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dissertation entitled

MOBILITY, STYLE, AND EXCHANGE
AMONG UPPER GREAT LAKES
LATE PALEOINDIANS

presented by

David Lee Ruggles

has been accepted towards fulfillment
of the requirements for

Ph. D. degree in Anthropology

Major professor

Date 19 February 2001

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MOBILITY, STYLE, AND EXCHANGE AMONG UPPER GREAT LAKES LATE PALEOINDIANS

VOLUME I

By

David Lee Ruggles

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Anthropology

2001

ABSTRACT

MOBILITY, STYLE, AND EXCHANGE
AMONG UPPER GREAT LAKES
LATE PALEOINDIANS

By

David Lee Ruggles

During the period between 10,000 B.P. and 8,000 B.P., a people known in archaeological literature as Late Paleoindians inhabited the upper Great Lakes region. Given that the archaeological record in this region is extremely constrained for this period, very little is known of these people and how they lived. Certainly, there has not been an in-depth regional study of these populations specifically as pertains to their social and cultural expressions of mobility, style, and exchange. It is to this task that this research is directed. The lithic lanceolate points of 40 Late Paleoindian sites and the known paleoenvironmental data provide the base data for this study.

Theories of ecology, style, and egalitarian exchange are employed to provide the structure for this research design. Through these theoretical constructs, inquiries are guided by scientific deductive frameworks. Additionally, both the stylistic and exchange properties of lithic raw material is explored.

During the Early Holocene, widespread and dramatic changes were occurring in the upper Great Lakes natural environment. These major changes included the final northward retreat of the Laurentide ice sheet accompanied by its glacially-associated tundra environs, leaving a large ecotonal area to develop, which included woodland-associated elements by the end of the 2,000 period. Also, a climatic warming trend accompanied by variable humidity levels developed across the region, with variation in

water levels of Lakes Michigan and Huron basins reaching >500 feet.

Studying the subtle interplay between these dynamic natural conditions and the diverse sociocultural developments of immigrating and resident Late Paleoindian populations, reveals three (and potentially four) contemporaneous but differing Late Paleoindian sociocultural organizations operating within four identified subregions of the upper Great Lakes area. Importantly, the previous hunting-focused viewpoint of Late Paleoindian lifeways is challenged with a proposed split in the subsistence system of 63% foraging (hunting) and 37% collecting (gathering).

Stylistic study suggests that the northern and western Late Paleoindian groups of the upper Great Lakes region were the first human occupants of the Superior region who, through time, appear to have developed a social boundary between the groups of the northern and northwestern areas of Lake Superior and those of the southern areas of Lakes Superior including Wisconsin. Still, a narrow area of some overlap between these populations is proposed along the western edge of Lake Superior in the eastern Minnesota (Duluth) area. Mobility patterns for both these populations appear to have ranged to 400 km, and possibly greater. Exchange analysis indicates there are no formal lithic-based exchange systems operating between these northern and western groups.

Populations in the northern Lower Peninsula of Michigan exhibited a 200 km range in their mobility patterns with a potential for increased mobility between this area and southern Ontario across dry land corridors that, through time, extended northward to beyond the Saginaw Bay area. Again, there is no indication of a formal lithic-based exchange system operating between groups in this area. Unfortunately, a very weak archaeological sample makes any strong assertions inappropriate for the Eastern area.

DEDICATION

This work is dedicated to my wife, Dianne Marie Boberg-Ruggles, whose intelligence, character, and compassion have been my constant source of inspiration and strength.

ACKNOWLEDGMENTS

I would like to express my sincere appreciation to my committee members Prof. William Lovis, Prof. Lynne Goldstein, Prof. Lawrence Robbins, and Prof. Helen Pollard for their insightful comments and supportive consultations. I especially owe a great debt of gratitude to Prof. Lovis for his sustained support and constructive critiques throughout this research undertaking.

A very special note of appreciation in Memory of Prof. Jerome A. (Jerry) Voss whose theories of style is central to this research and whose insightful consultations, down-to-earth candor, and scholarly legacy form standards of both personal and professional conduct that are of the highest character to which I could aspire. He is sorely missed.

Several other scholars have contributed to the success of this research and to whom I am indebted including: Prof. Charles E. Cleland (Emeritus) who provided me with access to the Samel's Field collection at Michigan State University and took time to travel with me to meet the Samel's brothers and record their collection at the Samel's farm; Prof. Marla Buckmaster who graciously opened her laboratory at Northern Michigan University and granted access to the Gorto Site collection and other area sites for this research; Prof. John O'Shea at the University of Michigan for access to the George Lake collection; Dr. Peter Storck of the Royal Ontario Museum in Toronto, Ontario; Mr. William Ross, Archaeologist for the Ministry of Parks, Ontario for access to the Thunder Bay and Rainey River collections; Prof. Patrick Julig, Laurentian University, for providing access, interpretation, and consultation for the INAA/XRF tests of the lithic samples; Judith Speth, Archaeologist at the Neville Museum and the Neville Museum for their high scholarly standards and assistance in gaining access and information on Wisconsin and Minnesota collections (including the Renier Site collection) as well as a lithic sample for destructive testing from the Renier Collection; Prof. Robert Salzer, Beloit College, for access to the Flambeau material. Additionally, while sequestered during this research, Dr. Michael Hambacher kept me copied on recent articles and papers germane to my focus as just a matter of scholarly interest and friendship; again, thank you. While space does not allow naming all who have directly and indirectly helped during this study, I do thank you all.

Finally, I wish to acknowledge my family and express my sincerest appreciation for their sacrifice and support throughout my educational experience. My thanks to my daughter Tara, my stepson Will, and especially my mother, Mrs. Glendeen Frances Trevino-Felax, whose unswerving commitment to her children exemplifies the love, generosity, and compassion that both defines and sustains a family through time. Also, I thank my father, Mr. Robert L. Ruggles and stepmother Dorothy (Dee) Ruggles who have suffered my silence and absence throughout these years and, yet, are always there to listen and support. I most humbly thank all of you.

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CHAPTER 1

INTRODUCTION

Problem Orientation

A major component in understanding archaeological cultures is ascertaining the subsistence/settlement strategies and tactics that were employed for survival in their environments. In compiling the archaeological record of the upper Great Lakes, numerous works have focused on the general and site-specific prehistoric archaeology of the region (Buckmaster and Paquette 1988; Cleland & Ruggles 1996; Ellis and Ferris 1990; Fitting 1970; Fox 1975; Mason 1981; Quimby 1960; Reid 1980; Ross 1992; Salzer 1974); yet, there has not been an in-depth study of Late Paleoindian (or LPI) mobility patterns for this region. It is to this task that this study is ultimately directed.

Until the last decade, there were relatively few Late Paleoindian sites known in the upper Great Lakes region; even fewer site reports had been published. Since then, a significant number of new sites have been discovered. In total, there are now a minimum of 40 Late Paleoindian sites reported in the upper Great Lakes region, the lithic assemblages of which provide the foundation for this research (Figure 1.1). This study concentrates on the geographic area with its southern-most boundaries in the northern area of Lake Huron on the eastern side, and just south of Green Bay, Wisconsin on the western side, and the northern boundaries extending to the area bordering the northern reaches of Lake Superior in the Thunder Bay, Quetico Park, and Rainey River area of northern Ontario (Figure 1.1).

Figure 1.1 Region of Study (Legend and Map)

SITES = ①

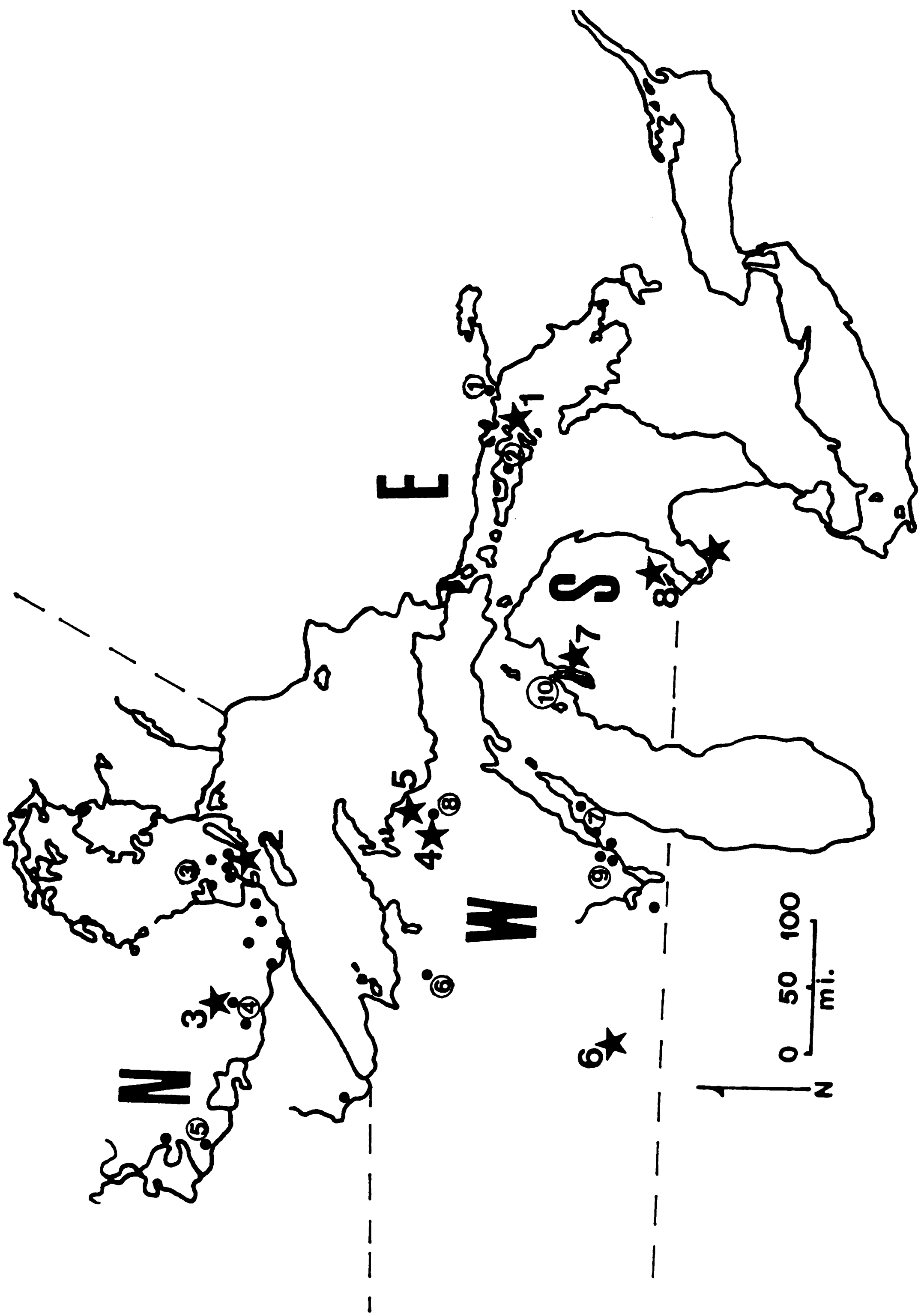
1. George Lake: GL-1;
2. Sheguiandah: SH-955;
3. Thunder Bay: DaJn-7, DbJm-6, DcJi-1, DcJh-9, DcJh-11, DdJe-1, DdJf-4, DeJi-6, DeJj-6, and, DfJo-3;
4. Quetico Park: DdJt-1, DdJt-3, Pine Point, and QP-72;
5. Rainey River/Lake of the Woods: HKM-1980, HK-1477, Rainey R., Rainey R. 2 thru 5, Kenora, Devlin Twp.;
6. Flambeau: 21732;
7. Renier: 2830;
8. Gorto: 20MQ39, Deer Lake, Witch Lake, 20MQ35-68;
9. Wisc.:3551, GrBa, 1417, 1930;
10. Samels Field: Lanc.-1 thru 19, Lake Cnty.

Lithic Resource Locations = ★

1. Sheguiandah Quartzite
2. Jasper-Taconite
3. Knife Lake Siltstone
4. Agibik Quartzite
5. Mt. Mesnard Quartzite
6. Silver Mound – Hixton Silicified Sandstone
7. Norwood Chert
8. Bayport Chert: AuGres and Saginaw Bay

Upper Great Lakes – Subregions

E = Eastern
N = Northern
W = Western
S = Southern


N
W
S
E
0 50 100
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N

Late Paleoindian, also Aqua Plano (Quimby 1960: 34), is a sociocultural phase that has been developed by archaeologists to differentiate upper Great Lakes subsistence and settlement strategies of 10,000 B.P. to 8,000 B.P. from their Early Archaic eastern, woodland-adapted contemporaries. The Late Paleoindian adaptations are believed to more closely conform to earlier Paleoindian culture (12,000 B.P.[+] to 10,000 B.P.) (Ellis & Deller 1990: 62-63; Fitting 1975; Justice 1987; Mason 1962: 233, 1981: 111, 1986: 192; Quimby 1960: 34; Wedel 1964: 199).

This dissertation approaches the anthropological issues of sociocultural organization, adaptation, and change through an ecological framework by development of a regional mobility model for the Late Paleoindian settlement systems of the upper Great Lakes region. The data are derived from both the archaeological and environmental records of the upper Great Lakes during the Early Holocene (12,500 B.P. - 8,000 B.P.) with appropriate references to the ethnographic record. The environmental data provide the basis for a reconstruction of the natural environments within which the Late Paleoindians operated, while both the archaeological and ethnographic records establishes and compares the human component of that past ecological system. Consequently, Cultural Ecology provides a framework for study of the LPI subsistence and settlement system.

