeisberger's history of Northern American Indians. Ohio Archaeological and Historical Publications 19:1-173.

1912 The Moravian records, Vol. II: The diaries of Zeisberger relating to the first missions in the Ohio Basin. Ohio Archaeological and Historical Publications 21:1-115.

Hunt, G.T. 1940. The wars of the Iroquois: A study in intertribal trade relations. Madison, Wis.: University of Wisconsin Press.

Hunter, A.F. 1907. Huron village sites. In Report to the Minister of Education for 1906. Toronto: Cameron.

Hunter, W.A.

1956 Pymatuming--An identified Delaware townsite in western Pennsylvania. Pennsylvania Archaeologist 26(3-4):174-177.

1960 Forts on the Pennsylvania frontier. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

1978 History of the Ohio Valley. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 588-593. Washington: Smithsonian Institution.

Huntington, G.C. 1863. Historical sketch of Kelleys Island. The Firelands Pioneer 4:30-49.

Hutchinson, D.R., and Wold, R.J. 1979. Lake Erie geological and geophysical data sources. USGS, Misc. Field Studies, Map MF-1102.

Hutter, H.K. 1952. Eighty years of weather and climate at Toledo, Ohio. Ohio Journ. Sci. 52(2):62-75.

Hyde, G.E. 1962. Indians of the woodlands from prehistoric times to 1725. Norman, Okla.: University of Oklahoma Press.

Illick, J.E. 1976. Colonial Pennsylvania: A history. New York: Charles Scribner's Sons.

Illick, J.S., and Aughanbaugh, J.E. 1930. Pitch pine in Pennsylvania. Dept. For. Waters Res. Bull. no. 2. Harrisburg, Pa.

Iltis, H.H. 1966. The western element in the eastern North American flora and its phytogeographic implications. Abstr. Am. Journ. Bot. 53:634.

Ingalls, R.L., et al. 1950. Nutritive value of fish from Michigan waters. Mich. State Coll. Agr. Exp. Sta. Tech. Bull. 219.

Inverarity, R.B. 1964. The conservation of wood from fresh water. In Diving into the past: Theories, techniques, and applications of underwater archaeology. St. Paul, Minn.: The Minnesota Historical Society and the Council of Underwater Archaeology.

Jacobs, H., and Moir, J. 1975. Photographic survey of H.M.S. Sapphire. I.J.N.A.U.E. 5.4:353-355.

Jacobs, W.R.

1950 Was the Pontiac uprising a conspiracy? Ohio State Archaeological and Historical Quarterly 59:26-37.

1969 British-colonial attitudes and policies toward the Indian in the American colonies. In Attitudes of colonial powers toward the American Indian, H. Peckham and C. Gibson, eds., pp. 81-106. Salt Lake City: University of Utah Press.

Janssen, C.R. 1966. Recent pollen spectra from the deciduous and coniferous deciduous forests of northwestern Minnesota: A study in pollen dispersal. Ecology 47:804-825.

Jenkins, H.M., ed. 1903-1907. Pennsylvania: Colonial and Federal, a history, 1608-1903. 3 vols. Philadelphia: Pennsylvania Historical Publishing Association.

Jennings, F. 1978. Susquehannock. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 362-367. Washington: Smithsonian Institution.

Jenny, H. 1941. Factors of soil formation: A system of quantitative pedology. New York: McGraw-Hill.

Jewell, D.P. 1969. Limnoarchaeology in California. In Diving into the past: Theories, techniques and applications of underwater archeology. St. Paul, Minn.: Minnesota Historical Society and the Council of Underwater Archaeology.

J.H. Beers and Co. 1894. Commemorative biographical record of the counties of Huron and Lorain, Ohio. Chicago:

Johnson, C.

1876 Centennial history of Erie County, New York. Buffalo, N.Y.: Matthews and Warren.

1879 History of Cuyahoga County, Ohio, in 3 parts. Philadelphia: D.W. Ensign and Co.

Johnson, C.E. 1925. The muskrat in New York: Its natural history and economics. Roosevelt Wildlife Bull. 3(2):199-320.

Johnson, E.D. 1960. Climate of the states--New York. US Dept. Comm. Climatog. U.S. No. 60-30.

Johnson, E.R. 1906. Ocean and inland water transportation. New York: D. Appleton and Co.

Johnson, W.C. 1976. The Late Woodland in northwestern Pennsylvania: A preliminary survey and analysis for the symposium on the Late Woodland Period in the Lake Erie drainage. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose. Scientific Papers of the Cleveland Museum of Natural History. pp. 48-75.

Johnson, W.C.; Richardson, J.B. III; and Bohnert, A.S. 1979. Archaeological site survey in northwestern Pennsylvania, region IV. Submitted by the Section of Man, Carnegie Museum of Natural History, to the Pennsylvania Historical and Museum Commission, Harrisburg, Pa.

Johnston, R.B., and Cassavoy, K.A. 1978. Fisheries at Atherley Narrows, Ontario. American Antiquity 43:697-709.

Jordan, D.S. 1878. Catalogue of fishes of Ohio. Ohio State Fish. Comm. 1st Annual Rept (1875-1876), pp. 43-87.

Kammen, M.G. 1975. Colonial New York: A history. New York: Charles Scribner's Sons.

Kapp, R.O., and Gooding, A.M. 1964. A radiocarbon dated pollen profile from Sunbeam Prairie Bog, Darke County, Ohio. Amer. Journ. Sci. 262:259-266.

Karpinski, L.C. 1931. Bibliography of the printed maps of Michigan, 1802-1860. Lansing, Mich.: Michigan Historical Commission.

Karrow, P.F., et al.

1961 The age of Lake Iroquois and Lake Ontario. Journ. Geol. 69:659-667.

1975 Stratigraphy, paleontology, and age of Lake Algonquin sediments in southwestern Ontario, Canada. Quaternary Res. 5:49-87.

Keeler, L.E.

1904 The Sandusky River. <u>Ohio Archaeological and Historical Publications</u> 13:191-246.

1912 Old Fort Sandusky and the De Lery portage. <u>Ohio Archaeological and Historical Publications</u> 21:345-378.

Keith, C.P. 1917. <u>Chronicles of Pennsylvania from the English Revolution to the Peace of Aix-la-Chapelle, 1688-1748</u>. 3 vols. Port Washington, N.Y.: Ira J. Friedman.

Kemp, A.L.W.; MacInnes, G.A.; and Harper, N.S. 1977. Sedimentation rates and revised sediment budget for Lake Erie. <u>Journ. of Great Lakes Res</u>. 3:221-233.

Kemp, A.L.W., et al. 1974. Sedimentation rates and sediment history of Lakes Ontario, Erie, and Huron. <u>Journ. of Sediment. Petrol</u>. 44:207-218.

Kennedy, J.H. 1896. <u>A history of the Cleveland: Its settlement, rise and progress. 1796-1896</u>. Cleveland: Imperial Press.

Kenoyer, L.A. 1930. Ecological notes on Kalamazoo County, Michigan, based on the original land survey. <u>Papers of the Michigan Academy of Science, Arts and Letters</u> 11:211-218.

Kent, B.C.; Smith, I.F. III; and McCann, C., eds. 1971. <u>Foundations of Pennsylvania Prehistory</u>. Anthropological Series of the Pennsylvania Historical and Museum Commission, no. 1. Harrisburg, Pa.

Kent, D.H. 1938. The frontier forts and trails survey of northwestern Pennsylvania. <u>Pennsylvania Archaeologist</u> 8(1):3-5.

Kenton, E., ed.

1925 <u>The Jesuit Relations and allied documents: Travels and explorations of the Jesuit missionaries in North America (1610-1791)</u>. New York: Albert and Charles Boni.

1927 <u>The Indians of North America: From the Jesuit Relations and allied documents</u>. 2 vols. New York: Harcourt, Brace.

Ketchum, W. 1864. <u>An authentic and comprehensive history of Buffalo, with some account of its early inhabitants both savage and civilized</u>. 2 vols. Buffalo, N.Y.: Rockwell, Baker and Hill.

Kick, J.F. 1962. An analysis of the bottom sediments of Lake Erie. M.A. thesis, University of Toronto.

Killits, J.M. 1923. <u>Toledo and Lucas County, Ohio, 1623-1923</u>. 3 vols. Chicago and Toledo: S.J. Clarke Publishing Co.

Kindle, E.M. 1937. Geology of Pelee and adjacent islands. <u>Ontario Dept. Mines, Ann. Rept</u>. 45(7):75-116.

Kinietz, W.V.

1940 The Indians of the western Great Lakes 1615-1760. Ann Arbor, Mich.: University of Michigan Press.

1946 Delaware culture chronology. Indian Historical Society Prehistory Research Series 3(1).

Kinsey, W.F. III

1968 A Pennsylvania Transitional Period radiocarbon date. American Antiquity 33(2):245-247.

1972 Archaeology in the Upper Delaware Valley. The Pennsylvania Historical and Museum Commission, Anthropological Series, no. 2.

Kirkland, E.C. 1961. Industry comes of age: Business, labor, and public policy, 1860-1897. New York: Holt, Rinehart, and Winston.

Klein, P.S., and Hoogenboom, A. 1973. A history of Pennsylvania. New York: McGraw-Hill.

Klopfenstein, C. 1976. The removal of the Indians from Ohio. In The historic Indian in Ohio, ed. R.L. Buchman, pp. 28-38. Columbus, Ohio: Ohio Historical Society.

Knabenshue, S.S.

1902 Mound Builders' fort within Toledo's limits. Ohio Archaeological and Historical Publications 19:381-384.

1903a Indian land cessions in Ohio. Ohio Archaeological and Historical Publications 11:249-255.

1903b The Mount Builders of Ohio. Ohio Archaeological and Historical Publications 11:148-150.

Kock, W.E.

1973 Radar, sonar, and holography. New York: Academic Press.

1974 New forms of ultrasonic and radar imaging. In Ultrasonic imaging and holography, G.W. Stroke, W.E. Kock, Y. Kikuchi, and J. Tsujiuchi, eds. New York: Plenum Press.

Kolb, C.C.

1977a The Eriez Indians: An archaeological and ethnohistorical reevaluation. Paper presented at the Society for American Archaeology Annual Meeting, New Orleans, La.

1977b The ethnohistory of the Eriez Indians: An evaluation of the historical and archaeological data. Paper presented at the Society for Pennsylvania Archaeology Annual Meeting, Erie, Pa.

1979 Ethnohistoric research along the southern Lake Erie littoral. Paper presented at the American Anthropological Association Annual Meeting, Cincinnati, Ohio.

1981 The Erie Indians: Myth and Fact. Journal of Erie Studies (in press).

Konitzky, G.A. 1969. Archaologie des Oberen Allegheny Tales. Verhandlungen des XXXVIII Internationalen Amerikanistenkongresses, Stuttgart-Munchen, 1968, Bd. 1:125-128.

Kormondy, E.J. 1969. Comparative ecology of sandspit ponds. Amer. Mid. Nat. 82(1):28-61.

Kraus, B. n.d. Archaeological survey of Ashtabula County, Ohio. Mimeographed.

Krebs, C.D. 1979. Kelleys Island survey project. Paper presented at the American Anthropological Association Annual Meeting, Cincinnati, Ohio.

Krecker, F.H., and Lancaster, L.Y. 1933. Bottom shore fauna of western Lake Erie: A population study to a depth of six feet. Ecology 14(2):79-93.

Kroeber, A.L. 1939. Cultural and natural areas of native North America. University of California Publications in American Archaeology and Ethnology, 38. Berkeley, Calif.: University of California Press.

Kubiak, W.J. 1970. Great Lakes Indians: A pictorial guide. Grand Rapids, Mich.: Baker Book House.

Kuchler, A.W., and McCormick, J., comps. 1965. Vegetation maps of North America--Ohio. In International bibliography of vegetation maps, Vol. 1, ed. A.W. Kuchler. Univ. Kansas Libr. Ser. 21:338-353.

Kujoory, M.A., and Earhat, N.E. 1978. Microwave holographic subtraction for imaging of buried objects. In Proceedings of the IEEE, vol. 66, no. 1 (January), pp. 94-96.

Kunkle, G.R. 1963. Lake Ypsilanti: A probable late Pleistocene low lake stage in the Erie Basin. Journ. Geol. 71:72-75.

Lafitau, J.F. 1724. Moeurs des sauvages amériquains, comparées aux moeurs des premiers temps. 2 vols. Paris: Saugrain l'ainé.

Lagler, K.F., and Ostenson, B.T. 1942. Early spring food of the otter in Michigan. Journ. Wildlife Management 6:244-254.

Laing, A. 1971. American ships. McGraw Hill Co., Canada.

Lake, D.J.

1873 Atlas of Huron County, Ohio. Philadelphia: Titus, Simmons and Titus.

1874a Atlas of Ashtabula County, Ohio. Philadelphia: Titus, Simmons and Titus.

1874b Atlas of Lake and Geauga Counties, Ohio. Philadelphia: Titus, Simmons and Titus.

1874c Atlas of Lorain County, Ohio. Philadelphia: Titus, Simmons and Titus.

Lake County [Ohio] Historical Society. 1976. Bicentennial edition Lake County history. Painesville, Ohio: Painesville Printing Co.

Lallo, J.W.

1979a Paleodemography at the Eiden Site. Ohio Archaeologist 29(3):47-50.

1979b Paleodemography at the Eiden Site. Ohio Archaeologist 29(4):47-50.

Lambing, Rev. A.A. 1920. Celoron's journal. Ohio Archaeological and Historical Publications 29:335-396.

Lane, R.A.

1977 The Allegany Seneca: A test of the genetic reliability of nonmetric osteological traits for intrapopulation analysis. Ph.D. dissertation, University of Texas.

1978 Historical demography and the evolution of consanguinity of the Allegany Seneca. In Essays in northeastern anthropology in memory of Marian E. White, W.E. Englebrecht and D.K. Grayson, eds. Occasional Publications in Northeastern Anthropology, 5:165-183.

Lane, S.A. 1892. Fifty years and over of Akron and Summit County. Akron, Ohio: Akron Atlas Co.

Lang, W. 1880. History of Seneca County, from the close of the Revolutionary War to July 1880. Springfield, Ohio: Transcript Printing Co.

Lange, W. 1979. A preliminary report on the Lillback Site: A Late Woodland culture in northeast Ohio. Ohio Archaeologist 29(2):24-26.

Langlois, T.H.

1954 The western end of Lake Erie and its ecology. Ann Arbor, Mich.: J.W. Edwards.

1964 Ecological processes at a section of shoreline of South Bass Island, Lake Erie. Ohio Journ. Sci. 65(6):343-352.

Laning, P.F. 1963. Colonial trail blazers around western Lake Erie. Inland Seas 19(4):266-276.

Large, M.W. 1924. History of Ashtabula County, Ohio. 2 vols. Indianapolis and Topeka: Historical Publishing Co.

Larkin, F. 1880. Ancient man in America. Jamestown, N.Y.: Privately printed, Miles A. Davis.

Laslett, P. 1968. History and the social sciences. In International encyclopedia of the social sciences, vol. 6, pp. 434-440.

Lawrence, C.H. 1912. Atlas of Lorain County. Elyria, Ohio: Century Printing Co.

Leach, J.H., and Nepszy, S.J. 1976. The fish community in Lake Erie. Journ. Fish. Res. Board Can. 33:622-638.

Leacock, E. 1961. Symposium on the concept of ethnohistory: Comment. Ethnohistory 8:256-261.

Lechner, C.B., Jr. 1975. The Erie triangle, 1782-1802. Ph.D. dissertation, Case Western Reserve University.

Lee, A. n.d. The Cooper Hollow Site. Ph.D. dissertation, Case Western Reserve University.

Lee, R.B., and DeVore, I., eds. 1968. Man the hunter. Chicago: Aldine.

Leeson, M.A., ed. 1886. History of Seneca County, Ohio. Chicago: Warner, Beers and Co.

Lenihan, D.J.; Carrell, T.D.; Hopkins, T.S.; Prokopetz, A.W.; Fayl, S.I.; and Tarasovic, C.S. 1977. The preliminary report on the National Reservoir Inundation Study. U.S. Department of the Interior, National Park Service, Santa Fe.

Leonard, A.L.

1945a The Presque Isle portage and the Venango Trail, Part IV. Pennsylvania Archaeologist 15(3):75-87.

1945b The Presque Isle portage and the Venango Trail, Part V. Pennsylvania Archaeologist 15(4):119-127.

Leverett, F.

1895 On the correlation of New York moraines with raised beaches of Lake Erie. Am. Journ. Sci. 150:1-20.

1902 Glacial formations and drainage features of the Erie and Ohio basins. USGS Monograph 41.

1934 Glacial deposits outside the Wisconsin terminal moraine in Pennsylvania. Pa. Topog. and Geol. Surv. G7.

Leverett, F., and Taylor, F.B. 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. USGS Monograph 53.

Lewis, C.F.M.

1963 Reconnaissance geology of the Lake Erie Basin. M.A. thesis, University of Toronto.

1966 Sedimentation studies of unconsolidated deposits in the Lake Erie Basin. Ph.D. dissertation, University of Toronto.

1968 Quaternary geology of the Great Lakes. Geol. Surv. Can., Paper 69-1, Pt. A: pp. 63-64.

1969 Late Quaternary history of lake levels in the Huron and Erie basins. Proc. 12th Conf. on Great Lakes Res., Internat. Assoc. for Great Lakes Res. pp. 250-270.

Lewis, C.F.M.; Anderson, T.W.; and Berti, A.A. 1966. Geological and palynological studies of early Lake Erie deposits. Univ. of Mich. Great Lakes Res. Div. Publ. 15, pp. 176-191.

Lewis Publishing Co.

1893a Biographical history of northeastern Ohio, embracing the counties of Ashtabula, Trumbull and Mahoning. Chicago.

1893b Biographical history of northwestern Ohio, embracing the counties of Ashtabula, Geauga and Lake. Chicago.

1894 Memorial record of the county of Cuyahoga and the city of Cleveland, Ohio. Chicago.

1902 A centennial biographical history of Seneca County, Ohio. Chicago.

Lindley, H. 1975. Fort Meigs and the War of 1812. 2d ed. Columbus, Ohio: Ohio Historical Society.

Lindsey, A.A.; Crankshaw, W.B.; and Qadir, S.A. 1965. Soil relations and distribution map of the vegetation of pre-settlement Indiana. Bot. Gazette 126(3):155-163.

Lindsey, David

1960 An outline history of Ohio. Cleveland: Howard Allen.

1962 Ohio's Western Reserve: Story of its place names. Cleveland: Press of Case Western Reserve University.

Lohmann, A.W 1974. Some aspects of optical holography that might be of interest for acoustical imaging. In Ultrasonic imaging and holography, G.W. Stroke, W.E. Kock, Y. Kikuchi, and J. Tsujiuchi, eds., pp. 363-377. New York: Plenum Press.

Londsdale, A.L., and Kaplan, B.R. 1964. A guide to sunken ships in American waters. Arlington, Va.: Compass Publications.

Lossings, B.J. 1888. The Empire State: A compendious history of the commonwealth of New York. Hartford, Conn.: American Publishing.

Lucherhand, K. 1970. Early Archaic projectile points and hunting patterns in the Lower Illinois Valley. Illinois State Museum, Report of Investigations no. 19.

Lupold, H.F.

1974 The latch string is out: A pioneer history of Lake County, Ohio. Mentor, Ohio: Lakeland Community College.

1975 The forgotten people: The Woodland Erie. Hicksville, N.Y.: Exposition Press.

Lutz, H.J.

1930a Original forest composition in northwestern Pennsylvania as indicated by early land survey notes. Journ. Forestry 28:1098-1103.

1930b The vegetation of Heart's Content, a virgin forest in northwestern Pennsylvania. Ecology 11:1-29.

Lyons, T.R., and Avery, T.E. 1976. Remote sensing: A handbook for archeologists and cultural resource managers. Washington: USGPO.

Lytle, W.M. 1952. Merchant steam vessels of the United States, 1807-1868. The Steamship Historical Society of America Pub. 6. Mystic, Conn.

MacDonald, G.G. 1968. Debert: A Paleo-Indian site in central Nova Scotia. National Museum of Canada Anthropological papers, no. 16. Ottawa, Ont.

MacElwain, T. 1978. Mythological tales and the Allegany Seneca. Stockholm Studies in Comparative Religion. Stockholm: Acta Universitatis Stockholmiensos.

MacLaren, A. 1965. A brief history of fisheries development on each of the Great Lakes, economic aspects of the Great Lakes fishery on Ontario. Fish. Res. Board Can. Bull. 149:143-160.

Maclean, W.F.

1961 Postglacial uplift in the Great Lakes region. U. of Mich. Great Lakes Res. Div. Spec. Rept. 14.

1963 Modern pseudo-upwarping around Lake Erie. Univ. of Mich., Great Lakes Res. Div., Proc. 6th Conf. on Great Lakes Res. Publ. 10:158-168.

MacNeish, R.S.

1952 Iroquois pottery types. National Museum of Canada, Bulletin 124.

1967 A summary of the subsistence. In Environment and subsistence, ed. D.S. Byers, pp. 290-310. The prehistory of the Tehuacan Valley, vol. 1. Austin: University of Texas Press.

MacNeish, R.S. (Cont.)

1976 The in situ Iroquois revisited and rethought. In Cultural change and continuity: Essays in honor of James Bennett Griffin, ed. C.E. Cleland, pp. 79-98. New York: Academic Press.

Marshall, O.H. 1920. De Celoron's expedition to the Ohio in 1749. Ohio Archaeological and Historical Publications 29:424-45 .

Martin, C. 1976. Wildlife diseases as a factor in the depopulation of the North American Indian. Western Historical Quarterly 7:47-62.

Mason, R.J.

1962 The Paleo-Indian tradition in eastern North America. Current Anthropology 3(3):227-278.

Mason, R.J. (Cont.)

1976 Ethnicity and archaeology in the Upper Great Lakes. In Cultural change and continuity: Essays in honor of James Bennett Griffin, ed. C.E. Cleland, pp. 349-361. New York: Academic Press.

Mathewson, R.D. 1977. Method and theory in New World historic wreck archeology: Hypothesis testing on the site of Nuestra Senora de Atocha, Marquesas Keys, Florida. M.A. thesis, Florida Atlantic University.

May, J.

1978a Guidance for application of remote sensing to environmental management, Appendix A: Sources of available remote sensor imagery. Mobility and Environmental Systems Laboratory, U.S. Army Engineer Waterway Experiment Station, Vicksburg, Miss.

1978b Guidance for application of remote sensing to environmental management, Appendix B: Sources of new imagery missions. Mobility and Environmental Systems Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Mayer-Oakes, W.J.

1952 Archeological problems in the Upper Ohio Valley, Part 2--The northern area. Pennsylvania Archaeologist 22(1):37-39.

1955a Aboriginal ceramics of the Upper Ohio Valley. Eastern States Archaeological Federation Bulletin 14:13.

1955b Prehistory of the Upper Ohio Valley, An introductory archeological study. Annals of the Carnegie Museum, vol. 34, (Anthropological Series, no. 2). Pittsburgh, Pa.,

McAndrews, J.H., and Boyko, M. 1972. Dating recent sediment in Lake Ontario by correlation with a varve dated pollen diagram. Abstr. 15th Conf. Great Lakes Res., pp. 86-87.

McCann, C. 1962. The Wilson Site, Bradford County, Pennsylvania. Pennsylvania Archaeologist 32(2):43-55.

McDermott, P.W. 1945. Lake Erie exploration to 1800: A selected list of source materials in the Cleveland Public Library. Inland Seas 1(2):2-7.

McGrane, R.C. 1913. The evolution of the Ohio-Erie boundary line. Ohio Archaeological and Historical Publications 22:326-339.

McKelvey, B.

1963 The urbanization of America, 1860-1915. New Brunswick, N.J.: Rutgers University Press.

1968 The emergence of metropolitan America, 1915-1966. New Brunswick, N.J.: Rutgers University Press.

1973 American urbanization: A comparative history. Glenview, Ill.: Scott, Foresman and Company.

McKenzie, D.H. 1967. The Graham Village Site: A Fort Ancient settlement in the Hocking Valley, Ohio. In Studies in Ohio archaeology, O. Prufer and D. McKenzie, eds. Cleveland: Press of Case Western Reserve University.

McKenzie, D.H.; Bier, D.; and Pierce, C. The Riverview Site: An early Late Woodland village in Cuyahoga County, Ohio. Cleveland: Cleveland State University, Department of Anthropology, Ms. on file.

McKenzie, D.H., and Blank, J.E. 1976. The Eiden Site: Late Woodland from the south-central Lake Erie region. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 305-326. Scientific Papers of the Cleveland Museum of Natural History.

McKenzie, D.H.; Blank, J.E.; Murphy, J.L.; and Shane, O.C. III. 1972. The Eiden Site: Terminal Late Woodland on the south-central Lake Erie Shore Land. Lorain County: Metropolitan Park Commission.

McMahon, H.G.

1938 Chautauqua County: A history. Buffalo, N.Y.: B.H. Stewart.

1958 Chautauqua County: A history. Buffalo, N.Y.: Henry Stewart, Inc.

Meek, B.

1909 Twentieth century history of Sandusky County, Ohio. Chicago: Richmond-Arnold Publishing Co.

1915 The evolution of Sandusky County. Ohio Archeological and Historical Publications 24:138-169.

Meinecke, F. 1972. Historicism and its problems. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 267-288. New York: Random House.

Meinzer, O.E. 1923. The occurrence of groundwater in the United States. USGS Water Supply Paper 489.

Metcalf, C.S. 1948. The Battle of Lake Erie. Inland Seas 4(4):245-248.

Michels, J. 1968. Settlement pattern and demography at Sheep Rock Shelter: Their role in culture contact. Southwestern Journal of Anthropology 24:66-82.

Michels, J.W., and Dutt, J., (ed.) 1968. Archaeological investigations of Sheep Rock Shelter, Huntingdon County, Pennsylvania. Vol. 3. Department of Anthropology, Penn State University.