Cultural ecology assumes culture to be an adaptive system which continually interacts with other subsystems in a specific environment exhibiting a range of responses, including sociocultural adaptations to the environment. According to Steward,

> *"Cultural ecology is the study of the processes by which a society adapts to its environment (Steward 1977: 43)".*

By viewing culture as an adaptive system, the analysis proceeds within a systemic framework bounded by environmental considerations. Therefore, a paleoecological reconstruction, within an ecological framework, undertakes to describe the relationships among the natural and sociocultural subsystems of past environments including climatic, geophysical, hydrologic, floral, faunal, and subsistence, settlement, and mobility. This reconstruction is especially significant when the sociocultural behavior that is of central interest involves a direct and constant interaction with the physical environment, e.g., group mobility. Along these lines of archaeological investigation, i.e., cultural ecology and group mobility, Lewis Binford offers this theoretical insight:

> *"Therefore, given the beginnings of a theory of adaptation, it is possible to anticipate both differences in settlement-subsistence strategies and patterning in the archaeological record through a more detailed knowledge of the distribution of environmental variables (Binford 1980: 4)."*

Binford goes on to develop a model that describes differing hunter-gatherer organizational structures and the relationship of variability in the corresponding archaeological record along a mixed continuum that extends between the polar strategies of "Collectors" and "Foragers". This is achieved by using the organizational components of "mapping-on" and "logistics" which is in response to "different security problems presented by the environments in which hunter-gatherers live" (Binford 1980: 4).

It is generally understood that Late Paleoindian societies were organized in small egalitarian groups whose subsistence and settlement strategies included high mobility hunting and gathering within large territories, +/- 200km range, (Ellis and Deller 1990: 62-63; Fitting 1975; Frison 1974 & 1982; Mason 1981; Quimby 1960). Interestingly, these organizational characteristics are those which Binford associates with supporting a logistically-organized foraging strategy (Binford 1980: 5-10). Still, the characteristics used by Binford to differentiate between the polar strategies of foragers and collectors are interwoven within the fabric of specific environments and archaeological records which allows for a high degree of variability in specific sociocultural organizational responses along the continuum (Binford 1980: 9).

Consequently, only after a thorough analysis of all the regional empirical data (i.e., natural, archaeological, and sociocultural) can there be any credible discussion of the sociocultural organization of a prehistoric society. This analytical approach to environmental reconstruction is central to cultural ecology:

> *"Cultural ecology does not assume that each case is unique. Its method, however, requires an empirical analysis of each society before broader generalizations of cross-cultural similarities in processes and substantive effects may be made (Steward 1977: 44)."*

Cultural ecology mitigates against the effects of environmental and economic determinism by recognizing that there is a range of potential sociocultural behaviors that may be represented in the structure and response of any individual social system within its particular environment (Steward 1955: 36-37). Binford also avoids this problem by use of the forager/collector continuum where a range of organizational structures is provided based on particular environments.

In his operationalization of cultural ecology, Steward lists three "fundamental procedures" (Steward 1955: 40-41):

> *"First, the interrelationship of exploitative or productive technology and environment must be analyzed" (40);*
>
> *"Second, the behavior patterns involved in the exploitation of a particular area by means of a particular technology must be analyzed" (40); and,*
>
> *"The third procedure is to ascertain the extent to which the behavior patterns entailed in exploiting the environment affect other aspects of culture" (41).*

Thus, the complexity of any particular adaptive strategy must influence the type of analysis which is indicated (Steward 1955: 39). Consequently, those systems that employ social structures and technologies which directly rely on the distribution of the natural resources within their environments, such as forager/collectors, require an in-depth environmental analysis inclusive of both the natural and cultural spheres.

Of course, there are competing theories in hunter-gatherer (or forager-collector) studies that also offer explanations of the archaeological and anthropological record as well as criticisms of the cultural ecological approach (Bettinger 1991; Kelly 1995). A central criticism of cultural ecology is the deterministic implications of the "culture core" concept which studies the relationship between the environment, technology, and society with the focus on how environment and technology shapes society (Kelly 1995: 42-43). According to Bettinger (1991) and Kelly (1995), the primary problems with cultural ecology is "...(1) a neofunctionalist concept of *adaptation*...", which is the view that the sociocultural system is at equilibrium within its environment and, therefore, adaptation is seen as a means of maintaining that equilibrium; and, "...(2) an implicit reliance on group selection.", which places the group at all intersections of primacy (including personal) in decision-making processes, i.e., the best decision for the group is uppermost in personal choices, not the individual or kin (Kelly 1995: 47). These criticisms are well-founded in Stewards (1955) original conception of cultural ecology, as well as its implications for a tautology to exist in the definition of culture as adaptation. The tautology being "...behavior is adaptive because it exists–otherwise, it would not exist." (Kelly 1995: 47).

Considering these criticisms of cultural ecology, there still remains a legitimate basis upon its foundations for fruitful study of forager and collector systems; particularly in the case of a very small, early prehistoric dataset such as that employed in this study. In this study, the smaller dataset is used in a coarse grained research design to reveal the regional mobility patterns of LPI groups. In this research, then, the paleoenvironmental reconstruction is used to establish the boundaries of practical and potential interaction between LPI groups with the natural world around them. To this end, Binford's middle-range, forager and collector continuum model (which is clearly based upon cultural ecology) is employed to reveal the broad intersections of regional LPI behaviors with the predictions of the model as interpreted from the available archaeological and ethnographic data (Binford 1980). Further, the significant developments in behavioral ecological and evolutionary studies that have occurred since Steward's and Binford's original works are also considered in this research particularly with attention to the interplay of the individual in stylistic expression of material culture (Bettinger 1991: Kelly 1995: Lovis, Holman, Monaghan, and Skowronek 1994; Voss and Young 1995).

In contemporary hunter-gatherer research, middle-range theory provides an elegant means of linking research questions in this case, organized within a cultural ecological framework, to empirical observations about the archaeological record (Bettinger 1991: 62). As will be shown, Binford's model of a continuum of subsistence-settlement systems with foragers and collectors at the polar ends and natural resource availability as the defining variable influencing the sociocultural organizational structure is well-suited, with some modification, to the research design of this dissertation (Binford 1980: 4; Kelly 1995: 117-120).

A criticism of Binford's model is offered by Robert L. Bettinger (1991). In applying Binford's model to three Great Basin forager-collector groups, namely the

Owens Valley Paiute, the Reese River Shoshone, and the Kawich Mountain Shoshone, it was found that the expectations predicted by the model were not evidenced (1991: 70-72). Between these three sociocultural systems whose subsistence and settlement patterns (within the same climatic conditions or *ET*) widely varied along Binford's Forager-Collector continuum, the expected concomitant variation in technology (i.e., curated vs. expedient) was not evidenced (72). Bettinger proposes significant influence is exerted on these settlement-subsistence systems by population pressures, while Binford's model relies only on the natural environment in establishing and interpreting the settlement-subsistence patterns. According to Bettinger, the issue of population pressure is not, therefore, satisfactorily accounted for by Binford's model (1991: 72-73). Bettinger acknowledges that Binford does somewhat address the effects of population pressure on his model by Binford's suggestion that, where population pressures occur, there can be a reduction in residential mobility with an increase in logistical mobility ([Binford 1980: 17] 72). Yet, Bettinger argues further that if one type of mobility is restricted by surrounding population pressures, then so is the other (Bettinger 1991: 72). Consequently, Bettinger asserts that a strictly environmentally-based model, such as Binford's, may not be as widely applicable as some researchers may assume.

While Bettinger's cautions regarding Binford's model are properly noted, population pressures are not assumed to be a significant element during the Late Paleoindian period except in the southern lower peninsula of Michigan. It is important to remember that the Late Paleoindian phase in the far northern upper Great Lakes region is the earliest known human occupation of much of the study area, which is north of the Mason-Quimby Line (Cleland, Holman, and Holman: 1998; Cleland and Ruggles: 1996;

Mason 1962; Quimby 1960). Supporting this observation is the very small and widely distributed LPI archaeological record of the region, which is typified by extremely low artifact densities and small discrete site locations. Consequently, a mobility model that places primacy on the articulation of natural environmental conditions with forager-collector systems development, as opposed to such forces as population pressure, does not appear out of line for productive LPI study.

In this study, analyses of lithic stylistic variation and exchange are central to the development of the mobility model. These analyses are based on the investigation of lithic raw material procurement, trade, and modification through tool manufacture as guided by the body of theory previously referred to as lithic sociology (Carr 1995; Renfrew 1977; Sackett 1990; Voss and Young 1995; Whallon 1972; Wiessner 1983; Wobst 1977). A central assumption of these theoretical approaches is that patterns exist in human social behavior which also find expression in elements of material culture. Therefore, the investigation and analysis of material culture may reveal the sociocultural patterns of the past.

An assumption in this study, then, is that lithic tools, as an element of material culture, can be relied upon as an indicator of certain past social behaviors. Further, that the patterned behavior of primary concern to this study (i.e., mobility) is, therefore, discernable through proper employment of a rigorous scientific investigation and analysis of Late Paleoindian lithic tools (Bettinger 1991; Binford 1980; Carr 1995; Kelly 1995; Steward 1955, 1977; Voss and Young 1995).

Archaeological Theory and Method

The information archaeologists both discern and impart about any extinct culture is derived from a combination of the natural, archaeological, ethnographic, and historical records. When these records are small or incomplete, the potential for interpretation may, likewise, be limited. Approaching relatively limited data bases requires theoretical foundations with well-defined and sound links between concept and variable, between explanation and data. Ecological approaches offers a sound foundation for explanation of varied sociocultural organizations through both time and space, as well as providing the analytic depth and flexibility of a systems approach which is especially useful for study of prehistoric hunter and gatherer sociocultural systems (Steward 1955:36-42; Kelly 1995; Bettinger: 1991).

This dissertation employs the cultural ecological framework through a middle-range approach to hunter-gatherer systems and a more general ecological approach to lithic sociology and exchange. Hypotheses, developed from these theories and observations, are tested through an appropriate application of empirical evidence. It is important to note that only the null hypotheses are tested in this research. In some cases, particularly the stylistic analysis, alternative hypotheses are offered for consideration, but are not tested.

As pertains to the ecological research orientation, the following research questions and hypotheses, as applies to group mobility, are addressed in this dissertation:

Research Questions

1. What Late Paleoindian subsistence, settlement, and mobility adaptations are affected by the environmental changes of the early Holocene in the upper Great Lakes? How did the development of ecotones in the upper Great Lakes affect these sociocultural adaptations among upper Great Lakes Late Paleoindian populations?

2. What effects did the arrival of woodland-associated flora and fauna have on Late Paleoindian subsistence and settlement systems?

3. How do Early Holocene Great Lakes lake level fluctuations affect the development of sociocultural adaptations between and among populations of Michigan's lower peninsula and the territories surrounding the upper Great Lakes region?

HYPOTHESIS A:

If: there was a shift from a faunal-intensive economy in a species-poor environment towards a mixed economy in a more species-rich environment among upper Great Lakes Late Paleoindians,

then: there should be a change in the adaptive strategies employed by Late Paleoindian sociocultural subsystems such as subsistence and settlement systems, with some diminishing of Late Paleoindian mobility patterns, accompanied by a general increase in ecofact and material culture quantity and diversity through time.

HYPOTHESIS B:

If: Late Paleoindian populations' adaptations remained faunal-intensive, and populations that are woodland-adapted and exploiting a mixed economy immigrated into the upper Great Lakes' developing ecotones,

then: there should be little change in the material culture or archaeological faunal/floral profile of Late paleoindian assemblages, but a change in mobility patterns should be evidenced by a general northward and westward trajectory, while a distinct immigration of Early Archaic woodland-adapted populations should be evidenced as discrete assemblages in the developing ecotones of the Lake Stanley and Lake Chippewa basins with a diminished presence of Late Paleoindian assemblages.

HYPOTHESIS C:

If: there was a shift from a faunal-intensive economy to a mixed economy among Late Paleoindian populations, and populations which are woodland-adapted, and which were also exploiting a mixed economy, immigrated into the upper Great Lakes' developing ecotones,

then: there should be generally reduced mobility patterns than those previously associated with Late Paleoindian groups with the potential for some overlapping of mobility patterns between Late

Paleoindian populations and those of the woodland-adapted Early Archaic immigrants, particularly in the developing ecotones of the Lake Stanley and Lake Chippewa basins. Additionally, there should be the same types of adaptive changes evidenced in the archaeological record for Late Paleoindians as specified in Hypothesis "A".

Given the rather broad scope of the stated research interests, it is necessary to provide further theoretical and methodological links between these questions and the empirical data that is available for testing. The nature and structure of the archaeological record, as applies to hunter and gatherer organizations of the antiquity of Late Paleoindians, suggests that rather robust explanatory devices be applied to the available data set. In determining the spatial distribution of Late Paleoindian interactions, the application of previously mentioned theories and methods in lithic sociology, i.e. style and exchange, can be employed (Carr 1995; Close 1978; Clark 1989; Hambacher 1992; Kelly 1995; Renfrew 1977; Sackett 1977, 1983, 1990; Wiessner 1983, 1990; Wilmsen 1973, 1974; Wobst 1977; Voss 1975; Voss & Young 1995). This dissertation employs these approaches in the investigation of the sociocultural organization of the Late Paleoindian period in the upper Great Lakes. The application of these approaches also provides an opportunity for theoretical assessment and refinement:

HYPOTHESIS D:

If: stylistic behavior is a visible referent of social group identity and is expressed in the lithic component of Late Paleoindian material culture, then: there should be a visible stylistic homogeneity of intra-group lithic assemblages, defined by a co-variance of stylistic attributes, which will cluster as a group, distinguishable from other assemblages.

HYPOTHESIS E:

If: lithic raw material was used stylistically among upper Great Lakes Late Paleoindian groups,

then: its occurrence should co-vary with the other lithic stylistic attributes of a specific lithic assemblage

HYPOTHESIS F:

If: certain lithic raw material was used as a medium in a non-preferential egalitarian exchange system among upper Great Lakes Late Paleoindian populations,

then: the law of monotonic decrement would apply, where there is a fall-off of the frequency of the lithic raw material as effective distance increases from its point of origin, which can also be graphically represented as a normal curve with quantity as the Y value and distance as the X value.