Michels, J.W., and Smith, I.F. (ed.) 1967. Archaeological investigations of Sheep Rock Shelter, Huntingdon County, Pennsylvania. 2 vols. Department of Anthropology, Penn State University.

Miller, E.M. 1932. Bibliography of Ohio botany. Ohio Biol. Surv. Bull. V, no. 27.

Miller, J. 1909. A twentieth century history of Erie County, Pennsylvania. 2 vols. Chicago: Lewis Publishing Co.

Miller, K. 1975. A cultural resource survey of the Pomfret and Sheridon Power Plant Site. New York: State University of New York, Department of Anthropology, Ms. on file.

Miller, N.G. 1973. Late-glacial and post-glacial vegetation change in southwestern New York State. N.Y. State Mus. Sci. Serv. Bull. 420.

Mills, J.C. 1910. Our inland seas: Their shipping and commerce for three centuries. Chicago: A.C. McClurg.

Mills, W.C. 1914. Archaeological atlas of Ohio showing the distribution of the various classes of prehistoric remains in the state. Columbus, Ohio: Ohio State Archeological and Historical Society.

Minard, J.S. 1896. Allegany County and its people: A centennial memorial history of Allegany County, New York. Alfred, N.Y.: W.A. Fergusson and Co.

Moeller, R.W., ed. 1977. Archaeological bibliography for eastern North America. Washington, Conn.: Eastern States Archeological Federation and American Indian Archaeological Institute.

Moffet, R. 1949. The Raisch-Smith Site, an early Indian occupation in Preble County, Ohio. Ohio State Archaeological and Historical Quarterly 58:428-442.

Mooney, J. 1910. Population. In Handbook of Indians north of Mexico, ed. F.W. Hodge. Bureau of American Ethnology Bulletin 30(2):286-287.

Moorehead, I. 1876. Erie County. In An illustrated history of the Commonwealth of Pennsylvania, ed. W.H. Egle, pp. 692-723. Harrisburg, Pa.: DeWitt C. Goodrich and Co.

Moorehead, W.K. 1900. The Indian tribes of Ohio. Ohio Archaeological and Historical Publications 7:1-109.

Morain, S.A., and Budge, T.K. 1978. Remote sensing: Instrumentation for nondestructive exploration of cultural resources. Washington: USGPO.

Mordoff, R.A. 1949. The climate of New York State. N.Y. State Coll. Agr. Ext. Bull. 764.

Morey, H.F. 1936. A comparison of two virgin forests in northwestern Pennsylvania. Ecology 17:43-55.

Morgan, L.H.

1851 The League of the Ho-de-no-sau-nee or Iroquois. New York: Dodd, Mead and Co.

Morgan, L.H. (Cont.)

1868 The American beaver and his works. Philadelphia: Lippincott.

1877 Ancient society. Cleveland: World. [Reprinted 1963.]

1959 The Indian Journals, 1859-1862, ed. L.A. White. Ann Arbor, Mich.: University of Michigan Press.

Morgan N.A. 1964. Geophysical studies in Lake Erie by shallow marine seismic methods. Ph.D. dissertation, University of Toronto.

Morgan, R.G. 1952. Outline of cultures in the Ohio region. In Archeology of eastern United States, ed. J.B. Griffin, pp. 83-98. Chicago: University of Chicago Press.

Morgan, R., and Ellis, H.H. 1943. The Fairport Harbor Village Site. Ohio State Archaeological and Historical Quarterly 52(1):3-64.

Morgan, R.G., and Rodabough, J.H. 1947. Bibliography of Ohio archaeology. Columbus, Ohio: Ohio State Archaeological and Historical Society.

Morrison, J.H. 1903. History of American steam navigation. New York: W.F. Sametz and Company, Inc.

Morrison, T.M.; Engle, C.C.; and Fuller, G.L. 1916. Soil survey of Chautauqua County, New York. U.S. Department of Agriculture Field Operations, Bureau of Soils, 16th Report, vol. 1914, pp. 271-326.

Mosely, E.L. 1931. Some plants that were probably brought to northern Ohio from the west by the Indians. Papers of the Michigan Academy of Science, Arts and Letters 13:169-172.

Mossman, R.E. 1972. A floristic and ecological evaluation of Camden (Bog) Lake, Lorain County, Ohio. M.Sc. thesis, Ohio State University.

Muckelroy, K.

1975 A systematic approach to the investigation of scattered wreck sites. I.J.N.A.U.E. 4.2:173-190.

1976 The integration of historical and archeological data concerning an historic wreck site: The Kennermerland. World Archaeology 7(3):280-290.

1978 Maritime archaeology. London: Cambridge University Press.

Muller, E.H.

1963 Geology of Chautauqua County, New York. Part II. Pleistocene geology. N.Y. State Mus. Sci. Serv. Bull. 392.

1965 Bibliography of New York Quaternary geology. N.Y. State Mus. Sci. Serv. Bull. 398.

Muller, R.A. 1966. Snowbelts of the Great Lakes. Weatherwise 19:248-255.

Murdock, G.P., and O'Leary, T.J. 1975. Ethnographic bibliography of North America. 4th ed., 5 vols. New Haven, Conn.: HRAF Press.

Murphy, J.L.

1971a The Fairport Harbor Site (33La5) Lake County, Ohio. Pennsylvania Archaeologist 41(3):6-43.

1971b The Lyman Site (33La2) Lake County, Ohio. Pennsylvania Archaeologist 41(3):12-25.

1971c Whittlesey ceramic types. Ohio Archaeologist 21(1):98-308.

1972a A note on the South Park ceramics. Ohio Archaeologist 22(2):31-35.

1972b The radiocarbon date from the Lyman earthworks (33La2): A correction and discussion. Pennsylvania Archaeologist 42(4):26-28.

1973 Five vessels from the McFate Site, Crawford County, Pennsylvania. Pennsylvania Archaeologist 43(2):51-57.

1974a An archaeological survey of Vickers Area, Sandusky County, Ohio. Ohio Historical Society. Department of Archaeology, Ms. on file.

1974b Preliminary report on the South Park Site: A statement. Pennsylvania Archaeologist 44(3):50-51.

1974d A radiocarbon date from the Reeve Site, Cuyahoga County, Ohio. Ohio Archaeologist 24(1):6-7.

1977 A bibliography of Ohio archeology. Ann Arbor, Mich.: University Microfilms International.

Murphy, L. 1978. 8 SO 19: Specialized methodological, technological, and physiological approaches to deep water excavation of a prehistoric site at Warm Mineral Springs, Florida. In Beneath the waters of time: The proceedings of the Ninth Conference on Underwater Archaeology. Texas Antiquities Committee Pub. no. 6.

Murphy, R.

1955 Discovery of the wreckage of the Griffon, Part I. Inland Seas 11(4):232-243.

1956a Discovery of the wreckage of the Griffon, Part II. Inland Seas 12(1):43-53.

1956b The Griffon wreckage at Tobermory. Inland Seas 12(4):275-285.

Murphy, R.E., and Murphy, M. 1937. Pennsylvania: A regional geography. Harrisburg, Pa.: Pennsylvania Book Service.

Murtaugh, W.J. 1976. The National Register of Historic Places. Washington: U.S. Department of the Interior, National Parks Service.

Naroll, R., and Cohen, R., eds. 1970. A handbook of method in cultural anthropology. Garden City, N.Y.: Natural History Press for the American Museum of Natural History.

National Oceanic and Atmospheric Administration. 1975. The NOAA diving manual: Diving for science and technology. Washington: National Oceanic and Atmospheric Administration.

National Register of Historic Places, Office of Archeology and Historic Preservation. 1972. The National Register of Historic Places 1972. Washington: USGPO.

Nestler, H. 1968. Bibliography of New York State communities, counties, towns, villages. Empire State Historical Publications Series 51. Port Washington, N.Y.: Ira J. Friedman.

Nettels, C.P. 1969. The emergence of a national economy, 1775-1815. New York: Harper Torchbooks.

New Century atlas of Lake County, Ohio. 1915. Phildelphia: Century Map Co.

Newcomb, W.W., Jr.

1956 The culture and acculturation of the Delaware Indians. University of Michigan Museum of Anthropology, Anthropological Papers 10.

1974 North American Indians: An anthropological perspective. Pacific Palisades, Calif.: Goodyear Publishing Co.

Newton, J.G. 1975. How we found the Monitor. National Geographic vol. 147, no. 1 (January).

Noble, W.C. 1978. The Neutral Indians. In Essays in northeastern anthropology in memory of Marian E. White, W.E. Englebrecht and D.K. Grayson, eds. Occasional Publications in Northeastern Anthropology, 5:152-164.

Norton, T.E. 1974. The fur trade in colonial New York; 1686-1776. Madison, Wis.: University of Wisconsin Press.

Notestein, W. 1906. The western Indians in the Revolution. Ohio Archaeological and Historical Publications 16:269-291.

Nunnally, N.R. 1969. Introduction to remote sensing--the physics of electromagnetic radiation. Report prepared for the Association of American Geographers Commission on Geographic Application. Johnson City, Tenn.

O'Callaghan, E.B., and Fernow, B., eds. 1856-1857. Documents relative to the colonial history of the State of New York. 15 vols. Albany: Weed, Parsons and Co.

Ogden, J.G. III

1965 Pleistocene pollen records from eastern North America. The Botanical Rev. 31(3):481-504.

Ogden, J.G. III (Cont.)

1966 Forest history of Ohio: I. Radiocarbon dates and pollen stratigraphy of Silver Lake, Logan County, Ohio. Ohio Journ. Sci. 66:387-400.

1967 Radiocarbon and pollen evidence for a sudden change in climate in the Great Lakes region approximately 10,000 years ago. In Quaternary Paleoecology, E.J. Cushing and H.E. Wright, Jr., eds., pp. 117-127. New Haven, Conn.: Yale University Press.

1969 Correlation of contemporary and Late Pleistocene pollen records in the reconstruction of post-glacial environments in northeastern North America. Mitt. Internat. Verein. Limnol. 17:64-77.

1977 The late Quaternary paleoenvironmental record of northeastern North America. In Amerinds and their paleoenvironments in northeastern North America, W.S. Newman and B. Salwen, eds. N.Y. State Mus. Sci. Serv. Bull. pp. 16-34.

Ogden, J.G. III, and Hay, R.J.

1964 Ohio Wesleyan University natural radiocarbon measurements I. Radiocarbon Supplem. 6:340-348.

1965 Ohio Wesleyan University natural radiocarbon measurements III. Radiocarbon Supplem. 7:166-173.

1968 Ohio Wesleyan University natural radiocarbon measurements IV. Radiocarbon Supplem. 11:137-149.

Ogden, J.G. III; Raynor, G.S.; and Vormevik, J.M. 1964. Travels of air-borne pollen. N.Y. State Mus. Sci. Serv. Prog. Rept. 5.

Orford, M. 1968. Early exploration of Lake Erie and Lake Huron. Inland Seas 24(4):267-278.

Osborn, H. 1930. Bibliography of Ohio zoology. Ohio Biol. Surv. Bull. IV, no. 23.

Oswalt, W.H. 1978. This land was theirs: A study of North American Indians. 3rd ed. New York: John Wiley.

Padgett, T. 1976. Dierks Lake: A problem study in cultural resource management. In Arkansas Archeological Survey Research Report no. 9. Fayetteville, Ark.

Parker, A.C.

1907 Excavations in an Erie Indian village and burial site at Ripley, Chautauqua County, N.Y. New York State Museum Bulletin 117:459-547.

1916 The origin of the Iroquois as suggested by their archeology. American Anthropologist 18(3):479-507.

Parker, A.C. (Cont.)

1922a Archeological localities in New York by counties. In The archeological history of New York, Pt. 2, ed. A.C. Parker. New York State Museum Bulletin 237-238:479-718.

1922b Burning Spring prehistoric Iroquoian site. In The archeological history of New York, Pt. 1, ed. A.C. Parker. New York State Museum Bulletin 235-236:162-169.

1922c The Owasco Algonkian site. In The archeological history of New York, Pt. 1, ed. A.C. Parker. New York State Museum Bulletin 235-236:340-343.

1922d A prehistoric Iroquoian site on the George Reed farm, Richmond Mills. In The archeological history of New York, Pt. 1, ed. A.C. Parker. New York State Museum Bulletin 235-236:182-206.

1922e A prehistoric Iroquoian village and burial site in Chautauqua County. In The archeological history of New York, Pt. 1, ed. A.C. Parker. New York State Museum Bulletin 235-236:170-181.

1922f The Ripley Erie Site. In The archeological history of New York, Pt. 1, ed. A.C. Parker. New York State Museum Bulletin 235-236:246-306.

1926a An analytical history of the Seneca Indians. Researches and Transactions of the New York State Archeological Association 6(1-5).

1926b The history of the Seneca Indians. Empire State Historical Publication 43. Port Washington, N.Y.: Ira J. Friedman.

Parker, A.C., ed.

1922a The archeological history of New York, Pt. 1. New York State Museum Bulletin 235-236.