HYPOTHESIS G:

If: lithic raw material was used as a medium in a preferential egalitarian exchange system among upper Great Lakes Late Paleoindian populations, then: the frequency:distance fall-off curve would not be normal but would be characterized as generally descending but interrupted by peaks and valleys, or deviations from the normal curve, which represent the exchanged lithic raw material occurring in frequencies and/or quantities at greater distances from the lithic source than the normal fall-off curve predicts.

HYPOTHESIS H:

If: social boundary maintenance is less proscribed in areas of low and widely dispersed economic resources (e.g.,flora/fauna), and there was a general increase in these exploitable floral/faunal resources in the upper Great Lakes region during the Early to Mid-Holocene (10,000 B.P. - 8,000 B.P.),

then: there should be evidence for an intensified expression of social boundaries within a more geographically refined (or smaller) area.

Conclusions

This is a regional study of the prehistoric sociocultural organization of upper Great Lakes Late Paleoindian populations. The data was gathered directly from private and public collections housed throughout the upper Great Lakes region in both the U.S. and Canada, and represents a synthesis of the available information pertaining to upper Great Lakes Late Paleoindians.

There are several contributions that are made by this dissertation. The study initiates within a cultural ecological framework, designed to explain upper Great Lakes Late Paleoindian settlement and subsistence systems and the physical environment of these prehistoric populations. This approach is operationalized through the application of middle-range theory. Specifically, the forager/collector sociocultural organizational continuum model is applied to the upper Great Lakes Late Paleoindian data as a means of interpreting the organization of subsistence and settlement (Binford 1980).

In order to address issues of LPI mobility, theories in style and exchange are applied to the lithic data in a way that requires some original constructions, such as testing the use of lithic raw material as a stylistic attribute, apart from the technological realm, as an indicator of prehistoric sociocultural adaptations. This approach provides a means of interpreting regional mobility patterns which is developed through using both continuous and nominal scale data to quantify and compare attributes of a small lithic data set, all within a stylistic theoretical framework. Theories of egalitarian exchange applied to pertinent lithic raw materials of the upper Great Lakes region provide a further comparative basis for description and explanation of regional mobility patterns.

This study, then, proceeds through the environmental reconstruction of the Early to Mid-Holocene period between 10,000 B.P. and 8,000 B.P., into a middle-range analysis of the upper Great Lakes Late Paleoindian forager/collector systems, to a detailed analysis of style and exchange patterns, and finally a concluding synthesis of these linked, but disparate, lines of evidence to produce an integrated explanation of Late Paleoindian regional mobility patterns for the upper Great Lakes region. It is also significant that this dissertation represents a single-source document for the Late Paleoindian occupation of the upper Great Lakes region.

CHAPTER 2

PALEOECOLOGICAL RECONSTRUCTION

Introduction

As was discussed in Chapter 1, this study is developed within a cultural ecology framework (Steward 1955). According to Steward,

> *"Cultural ecology is the study of the processes by which a society adapts to its environment (Steward 1977: 43)".*

In short, cultural ecology assumes culture to be an adaptive system which continually interacts with other subsystems in each specific environment, thereby exhibiting a range of responses (or sociocultural adaptations) to each environmental construct (Steward 1955: 36-41). This study suggests that through the early Holocene period Late Paleoindian groups of the upper Great Lakes were confronted with dramatic changes in the natural environment which necessitated changes in their sociocultural patterns to adapt to their changed environs. Therefore, in this chapter, a paleoecological reconstruction is undertaken to describe the nature of these reconstructed environmental changes including climatic, geophysical, hydrologic, floral, and faunal on the sociocultural organization of LPI groups.

This chapter establishes a reasonable reconstruction of the ecological system, including both natural and cultural subsystems, that was most likely operating in the upper Great Lakes region between 10,000 and 8,000 years ago. Based on this reconstruction, a contextual analysis of the data presented in chapters 3 through 7 is possible providing an appropriate means for interpretation of Late Paleoindian mobility.

Forager-Collector Systems and the Environment

By viewing culture as an adaptive system, the analysis proceeds within a systemic framework which is bounded by reasonably ascertainable environmental considerations. This is especially significant when the research interest at hand involves behavioral patterns deemed highly sensitive to environmental conditions and their perturbations; specifically, forager/collector group mobility. Along these lines of archaeological investigation (i.e., cultural ecology and group mobility), Binford (1980) offers this theoretical insight:

> *"Therefore, given the beginnings of a theory of adaptation, it is possible to anticipate both differences in settlement-subsistence strategies and patterning in the archaeological record through a more detailed knowledge of the distribution of environmental variables (Binford 1980: 4)."*

Binford goes on to develop a model that describes differing hunter-gatherer organizational structures and the relationship of variability in the corresponding archaeological record along a mixed continuum that extends between the polar strategies of "Collectors" and "Foragers". This is achieved by using the organizational components of "mapping-on" and "logistics" which is in response to "different security problems presented by the environments in which hunter-gatherers live" (Binford 1980: 4).

Since Steward's initial work in cultural ecology theory (1955), there have been numerous research projects (both archaeological and ethnographic) that have sought to discern the various relationships between human groups and their environments (Binford 1978a, 1978b, 1980, and 1982; Bettinger 1991; Butzer 1971 and 1982; Cleland, Holman, and Holman 1998; Heffley 1981; Jochim 1976 and 1981; Keene 1981; Kelley 1983; Kelly 1995; Lee 1968, 1969, 1972, and 1976; Lovis 1993, 1994; Smith 1981 and 1983;

Winterhalder 1981; Yellen 1977). In short, as suggested by these studies and the ethnographic and archaeological records, there is a demonstrable correlation between the variability in hunting and gathering sociocultural organizations and the variability of the environments within which they choose to operate. Further, there is variability between sociocultural adaptations to the same environments attesting to the diversity of choices selected by differing groups within these environments. Therefore, it is reasonable to assert that by delineation of the ascertainable paleoenvironmental data, both natural and cultural, it is possible to infer a reasonable regional paleoenvironment within which the Late Paleoindian sociocultural system was articulated an integral part. The subject of this chapter is development of the environmental reconstruction of available data for the period; whereas, articulation of this data with theoretical expectations for LPI sociocultural patterns is the subject of Chapter 3.

Early Holocene Environment (10,000 B.P. - 8,000 B.P.)

Regionally distinct natural and cultural phenomenon were exhibited during the Early Holocene (10,000 B.P. - 8,000 B.P.) including: 1) Deglaciation of the region; 2) upper Great Lakes lake levels fluctuated by more than 500 ft.; 3) faunal and floral profiles dramatically changed in both character and quantity; and, 4) Early Archaic woodland-adapted groups immigrated into the upper Great Lakes region while Late Paleoindian groups were still present (Chapter 1). This environmental reconstruction undertakes to reasonably describe the Early Holocene environment through the Late Paleoindian period (10,000 B.P. - 8,000 B.P.); thereby, providing a basis for further analysis of the upper Great Lakes Late Paleoindian sociocultural system.

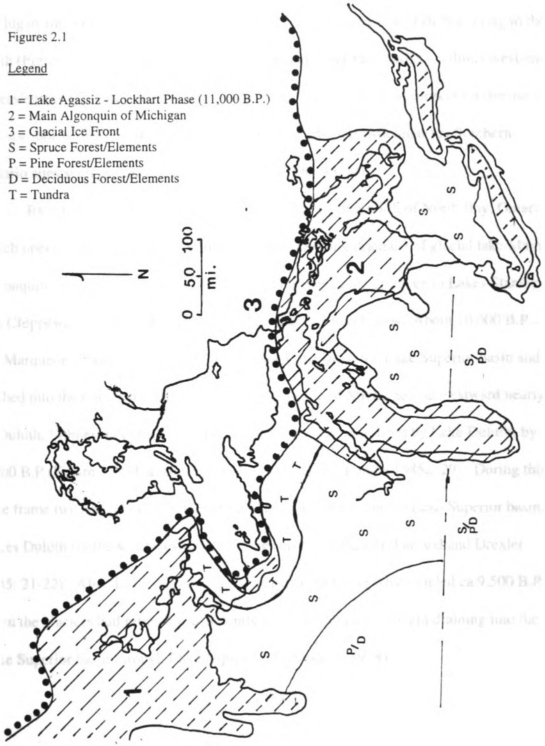
Great Lakes Glacial Record

During the Early Holocene epoch of the Quaternary period, gregarious herbivores and Late Paleoindians followed the retreating Laurentide ice sheet north into the upper Great Lakes region, moving into newly formed periglacial and tundra environs. The glacier, however, did not retreat along a geographically uniform front, nor at a uniform speed. Rather, deglaciation of this region is more reasonably characterized as perturbations among distinct glacial lobes which underwent individual stadial advances and interstadial retreats as the Wisconsinan ice mass slowly withdrew to the north (Bjorck 1985; Chapman and Putnam 1984: 26; Christian 1979; Clayton 1983; Cowan 1985; Farrand and Drexler 1985; Larsen 1985a and 1985b; Leverett and Taylor 1915; Teller 1985).

At the glacial margins were large glacial lakes, the predecessors of the modern Great Lakes, which also fluctuated greatly over time. Therefore, to place Late Paleoindian mobility patterns in the proper perspective, a chronological view of the changing glacial margins and lake shorelines provides valuable insight into accessible terrestrial landscapes through time.

At 11,000 yr B.P., the Two Creeks ice sheet had retreated to a position north of the Straits of Mackinac in the northern area of Michigan's upper peninsula (Figure 2.1) (Teller 1985; Cleland, Holman and Holman 1999: 19; Larsen 1999: 26). The higher water levels of the glacial Lake Main Algonquin of Michigan (184.5 m [605 ft] amsl) inundated vast areas along the ice front during this time with drainage at the northeastern point of the lake at the Mink Lake Sill (Larsen 1985a: 28; 1985b: 93). Much of Wisconsin, Minnesota, the upper peninsula of Michigan, and the George Lake area of southern Ontario were now ice-free; however, the northeastern area of Wisconsin, Michigan's upper peninsula, and the George Lake area of southern Ontario were all inundated by the Main Algonquin of Michigan Lake and much of northeastern Minnesota was covered by Lake Agassiz (Farrand and Drexler 1985: 21; Larsen 1985a: 28; Haywood 1989: 56). Additionally, by 10,700 B.P. (Farrand and Drexler 1985: 21), as the ice continued to retreat northwards, numerous spillways opened between Lake Agassiz to Lake Nipigon and Lake Superior, resulting in the sudden and dramatic lowering of Lake Agassiz called the "Moorhead Phase" (Haywood 1989: 7). All the Ontario geographic area considered in this study including the Lake Superior basin (Figure 1.1), was either glaciated or inundated by the glacial lakes at this time (Figure 2.1). As discussed by Larsen (1985b), another related effect of fluctuating lake levels is that elevated lake levels affect elevated stream base levels by causing aggradation along the floodplains near stream mouths; also, it leads to the establishment of marshes in low-lying coastal areas; and, the higher groundwater tables promote the formation of soil profiles in the dune areas (Larsen 1985b: 106). Aside from the geomorphological implications of these observations, there is the obvious impact on terrestrial mobility and habitation to be considered.

Figure 2.1 Map of the Upper Great Lakes 11,000 B.P.



Another particularly interesting aspect of the Main Algonquin level of Michigan Lake is that there was an extremely wide dry-land corridor between eastern lower Michigan and western southern Ontario with a much reduced Lake Erie bordering to the south (Figure 2.1). This dry land corridor provided Early Paleoindians a direct west-east access/egress capability in their mobility patterns. Archaeological support for the use of this corridor is implicated by the presence of Bayport chert (Michigan) at Southern Ontario sites such as Parkhill (Ellis and Deller 1990: 43-44).

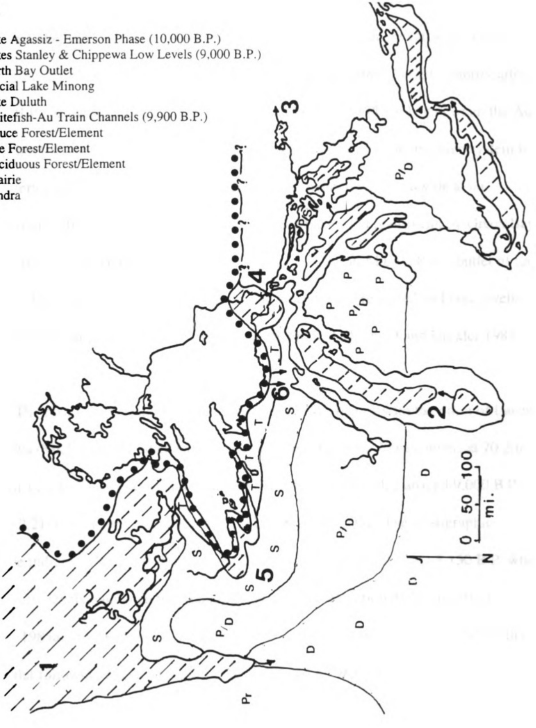
By 10,300 B.P. the glacier had withdrawn to a point north of North Bay, Ontario, which opened an outlet across a controlling sill providing drainage of glacial lake Main Algonquin of Michigan (Larsen 1985a: 29). Thus began the drainage to Lakes Stanley and Chippewa low levels in the Lake Michigan and Huron basins. About 10,000 B.P., the Marquette Phase readvance of the Superior Lobe filled the Lake Superior basin and pushed into the northern edges of the upper peninsula of Michigan and westward nearly to Duluth, Minnesota (which, if not covered by ice, was inundated by Lake Duluth) by 9,900 B.P.(Figure 2.2) (Farrand & Drexler 1985: 21-22; Larsen 1985a: 29). During this time frame two glacial lakes bordered the Superior Lobe ice in the Lake Superior basin, Lakes Duluth (in the southwest) and Minong (in the southeast) (Farrand and Drexler 1985: 21-22). Also, Lake Agassiz was in its Emerson Phase which ended ca.9,500 B.P. when the glaciers had retreated sufficiently for Lake Agassiz to begin draining into the Lake Superior basin through Lake Nipigon (Haywood 1989: 8).

Figure 2.2 Map of the Upper Great Lakes 10,000 B.P. to 9,000 B.P.

Figure 2.2

Legend

1 = Lake Agassiz - Emerson Phase (10,000 B.P.)
2 = Lakes Stanley & Chippewa Low Levels (9,000 B.P.)
3 = North Bay Outlet
4 = Glacial Lake Minong
5 = Lake Duluth
6 = Whitefish-Au Train Channels (9,900 B.P.)
S = Spruce Forest/Element
P = Pine Forest/Element
D = Deciduous Forest/Element
Pr = Prairie
T = Tundra



The Portage and Brule outlets located at the southwestern end of the Lake Superior basin were both active drainages to the Mississippi River (via Moose Lake and the St. Croix River valley, respectively) when the Superior Lobe, Porcupine Phase, ice filled the Lake Superior basin and Glacial Lake Duluth was at an elevation of 331m (1085 ft.) a.m.s.l. around 11,000 B.P. (Farrand and Drexler 1985: 21-23). Shortly after 10,000 B.P., as the southern ice front shifted, the Post-Duluth Phase began when the Au-train-Whitefish channel near Munising, Michigan (U.P.) became the drainage system for the western Lake Superior basin (Figure 2.3). This channel, with its divide at an elevation of 234m (768 ft.) a.m.s.l., drained into the Lake Michigan Basin by Green Bay at Little Bay de Noc (Farrand and Drexler 1985: 22). The St. Mary's River outlet of Lake Superior (Lake Minong) has been its sole outlet since the ice retreated and lake levels dropped below the 234m (768 ft.) level around 9,500 B.P. (Farrand and Drexler 1985: 22).

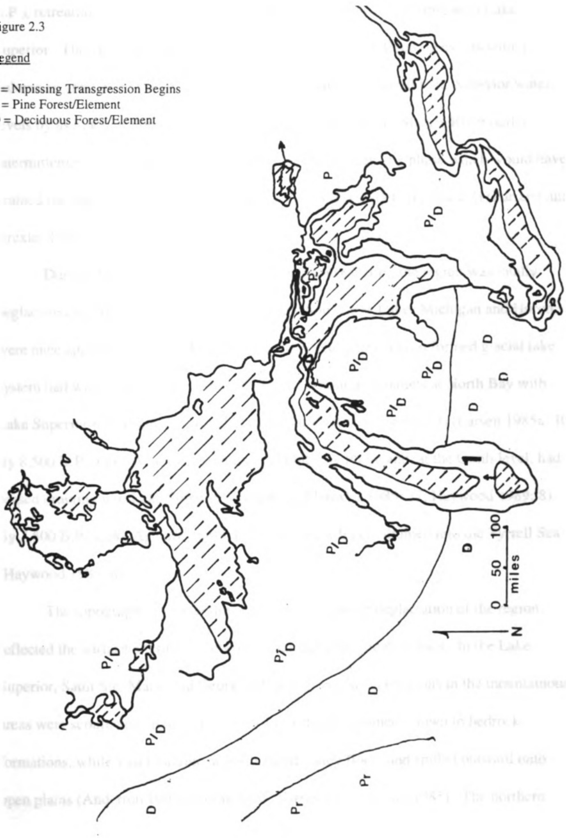
The post-glacial history of the upper Great Lakes begins with the onset of Lakes Chippewa (Michigan) and Stanley (Huron) which reached their lowest levels at 70.2m (230.2 ft.) for Lake Chippewa and 60m (196.7 ft.) for Lake Stanley around 9,000 B.P. (Figure 2.2) (Farrand and Drexler 1985: 27; Larsen 1985b: 93). The stratigraphic evidence indicates that Lakes Stanley and Chippewa low levels pre-date 8,150 B.P. when rising water levels inundated the Mackinac Straits at an elevation of 140m a.m.s.l. (Larsen 1985a: 16). The rising water levels are attributed to the isostatic of the North Bay outlet following deglaciation of the region (Larsen 1985: 16).

Figure 2.3 Map of the Upper Great Lakes 8,000 B.P.

Figure 2.3

<u>Legend</u>

1 = Nipissing Transgression Begins
P = Pine Forest/Element
D = Deciduous Forest/Element



Significantly, during the Nipigon Phase of Lake Agassiz (9,500 B.P. to 8,500 B.P.), retreating ice re-opened drainage from Lakes Agassiz and Nipigon to Lake Superior. This drainage has been postulated as catastrophic flooding events with a volume as great as 3,000 km3 that may have intermittently raised Lake Superior water levels by as much as 36m. Also, this drainage, through the St. Mary's River outlet, intermittently raised Lake Hurons levels during the Stanley low phase which would have drained the Agassiz flood waters through the North Bay outlets (Figure 2.3) (Farrand and Drexler 1985: 27; Larsen 1985a: 19).

During the Pre-Nipissing transgression, by 8,000 B.P., the region was totally deglaciated and lake levels had risen to an elevation where Lakes Michigan and Huron were once again joined at the Mackinac Straits (Figure 2.3). This reformed glacial lake system had water levels being controlled by the rebounding outlets at North Bay with Lake Superior now draining through the St. Mary's River (Figure 2.3) (Larsen 1985a: 30). By 8,500 B.P., Lake Agassiz was in its final Ojibway Phase and, at the Gimli level, had ceased draining into Lake Superior (Farrand and Drexler 1985: 27; Haywood 1989: 8). By 7,500 B.P., Lake Agassiz ceased to exist when it finally drained into the Tyrrell Sea (Haywood 1989: 8).

The topography of the entire study area, following deglaciation of the region, reflected the surface altering effects of glacial and geologic dynamics. In the Lake Superior, Sault Ste. Marie and Georgian Bay region lower elevations in the mountainous areas were scoured clean of soil deposits from stadial advances, down to bedrock formations, while vast morainic deposits filled valley floors and spilled outward onto open plains (Anderton 1993; Cowan 1985; Farrand and Drexler 1985). The northern areas of Lake Michigan and Lake Huron are also composed of the rougher exposed elevated bedrock and morainic deposits, while the western and southern areas present larger areas at lower elevations interspersed with vast morainic deposits such as the moraines of the northern lower peninsula of Michigan (Anderton 1993; Chapman and Putnam 1984; Leverett and Taylor 1915). Obviously, the topography of the study area is significant to the immigration of floral, faunal, and human populations.

As pertains to the various interdependent relationships in an ecological reconstruction, there are numerous implications of significance attached to the ice boundaries and lake levels through time. A major relationship exists between glaciers, tectonics, water budgets, and climate. Since the chronology and spatial distribution of the glaciers, and pro-glacial and post-glacial upper Great Lakes have been discussed, it is now desirable to discuss the relationship that existed between these systems and climate through time.

Climate

The 2,000 year time period intervening between 10,000 B.P. and 8,000 B.P. appears to be associated with a "rapid and dramatic change in temperature and/or precipitation" in the upper Great Lakes region (Ogden, III 1967: 124). In discussing lake level trends over the last 2,000 years, Larsen contends that climatic perturbations (including evaporation and precipitation rates) are responsible for:

> *"a complex record of episodic lake-level changes that lasted between 200 and 300 years and that fluctuated with an amplitude of 1 to 2 m above the apparent mean lake level (Larsen 1985b: 96)."*

Ultimately, Larsen is suggesting that changes in Great Lakes water levels through time is not just a product of tectonic dynamics, nor outlet downcutting; but, also involves climate-related activity (Larsen 1985b: 96). According to pollen profiles from Ontario, Minnesota, Wisconsin, and Michigan, a trend towards warmer and dryer conditions emerged between 12,000 B.P. - 10,000 B.P. (Haywood 1989: 61-65; Kapp 1999: 49-51; Karrow and Warner 1990: 33). It is between 10,000 B.P. and 8,000 B.P., however, that the most rapid and pronounced climatic changes in the region is evidenced in the pollen record (Haywood 1989: 65-69; Kapp 1999: 51-55; Ogden, III 1967: 124; Ritchie 1987: 84-85 & 136-137):

> *"The apparently abrupt replacement of conifer forest by prairie across the plains region in the early Holocene and the rapid extension eastward of the 'Prairie Peninsula' by 8,000 B.P. have been interpreted as a transition from an early Holocene that 'was slightly cooler and more moist than the late Holocene...' due to the influence of the wasting Laurentide Ice mass to the north, to a warmer, drier interior climate with steeper gradients across the interior than today [Webb, Cushing, and Wright 1983; Jacobson and Grimm 1986] (Ritchie 1987: 137)."*

Based on Pollen PAR and macrofossil analysis of *Tsuga* and *Pinus strobus* from New Hampshire, it is estimated that the mean annual temperature was 2 degrees C. warmer with 125mm lower annual precipitation during the early Holocene than at present (Ritchie 1987: 139-140). Interestingly, another, somewhat different picture is offered for southwest Ontario by Karrow and Warner who basically agree with the increased temperature trend but identify increased atmospheric moisture along a gradual continuous gradient with the driest point at about 13,500 B.P. (Karrow and Warner 1990: 33-34). By 10,000 B.P., summers were warmer and potentially longer than at present. Winters also became gradually warmer throughout the early Holocene period (Karrow and Warner 1990: 34).

In summary, it appears that the Great Lakes region experienced a warming trend throughout the early Holocene period. Yet, both glacial and pollen records indicate that the climatic change was not evenly distributed along a linear (north to south) geographic gradient. In short, it appears that humidity levels were operating differently in the inland areas of the study area as opposed to the areas bordering the upper Great Lakes. The Prairie Peninsula extends into the western regions of both Wisconsin and Minnesota by 8,000 B.P. which indicates a warmer and drier climate existed in those areas (Haywood 1989: 10, 38, & 67; Ritchie 1987: 84). Also, by 8,000 B.P., Southwestern Ontario experienced warmer temperatures combined with higher humidity levels, which gave rise to a dominant white pine community (Karrow and Warner 1990: 34). After deglaciation, the northern region appears to have exhibited a rather constant climatic trend towards the warmer and drier conditions as evidenced by the rather gradual, but persistent, penetration of the boreal forest (Haywood 1989: 10). This trend may be partially attributed to the receding, but present, glacial ice, and a shrinking Lake Agassiz. The sudden climatic change proposed by Ogden for the 10,000 B.P. period is summarily supported by a general observation that the 170 to 1,160 year time period available for pollen replacement in the upper Great Lakes paleoenvironment is too short to be reasonably explained by normal plant migration. Therefore, Ogden (1967) observes:

> *"The only mechanism sufficient to produce a change of the kind described here would therefore appear to be a rapid and dramatic change in temperature and/or precipitation approximately 10,000 years ago (Ogden, III 1967: 124)."*

In short, it appears that Ogden's 1967 observation regarding a dramatic climatic change at 10,000 B.P. is also supported by the data that has been accumulated since his publication (Cleland, Holman and Holman 1998; Haywood, 1989; Kapp 1999: Karrow and Warner 1990; Kuehn 1998: 458-459; Ritchie 1987).

As indicated above, pollen profiles provide a sensitive indicator of environmental change through time. Inasmuch as Late Paleoindians relied predominately on the distribution of natural resources across the environment for their subsistence and settlement needs, both the character and quantity of those resources was of immense significance to the development of appropriate subsistence strategies. Therefore, the next logical step in this analysis is the reconstruction of the major biotic provinces (i.e., flora and fauna) in the upper Great Lakes that are evidenced in the natural and archaeological records during the Late Paleoindian period.

Vegetation

Pollen profiles, macrofossils, and geomorphological evidence provide a reasonably accurate record depicting the formation, establishment, and change of specific flora communities through time. To the archaeologist, this record is, yet, another significant element in the environmental reconstruction of past human lifeways. There can be little credible discussion of past or present human lifeways unless there is a reasonable understanding of the structure of the environment within which they operate and upon which they rely for the development of subsistence and settlement strategies. This is not to say, for example, that because a particular species of flora was present that it was either directly or indirectly exploited by past peoples. Flora profile reconstruction, however, does provide an understanding of what was available in a given environment, and what implications its presence may have for other elements within the environment, including fauna and humankind.

For purposes of this study, the development of forests throughout the Great Lakes region during the Early Archaic will be of paramount significance. The forest reconstruction is predominately based on the pollen profiles represented at various sites across the study area (Figures 2.1-2.3) (Haywood 1989: 61; Karrow and Warner 1990: 22-26; Kuehn 1998; Ogden, III 1967: 121; Ritchie 1987: 58).

Around 11,000 B.P., glacial ice, glacial lakes, boreal forest, and tundra appears to dominate the landscape of the study region. A zone of tundra vegetation, adjacent to the western Lake Superior basin and glacial Lake Duluth, was bounded by spruce forest on the west and south, and glacial lakes and ice to the east and north (Figure 2.1). About half-way across Minnesota (east to west) and along the western edge of Wisconsin, bordering the spruce forest, a pine and deciduous forest was dominant with a spruce forest (including some black ash) to the south in Wisconsin (Haywood 1989: 63; Ritchie 1987: 84). In southwestern Ontario bordering Lake Huron, a spruce forest interspersed with open meadows and marshes (composed mostly of sedges, sage, ragweed, and grasses) dominated the landscape (Karrow and Warner 1990: 30). At Manitoulin Island, open herbaceous meadows and spruce parkland dominated the small island's vegetational composition from the time of its deglaciation throughout the duration of Main Lake Algonquin (Karrow and Warner 1990: 31). Lower Michigan was most representative of a boreal forest with a mosaic of open spruce parkland with some red/jack pine and cold-tolerant deciduous elements present in the lower latitudes (Figure 2.1) (Cleland, Holman and Holman1998: 16-17; Holman, Fisher, & Kapp 1986: 435-439; Shoshani, Wright, and Pilling 1990: 14-15).