1922b The archeological history of New York, Pt. 2. New York State Museum Bulletin 237-238.

Peeke, H.L.

1916 A standard history of Erie County, Ohio. Chicago and New York: Lewis Publishing Co.

Peeke, H.L. (Cont.)

1925 The centennial history of Erie County, Ohio. 2 vols. Cleveland: Penton Press Co.

Pegrum, R.H. 1929. Topography of the Lake Erie Basin. In Preliminary report on the cooperative survey of Lake Erie, ed. C.J. Fish. Buffalo Soc. Nat. Sci. Bull. 14, pp. 17-24.

Pelto, P.J. 1970. Anthropological research: The structure of inquiry. New York: Harper and Row.

Pelto, P.J., and Pelto, G.H. 1973. Ethnography: The fieldwork enterprise. In Handbook of social and cultural anthropology, ed. J.J. Honigmann, pp. 241-288. Chicago: Rand McNally.

Pennsylvania Archeologist

1934a Discoveries in city of Erie. Pennsylvania Archeologist 4(3):18-19.

1934b Evidence of mound builder Indians found in northwestern Pennsylvania. Pennsylvania Archeologist 4(2):13-14.

1935 Cornplanter tribe asks state archeological group to halt dam plan. Pennsylvania Archeologist 5(3):66.

Pennsylvania Archives. 1874-1935. Papers relating to the establishment at Presqu'Isle. Pennsylvania Archives Ser. 1, vols. 7, 8, 10, 11, 12; Ser. 2, vols. 4, 6.

Pennsylvania Historical and Museum Commission

1957 Bibliography of Pennsylvania history. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

1976 Bibliography of Pennsylvania history, supplement. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

Perrin, W.H. 1881. Summit County [Ohio]. Chicago: Baskin.

Peterson, C. 1974. The nature of data from underwater archeological sites. In Underwater archeology in the National Park Service, ed. D.J. Lenihan. U.S. Department of the Interior, National Park Service, Southwest Regional Office, Santa Fe.

Peterson, C.S.

1946 Bibliography of county histories of the 3111 counties in the United States. 2d ed. Baltimore: Published by the author.

1963 Consolidated bibliography of county histories in fifty states in 1961, consolidated 1935-1961. Baltimore: Genealogical Publishing Co.

Peterson, M.L.

1964 The condition of materials found in salt water. In Diving into the past: Theories, techniques and applications of underwater archaeology, J.D. Holmgist and A.H. Wheeler, eds. St. Paul, Minn.: The Minnesota Historical Society and the Council of Underwater Archaeology.

1973 History under the sea. Alexandria, Va.: Published by the author.

Peterson, R.L.

1955 North American moose. Toronto: University of Toronto.

1966 The mammals of eastern Canada. Toronto: Oxford University Press.

Pfirman, K.R. 1952. Baked clay bowl from the East 28th Street Site. Pennsylvania Archaeologist 22(2):68.

Phillips, D.W., and McCulloch, J.A.W. 1972. The climate of the Great Lakes Basin. Atmos. Environ. Serv., Dept. Environ. Toronto, Ont. Climatol. Stud. 20.

Pierce, F. 1857. Surveys of the frontier lakes. In Senate Documents, no. 52, Washington, D.C.

Plumb, R.G. 1911. History of the navigation of the Great Lakes. Washington: USGPO.

Potter, L.D. 1947. Post-glacial forest sequence of north central Ohio. Ecology 28(4):396-417.

Potter, M.A. 1968. Ohio's prehistoric peoples. Columbus: Ohio Historical Society.

Prahl, E.J.

1969 Preliminary comparison of three prehistoric sites in the vicinity of the western Lake Erie shore. Toledo Area Aboriginal Research Club Bulletin 1(1):32-63.

n.d. Archaeological and historical resources of Kelley's Island, Ohio. Columbus: Ohio Historical Society, Division of Archaeology, Ms. on file.

Prahl, E.J., and Becker, M.J.

1966-1967 Preliminary archaeological investigations in the Maumee Valley. Northwest Ohio Quarterly 39(1):40-50.

1967 Preliminary archaeological investigations in the Maumee Valley. Northwest Ohio Quarterly 39(2):40-50.

Prahl, E.J.; Brose, D.S.; and Stothers, D.M. 1976. A preliminary synthesis of late prehistoric phenomena in the western basin of Lake Erie. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 251-282. Scientific papers of the Cleveland Museum of Natural History.

Pratt, G.M.

1977 An assessment of the potential for prehistoric and/or historic cultural resources within the Ottawa National Wildlife Refuge. Report submitted to Miller and Lee Inc.

1978 An assessment of the prehistoric and historic resources of the Ten Mile Creek Sewer Area, Toledo, Lucas County, Ohio. Report submitted to Jones and Henry Engineers Ltd., Toledo, Ohio.

1979a An assessment of the potential for prehistoric and/or historic archaeological resources within the Danbury Township Seven Project Area. Report submitted to Ottawa County Sanitary Engineer. Ottawa County, Ohio.

1979b An assessment of the potential for prehistoric and/or historic archaeological resources within the Maumee Bay State Park, Lucas County, Ohio. Submitted to Ohio D.N.R.

Pratt, G.M. (Cont.)

1979c Salvage excavation at the Walnut Tree Site (33Cu40): Evidence for agricultural intensification in northeastern Ohio. Ohio Archaeologist 29(1):26-27.

Pratt, G.M., and Brose, D.S.

1975a Test excavation at 33La2, the Andrews School Site, Lake County, Ohio. Ohio Archaeologist 25:20-23.

1975b Test excavation at 33La2, the Andrews School Site, Lake County, Ohio. Ohio Archaeologist 26(1):7-9.

1976 Test excavations at the Seibert Site: A late prehistoric village in the Cuyahoga Valley. Ohio Archaeologist 26(1):7-9.

Prest, V. 1970. Quaternary geology of Canada. In Mineral and economic resources of Canada. Geol. Surv. of Can., Econ. Geol. Rept. no. 1, ch. 12.

Price, J.W. 1963. Food habits of some Lake Erie fishes. Ohio Biol. Surv. Bull., n.s. vol. 2, no. 1.

Prince, B.F. 1921. Early journeys to Ohio. Ohio Archaeological and Historical Publications 30:54-70.

Pritchett, W.L. 1979. Properties and management of forest soils. New York: Wiley.

Prucha, F.P.

1962 American Indian policy in the formative years: The Indian Trade and Intercourse Acts, 1790-1834. Cambridge, Mass.: Harvard University Press.

1977a A bibliographical guide to the history of Indian-white relations in the United States. Chicago: University of Chicago Press.

1977b United States Indian policy: A critical bibliography. Bloomington, Ind.: Indiana University Press.

Prufer, O.H. 1961. The Paleo-Indian problem in Ohio. Ohio Archaeologist 11:90-92.

Prufer, O.H., and Baby, R.S. 1963. Paleo-Indians of Ohio. Columbus, Ohio: Ohio Historical Society.

Prufer, O.H., and McKenzie, D.H., eds. 1967. Studies in Ohio archaeology, Cleveland: Case Western Reserve University Press.

Prufer, O.H., and Shane, O.C. III. 1976. The Portage-Sandusky-Vermilion River region in Ohio. In The late prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 283-304. Scientific Papers of the Cleveland Museum of Natural History.

Prufer, O.H., and Sofsky, C. 1965. The McKibben Site (33TR57), Trumbull County, Ohio. Michigan Archaeologist 11(1):9-40.

Quaife, M.M., and Glazer, S. 1948. Michigan: From primitive wilderness to industrial commonwealth. New York: Prentice-Hall.

Quain, B.H. 1937. The Iroquois. In Cooperation and competition among primitive peoples, ed. M. Mead, pp. 240-281. New York: McGraw-Hill.

Quimby, G.I.

1958 Fluted points and geochronology of the Lake Michigan Basin. American Antiquity 23(3):247-254.

1959 Lanceolate points and fossil beaches in the Upper Great Lakes region. American Antiquity 24(4):424-426.

Radisson, P.E. 1961. The explorations of Pierre Esprit Radisson, ed. A.T. Adams. Minneapolis: Ross and Haines.

Ralph, E.K. 1964. Comparison of a proton and a rubidium magnetometer for archaeological prospecting. Archaeometry, vol. 7.

Ralph, E.K.; Michael, H.N.; and Han, M.C. 1974. Radiocarbon dates and reality. Archaeology of eastern North America 2:1-21.

Randall, E.O. 1903. Pontiac's conspiracy. Ohio Archaeological and Historical Publications 12:410-437.

Randall, E.O., and Ryan, D.J. 1912. History of Ohio, the rise and progress of an American state. 5 vols. New York: Century History Co.

Rapp, M.A.

1961a Buffalo and Great Lakes trade--1825-1900, Part I. Inland Seas 17(1):18-24.

1961b Buffalo and Great Lakes trade--1825-1900, Part II. Inland Seas 17(2):143-149.

Rawson, D.S. 1952. Mean depth and the fish production of large lakes. Ecology 33(4):513-521.

Ray, J.W. 1941. A history of western Pennsylvania. Published by the author. [Athens, Pa.: Riverside Press.]

Read, M.C. 1892. Archaeology of Ohio. Western Reserve Historical Society Tract 73(3):1-121.

Reed, J.E.

1925 History of Erie County, Pennsylvania. 2 vols. Topeka and Indianapolis: Historical Publishing Co.

1929 The Erie triangle. Erie County Historical Society Publication 1(6):143-161.

Reeves, P.W.

1958 Navigation on Lake Erie, 1825-1860, Chapter I, Part I. Inland Seas 14(4):256-262.

1959a Navigation on Lake Erie, 1825-1860, Chapter I, Part II. Inland Seas 15(1):55-60.

1959b Navigation on Lake Erie, 1825-1860, Chapter II, Part I. Inland Seas 15(2):97-105.

1959c Navigation on Lake Erie, 1825-1860, Chapter II, Part II. Inland Seas 15(3):190-199.

1959d Navigation on Lake Erie, 1825-1860, Chapter III, Part I. Inland Seas 15(4):306-311.

1960a Navigation on Lake Erie, 1825-1860, Chapter III, Part II. Inland Seas 16(1):25-31.

1960b Navigation on Lake Erie, 1825-1860, Chapter IV. Inland Seas 16(2):100-110.

Reeves, R.G. 1968. Introduction to electromagnetic remote sensing, with emphasis on applications to geology and hydrology. Washington: American Geological Institute.

Regier, H.A., and Hartman, W.L. 1973. Lake Erie's fish community: 150 years of cultural stress. Science 180:1248-1255.

Reineck, H.E., and Singh, I.B. 1975. Depositional sedimentary environments. Berlin: Springer-Verlag.

Remick, J.T. 1942. Effect of Lake Erie on the local distribution of precipitation in winter. Bull. Amer. Meteorol. Soc. 23:1-4;111-117.

Retter, O. 1932. Pictorial Buffalo and Niagara Falls and surroundings. Buffalo, N.Y.

Riddell, J.L. 1837. Trees and shrubs of Sandusky, Wood, and Lucas counties. Ohio Executive Docs. 60(1):20-21.

Ridley, F.

1957 Culture contacts of Iroquoian and Plains. Pennsylvania Archaeologist 27(1):33-37.

1961 Archaeology of the Neutral Indians. Port Credit, Ontario: Etobicoke Historical Society.

Riesenman, J., Jr. 1943. History of northwestern Pennsylvania, comprising the counties of Erie, Crawford, Mercer, Venango, Warren, Forest, Clarion, McKean, Elk, Jefferson, Cameron and Clearfield. 3 vols. New York: Lewis Historical Publishing Co.

Ripley, New York, Sesquicentennial, 1816-1966 (July 4-8, 1966). 1966. Ripley, N.Y.: n.p.

Rippeteau, B.E.

1973 The principles and theory of radiocarbon chronology and a radiocarbon chronology for lithic variation in the north-eastern United States during 3000 to 500 calendar years B.C. Ph.D. dissertation, Case Western Reserve University.

1977 New data and modes for 8,000 years of Archaic societies and their environments in the Upper Susquehanna Valley of New York State. In Amerinds and their paleoenvironments in northeastern North America, W.S. Newman and B. Salwen, eds. New York: New York Academy of Science. pp. 392-399.

Ritchie, W.A.

1932 The Lamoka Lake Site. Researches and Transactions of the New York State Archaeological Association vol. 7, no. 2.

1937 Cultural influences from Ohio in New York archaeology. American Antiquity 2(3):182-194.

1938 A perspective of northeastern archaeology. American Antiquity 4(2):94-112.

1957 Traces of early man in the northeast. N.Y. State Mus. Sci. Serv. Bull. 358.

1958 The Paleo-Indian in the northeast. Massachusetts Archaeological Society Bulletin 19(2):21-22.

1965 The archaeology of New York State. Garden City, N.Y.: Natural History Press.

1969 The archaeology of New York State. Rev. ed. Garden City, N.Y.: Natural History Press.

1971 The Archaic in New York. N.Y. State Archaeological Association Bulletin 52:2-12.

Ritchie, W.A., and Dragoo, D.W. 1960. The eastern dispersal of Adena. N.Y. State Mus. Sci. Serv. Bull. 379.