By 10,000 B.P., rapid changes in the flora composition are evidenced in the natural and archaeological records of the upper Great Lakes south of the Lake Superior region with a general shift from boreal and tundra vegetation to a mix between a "north temperate: pine", and a "temperate: deciduous", forest composition (Figure 2.2) (Holman, Fisher, & Kapp 1986: 435-439). Still, the boreal spruce forest and tundra persisted in the Lake Superior basin where the Marquette readvance of the Superior Lobe had refilled the basin with ice (Farrand and Drexler 1985: 21; Haywood 1989: 65;). It is at this point in time that a divergence in the vegetational composition in the study area between the tundra/boreal forest area surrounding Lake Superior, the pine forest of Manitoulin Island, and the more temperate deciduous/pine of central/southern Wisconsin, Lower peninsula of Michigan, and southwestern Ontario becomes most evident (Figure 2.2) (Cleland, Holman, and Holman 1998: 17-20; Haywood 1989: 65; Holman, Fisher, & Kapp 1986: 435-439; Kapp 1999; Karrow and Warner 1990: 31; Shoshani, Wright, & Pilling 1990: 15). It is noted that Manitoulin Island, however, was once again dominated by spruce forest by 9,900 B.P. which lasted until 8,580 B.P. when white pine arrived (Karrow and Warner 1990: 31).

By 9,000 B.P. the spruce forests (except for northern Lake Superior, Manitoulin Island, and the Bruce Peninsula in Ontario) were replaced throughout the study region by a mixed pine and deciduous forest composition (Haywood 1989: 66; Karrow and Warner 1990: 29; Ritchie 1987: 84-85). A more common pollen profile is also evidenced along similar latitudes, except that a prairie savannah vegetation zone is emerging in the western area of Minnesota and some spruce forest remains present in the northernmost reaches of Lake Superior (Figure 2.2). Typically, the southernmost region of the study area, from Wisconsin to Ontario, exhibits the widest range and greatest quantity of deciduous species, which generally diminishes towards the northern limits of the study area with pine dominating the forest profile throughout the region (Haywood 1989: 10; Karrow and Warner 1990: 29; Ritchie 1987: 85).

After 8,000 B.P. a temperate deciduous forest belt is evidenced in western Minnesota and Wisconsin which is bounded by prairie to the west and pine and a dominant pine/deciduous forest to the east, north, and south (Figure 2.3) (Haywood 1989: 10&67; Ritchie 1987: 84). Pine/deciduous forest was present in the Lake Superior basin and in the Georgian Bay area with a weakly developed deciduous element (Haywood 1989: 10; Karrow and Warner 1990: 31; Ritchie 1987: 85). Southern Wisconsin, lower Michigan, and southwestern Ontario becomes more a closed deciduous/pine forest with many nut-bearing tree species and sugar maple present. There is little change in the forest compositions recorded after 7,500 B.P. when "hickory, basswood, and walnut" arrived (except for the arrival of the chestnut much later) (Ellis , Kenyon and Spence 1990: 68; Karrow and Warner 1990: 30).

Fauna

Significantly, by around 9,700 B.P., the archaeological and natural records indicates that in the southern region of the study area the more closed mixed pine and deciduous forest provided a suitable habitat for such woodland fauna as "shrew, muskrat, eastern cottontail, white-tailed deer, woodland caribou, elk, and moose" as well as the Early Archaic woodland groups who had immigrated from the deciduous woodlands of the east and south (Shoshani, Wright, and Pilling 1990: 14). Yet, at the same time in the northern climes of the study area, the dominant tundra and open spruce forest was occupied by caribou, bison, and moose, as well as those human groups whose settlement and subsistence strategies were intimately tied to this sparse environment as well as that of the western plains, i.e., the Late Paleoindian Plano groups. Further, there is recent archaeological evidence for dramatic increases in faunal species richness for the western Lake Superior region during the 10,000 B.P. to 8,000 B.P. period (Kuehn 1998). Therefore, the next environmental element of interest in this study is that of the faunal resources that were available during the early Holocene and, more precisely, the Early Holocene period.

The faunal record of the Early Holocene in the upper Great Lakes region is generally characterized by the initial immigration of the smaller and more diverse woodland species and the extinction and/or further northward migration of some of the more robust, gregarious cold-adapted species associated with the preceding open spruce forest and tundra habitat (Butzer 1971: 506-507). This trend in fauna distribution closely approximates the distribution of biotic provinces in the upper Great Lakes, both through time and across space during the Early Holocene period.

Briefly, as the warming trend continued throughout the Early Holocene, the glacial ice rapidly retreated to the north allowing the more closed temperate forest to quickly migrate northward. This provided the woodland fauna access to newly formed closed deciduous forest environments and the deciduous/pine ecotones now present and expanding in the southern and western areas of the upper Great Lakes region. The deglaciation in the northern area of the upper Great Lakes, however, was much slower (by about 2,000 years) than that of the southern reaches of the study area (Farrand and Drexler 1985: 23; Larsen 1985a: 26). Consequently, an obvious discordance developed between the faunal profiles that were present through the Early Holocene period in the northernmost area of the region and those of the southern area of the region.

Interestingly, however, the rather broad belt of mixed pine and deciduous forest that developed between the open spruce parkland in the north and the closed deciduous forest of the south and west (Figures 2.1-2.3) appears to have acted as an ecotone producing a clinal effect between woodland, prairie, and boreal faunal species from south, west, and north (respectively) that were populating the landscape of the upper Great Lakes region during the Early Holocene period.

Before providing further information on faunal resources of the Early Holocene period, it is necessary to stipulate that fish are not included within the scope of this study as a scheduled subsistence resource for the Late Paleoindian populations in the upper Great Lakes region. While it has been implied by several authors that fish resources were available to, and even exploited by, Early Archaic and Late Paleoindian populations in the Great Lakes region (Ellis, Kenyon, & Spence 1990: 68; Haywood 1989: 6&9; Holman, Fisher, and Kapp 1986: 443; Kuehn 1998: 461; Mason 1981: 131-132), there is no direct archaeological evidence for a fishing technology among Late Paleoindians of the upper Great Lakes (Cleland 1982: 768). This lack of evidence may be due to differential preservational processes in the archaeological record. Late Paleoindian peoples were certainly capable of possessing a fishing technology; however, this conjecture does not militate against the need for direct evidence for any assertions of fact in this study. Therefore, I have elected to refrain from developing a fishing hypothesis in this study. Perhaps, as is the case in many archaeological queries, the evidence remains buried and continues to elude discovery.

Unfortunately, the combination of extensive elapsed time, generally acidic and, in some areas of glacial scouring, poorly developed soils, and archaeological recovery techniques (i.e., insufficient screening, flotation) have contributed to poor preservation/recovery of faunal remains, thereby impacting the faunal record recovered from the early Holocene period. Also, given the lower lake levels of Chippewa and Stanley during this period, it is possible that a great many LPI sites are submerged under Lakes Huron and Michigan. Therefore, it is most likely that the record that has been established reflects neither the true quantity nor "species richness" (i.e., "...the number of species in a sample area" [Meltzer and Smith 1986: 7]) of the actual range of fauna that populated the region, especially in the pine/deciduous ecotones which most likely occupied a large part of the Lake Michigan and Lake Huron Basins, and the western edges of Minnesota and Wisconsin during most of this period (Figures 2.1-2.3). In constructing general and reasonable expectations for "species richness" in the Early Holocene environment of the upper Great Lakes, it is suggested that:

> *"The net result is that high latitude, highly seasonal, and environmentally unpredictable environments have large numbers of a very few species (Meltzer and Smith 1986: 6)."*

In the northern and western Lake Superior region, caribou, bison, and moose remains have been identified which post-date the Marquette readvance (10,000 B.P.) and which appear to be the dominant faunal species of that region throughout a significant portion of the Early Holocene period (Haywood 1989: 11&70; Jackson 1989: 72-74; Julig 1984; Shay 1971). Yet, recent archaeological evidence at the Deadman Slough site (47PR46) and Sucices site (47DG11) of northern Wisconsin indicates significantly more faunal diversity, with a clearly woodland-adapted character, was present during this period than has been previously considered (Kuehn 1998: 458). Reviewing the faunal profiles from both of these sites we find the remains of white-tailed deer, porcupine, black bear, painted and box turtles, bird, mussel, fish, and beaver (Kuehn 1998: Tables 2 and 3). Given the foregoing expectations as provided by Meltzer and Smith (1986), these faunal profiles appear to be conflicting in species richness. Yet, Meltzer and Smith's (1986) model assumes some dominant level of environmental homogeneity, based on latitude, which is not an unrealistic expectation for rather fixed or static conditions. The highly variable and unstable environmental conditions that were operating in the large and patchy ecotonal areas of the upper Great Lakes region during the Early Holocene, however, did provide opportunities for the developing microhabitats to display tremendous variation in species richness and all within a relatively common latitude.

Therefore, given this faunal profile, along with the vegetational profile provided earlier, it is also reasonable to assume that all these fauna could have been components of the subsistence and settlement strategies among Late Paleoindian groups of the northern upper Great Lakes region. Additionally, the lithic tool assemblages of the upper Great Lakes Late Paleoindians also appear to support a highly mobile, meat-intensive subsistence and settlement strategy early in the Early Holocene period with changes in the tool hafting styles evidenced in later assemblages of these LPI groups (Ellis and Deller 1990: 63; Frison 1974; Frison and Stanford 1982; Mason 1981: 112; Mason and Irwin 1960: 55; Ritzenthaler 1972; Salzer 1974; Wheat 1972).

The character of the vegetation and faunal profiles in the southern regions of the study area appears to be much more uniformly diverse when compared to the northern profile during the period between 10,000 B.P. and 8,000 B.P.. In southern Wisconsin, Michigan, and Ontario accompanying the northward migration of the deciduous forest, there is a definite immigration of woodland associated fauna species (Ellis, Kenyon and Spence 1990: 68; Kuehn 1998; Mason 1981: 131; Shoshani, Wright, & Pilling 1990: 14).

Prairie fauna species of Bison occidentalis or antiquus of the early Holocene period exists in west central Wisconsin (Boszhardt 1993: 7) and northwestern Minnesota (Shay 1971:29-30). Woodland fauna species were also present in northern Wisconsin, southern Ontario, and southern Michigan during the early Holocene period (Ellis, Kenyon, and Spence 1990: 68; Shoshani, Wright, and Spence 1990: 14; Kuehn 1998: 458).

In summary, the faunal profiles of the Early Holocene appear closely aligned with that of the vegetation profiles in terms of species richness. Specifically, the sparser northern climes had fewer faunal species; whereas, the deciduous forests of the southern areas had greater floral and faunal resources. Based on observations of the differing toolkits used by Late Paleoindian and Early Archaic groups, it is apparent that differing subsistence and settlement strategies were also operating between these groups. Additionally, there is archaeological evidence that the upper Great Lakes Late Paleoindian culture was not isolated from its Early Archaic contemporaries in southern regions which is discussed further in Chapters 3 and 5 (Buckmaster and Paquette 1988; 115; Mason and Irwin 1960: 54; Greenman 1943; Greenman and Stanley 1942).

Conclusions

Based on the ecological reconstruction provided in this chapter it is apparent that the period between 10,000 B.P. and 8,000 B.P. was one of dramatic change in the natural environment of the upper Great Lakes region. Glacial, geologic, and water budget dynamics drastically reduced water levels in the Lake Michigan and Lake Huron basins exposing land masses not available for human occupation either before or after the early Holocene period. A trend toward relatively warmer temperatures, accompanied by geographically variable humidity levels, had a profound impact upon the distribution and composition of floral and faunal communities within the region, and also contributed to development of a large ecotone within the area.

These changes, then, are significant to LPI groups whose economic strategies need to consider such basic concerns as resource abundance, reliability, and predictability. Additionally, there are the social considerations of the impacts of shifting and new population pressures by both different LPI groups immigrating into the newly opened biomes of the region, as well as the initial arrival and increased population trajectories of woodland-associated Early Archaic groups in the southern areas of the region throughout the 10,000 B.P. to 8,000 B.P. period.

CHAPTER 3

LATE PALEOINDIANS

Introduction

Of most significance to this study are the changes through time in the Late Paleoindian subsistence and settlement systems that were likely necessitated by the changes in the character and distribution of natural and social resources during the Early Holocene in the upper Great Lakes region. Therefore, considering the extensive and complex variation in the natural and archaeological records of the upper Great Lakes region, an objective approach to assessing the implications of these conditions on LPI settlement, subsistence, and mobility systems is applied. To this end, this chapter describes the cultural systems of the upper Great Lakes Late Paleoindians through a cultural ecological framework employing the available natural, archaeological, and ethnographic records. Whereas, a more general ecological approach is employed in Chapters 4 through 6 which reveals further patterns in LPI social interaction, exchange, and mobility through intensive study of the lithic projectile lanceolates of these early prehistoric peoples.

The upper Great Lakes Late Paleoindian material culture has been typologically associated with the western plains Plano tradition, which is most densely expressed in the archaeological record during the period between 10,000 B.P. and 8,000 B.P. (Buckmaster and Paquette 1988; Clark 1989; Cleland and Ruggles 1993; Ellis and Deller 1990; Frison 1974; Fox 1975; Frison and Stanford 1982; Haywood 1989; Jennings 1974; Justice 1987; Lee 1955; Mason 1981; Mason and Irwin 1960; Reid 1980; Ritzenthaler 1972; Ross 1992; Salzer 1974; Wheat 1972). In short, the lithic projectile points that are directly associated with Late Paleoindian tradition are categorically described as a wide array of non-fluted lanceolates which normally display fine collateral and/or transverse parallel pressure-flaking patterns, lateral and basal edge grinding, and include stemmed and unstemmed varieties (Figure 4.1) (Ellis and Deller 1990: 57; Irwin and Wormington: 28-29; Jennings 1974: 109-124; Justice 1987: 30-50).