Ritchie, W.A., and Funk, R. 1973. Aboriginal settlement patterns in the Northeast. The University of New York, State Education Department, New York State Museum, Memoir 20.

Ritzenthaler, R.E., and Ritzenthaler, P. 1970. The Woodland Indians of the western Great Lakes. Garden City, N.Y.: Natural History Press for the American Museum of Natural History.

Robbins, D.P. 1894. Popular history of Erie County, Pennsylvania. Erie, Pa.: Advertiser Printing Co.

Robinson, J.H., and Beard, C.A. 1972. A 'new history' in America. In The varieties of history from Voltaire to the present, ed. F. Stern, pp. 256-266. New York: Random House.

Robinson, W.J. 1961. The Archaic epoch in the Erie region. Pennsylvania Archaeologist 31(3-4):151-154.

Rogers, E.S. 1978. Southeastern Ojibwa. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 760-771. Washington: Smithsonian Institution.

Romain, W.F.

1979a The Libben Site, Ottawa County, Ohio, Part I: Environment, excavation and temporal position. Ohio Archaeologist 29(40): 40-41.

1979b The Libben Site, Ottawa County, Ohio, Part II: The subsistence-settlement system. Ohio Archaeologist 29(40):42-43.

Roosa, W.B. 1977. Great Lakes Paleo-Indian: The Parkhill Site, Ontario. In Amerinds and their paleoenvironments in northeastern North America, W.S. Newman and B. Salwen, eds., pp. 349-368. New York: New York Academy of Science.

Rosenbloom, E.H., and Weisenburger, F.P. 1967. A history of Ohio. 2d ed. Columbus, Ohio: Ohio State Archaeological and Historical Society.

Rosencrantz, D.M.; Klein, M.; and Edgerton, H.E. 1972. The uses of sonar. In Underwater archaeology: A nascent discipline. UNESCO, Paris.

Rouse, I., and Goggin, J.M., eds. 1947. An anthropological bibliography of the eastern seaboard. Vol. 1. Eastern States Archeological Federation, Research Publication 1. Trenton, N.J.

Rupp, M., Jr.

1936a Erie County archaeological survey. Pennsylvania Archaeologist 5(4):94.

1936b Fortified site--Lake LeBoeuf. Pennsylvania Archaeologist 6(3):49.

Ruppe, R.J. 1978. Underwater site detection by use of a coring instrument. In Beneath the waters of time: The proceedings of the Ninth Conference in Underwater Archaeology, ed. J.B. Arnold III. Texas Antiquities Committee Publication no. 6.

Ryall, L.J. 1913. Sketches and stories of Lake Erie islands. Norwalk, Ohio: American Publishing Co.

Sagard-Théodat, G. 1939. Father Gabriel Sagard: The long journey to the country of the Hurons [1632], ed. G.M. Wrong. Toronto: Champlain Society.

Sahlins, M.D. 1958. Social stratification in Polynesia. Seattle: University of Washington Press.

St. Jacques, D.A., and Rukavina, N.A. 1973. Lake Erie nearshore sediments, Mohawk Point to Port Burwell, Ontario. Proc. 16th Conf. Great Lakes Res. Internat. Assoc. for Great Lakes Res., pp. 454-467.

Salwen, B. 1970. Cultural inferences from faunal remains: Examples from three northeast coastal sites. Pennsylvania Archaeologist 40(1-2):1-8.

Sampson, H.C.

1930a Succession in the swamp forest formation in northern Ohio. Ohio Journ. Sci. 30(5):340-357.

1930b The mixed mesophytic forest community of northeastern Ohio. Ohio Journ. Sci. 30(5):358-367.

Sanders, W.T. 1965. Cultural ecology of the Teotihuacan Valley, A preliminary report. University Park, Pa.: The Pennsylvania State University.

Sanford, L.G.

1862 The history of Erie County, Pennsylvania. Philadelphia: Lippincott.

1894 The history of Erie County, Pennsylvania, from its first settlement. Philadelphia: Published by the author.

Sanson, N.

1650 Amérique septentrionale. Paris: Chez l'auteur et Pierre Mariette.

1656 Le Canada, ou Nouvelle France. Paris.

Santer, R.A. 1977. Michigan: Heart of the Great Lakes. Dubuque, Iowa: Kendall-Hunt Publishing Co.

Sargent, M.P. 1891. Pioneer sketches, scenes and incidents of former days. Erie, Pa.: Herald Printing and Publishing Co.

Schaeffer, C., and Roland, L.J. 1941. Partial bibliography of the archaeology of Pennsylvania and adjacent states. Harrisburg, Pa.: Pennsylvania Historical Commission.

Scheele, R. 1947. Warfare among the Iroquois and their neighbors. Ph.D. dissertation, Columbia University.

Scheiber, H.N. 1969. Ohio Canal Era: A case study of government and the economy, 1820-1861. Athens, Ohio: Ohio University Press.

Schenck, J.S., and Rann, W.S., eds. 1887. History of Warren County, Pennsylvania. Syracuse, N.Y.: D. Mason and Co.

Schlup, E. 1906. The Wyandot Mission. Ohio Archaeological and Historical Publications 15:163-181.

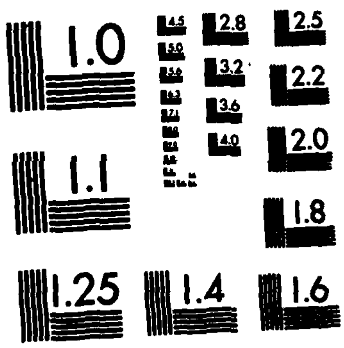
Schmitz, E. 1878. Les Eriés on Ka-Kwaks et leur destruction par les Sénécas. Second International Congress of Americanists, Proceedings, Luxembourg, 1887, 1:360-361.

AD-A123 745 CULTURAL RESOURCES IN THE SOUTHERN LAKE ERIE BASIN: A PREDICTIVE STUDY(U) ARGONNE NATIONAL LAB IL DIV OF ENVIRONMENTAL IMPACT STUDIES S A CURTIS ET AL. 1981

7/7

UNCLASSIFIED F/G 5/1 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Schneider, F., Jr. 1979. Surface finds from western Pennsylvania [French Creek at Allegheny River, Fairfield Township, Crawford County]. Ohio Archaeologist 29(2):13.

Schock, J.M.

1974 The Chautauqua Phase and other Late Woodland sites in southwestern New York. Ph.D. dissertation, State University of New York at Buffalo.

1976 Southwestern New York: The Chautauqua Phase and other Late Woodland occupation. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose. Scientific Papers of the Cleveland Museum of Natural History. pp. 89-109.

Schoenfeld, M.P. 1979. Fort de la Presqu'ile and the French penetration into the upper Ohio country, 1753-1759. Erie, Pa.: Erie County Historical Society.

Schoff, H.L.

1938a Activities of the Archaeological Division of Frontier Forts and Trails Survey, 1937 and 1938. Pennsylvania Archaeologist 8(3):69-70.

1938b McFate Site report on archaeological excavations in northwestern Pennsylvania by the Works Progress Administration (O.P. 665-23-3-47). Harrisburg: Pennsylvania Historical Commission, Ms. on file.

n.d. A fortified pre-contact Indian village site in Crawford County, Pa. Harrisburg: William Penn Memorial Museum, Ms. on file.

Schoolcraft, H.R. 1860. Information respecting the history, conditions, and prospects of the Indian tribes of the United States. 6 vols. Philadelphia: Lippincott, Grambo.

Schooler, E.E. 1974. Pleistocene beach ridges of northwestern Pennsylvania. Pa. Topol. and Geol. Surv., Gen'l. Geol. Rept. 64.

Scully, V. 1969. American architecture and urbanism. New York: Frederick A. Praeger.

Sears, P.B.

1925 The natural vegetation of Ohio. Ohio Journ. Sci. 25:139-149.

1930 A record of post-glacial climate in northern Ohio. Ohio Journ. Sci. 30(4):205-217.

1941 Post-glacial vegetation in the Erie-Ohio area. Ohio Journ. Sci. 41:225-234.

1942a Xerothermic theory. Botanical Rev. 8:708-736.

1942b Forest sequences in the north central states. Botanical Gaz. 103(4):751-761.

Sears, P.B. (Cont.)

1948 Forest sequence and climatic change in northeastern North America since Early Wisconsin time. Ecology 29(3):326-333.

1967 The Castalia prairie. Ohio Journ. Sci. 67(2):78-88.

Sears, P.B., and Bopp, M. 1960. Pollen analysis of the Michillinda peat seam. Ohio Journ. Sci. 60:149-154.

Sears, W. 1948. What is the Archaic? American Antiquity 14:122-124.

Secor, R., ed. 1975. Pennsylvania 1776. University Park, Pa.: Pennsylvania State University Press.

Seeman, M.F., and Bush, J. 1979. The Enderle Site: An historic burial locality in Erie County, Ohio. Pennsylvania Archaeologist 49(3):1-12.

Segedi, R.R. 1979. It isn't an arrowhead! [Field project of Cleveland Museum of Natural History at the South Park Site, 33 Cu 8.] Ohio Archaeologist 29(2):38-39.

Shane, L.K. 1975. Palynology and radiocarbon chronology of Battaglia Bog, Portage County, Ohio. Ohio Journ. Sci. 75:96-102.

Shane, O.C. III

1965 Personal communication to the L.C.M.P.D.

1967a The Leimbach Phase and its position in eastern North America Prehistory. Ann Arbor, Mich.: University Microfilm.

1967b The Mixter Site. In Studies in Ohio archaeology, O.H. Prufer and D.H. McKenzie, eds., pp. 121-186. Cleveland: Case Western Reserve University Press.

1971 The Scioto Hopewell. In Adena: The seeking of an identity, ed. B.K. Swartz. Muncie, Ind.: Ball State University Press.

1974a Archaeological survey of Erie County. Report submitted to Commonwealth Associates.

1974b Archaeological survey of Erie County. Ohio Historical Society Association #1177.

n.d. The Burrell Fort Site: A preliminary report. Manuscript presented to the Lorain County Metropolitan District.

Shane, O., and McKenzie, D. n.d. Unpublished survey of South Shore of Sandusky sites as Footnote 25 Lake Erie EIS 2.6-13 (Shane 1974).

Shanks, R.E. 1953. Forest composition and species association in the beech-maple forest region of western Ohio. Ecology 34:455-466.

Shantz, H.L., and Zon, R. 1924. Natural vegetation. In Atlas of American agriculture, physical basis. Washington: USGPO 1936.

Shaw, R. 1966. Erie water west: A history of the Erie Canal, 1792-1854. Lexington, Ky.: University of Kentucky Press.

Shepps, V.C., et al. 1959. Glacial geology of northwestern Pennsylvania. Pa. Topog. and Geol. Surv. Bull. G32.

Sheridan, L.W. 1941. The influence of Lake Erie on local snows in western New York. Amer. Meteorol. Soc. Bull. 22(10):393-395.

Shetrone, H.C.

1918 The Indian in Ohio. Ohio Archaeological and Historical Publications 27:273-510.

1928 Some Ohio caves and rock shelters bearing evidence of human occupancy. Ohio Archaeological and Historical Quarterly 37:1-34.

Shimony, A.A. 1961. Conservatism among the Iroquois at the Six Nations Reserve. Yale University Publications in Anthropology, 65.

Silver, D.M. 1923. The location of the nations of Indians called the Wenroes or Wenrohronons and the Eries. Buffalo, N.Y.

Simon, T.J. 1976. Continuous dynamical computations of water transports in Lake Erie for 1970. Journ. Fish. Res. Board Can. 33:371-384.

Simonett, D.S. 1974. Quantitative data extraction and analysis of remote sensor images. In Remote sensing: Techniques for environmental analysis, J. Estes and L.W. Senger, eds. Santa Barbara, Calif.: Hamilton Pub. Co.

Simonson, R.W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. of Am. Proc. 23:152-156.

Skinner, A. 1921. Notes on Iroquois archaeology. Heye Foundation, Museum of the American Indian, Indian Notes and Monographs 18. New York.

Skinner, et al. n.d. A preliminary archaeological survey for the proposed improvement of U.S. Route 250 in Erie County, Ohio.

Sly, P.G. 1976. Lake Erie and its basin. Journ. Fish. Res. Board Can. 33:355-370.

Smith, A.C. 1954. Onondaga chert in northern Ohio. Ohio Archaeologist 4(4):9-11.

Smith, A.G. 1960. The Sawmill Site, Erie County, Ohio. Ohio Archaeologist 10:84-97.

Smith, D.L. 1954. The problem of the historic Indian in the Ohio Valley: the historian's view. Ohio State Archaeological and Historical Quarterly 63:172-180.

Smith, H.P., ed. 1884. History of the City of Buffalo and Erie County [New York]. 2 vols. Syracuse, N.Y.: D. Mason.

Smith, P. 1966. As a city upon a hill. New York: Alfred A. Knopf.