The upper Great Lakes Early Archaic woodland-associated sites are also weakly represented in the known archaeological record of the upper Great Lakes. These sites are easily recognized by the notched projectile point types and the greater diversity in both formal and informal tool assemblages, which are thought to be derived from the resource-rich woodland habitats inhabited by these populations. As discussed in Chapter 1, there is ample archaeological evidence that these two cultural traditions, LPI Plano and woodland Early Archaic, were occupying the upper Great Lakes region at the same time. And, there is further evidence of a clear disparity between terminal LPI (9,500 B.P.) for the southwestern Ontario area adjacent to the southern limits of Lake Huron (Ellis and Deller 1990: 55) and northwestern edge of Lake Superior at 7,000 B.P. (Salzer 1974: 45), or 8,000 B.P. as suggested by others (Ross 1995: 249). Given lake level fluctuations of more than 400 feet during the Early Holocene period in the Lake Michigan and Lake Huron basins, as discussed in Chapter 2, it is not unreasonable to suggest that many sites of this period are presently submerged and inaccessible. Therefore, the lack of a substantial archaeological record from this period is not unexpected. Still, the material record that does exist for the Early Archaic tradition in the upper Great Lakes indicates a distinct affinity with the Early Archaic side-notched, corner-notched, and bifurcate lithic projectile points of the eastern woodlands and western plains (Ellis, Kenyon and Spence

1990: 70; Mason 1981: 128-129; Mason 1986: 192-193; Shay 1971: 52-58; Shoshani, Wright and Pilling 1990: 1; Storck 1978: 25-46).

The "Late Paleoindian" designation is laden with two very significant meanings. First, it is the common view that Late Paleoindian lifeways very closely approximated that of their antecedents, the Early Paleoindians (Ellis and Deller: 62-63; Fitting 1975; Mason 1962: 233; Mason 1986; 192). Both cultures are characterized as highly mobile, small egalitarian groups whose subsistence and settlement strategies were heavily influenced by the distribution of faunal resources (e.g. bison, caribou and moose) across the landscape, which were abundant on the plains and near the ice margins during this period (Meltzer and Smith 1986: 20). Second, that Late Paleoindian subsistence and settlement strategies are indicative of a different environmental adaptation than that of their Early Archaic contemporaries in the adjacent eastern and southern woodlands. Specifically, the Early Archaic woodland strategies are generally more diverse and exhibit a greater reliance on floral resources and a wider array of choices of faunal resources, both of which are associated with deciduous woodland habitats wherein this culture, with its more diverse lithic assemblage, is thought to have developed and flourished (Caldwell 1965: 67; Meltzer and Smith 1986: 20; Smith 1986).

It is recognized that Late Paleoindian and Early Archaic groups exhibited distinctly different but contemporary subsistence and settlement strategies, and material culture, which is significant to reconstruction of the ecological systems that operated in the upper Great Lakes region during the Early Holocene period. As discussed in Chapter 2, culture, as adaptation, is necessarily interwoven within the fabric of specific ecological systems. Consequently, the material remains of a culture can provide insight into both the character of the ecological system, as well as the various means by which a culture likely operated as an element within that system.

Presently, in the upper Great Lakes region, archaeological evidence reveals contemporaneous occupation by both Late Paleoindian and Early Archaic groups along the southernmost boundaries of the study area (Figure 1.1). Along with this co-residence pattern emerges the possibility of inter-culture contact (Buckmaster and Paquette 1988: 115; Mason 1960: 54; Mason 1986: 198). Also, as discussed in Chapter 2, accompanying this co-cultural phenomenon were relatively rapid and dramatic changes in the natural environment which can be said to characterize the duration of the Early Holocene period (10,000 B.P. and 8,000 B.P.) (Buckmaster and Paquette 1988: 115 & 121-122; Ellis, Kenyon and Spence 1990: 79; Fitting 1970; Greenman 1943: 260-265; Kuehn 1998; Lee 1954: 101-111; Mason and Irwin 1960: 54-55; Shoshani, Wright and Pilling 1990: 1).

Significantly, while the LPI and Early Archaic groups in this study are cited as occupying that time frame between 10,000 B.P. and 8,000 B.P., it is not intended to imply that these cultures did not exist either before or after the 2,000-year period. It is viewed, however, that this Early Holocene period does embody the dominant archaeological expression of these cultures. Therefore, it is appropriate to next discuss the specific chronology of the upper Great Lakes as constructed from the archaeological and natural records.

Upper Great Lakes LPI Chronology

The Late Paleoindian occupation of the upper Great Lakes is a source of much debate within the archaeological community of the region. While common usage of the term "Late Paleoindian" within this region's archaeological community has been in reference to a specific cultural tradition, proposed to have predominately derived from the Plano phase of the western plains, the term has also been used to delineate a specific time period in prehistory which generally extends from 10,500 B.P., in the western plains, to between 8,000 B.P. and 7,000 B.P., in the upper Great Lakes region (Cleland and Ruggles 1996; Ellis and Deller 1990:55; Fitting 1970; Frison and Stanford 1982: 178-180; Gryba 1980: 60: Haywood 1989: 12; Justice 1987: 30-50; Mason 1981: 112; Ross 1992: 3; Salzer 1974: 45). Although relative dating indicates an upper Great Lakes Late Paleoindian occupation between 10,400 B.P. to 7,000 B.P. (Ellis and Deller 1990: 55; Salzer 1974), there are no corroborating absolute dating (e.g., 14_{c}) for this time period (Ellis and Deller 1990: 44 & 55; Ellis, Kenyon and Spence 1990: 68-69; Mason 1986: 201; Ross 1992: 3;).

Therefore, in accordance with the accepted absolute dating chronologies of the western plains LPI sites, which also represents all the type sites for LPI Plano materials, I have elected to restrict the body of this study to the period intervening between 10,000 B.P. and 8,000 B.P., with the assumption being that the greatest amount of Late Paleoindian activity presently known in this region transpired within this time frame. Still, the specific chronology for the upper Great Lakes region, as supported by site data, needs to be reviewed for insights into the chronological record and the variously proposed cultural phases, complexes, and composites for the region of the Late Paleoindian occupation during the Early Holocene period.

Several problems have continually hampered attempts to construct a well-informed chronology for the upper Great Lakes region during the Early Holocene period. As has been previously discussed, poor site and material preservation, low population densities coupled with high mobility, fluctuating lake levels, and past limited archaeological research, have collectively contributed to a rather sparse archaeological record for the Early Holocene period in the upper Great Lakes region (Ellis and Deller 1990: 54; Ross 1992: 3-4). Fortunately, however, adequate archaeological evidence has accumulated since to provide a general chronology of the period using relative dating techniques based in geochronology and lithic projectile typologies and some meager direct dating by radiocarbon.

It should be noted that this study concentrates geographically on the area north of the lower limit of Lake Huron on the eastern side and just south of Green Bay, Wisconsin on the western side, to the northern areas surrounding Lake Superior. This is not to say that natural and cultural developments adjacent to the study region are not of any consequence to this study. In fact, these developments in the adjacent areas are especially significant in understanding the peripheral influences affecting upper Great Lakes LPI lifeways. Consequently, it will be noted that references will sometimes include archaeological sites both from within the defined study region (Figure 1.1) as well as the area immediately adjacent to the region.

The range of dates given in specific site reports has led to a rather extensive time range (i.e., 3,400 years) for the occupation of this region by Late Paleoindian and Early Archaic groups, with a time span that extends to 4,000 years for areas adjacent to the upper Great Lakes region (Caine 1974 : 57; Cleland and Ruggles 1993; Ellis and Deller 1990: 44 & 55; Ellis, Kenyon and Spence 1990: 67-69; Fitting 1963: 96; Haywood 1989: 12-14; Mason 1962: 236; Mason and Irwin 1960; Pettipas and Buchner 1983: 437; Ross 1992: 3; Salzer 1974: 45; Shay 1971: 1; Shoshani, Wright and Pilling 1990: 8-13;

Wright 1972a: 13). Yet, all upper Great Lakes region dates that are in direct association with Late Paleoindian/Early Archaic cultural material are within the 2,000-year time period intervening between 10,000 B.P. and 8,000 B.P. This disparity in time frames for the upper Great Lakes Late Paleoindian and Early Archaic occupation is principally the result of inferences derived from western plains Plano tool typologies and associated 14_c dates (Wheat 1972; Frison 1974; Frison and Stanford 1982; Frison and Todd 1987; Irwin-Williams, Irwin, Agogino and Haynes, Jr. 1973), and upper Great Lakes geochronological evidence and associated site locations (Anderton 1993; Chapman and Putnam 1984; Cowan 1985; Farrand and Drexler 1985; Larsen 1985; Leverett and Taylor 1915). Typically, for sites in the upper Great Lakes, unless direct evidence is available for absolute dating of an archaeological site, the lithic tool typology has been used to establish the cultural affiliation and, hence, relative time frame of the site's occupation. Then, more site-specific relative data is used (such as geochronological dating of glacial lake beach ridges), along with evidence from other sites in the region, to refine this chronology.

Based on the foregoing information, it appears that the Late Paleoindian and Early Archaic cultural traditions are evidenced most in the archaeological record of the upper Great Lakes during the 2,000-year period intervening between 10,000 B.P. and 8,000 B.P..

As a further point of clarification, following the pressure-flaked tool tradition of Late Paleoindians in the northern regions was a percussion-flaked lanceolate tool tradition referred to by some as the Shield Archaic (Pollock 1976; Wright 1972b;). It should be noted that the "Shield Archaic" has been the subject of some criticism including the duration (about 5,000 years), the geographical distribution (from the Keewatin District to Labrador along the Canadian Shield; about 3,000 miles), as well as the "Shield Archaic" as a properly defined tradition (Hanna 1980: 86). Yet, there does appear to be some agreement that in the upper Great Lakes region, at least, that the identified percussive tool tradition of the "Shield Archaic", as a technological tradition, is expressed and most likely derives from the Plano tool tradition of the antecedent Late Paleoindians (Wright 1972b).

Therefore, with reference to this study, the Shield Archaic is recognized as that tradition which immediately succeeds the Late Paleoindian tradition between at about 8,000 B.P. and for the area along the northern shore of Lake Superior and in the adjacent regions south of, and east along, the Canadian Shield in the upper Great Lakes region (Wright 1972b).

It appears reasonable to assert that by 8,000 B.P. the general environmental character of the southern and central portion of the study area had changed sufficiently from a spruce/tundra composition to a pine/deciduous mosaic forest that a transformation in regional LPI settlement, subsistence, and mobility strategies was possible. This change, then, could accommodate the increased range of diversity in both floral and faunal resources, as well as increased population pressures from the immigration of both plains and woodland groups. Further, it is significant to remember that it is also at about this time that the onset of the warmer/drier conditions of the Altithermal is providing climatic conditions conducive to the eastward migration of the prairie into the western edges of the study region (Figure 2.3) (Shay 1971). Additionally, there is archaeological evidence of a shift in the subsistence and settlement patterns of this region by 8,000 B.P..

This is further demonstrated by the change in the character of lithic tool assemblages found in the archaeological record of the woodland-adapted Early Archaic groups, as well as the succeeding Middle Archaic groups (8,000 B.P. to 5,000 B.P.) in the northern, southern, and central areas of the study region (Fowler 1959; Gryba 1980).

As can be seen, the chronology of the upper Great Lakes is complex as it involves populations with differing subsistence and settlement strategies inhabiting a large and patchy developing ecotone between the deciduous forests of the south and east, the prairie of the west, and the spruce/tundra of the far north.

Interestingly, the contemporaneity of the Late Paleoindian and Early Archaic groups within the same geographic region, and the persistence of their respective tool traditions through the early and middle parts of the Early Holocene period, indicates that the environment may have provided for a regional subsistence and settlement practice during that time where both groups could persist in their respective traditional lifeways without significantly diminishing or impacting the socioeconomic base of the other. The continued northward migration of deciduous forest, and eastward migration of the prairie towards the end of the Early Holocene period, however, apparently resulted in the gradual northward immigration of woodland adaptations as evidenced in the slightly mixed assemblages (i.e., lanceolates and notched points) of predominately Late Paleoindian groups (Buckmaster and Paquette 1988; Mason and Irwin 1960; Shay 1971). Additionally, in the upper Great Lakes, it is noted that while there is evidence for the notched points of Early Archaic affiliation within Late Paleoindian assemblages, there is no indication of a Late Paleoindian lanceolate component within Early Archaic woodland assemblages. Specifically, presently, there are no known directly associated mixed Plano lanceolate and Early Archaic notched points assemblages wherein the Early Archaic notched points dominate and the LPI lanceolates are even slightly represented. These observations, then, also support the assertion that the continued lanceolate tradition of the subsequent Shield Archaic derived from the last vestiges of the Plano tradition of Late Paleoindians, as suggested by Wright (1972b).

Unlike Wright (and others), however, I suggest that the transition from Late Paleoindian to the Shield Archaic in the north, and Middle Archaic in the east, south, and west, was effectively initiated by 8,000 B.P. (Caine 1974; Haywood 1989; Salzer 1974; Wright 1972a & 1972b). This is not to say that there may not be some temporal overlap between individual elements of these respective traditions. However, I do not agree with Salzer's assertion that the Late Paleoindian tradition, as such, firmly extended another 1,000 years later, to 7,000 B.P., in the upper Great Lakes region.

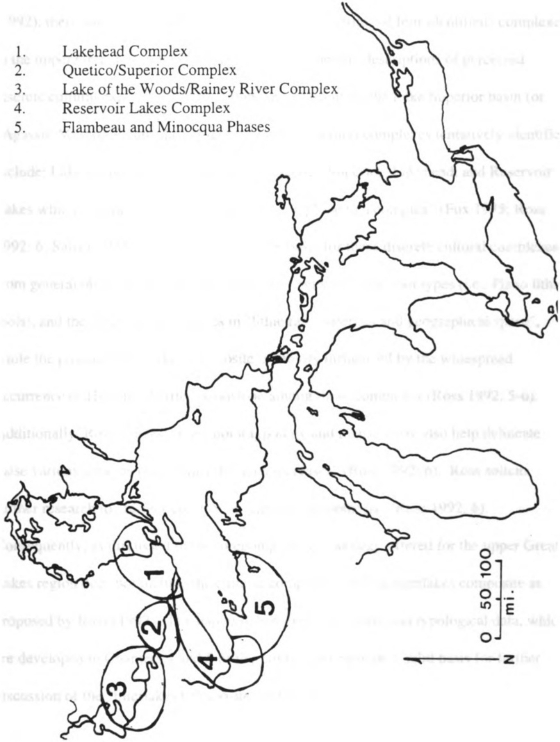
In further evidence for a terminal date of 8,000 B.P. for the Early Holocene period in the upper Great Lakes region, the following observations are offered: First, as previously discussed, there is a genuine lack of direct archaeological evidence to support a proposal for a distinct Late Paleoindian occupation of the upper Great Lakes region beyond the 2,000-year period intervening between 10,000 B.P. and 8,000 B.P.; second, by 7,000 B.P., pine and deciduous forest elements dominate the pollen profiles of the entire region from the southern limits of the study area to the north shore of Lake Superior, suggesting that a more diverse ecological system was operating throughout the region, which would not have been as productively exploited by a plains adapted lithic toolkit as compared to the woodland adapted assemblages of the Early and Middle Archaic woodland groups (Kuehn 1998); and finally, if Late Paleoindians are still operating in the upper Great Lakes, then the highly diverse Middle Archaic lithic tool tradition (8,000 B.P. to 4,500 B.P.) is being contemporaneously expressed for 1,000 years in the central, southern, eastern, and western areas of the upper Great Lakes region along with development of a distinct deciduous forest in the areas east, south, and west of the region (Ellis, Kenyon and Spense 1990; Fowler 1959; Gryba 1980).

Given the foregoing information, it is my interpretation that while populations using lanceolate points continued to inhabit the northernmost areas of the region after 7,600 B.P., they were no longer definable as Late Paleoindian in either their cultural tradition or ecological system; they were the Shield Archaic in the north, and the Middle Archaic in the south.

Figure 3.1 Map of Interlakes Composite (After Ross 1992)

Legend for Figure 3.1 (inter lakes composite)

1. Lakehead Complex
2. Quetico/Superior Complex
3. Lake of the Woods/Rainey River Complex
4. Reservoir Lakes Complex
5. Flambeau and Minocqua Phases



The final element in the development of an upper Great Lakes chronology is a discussion of the record of proposed cultural complexes. In a paper authored by Ross (1992), there was a proposal for an "Interlakes Composite" of four identified "complexes" in the upper Great Lakes which were defined by specific descriptions of perceived discrete cultural expressions both within, and adjacent to, the Lake Superior basin (or "Agassiz-Minong Peninsula") (Figure 3.1). The cultural complexes tentatively identified include: Lake of the Woods/Rainey River; Quetico/Superior; Lakehead; and Reservoir Lakes which "upgrades Reservoir Lakes from a phase to a complex" (Fox 1975; Ross 1992: 6; Salzer 1974; Steinbring 1974). The basis for these discrete cultural complexes is from general observations of both, similarities between lithic tool types (i.e., Plano lithic tools), and the observed differences in "lithic raw materials and geographical space", while the proposed interlakes composite is heavily influenced by the widespread occurrence of Hixton Silicified Sandstone among these complexes (Ross 1992: 5-6). Additionally, Ross suggests that "point typology and metrics may also help delineate these various areas as our comparable data increases" (Ross 1992: 6). Ross solicits further research to "further confirm or reject this hypothesis" (Ross 1992: 6). Consequently, as discussed in the foregoing, the chronology offered for the upper Great Lakes region does not include the cultural complexes and the interlakes composite as proposed by Ross (1992). In Chapter 6, however, the metric and typological data, which are developed in Chapters 4 and 5 of this study, does provide a solid basis for further discussion of the "Interlakes Composite" in Chapter 7.

Western Plains Plano Sites

The general consensus among the archaeological community of the upper Great Lakes region is that the Late Paleoindian Plano lithic tool assemblage first developed among populations of the western plains region, and whose material culture diffuses northward and eastward as the Wisconsinan ice sheet retreats to the north. The significance of this relationship is consistently demonstrated by the relative dating through lithic tool typologies, which is an inherent characteristic of all upper Great Lakes Late Paleoindian site and regional chronologies (Buckmaster and Paquette 1988; Clark 1989; Cleland and Ruggles 1993; Ellis and Deller 1990; Fitting 1975; Fowler 1959; Fox 1975; Frison 1974; Frison and Stanford 1982; Greenman 1943; Haywood 1989; Irwin-Williams, Irwin, Agogino and Haynes 1973; Julig 1984; Mason and Irwin 1960; Mason 1981; Quimby 1966; Reid 1980; Ritzenthaler 1972; Ross 1992; Salzer 1974; Wheat 1972). Consequently, certain information from western plains Plano sites, which are directly relevant to this study, is provided in the following discussion.

The Plano tool complex includes several lithic point types that provide the typological foundation for this study (Figure 4.1). These lanceolate points are variously classified as Agate Basin (including the Angostura, Midland, and Samel's variants), Plain View, and Hell Gap lanceolates, and the Cody complex Scottsbluff (including the Great Lakes variants), and Eden stemmed lanceolate points (Barbour and Schultz 1932; Dick and Mountain 1960; Frison 1974; Frison and Stanford 1982; Irwin and Wormington 1970; Jennings 1974; Justice 1987; Krieger 1947; Wheat 1972; Wormington 1957). Additionally, the plains Plano culture is widely associated with bison hunting on the western plains.

The Plainview lanceolate, named after the Plainview site on the high plains of Texas, has been radiocarbon dated from well stratified sites on the plains to a date of about 10,000 B.P. (Justice 1987: 30):

> *"This is a lanceolate form with a shallow concave base and heavy basal grinding. The blade form varies from parallel-sided to recurvate. The flaking pattern ranges from collateral to transverse parallel with an irregular flake scar pattern being most typical (Justice 1987: 30)."*

The Agate Basin lanceolate, named after the Agate Basin site on the western plains of Wyoming, has been radiocarbon dated from well stratified sites on the plains that have produced a range that dates from about 10,500 B.P. to 9,400 B.P. (Frison 1974; Frison and Stanford 1982; Irwin-Williams et al. 1973; Justice 1987):

> *"This is a long, slender, lanceolate form with horizontal parallel pressure flaking across the blade and fine marginal retouch along the edges....The blade shape varies from parallel-sided to slightly excurvate. Maximum width of the blade occurs at the midline or between the midline and tip. The cross section is biconvex. In all variations of blade shape, nearly perfect bilateral symmetry is maintained. The blade constricts toward the base in all dimensions, and lateral grinding demarcates the haft region. Certain specimens of the type possess rounded basal features suggesting a nearly bi-pointed appearance. Slightly concave basal edges appear to be fairly common (Justice 1987: 33)."*

The Hell Gap lanceolate, also from Wyoming, has been radiocarbon dated in a stratified matrix to between 10,000 B.P. and 9,500 B.P. at the Hell Gap Site, and 10,000 B.P. at the Casper site, and 10,500 B.P. at the Agate Basin site (Frison 1974; 108; Frison and Stanford 1982: 179; Irwin-Williams, Irwin, Agogino and Haynes 1973). Justice includes Hell Gap as a morphological variant of Agate Basin points which, presumably, implies the same time frame for its use, i.e., 10,500 B.P. to 9,400 B.P. (Justice 1987: 34-35). Additionally, Irwin and Wormington (1970) in comparing components of various Paleoindian lithic assemblages (including projectile points, side scrapers, raclettes, end scrapers, drills, burins, knives, notches, groovers and perforators, and denticulates), noted a distinct grouping of the Agate Basin and Hell Gap assemblages; thereby, providing further diagnostic evidence of an Agate Basin/Hell Gap affiliation (Irwin and Wormington 1970: 33). Therefore, in the western plains, the time frame of 10,500 B.P. to 9,400 B.P. appears to be applicable to the Hell Gap point:

> *"Points with such a marked basal constriction that they may be considered essentially stemmed. Length: range 5 to 16 cm; average 9 cm. Bases are straight or slightly convex. Flake scars are relatively broad and rarely parallel (Irwin and Wormington 1970: 29)."*

At the well-stratified Hell Gap site in northeastern Wyoming, a time range for the Scottsbluff and Eden complex has been dated between 8,800 B.P. and 8,400 B.P. (Irwin-Williams et al. 1973; Justice 1987: 47).

> *"Scottsbluff projectile points are distinctive lanceolate straight stemmed forms that characteristically exhibit a transverse parallel flaking pattern across the elongated blades....Type I points possess triangular or parallel-sided blades with weak shoulders and broad stems. The flaking pattern is usually a transverse parallel but is at times more irregular. The cross section is a symmetrical biconvex shape. Type II are essentially the same except that they have wider triangular blades and have thin lenticular cross sections with more clearly defined shoulders....In addition, a Scottsbluff III variant [Satterthwaite 1957: 12-17] is also within range of variation described above [Wheat 1972: 141-142]. Slight basal ears are present on certain specimens of the type in Wisconsin [Ritzenthaler 1967: 15] (Justice 1987: 46-47)."*

> *"Eden style projectile points [Wormington 1957: 124-126, 267] closely resemble Scottsbluff in overall form and flaking quality. However, Eden points are very narrow and often have only very slight shoulders [Figure 10]. In the extreme, these shoulders can be so minute that pronounced lateral grinding may largely account for the juncture between stem and blade which is probably a result of resharpening. Eden points, like Scottsbluff, exhibit collateral or transverse parallel flaking patterns on the blades. However, the narrow width in conjunction with a diamond-shaped cross section and often pronounced median ridges are attributes lacking on the Scottsbluff type. The haft region is characterized by straight lateral margins and a straight to slightly convex basal edge. Full haft grinding is typical. Slight basal ears occur on certain specimens in Wisconsin*

[Ritzenthaler 1967: 16] resulting in an eared variant which apparently does not exist on the Plains (Justice 1987: 49)."

For purposes of this study, and in accordance with Justice (1987), the unshouldered Midland lanceolate point which dates to about the 10,000 B.P. time period will be included as a temporal correlate of the Agate Basin point (Justice 1987: 34-35). Also, as a later variant of the Agate Basin, and as a initial pseudo-shouldered projectile point type, Hell Gap is considered in this study as a later development in the upper Great Lakes LPI tradition and included in the shouldered category of lanceolates. The small quantity of Early Archaic notched points included in this study are briefly discussed in Chapters 5 and 6, and recorded in Appendix A, Table A.1-1. Neither Holcombe nor Hi-Lo points are present in any of the material assemblages in this study and are considered both temporally and geographically outside the boundaries of this study's universe.

Lithic Raw Material

An interesting aspect of the lithic assemblages of upper Great Lakes Late Paleoindians is the demonstrated continued preference for specific types of raw material, a phenomenon which was also expressed by the Early Paleoindians of southwestern Ontario and lower Michigan (Ellis and Deller 1990: 43-45 and 56-57). Additionally, along with this preference, there is a distinct use of quarrying as the prevalent procurement strategy. Also, these preferences appear most pronounced in the raw material profile of the finished biface component of Late Paleoindian lithic assemblages (Arthurs 1987; Buckmaster and Paquette 1988; Clark 1989; Cleland and Ruggles 1993; Dawson 1983; Ellis and Deller 1990; Fox 1975; Greenman 1943; Haywood 1989; Julig, Pavlish and Hancock 1989; Lee 1954; Mason 1981; Mason and Irwin 1960; Reid 1980; Ritzenthaler 1972; Ross 1992; Salzer 1974). Certainly, patterns in lithic raw material usage that are readily observable in the archaeological record may be valuable in both their interpretive and predictive potential. As an example, the widespread use of one particular lithic raw material (i.e., Hixton Silicified Sandstone) has provided a basis for hypothesis construction by some regional archaeologists, where this raw material is seen as a distinct material culture marker in identifying a specific cultural Phase, a cultural Complex, and a Composite for certain groups of the upper Great Lakes region (Fox 1975; Ross 1992; Salzer 1974; Steinbring 1974). Still, these cultural constructions have yet to benefit from a uniform application of both continuous and nominal scale data in assessing issues of intergroup v. intragroup sociocultural dynamics in the upper Great Lakes region.

Research over the past 50 years has provided valuable information on the location of lithic raw material resources in the upper Great Lakes region. Also, information on quarry site locations is available for material that is exotic to assemblages in this region, such as Knife River Chalcedony from North Dakota. A list of the recognized lithic raw materials contained in the upper Great Lakes Late Paleoindian lithic assemblages, and the location of the raw material sources is provided on the map in Figure 1.1 (Chapter 1), and raw material descriptions are provided in Table 5.1 (Chapter 5). These lithic raw materials are used as a component for stylistic analysis of Late Paleoindian lithic projectile points in Chapter 5 and 6 and assessment of potential exchange systems. The conclusions in Chapter 7 provides a synthesis of the findings from Chapters 5 and 6, and the predictive potential of lithic raw material usage in investigating extinct lithic technologically-based systems such as the Late Paleoindians of the upper Great Lakes.

Since Raw Material is a significant variable considered within the stylistic and exchange analysis (Chapters 4, 5, and 6), it is important to note some considerations regarding its properties in this study. To begin, it is assumed that the hardness and fracturing properties of the lithic raw materials are sufficiently similar in this study to hold the pressure flaking effects relatively constant. The cherts, chalcedony, and jasper/taconite, are all of a sufficient similarity in hardness and texture to exhibit the relative same flaking properties at a scale sufficient for productive stylistic analysis. As an example, the Hixton Silicified Sandstone exhibits somewhat larger crystalline granularity in its microscopic structure; however, its intergranular silicified bonding provides a uniform hardness and texture which closely approximates that of the cherts in its flaking properties with its ability to produce conchoidal fractures during the flaking process such as are produced on chert and flint materials. Likewise, the other stylistic attributes of width, length, thickness, and all shoulder and base variables used in this study are of a type that can be equally produced among all raw materials found in this sample. Still, it was determined that any potential meaningful differences in flaking characteristics of these raw materials would be most evidenced in the size of the flake scars and/or flake channels which are not, therefore, measured nor considered in this study. Consequently, it has been determined that this approach adequately mitigates against the idiosyncratic behaviors of both the differing raw materials used, and the individuals (with their respective toolkits) engaged in the production of LPI lanceolates.