Smith, T.H. 1977. The mapping of Ohio: The delineation of the State of Ohio through the use of manuscript maps, printed maps, and plats, sketches and plans from original map makers. . . . Kent, Ohio: Kent State University Press.

Smith, W. 1765. An historical account of the expedition against the Ohio Indians, in the year 1764, under the command of Henry Bouquet, Esq. Philadelphia: William Bradford.

Snow, D.R. 1978. Late prehistory of the east coast. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp.58-69. Washington: Smithsonian Institution.

Snyderman, G. 1948. Behind the tree of peace: A sociological analysis of Iroquois warfare. Ph.D. dissertation, University of Pennsylvania.

Sparling, D.R. 1965. Geology of Ottawa County, Ohio. Ph.D. dissertation, Ohio State University.

Speck, F.G.

1945 The Iroquois: A study in cultural evolution. Cranbrook Institute of Science, Bulletin 23.

1946 The Delaware Indians as women: Were the original Pennsylvanians politically emasculated? Pennsylvania Magazine of History and Biography 70(4):377-389.

1955 The Iroquois: A study in cultural evolution. 2d ed. Cranbrook Institute of Science, Bulletin 23. Bloomfield Hills, Mich.

Spencer, H.R. 1962. Erie ... a history. Erie, Pa.: Published by the author.

Spencer, R.F., Jennings, J.D., et al. 1977. The Native Americans: Ethnology and backgrounds of the North American Indians. 2d ed. New York: Harper and Row.

Squier, E.G.

1849 Aboriginal monuments of the State of New York, comprising the results of original surveys and explorations. Smithsonian Contributions to Knowledge 2(10):9-188.

1851 Antiquities of the State of New York. Buffalo, N.Y.

Squier, E.G., and Davis, E. 1848. Ancient monuments of the Mississippi Valley. Smithsonian Contributions to Knowledge vol. 1.

Stacy, C.D. 1958. Another look at the Battle of Lake Erie. Canadian Historical Review, 36:41-51.

Stern, F., ed. 1972. The varieties of history from Voltaire to the present. Rev. ed. New York: Random House.

Stevens, S.K.

1956 Pennsylvania: Keystone State. 2 vols. New York: American Historical Co.

1964 Pennsylvania history in outline. Revised and enlarged 3rd ed. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

Stevens, S.K., and Kent, D.H. 1941. Wilderness chronicles of northwestern Pennsylvania. Harrisburg, Pa.: Pennsylvania Historical Commission.

Stevens, S.K.; Kent, D.H.; and Woods, E.E. 1941. Travels in New France by J.C.B. Harrisburg, Pa.: Pennsylvania Historical Commission.

Stevenson, A.L., and Benninghoff, W.S. 1969. Late post-glacial rise of Lake Erie and changes in vegetation on the Maumee lake plain. Proc. 12th Conf. Great Lakes Re pp. 347-350.

Steward, J.

1938 Basin-plateau aboriginal sociopolitical groups. Bureau of American Ethnology Bulletin no. 120.

1942 The direct historical approach to archaeology. American Antiquity 7(4):337-343.

Steward, J.H. 1955. Theory of culture change. Urbana, Ill.: University of Illinois Press.

Stewart and Page Publishers. 1874. Combination atlas map of Erie County, Ohio. Philadelphia.

Stewart, A.M. 1970. French pioneers in the eastern Great Lakes area 1609-1791, ed. J.R. Lee. New York State Archeological Association, Occasional Paper 3. Rochester, N.Y.

Stewart, J.S. 1935. History of northeastern Ohio. 3 vols. Indianapolis: Historical Publishing Co.

Stites, S.H. 1905. Economics of the Iroquois. Bryn Mawr College Monographs 1(3).

Storck, P.L.

1978a Some recent development in the search for early man in Ontario. Ontario Archaeology 29:3-16.

1978b Coates Creek Site: A possible Late Paleo-Indian Early Archaic site in Simcoe County, Ontario. Ontario Archaeology 30:25-46.

Stothers, D.M.

1971 The Princess Point Complex. Paper presented at the Fourth Annual Canadian Archaeological Association Meetings. Symposium: Iroquois-Eastern Woodlands. Mimeographed. Calgary, Alberta.

1973 The Doctors Site, 33 Lu 11 Lucas County, Ohio. Toledo Area Aboriginal Research Bulletin 2:44-57.

1974 The Priucess Point Complex. Ph.D. dissertation, Case Western Reserve University.

1975 The emergence and development of the Young and Ontario Iroquois Tradition. Ontario Archaeology no. 25.

1977 The Princess Point Complex. Archaeological Survey of Canada, Mercury Series, no. 58. National Museum of Canada, Ottawa.

1978a New perspective on the Wolf Phase: An upper Mississippi manifestation in the Western Lake Erie Basin. Ohio Archaeologist 28(4):25.

1978b The Western Basin Traditions: Algonkin or Iroquois. Michigan Archaeologist 24(1):11-36.

1979a Cult of the dead thirty centuries ago: The birthplace of Adeno-Hopewell phenomena. Ohio Archaeologist 29(1):14-16.

1979b Fort Ancient ceramics in the Maumee River Valley of northwestern Ohio. Ohio Archaeologist 29(1):20.

1979c The Western Basin Tradition: Algonquin or Iroquois. Pennsylvania Archaeologist 49(3):13-30.

Stothers, D.M.; Pratt, G.M.; and Shane, O.C. III. 1979. The Western Basin Middle Woodland: Non-Hopewellians in a Hopewellian world. In Hopewell archaeology: The Chillicothe conference, D.S. Brose and N. Greber, eds. Kent, Ohio: Kent State University Press.

Stothers, D.M., and Rutter, W. 1978. Pipe Creek Chert: Newly discovered aboriginal quarry source. Ohio Archaeologist 28(3):13.

Stothers, D.M., and Yarnell, R.A. 1977. An agricultural revolution in the Lower Great Lakes. In Geobotany, ed. R.C. Romans. Proceeding of the Geobotany Conference held at Bowling Green, Feb. 21, 1976. New York: Plenum Press.

Stout, C.H. 1976. An amazing surface find [complete Fort Ancient miniature vessel]. Ohio Archaeologist 26(2):14-15.

Stranahan (H.B.) and Co.

1896 Atlas and directory of Lorain County, Ohio. Cleveland.

1900 Atlas of Geauga County, Ohio. Cleveland.

Strandberg, C.H. 1967. Aerial discovery manual. New York: Wiley & Sons.

Streeter, F.B. 1921. Michigan bibliography. 2 vols. Lansing, Mich.: Michigan Historical Commission.

Struever, S. 1968. Woodland subsistence--Settlement systems in the Lower Illinois Valley. In New perspectives in archaeology, S.R. Binford and L.R. Binford, eds. Chicago: Aldine. pp. 285-312.

Struever, S., and Vickery, K.D. 1973. The beginnings of cultivation in the Midwest-Riverine area of United States. American Anthropologist 75(5):1197-1220.

Stuewer, F.W.

1943a Reproduction of raccoons in Michigan. Journ. Wildlife Mgmt. 7:60-73.

1943b Raccoons: Their habits and management in Michigan. Ecol. Monogr. 13:203-257.

Sullivan, J., ed. 1927. History of New York State, 1523-1927. 5 vols. New York and Chicago: Lewis Historical Publishing Co.

Sulte, M.B. 1899. The war of the Iroquois, trans. M.E.R. Holden. Ontario Provincial Museum, Archaeological Report 1899:124-151.

Swain, A.M. 1978. Environmental changes during the past 2000 years in north central Wisconsin: Analysis of pollen, charcoal, and seeds from varved lake sediments. Quaternary Res. 10(1):55-68.

Swanton, J.R.

1946 Indians of the southeastern United States. Bureau of American Ethnology, Bulletin 137.

1952 The Indian tribes of North America. Bureau of American Ethnology, Bulletin 145.

Swartz, B.K., ed. 1971. Adena: The seeking of an identity. Muncie, Ind.: Ball State University Press.

Sweetney, D. 1920. Buffalo and Erie County, 1914-1919. Buffalo, N.Y.: Stewart.

Swetnam, G., and Smith, H. 1976. A guidebook to historic western Pennsylvania. Pittsburgh: University of Pittsburgh Press.

Talcott, A.L. 1906. Historical notes of Ashtabula County, Ohio. Cleveland: W.A. Robertson Printing.

Tanner, H.H., and Wheeler-Voegelin, E. 1974. Indians of Ohio and Indiana prior to 1795: The Greenville Treaty 1795, ethnohistory of Indian use and occupancy in Ohio and Indiana prior to 1795. 2 vols. New York: Garland Publishing.

Taylor, (Col.) E.L.

1898 The Ohio Indians. Ohio Archaeological and Historical Publications 6:72-94.

Taylor, (Col.) E.L. (Cont.)

1909 Ohio Indians and other writings. Columbus, Ohio: F.J. Heer Printing Co.

Taylor, F.B. 1928. The status of Lake Erie in present and recent land tilting. Papers of the Michigan Academy of Science, Arts and Letters 10:251-260.

Taylor, G.R.

1951 The transportation revolution, 1815-1860. New York: Rinehart.

1968 The transportation revolution, 1815-1860. New York: Harper & Row.

Taylor, T.W. 1972. The states and their Indian citizens. Washington: U.S. Bureau of Indian Affairs.

Tesmer, I.H. 1963. Geology of Chautauqua County, New York. N.Y. State Mus. Sci. Serv. Bull. 391-392.

Thomas, A. 1871. Pioneer history of Orleans County, New York. Albion, N.Y.: H.A. Bruner.

Thomas, C. 1894. Report on the Mound Explorations of the Bureau of Ethnology. In Twelfth Annual Report of the Bureau of American Ethnology.

Thomas, Mrs. Cyrus. 1887. Bibliography of the earthworks of Ohio. Ohio Archaeological and Historical Publications 1:69-78;191-200;272-282.

Thomas, K. 1963. History and anthropology. Past and Present 24:3-24.

Thomas, M.K.

1964 A survey of Great Lakes snowfall. Proc. 7th Conf. Great Lakes Res., Univ. Mich. Great Lakes Res. Div. Publ. 11:298-318.

1968 Some notes on the climatic history of the Great Lakes region. Proc. Entomol. Soc. Ont. 99:21-31.

Thomas, R.L.; Jacquet, J.M.; and Kemp, A.L.W. 1976. Surficial sediments of Lake Erie. Journ. Fish. Res. Board Can. 33(3):385-403.

Thompson, D.W. 1964. A study of waterfowl nesting in the southwest Lake Erie region. M.S. thesis, Ohio State University.

Thompson, J.H., ed. 1966. Geography of New York State. Syracuse, N.Y.: Syracuse University Press.

Thomson, P.G.

1880 A bibliography of the State of Ohio: Being a catalogue of the books and pamphlets relating to the history of the state, with collations and bibliographical and critical notes. 2 vols. Cincinnati: Published by the author.

1890 Catalogue of books relating to the State of Ohio, the west and northwest. Cincinnati: Published by the author.

Thwaites, R.G., ed.

1896-1901 The Jesuit Relations and allied documents. 73 vols. Cleveland: Burrows Brothers Co.

1959 The Jesuit Relations and allied documents. 73 vols. New York: Pageant Book Co.

Tiell, W.W. 1979. Burial 16, Mixter Site, Erie County, Ohio. Ohio Archaeologist 29(2):12.

Tomikel, J.C., and Sepps, V.C. 1967. The geography and geology of Erie County, Pennsylvania. Pennsylvania Geol. Surv. Inf. Circ. 56.

Tooker, E.

1963 The Iroquois defeat of the Huron: A review of causes. Pennsylvania Archaeologist 33(1-2):115-123.

1964 An enthnography of the Huron Indians, 1615-1649. Bureau of American Ethnology, Bulletin 190.

1970a The Iroquois ceremonial of midwinter. Syracuse, N.Y.: Syracuse University Press.

1970b Northern Iroquoian sociopolitical organization. American Anthropologist 72(1):90-97.

1978a The Indians of the northeast: A critical bibliography. Bloomington, Ind.: Indiana University Press.

1978b Iroquois since 1820. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 449-465. Washington: Smithsonian Institution.

1978c The League of the Iroquois: Its history, politics, and ritual. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 418-441. Washington: Smithsonian Institution.

1978d Wyandot. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 398-406. Washington: Smithsonian Institution.

Tooker, E., ed. 1967. Iroquois culture, history, and prehistory: Proceedings of the 1965 conference on Iroquois research. Albany, N.Y.: University of the State of New York.

Transeau, E.N.

1935 The Prairie peninsula. Ecology 16:205-218.

1941 Prehistoric factors in the development of the vegetation of Ohio. Ohio Journ. Sci. 41(3):207-211.

Transeau, E.N., and Williams, P.E. 1929. Distribution maps of certain plants in Ohio. Ohio Biol. Surv. Bull. IV, no. 20.

Trelease, A.W.

1960 Indian affairs in colonial New York: The seventeenth century. Ithaca, N.Y.: Cornell University Press.

Trelease, A.W. (Cont.)

1962 The Iroquois and the western fur trade: A problem in interpretation. Mississippi Valley Historical Review 49:32-51.

1969 Dutch treatment of the American Indian, with particular reference to New Netherland. In Attitudes of colonial powers toward the American Indian, H. Peckham and C. Gibson, eds., pp. 47-59. Salt Lake City: University of Utah Press.

Trigger, B.G.

1960 The destruction of Huronia: A study in economic and cultural change. Royal Canadian Institute Transactions 68:14-45.

1962 The historical location of the Hurons. Ontario History 54:137-148.

1963 Settlement as an aspect of Iroquoian adaptation at the time of contact. American Anthropologist 65(1):86-101.

1969 The Huron: Farmers of the North. New York: Holt, Rinehart and Winston.

1978 Early Iroquoian contacts with Europeans. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 344-356. Washington: Smithsonian Institution.

Trigger, B.G., and Pendergast, J.F. 1978. Saint Lawrence Iroquoians. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 357-361. Washington: Smithsonian Institution.

Trubowitz, N.L. 1979. The Early Archaic in western New York. New York State Archeological Association Bulletin 75:52-58.

Tsujiuchi, J.; Ueha, S.; and Ueno, K. 1974. Holographic synthetic aperture system. In Ultrasonic imaging and holography, G.W. Stroke, W.E. Kock, Y. Kikuchi, and J. Tsujiuchi, eds. New York: Plenum Press.

Tuck, J.A.

1971 Onondaga Iroquois prehistory: A study in settlement archaeology. Syracuse, N.Y.: Syracuse University Press.

1974 Early Archaic horizon in eastern North America. Archaeology of Eastern North America 2(1):72-80.

1977 A look at Laurentian. In Current perspectives in northeastern archaeology, R.E. Funk and C.F. Hayes III, eds., pp. 31-40. Researches and transactions of the New York State Archaeological Association, vol. 17, no. 1.

1978a Northern Iroquoian prehistory. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 322-333. Washington: Smithsonian Institution.

1978b Regional cultural development, 3000 to 300 B.C. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 28-43. Washington: Smithsonian Institution.

Turnbaugh, W. 1974. The growth and development of archaeology in Pennsylvania. Pennsylvania Archaeologist 44(4):44-51.

Turner, O. 1850. Pioneer history of the Holland Land Purchase. Boston: Jewett, Thomas and Company.

Twenhofel, W.H. 1950. Principles of sedimentation. New York: McGraw-Hill.

Ubelaker, D. 1976. The sources and methodology of Mooney's estimates of North American Indian populations. In The native population of the Americas in 1492, ed. W.M. Denevan, pp. 243-288. Madison, Wis.: University of Wisconsin Press.

Uhl Brothers. 1901. History and atlas of Lucas County Ohio. Toledo: Uhl Brothers.

Underhill, R.M. 1953. Red man's America: A history of Indians in the United States. Chicago: University of Chicago Press.

United States Army Corps of Engineers, Buffalo District. 1979. Final Environmental Impact Statement: Permit application by United States Steel Corp. proposed lake front steel mill, Conneaut, Ohio. 4 vols. Buffalo, N.Y.: U.S. Army Corps of Engineers, Buffalo District.

United States Department of Agriculture

1919 Soil survey of Chautauqua County, New York. USDA Bureau of Soils, Field Oper. of the Bur. of Soils. 16th Rept. Series 1914. pp. 171-326. Washington: USGPO.

1923 Soil survey of Sandusky County, Ohio. USDA Bureau of Soils. Field Oper. of the Bur. of Soils, Series 1917, 19th Rept., pp. 1079-1138. Washington: USGPO.

1928 Soil survey of Ottawa County, Ohio. USDA Bureau of Chemistry and Soils, Series 1928, no. 28. Washington: USGPO.

1929 Soil survey of Erie County, New York. USDA Bureau of Chemistry and Soils, Series 1929, no. 14. Washington: USGPO.

1940 Soil survey of Cattaraugus County, New York. USDA Bureau of Plant Industry, in cooperation with Cornell Univ. Agr. Expt. Sta., Series 1935, no. 12. Washington: USGPO.

1941 Climate and man. Yearbook of Agriculture. Washington: USGPO.

1943 Soil survey of Lucas County, Ohio. USDA Soil Cons. Serv. Series 1934, no. 24. Washington: USGPO.

1951 Soil survey manual. USDA Handbook, no. 18. Washington: USGPO.

1960 Soil survey of Erie County, Pennsylvania. USDA Soil Cons. Serv., in cooperation with PSU Coll. of Agr., and Agr. Expt. Sta., and Pa. Dept. of Agr., Series 1957, no. 9. Washington: USGPO.

United States Department of Agriculture (Cont.)

1971 Soil survey of Erie County, Ohio. USDA Soil Cons. Serv., in cooperation with Ohio DNR, Div. of Lands and Soils, and Ohio Agr. Res. and Devel. Center. Washington: USGPO.

1972 Erie County, Pennsylvania: Soil interpretations. USDA Soil Cons. Serv., in cooperation with PSU Coll. of Agr., and Pa. Dept. Environ. Res. State Soil and Water Cons. Comm. Washington: USGPO.

1973 Soil survey of Ashtabula County, Ohio. USDA Soil Cons. Serv., in cooperation with Ohio DNR, Div. of Lands and Soils, and Ohio Agr. Res. and Devel. Center. Washington: USGPO.

1975 Soil Taxonomy. USDA Agr. Handbook, no. 436.

1976 Soil survey of Lorain County, Ohio. USDA Soil Cons. Serv., in cooperation with Ohio DNR, Div. of Lands and Soils, and Ohio Agr. Res. and Devel. Center. Washington: USGPO.

1977 An inventory of Ohio soils: Lucas County. Ohio DNR, Div. of Lands and Soils, Prog. Rept. 52.

1978a An inventory of Ohio soils: Cuyahoga County. Ohio DNR, Div. of Lands and Soils, Prog. Rept. 54.

1978b Soil survey of Huntingdon County, Pennsylvania. USDA Soil Cons. Serv., in cooperation with PSU Coll. of Agr., and Pa. Dept. Environ. Res., State Soil and Water Cons. Comm. Washington: USGPO.

1979 Soil survey of Lake County, Ohio. USDA Soil Cons. Serv., in cooperation with Ohio DNR, Div. of Lands and Soils, and Ohio Agr. Res. and Devel. Center. Washington: USGPO.

United States Department of the Interior, National Park Service. 1977. Cuyahoga Valley National Recreation Area, Ohio: Final general management plan. U.S. Department of the Interior, Washington.

United States Great Lakes Basin Commission. 1974. Recession rate workshop, 1974. Proc. of the Recession Rate Workshop, Dec. 5-6, 1974. Great Lakes Basin Comm., Standing Comm. on Coastal Zone Mgmt. Ann Arbor, Mich.

United States Weather Bureau. 1914-1970. Climatological data for states bordering the Great Lakes. U.S. Department Commerce, Weather Bureau.

Upchurch, S.B. 1976. The Great Lakes Basin. In Appendix 4: Limnology of lakes and embayments, Great Lakes Basin Framework Study. Great Lakes Basin Commission. Ann Arbor, Michigan.

Upton, H.T. 1910. History of the Western Reserve. 3 vols. New York: Lewis Publishing Co.

Urban, D. 1968. The ecology of raccoons on a managed waterfowl marsh in southwestern Lake Erie. M.Sc. thesis, Ohio State University.

Utter, W.T. 1942. The frontier state, 1803-1825. History of the State of Ohio, ed. Carl Wittke, vol. 2. Columbus, Ohio: Ohio State Archaeological and Historical Society.

Van Gemert, R.C. 1972. Ships of the Great Lakes. In A history of seafaring, ed. G.F. Bass. New York: Walker & Co.

Van Genderen, J.L., and Collins, W.G. 1975. Remote sensing data processing. University of Sheffield, England.

VanMeter, H.D., and Trautman, M.B. 1970. An annotated list of the fishes of Lake Erie and its tributary waters, exclusive of the Detroit River. Ohio Journ. Sci. 70(2):65-78.

VanOosten, J. 1957. Great Lakes fauna, flora, and their environment: A bibliography. Ann Arbor, Mich.: Great Lakes Basin Commission.

Veatch, J.O. 1928. Reconstructing forest cover based on soil maps. Mich. Agr. Exp. Sta. Quarterly Bull. 10:116-126.

Verstappen, H.T. 1977. Remote sensing in geomorphology. New York: Elsevier Scientific Publishing Co.

Vexler, R.I. 1978. Chronology and documentary handbook of the State of Michigan. Dobbs Ferry, N.Y.: Oceania Publications.

Vickers, R.S., and Dolphin, L.T. 1975. A communication on an archaeological radar experiment at Chaco Canyon, New Mexico. MASCA Newsletter 11, no. 1. Applied Science Center for Archaeology, University Museum, University of Pennsylvania. Philadelphia.

Vietzen, R.C.

1945 The immortal Eries. Elyria, Ohio: Wilmot Printing Co.

1965 Indians of the Lake Erie basin or lost nations. Published by the author. [Wahoo, Nebr.: Lodi Press.]

Visher, S.S. 1943. Some climatic influences of the Great Lakes. Amer. Meteorol. Soc. 24:205-210.

Voegelin, E.W. 1954. An enthnohistorian's viewpoint. Ohio State Archaeological and Historical Quarterly 63:166-171.

Vollenweider, R.A., et al. 1974. A comparative review of phytoplankton and primary production in the Laurentian Great Lakes. Journ. Fish. Res. Board Can. 31:739-762.

Wade, M. 1969. The French and the Indians. In Attitudes of colonial powers toward the American Indian, H. Peckham and C. Gibson, eds., pp. 61-80. Salt Lake City: University of Utah Press.

Wade, R.C. 1957. The urban frontier, 1790-1830. Cambridge, Mass.: Harvard University Press.

Waggoner, C., ed. 1888. History of the City of Toledo and Lucas County, Ohio. New York and Toledo: Munsell and Co.

Wakefield, T.D. 1976. A view of the Great Lakes in 1648: A tribute to the Jesuit Relations. Inland Seas 32(3):184-191.

Walker, P.C., and Hartman, R.T. 1960. The forest sequence of Hartstown Bog area in western Pennsylvania. Ecology 41:461-474.

Wall, R.E. 1968. A sub-bottom reflection survey in the Central Basin of Lake Erie. Geol. Soc. Amer. Bull. 79:91-206.

Wallace, A.F.C. 1978. Origins of the longhouse religion. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 442-448. Washington: Smithsonian Institution.

Wallace, A.F.C., with Steen, S.C. 1973. The death and rebirth of the Seneca. New York: Alfred A. Knopf.

Wallace, P.A.W.

1952 Historic Indian paths of Pennsylvania. Pennsylvania Magazine of History and Biography 76(4):411-439.

1953 Indian highways of Pennsylvania. Pennsylvania Archaeologist 23(3-4):111-122.

1956 The Iroquois: A brief outline of their history. Pennsylvania History 23(1):15-28.

1961 Indians in Pennsylvania. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

1962 Pennsylvania: Seed of a nation. New York: Harper and Row.

1965 Indian paths of Pennsylvania. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

Wallace, P.A.W., ed. 1958. Thirty thousand miles with John Heckewelder. Pittsburgh: University of Pittsburgh Press.

Wallower, L. 1956. Indians of Pennsylvania. State College, Pa.: Penns Valley Publishers.

Walmsley, M.M., and Conlin, M.L. 1968. The Heckewelder Map 1796. Cleveland: Western Reserve Historical Society.

Warren, E.F. 1846. Sketches of the history of Chautauqua County. Jamestown, N.Y.: J. Warren Fletcher.

Warren, E.R. 1927. The beaver, its works and ways. Baltimore: Williams and Wilkins.

Washburn, W.E. 1961. Ethnohistory: History "in the round." Ethnohistory 8:31-48.

Washburn, W.E., comp. 1973. The American Indian and the United States: A documentary history. 4 vols. New York: Random House.

Webb, T. III, and Bryson, R.A. 1972. Late and post-glacial climatic change in the northern midwest United States: Quantitative estimates derived from fossil pollen spectra by multivariate statistical analysis. Quaternary Res. 2:70-115.

Webb, T. III, and Clark, D.R. 1976. Calibrating micropaleontological data in climatic terms: A critical review. NY Acad. of Sci. Annals. 288:93-118.

Webster, G.S. 1979. Deer hides and tribal confederacies: An appraisal of Gramly's Hypothesis. American Antiquity 44(4):816-820.

Weisenburger, F.P.

1946 Lake Erie: The Ohio shore a century ago. Inland Seas 2(1):41-44.

1965 Ohio: Students' guide to localized history. New York: Teachers College, Columbia University.

Wellman, B., and Jantgen, K.S. 1974. Prehistoric site survey and salvage in the Upper Schoharie Valley, New York. Albany: New York State Museum Science Service, report on file.

Wendland, W.M., and Bryson, R.A. 1974. Dating climatic episodes of the Holocene. Quaternary Res. 4:9-24.

Weslager, C.A.

1941 Aboriginal sites in the vicinity of Conneaut Lake, Pennsylvania. Pennsylvania Archaeologist 11(4):71-75.

1942 Delaware Indian villages. Pennsylvania Archaeologist 12(1):53-56.

1978a The Delawares: A critical bibliography. Bloomington, Ind.: Indiana University Press.

1978b The Delaware Indian westward migration, with the texts of two manuscripts (1821-22) responding to General Lewis Cass's inquiries about Lenape culture and language. Wallingford: Middle Atlantic Press.

Weymouth, J.W.

1976 A magnetic survey of the Walth Bay Site (39 WW 203). Lincoln, Nebr.: Midwest Archeological Center, National Park Service, Ms. on file.

1977 A magnetometer survey of the Knife River Indian villages. Plains Anthropologist 13:22-78, pt. 2.

1979a A magnetic survey of the Big Hidasta Site (32 ME 12), Knife Indian Villages National Historic Site. Lincoln, Nebr.: Midwest Archeological Center, National Park Service, Ms. on file.

Weymouth, J.W. (Cont.)

1979b Magnetic surveying of archaeological sites. In Proceedings, Scientific Research in the National Parks, U.S. Department of the Interior, NPS Transactions, #5. Washington.

1979c A magnetic survey of Tumacacori National Monument. Lincoln, Nebr.: Midwest Archeological Center, National Park Service, Ms. on file.

Whallon, R., Jr. 1968. Investigations of late prehistoric social organization in New York State. In New perspectives in archeology, S.R. Binford and L.R. Binford, eds., pp. 223-244. Chicago: Aldine.

Wheeler, R.C. 1972. The North American fur trade. In A history of seafaring, ed. G.F. Bass. New York: Walker & Co.

Whigham, D.F., et al. 1978. Biomass and primary production in freshwater tidal wetlands of the Middle Atlantic Coast. In Freshwater wetlands: Ecological processes and management potential, R.E. Good, D.F. Whigham, and R.L. Simpson, eds., pp. 3-20. New York: Academic Press.

White, G.W.

1951 Illinoian and Wisconsin drift of the southern part of the Grand River lobe in eastern Ohio. Geol. Soc. Amer. Bull. 62:967-977.

1953 Geology and water bearing characteristics of the unconsolidated deposits of Cuyahoga County. In The water resources of Cuyahoga County, Ohio. Ohio DNR, Div. of Water, Bull. 26., pp. 36-42.

White, G.W.; Totten, S.M.; and Gross, D.L. 1969. Pleistocene stratigraphy of northwestern Pennsylvania. Pa. Topog. and Geol. Surv. Bull. G55.

White, M.E.

1956 Iroquois culture history in the Niagara Frontier area of New York State. Ph.D. dissertation, University of Michigan.

1958 An Iroquois sequence in New York's Niagara Frontier. Pennsylvania Archaeologist 28(3-4):145-150.

1961 Iroquois culture history in the Niagara Frontier area of New York State. University of Michigan, Museum of Anthropology, Anthropological Papers, no. 16.

1963 Settlement pattern change in the New York-Ontario area. Pennsylvania Archaeologist 33(1-2):1-11.

1967 An early historic Niagara Frontier Iroquois cemetery in Erie County, New York. Researches and Transactions of the New York Archeological Association 16(1).

1971 Ethnic identification and Iroquois groups in western New York and Ontario. Ethnohistory 18(1):19-38.

White, M.E. (Cont.)

1976 Late Woodland archaeology in the Niagara Frontier of New York and Ontario. In The Late Prehistory of the Lake Erie Drainage Basin: A 1972 symposium revised, ed. D.S. Brose, pp. 110-136. Scientific Papers of the Cleveland Museum of Natural History.

1978a Erie. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 412-417. Washington: Smithsonian Institution.

1978b Neutral and Wenro. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 407-411. Washington: Smithsonian Institution.

White, M.E.; Englebrecht, W.E.; and Tooker, E. 1978. Cayuga. In Handbook of North American Indians, Vol. 15, ed. B.G. Trigger, pp. 500-504. Washington: Smithsonian Institution.

White, T.C., ed. 1898. Our county and its people: A descriptive work on Erie County, New York. 2 vols. Boston: Boston History Co.

Whitman, B. 1896. Nelson's biographical dictionary and historical reference book of Erie County, Pennsylvania. Erie, Pa.: S.B. Nelson, Publisher.

Whitman, B., and Russell, N.W. 1884. History of Erie County, Pennsylvania. Chicago: Warner, Beers and Co.

Whittlesey, C.

1852 Descriptions of ancient works in Ohio. Smithsonian Contributions to Knowledge 3(7).

1871 Ancient earth forts of the Cuyahoga Valley, Ohio. Western Reserve Historical and Archaeological Society Tract 5:1-40.

1888 Ancient earthworks--northern Ohio. Western Reserve Historical Tracts 2.

Wiebe, Robert H. 1967. The search for order, 1877-1920. New York: Hill and Wang.

Wilde, S.A. 1958. Forest soils: Their properties and relation to silviculture. New York: Ronald Press.

Wilkinson, N.B.; Stevens, S.K.; and Kent, D.H. 1957. Bibliography of Pennsylvania history. Rev. ed. Harrisburg, Pa.: Pennsylvania State Bureau of Publications.

Willey, G., and Phillips, P. 1958. Method and theory in American archaeology. Chicago: University of Chicago Press.

Willey, G.R. 1953. Prehistoric settlement patterns in the Viru Valley, Peru. Bureau of American Ethnology, Bulletin 155.

Williams, A.B.

1936 The composition and dynamics of a beech-maple climax community. Ecol. Monogr. 6:317-408.

1949 The native forests of Cuyahoga County, Ohio. The Holden Arboretum, Bull. no. 1. Sci. Publ. of Cleveland Mus. Nat. Hist., vol. 9.

Williams, A.S. 1974. Late-glacial--post-glacial vegetational history of the Pretty Lake region, northeastern Indiana. USGS Prof. Pap. 686-B.

Williams (H.Z.) and Brothers. 1882. History of Sandusky County, Ohio. Cleveland.

Williams, N.N. 1957. Pollen analysis of a central Ohio bog located in the Prairie Peninsula. M.S. thesis, Ohio State University.

Williams, W.W.

1878 History of Ashtabula County, Ohio, with illustrations and biographical sketches. Philadelphia: Williams Brothers.

1879a History of the Firelands, comprising Huron and Erie Counties, Ohio. Cleveland: Press of Leader Printing Co.

1879b History of Lorain County, Ohio, with illustrations and biographical sketches of some of its prominent men and pioneers. Philadelphia.

Williams Brothers. 1878. History of Geauga and Lake Counties, Ohio. Philadelphia.

Wing, T.E., ed. 1890. History of Monroe County, Michigan. New York: Munsell and Co.

Winter, N.O. 1917. A history of northwest Ohio. 3 vols. New York: Lewis Publishing Co.

Winters, H.D.

1968 Value systems and trade cycles of the Late Archaic in the Midwest. In New perspectives in archaeology, S.R. Binford and L.R. Binford, eds. Chicago: Aldine. pp. 175-221.

1969 The Riverton Culture: A second millenium occupation in the Central Wabash Valley. Illinois State Museum, Report of Investigations no. 13.

Witthoft, J.

1949 An outline of Pennsylvania Indian history. Pennsylvania History 16(3):165-176.

1951 Iroquois archeology at the mid-century. Proceedings of the American Philosophical Society 95(3):311-322.

1953 Broad spearpoints and the Transitional Period cultures. Pennsylvania Archaeologist 23(1):4-31.

Witthoft, J. (Cont.)

1959 Notes on the Archaic of the Appalachian Region. American Antiquity 25(1):79-85.

1965 Indian Prehistory of Pennsylvania. Harrisburg, Pa.: Pennsylvania Historical and Museum Commission.

Wittke, C.F., ed. 1941-1944. The history of the State of Ohio. 6 vols. Columbus, Ohio: Ohio State Archaeological and Historical Society.

Wolfe, J.N.; Wareham, R.T.; and Scofield, H.T. 1949. Microclimates and macroclimates of Neotoma, a small valley in central Ohio. Ohio Biol. Surv. Bull. 41.

Wolynec, R.B.; Werner, B.; Kolb, C.C.; and Kolb, J.B. 1978. Cultural resource overview of the Allegheny National Forest: Warren, Elk, Forest and McKean counties, Pennsylvania. Final report to the U.S. Department of Agriculture, Forest Service, Eastern Region.

Wray, C.F., and Schoff, H.L. 1953. A preliminary report on the Seneca sequence in western New York, 1550-1687. Pennsylvania Archaeologist 23(2):53-63.

Wright, A., and Wright, R. 1930. Erie County archaeological survey. Harrisburg: Pennsylvania Historical Commission, Ms.

Wright, G.F.

1887a Archaeological, historical and pioneer collections in Ohio. Ohio Archaeological and Historical Publications 1:402-403.

1887b The importance of the study of archaeology in Ohio. Ohio Archaeological and Historical Publications 1:55-60.

1913 Old Fort Sandoski of 1745. Ohio Archaeological and Historical Publications 22:371-380.

Wright, G.F., ed. 1916. A standard history of Lorain County, Ohio. 2 vols. Chicago and New York: Lewis Publishing Co.

Wright, G.K. 1963. The Neutral Indians: A sourcebook. Occasional Papers of the New York State Archeological Association 4.

Wright, H.E., Jr.

1964 Aspects of the early post-glacial forest succession in the Great Lakes region. Ecology 45:439-448.

1968a History of the Prairie Peninsula. In The Quaternary of Illinois, ed. R.E. Bergstrom. Univ. of Ill. Coll. of Agr. Spec. Rept. 14:78-88.

1968b The roles of pine and spruce in the forest history of Minnesota and adjacent areas. Ecology 49:937-955.

1971 Late Quaternary vegetational history of North America. In The Late Cenezoic Glacial Ages, ed. K.K. Turekian. New Haven, Conn.: Yale University Press.

Wright, H.E., Jr. (Cont.)

1974 The environment of early man in the Great Lakes region. In Aspects of Upper Great Lakes anthropology: Papers in honor of Lloyd A. Wilford, ed. E. Johnson, pp. 8-14. Minnesota Historical Societies, Prehistoric Archaeology Series 12.

1976a The dynamic nature of Holocene vegetation: A problem in paleoclimatology, biogeography, and stratigraphic nomenclature. Quaternary Res. 6(4):581-596.

1976b Ice retreat and revegetation in the western Great Lakes area. In Quaternary stratigraphy of North America, ed. W.C. Mahaney, pp. 119-132. Stroudsburg, Pa.: Dowden, Hutchinson, and Ross.

Wright, J.E., and Corbett, D.S. 1940. Pioneer life in western Pennsylvania. Pittsburgh: University of Pittsburgh Press.

Wright, J.V.

1960 The Middleport Horizon. Anthropologica 2:113-120.

1964 The Ontario Iroquois Tradition. Ph.D. dissertation, University of Wisconsin.

Wright, J.W. 1952. Pollen dispersion of some forest trees. US For. Serv. Northeastern Forest. Expt. Sta. Paper 46.

Wright, R.J.

1958 Conneaut Harbor, Part I. Inland Seas 14(4):277-285.

1959 Conneaut Harbor, Part II. Inland Seas 15(1):29-35.

Wright, R.P. 1931. Westfield, N.Y. Pennsylvania Archaeologist 2(2):4.

Writers' Program of the Work Projects Administration. 1941. Lake County history. Mentor, Ohio: Western Reserve Historical Society, Lake County Chapter.

Writers' Program of the Work Projects Administration in the State of Michigan. 1941. Michigan: Guide to the Wolverine State. New York: Oxford University Press.

Writers' Program of the Work Projects Administration in the State of New York. 1940. New York: A guide to the Empire State. New York: Oxford University Press.

Writers' Program of the Work Projects Administration in the State of Ohio. 1940. The Ohio guide. New York: Oxford University Press.

Writers' Program of the Work Projects Administration in the State of Pennsylvania. 1940. Pennsylvania: Guide to the Keystone State. New York: Oxford University Press.

Yarnell, R.A. 1964. Aboriginal relationships between culture and plant life in the Upper Great Lakes region. Museum of Anthropology, University of Michigan Anthropology Papers.

Young, A.W. 1875. History of Chautauqua County, New York, from its first settlement to the present time. Buffalo, N.Y.: Matthews and Warren.

Yue, O.C.; Rope, E.I.; and Tricoles, G. 1975. Two reconstruction methods for microwave imaging of buried dielectric anomalies. IEEE Transactions on Computers, vol. 24, no. 4 (April), pp. 381-390.

Zakucia, J.A.

1958 A preceramic manifestation at the Pymatuming Reservoir Site. Eastern States Archeological Federation Bulletin 17:11.

1961 The excavation of the Chamber's Mound. Eastern States Archaeological Bulletin 20:14.

1974 New radiocarbon dates from the Upper Ohio Valley, Appendix A. In The Boarts Site: A lithic workshop in Lawrence County, Pennsylvania. Pennsylvania Archaeologist 44(1-2):100-102.

Zenkert, C.A. 1934. The flora of the Niagara Frontier region. Buffalo Soc. Nat. Sci. Bull. 16.