The issue of the effects of handedness, i.e., right vs. left, in comparing variables of lithic flaking patterns and angles is also considered. A seminal study of early hominid handedness in stone tool production was conducted by Nicolas Toth (1985). Using both archaeological (Koobi Fora, Kenya and Ambrona, Spain) and experimental archaeological data, Toth's study revealed that handedness was observable in the flaking patterns produced by primary reduction percussion flaking of cores (Toth 1985: 607-614). Therefore, in Toth's research, flaking angles and patterns are the by-product of bio-mechanical processes rather than stylistic expression.

Unlike Toth's data, the flaking patterns and angles considered within this study are produced by means of a pressure flaking technique which, when employed, typically produces fine collateral and/or transverse flake scars across both faces of the LPI lanceolates. Preventing production failure by accidental fracture in this late stage of lithic tool manufacture is achieved by carefully manipulating and controlling both flaking tools and raw materials while executing a finely flaked finished surface. This pressure flaking procedure, then, obscures the effects of handedness by the producers' ability to orient the raw material and employ production tool-use to create any flaking direction or angle, and resultant flaking patterns of any desired type at their discretion and, of course, within the natural reduction constraints of the lithic raw material being reduced. Therefore, the bio-mechanics of handedness are not considered a serious impediment to appropriate comparative analysis of flaking pattern or flaking angle variables in this study.

Forager/Collector Systems and the Environment

Following Steward's initial work in cultural ecology (1955), there have been numerous archaeological and ethnographic studies of the relationships between human groups and their environments (e.g., Bettinger 1991; Binford 1978a, 1978b, 1980, and 1982; Butzer 1971 and 1982; Heffley 1981; Jochim 1976 and 1981; Keene 1981; Kelly 1983; Kelly 1995; Lee 1968, 1969, 1972, and 1976; Lovis 1993, 1994; Smith 1981 and 1983; Winterhalder 1981; Yellen 1977). These studies demonstrate wide variation in hunting and gathering organizational responses to the variability of the natural and social environments within which they operate. Therefore, an appropriate and important first step in understanding the Late Paleoindian foragers of the upper Great Lakes involves the use of available paleoenvironmental data to describe the natural environment of the early Holocene period in the region which is provided in Chapter 2. The next step, then, is to employ these data within a predictive model to objectively describe the upper Great Lakes LPI forager and collector system/s particularly as pertains to settlement and mobility.

Forager-Collector Settlement & Mobility, Middle Range Model

The LPI researcher faces three major obstacles to fine-grained research in the upper Great Lakes region: First, the glacial and post-glacial Great Lakes basins lake levels fluctuated enormously (about 400 ft.) during the 2,000 year period between 10,000 B.P. and 8,000 B.P. with much of the potentially data-rich topography presently inundated by modern lake levels; secondly, differential preservation has left, predominately, a highly skewed lithic-based material culture data set; and, finally, very little research in this vast region has meant a highly dispersed and limited archaeological and natural record. In view of these obstacles, it was determined that an explanatory device within an ecological framework be implemented in developing an explanation of regional LPI mobility patterns. Therefore, to articulate analysis between the natural and archaeological data and anthropological issues, a middle-range approach was determined to be both appropriate to the data and productive for this specific research design (Binford 1980; Bettinger 1991; Kelly 1995).

Binford (1980) proposes a middle-range settlement model with a continuum that extends between the polar subsistence systems of foragers, who "...move consumers to goods with frequent residential moves..." and collectors who "...move goods to consumers with generally fewer residential moves." (Binford 1980: 15). To operationalize this model, Binford uses both the quantity and temporal distribution of available resources (or resource productivity) in which richness is objectively determined through the calculation of the "effective temperature" (or *ET*) calculated as follows ([Bailey 1960] Bettinger 1991: 65; Binford 1980: 13-15; Kelly 1995: 66; Shott 1986: 104):

$$ET = \frac{8T + 14AR}{AR + 8} = \frac{18WM - 10CM}{WM - CM + 8}$$

where

> *T is mean annual temperature in degrees Centigrade*
> *AR is the annual range in temperature between the average temperatures in degrees Centigrade of the coldest and warmest months*
> *WM is the average temperature in degrees Centigrade of the warmest month*
> *CM is the average temperature in degrees Centigrade of the coldest month*
> (Bettinger 1991: 65)

Therefore, *ET* is providing a direct objective measure of floral productivity which indirectly provides a measure of animal productivity. This translates to a measure of latitudinal and, indirectly, seasonal distribution and availability of resources.

> *"Other things being equal, the higher the ET value, the greater the production of new cells within the plant or producer component of the habitat. This means that in a very simplistic sense we might expect 'food rich' environments when ET is high and 'food poor' environments when ET is low (Binford 1980: 13-14)."*

Yet, Binford notes that human group mobility is greatest in both areas where *ET* is highest (at the equator) and lowest (at the arctic region) (1980: 14). Consequently, Binford goes on to suggest that mobility is used as a "positioning strategy" that is directed towards the structure (or distribution) of food within the environments and is not determined as just a matter of food abundance. Therefore, mobility is employed by

Binford as the means by which the continuum between Forager (highly mobile groups) and Collector (highly sedentary groups) is articulated. These constructions, then, produce certain expectations for archaeological site formation and distribution.

The forager groups use a "mapping on" strategy for resource capture which produces settlement types given as "residential bases", where foragers carry out resource procurement activities in task groups operating out of a central site, and "locations" which are the individual site locations of task group foraging activities (kill sites, lithic procurement, etc.) (Binford 1980: 17-19). This system appears most in high *ET* areas with a rich resource base that is widely distributed. Yet, as noted above, the Arctic groups are also classified as foragers. These forager site types produce expectations for archaeological assemblages which Binford associates with "grain" size. A "fine-grained" assemblage would likely occur at a short-duration extraction site where material remains can be immediately related to a central activity; whereas, coarse-grained assemblages would be expected at residential sites which can be occupied for extended periods with numerous activities being undertaken producing poor associations between assemblages and specific activities (Binford 1980: 17).

Collector systems exhibit lower residential mobility and engage in resource storage or "caching" strategies which acts to tether groups to geographic locations. This strategy is typically found in lower *ET* environments where seasonality is greater, thereby affecting resources which can be patchy and may exhibit seasonal resource shortfalls. Subsistence strategies includes bulk resource procurement, such as taking large quantities of migratory fish or mammals for storage. This system also provides for development of technologies characterized by specialization and efficiency which can be curated for future use. Site types for collectors can include residential camps, locations, field camps, stations, and caches (Binford 1980: 18).

Therefore, the forager group moves residential camps during resource shortfalls, while collectors employ storage and intensified resource extraction strategies by increased logistical forays and reduced residential camp mobility (Bettinger 1991: 70). Collector archaeological assemblages can be characterized as coarse-grained with curated specialized and diverse tools and equipment allowed by lower residential mobility. Forager archaeological assemblages will be fine-grained, characterized by fewer more generalized tool types providing for higher mobility (Bettinger 1991: 70).

Upper Great Lakes LPI, Settlement & Mobility Analysis

In analyzing the data with respect to Binford's model, there are important considerations that must be identified. As previously mentioned in Chapters 1 and 2, the archaeological and natural records of the Early Holocene in the vast upper Great Lakes region are, at best, rather small and patchy which requires a broad application in terms of reconstruction. Another issue are the effects of increasing human populations on mobility. This is of particular note with the developing Early Archaic traditions of the woodlands that are being expressed within the adjacent southern areas of the research region, as well as represented within two prominent Plano mortuary sites within the study region, including the Gorto Site in the Upper Peninsula of Michigan and the Renier Site located on the Door Peninsula of Wisconsin (Buckmaster and Paquette 1988: 115; Mason and Irwin 1960: 47; Shott 1986: 43, 104-105). Therefore, an absolute calculation of *ET* for the Early Archaic is not possible; however, data collected by various researchers for similar environmental latitudes and topography are employed to develop realistic *ET* ranges in this study as a comparative tool to generally characterize the region's resource productivity (Bettinger 1991, Binford 1980, Kelly 1995, Kuehn 1998, Shott 1986).

Effective Temperature (*ET*) has been previously calculated for numerous environments where ethnographic groups have been the subject of anthropological and archaeological investigations. Michael Shott was interested in ethnographic groups within Boreal Forest and Tundra habitats as an analog while researching lower Michigan Early Paleoindian mobility (Shott 1986: 106). Robert Kelly, on the other hand, provides a fairly complete compilation of *ET's,* Primary Production *(PP),* and percents of hunting, gathering, and fishing that makes up the economic systems of groups worldwide in his study of hunter-gatherer diversity (Kelly 1995:67-69). Primary production (*PP*) is briefly defined as follows:

> *"Primary production (PP) refers to annual net above-ground plant production ($g/m^2/yr$), and is a more direct indicator of the amount of food available to herbivores than ET. A product of effective precipitation and solar radiation, primary production is computed from evapotranspiration (E) values [UNESCO 1974; Thornwaite Associates 1962, 1963, 1964] using Sharpe's equation [1975]:*
>
> *Primary Production* $= .0219\, E^{1.66}$ (Kelly 1995: 69)".

A problem that plagues prehistoric archaeologists, particularly those with an interest in Paleoindian and Archaic populations, is developing a reasonably accurate reconstruction of paleoenvironments with no clear analogues to historic environmental conditions (Shott 1986: 107). Consequently, ethnographic analogues are selected that are thought to best represent the environmental conditions that existed. These are then further modified to accommodate some of the known prehistoric elements comprising the specific area of interest. While Shott's reconstruction of the Early Paleoindian period in the upper Great Lakes may be adequately characterized by Tundra and Boreal habitats (1986: 104-107), the Late Paleoindian groups of the Early Holocene period, as indicated in Chapter 2, were confronted with new glacial, climatic, hydrologic, floral, and faunal elements creating increasingly more complex environmental and ecological systems during the Early Holocene period. In short, the introduction of these new elements through time and across space in the upper Great Lakes region was neither uniform nor stable even within the same latitudes. Therefore, a different range of *ET* must be developed and applied than that used by Shott of 7.5-12 (Shott 1986: 105). Likewise, considerations of topography become more significant with the much larger and diverse geographic area of this study. The LPI groups of the upper Great Lakes region routinely traversed landscapes that varied between open plains, lowland wetlands, riverine and lacustrine marshes and shorelines, mountainous and rolling morainic regions, and including the valleys and ridges and presently submerged shorelines of the Great Lakes glacial lake beds. Kelly presents data from ethnographic groups operating in variously distributed latitudes and habitats that, at some varying scale, possesses elements believed to have been present during the Early Holocene period of the upper Great Lakes (Kelly 1995: Table 3-1, 67-69). Kelly's data has been condensed in Table 3.1 for purposes of easy and specific reference.

It is significant to point out that of the 42 archaeological sites contained in this study, only 13 have more than 1 LPI lanceolate point (Appendix A, Table A.1.1). Additionally, regardless of the other assemblage components, only data derived from the LPI points are included within this study, although most of the sites in the region are only represented by these points. Also, two of these larger site assemblages (Gorto N=19 and

Renier N=4) are reported as cremation burials with associated projectile points identified as grave goods (Buckmaster and Paquette 1988; Mason and Irwin 1960). The period of study is, at minimum, a 2,000 year interval, while Binford's model was based on a yearly subsistence-settlement round (Binford 1980: 19). All these factors condition the application of Binford's to the data in this study. Still, there are some significant insights into LPI mobility to be gained from judicious employment of this model to the LPI data.

To begin, it appears that most of the assemblages within this dataset exhibit characteristics that could be associated with either the forager or collector ends of the continuum. These are typically small sites (<N=4) that could easily have functioned as logistical camps for a forager system or as locations, field camps, and/or stations for collector systems (Appendix A, Table A.2). Also, some of the single point sites may have resulted from projectile points lost by LPI owners. In fact, of the 13 sites with multiple LPI projectile points in this dataset, 6 exhibit <N=4 points (Appendix A, Table A.2). Of the remaining 7 sites, two are the specialized cremation sites at Gorto (Buckmaster and Paquette 1988) and Renier (Mason and Irwin 1960), three appear identified as specialized sites for lithic procurement activities at Sheguiandah on Manitoulin Island (Lee 1955; Julig, Storck, and Mahaney 1994), Brohm in the Thunder Bay area (MacNeish 1952), and Biloski in Thunder Bay area (Hinshelwood and Webber 1987) (Appendix A, Table A.2). This leaves two sites with archaeological assemblages consistent with residential camp characteristics: The Samel's Field site at the northern point of the lower peninsula of Michigan, and the Cummins site located on the north shore of Lake Superior in Thunder Bay Ontario. The Samel's Field Site exhibits the largest and most complete lithic assemblage between the two sites, and will, therefore, be

the subject of analysis for implementation of this research.

The Samel's Field Site in the southern subregion is located on an "Upper Group" beach strandline of Skegemog Point, overlooking Skegemog Lake which is adjacent to Elk Lake and empties into the Traverse Bay of Lake Michigan (Cleland and Ruggles 1996: 59-60). The lithic assemblage exhibits the unshouldered LPI lanceolate types, with an observed stylistic affinity with the Agate Basin Plano material which, together with the geochronological data, dates this site towards the earlier end of the Early Holocene (around 10,000 B.P.). The patchy closed spruce forest, which contained some deciduous elements that emerged in the northern lower peninsula of Michigan about 10,000 B.P. would have supported immigration of a more diverse (but widely distributed) plant/animal community (Chapter 2). This developing ecotonal environment would have facilitated a settlement-subsistence strategy of small groups of foragers likely employing high mobility as a logistical means of dealing with both seasonal and distributional resource shortfalls (Chapter 2, pp. 13; Cleland, Holman, and Holman 1998: 23). Ethnographic analogues do not exist for LPI environments; however, by combining and averaging *ET's* from groups who are thought to represent both environmental and settlement/subsistence patterns similar to those conditions identified, produces a reasonably objective measure of the *ET* around 10,000 B.P. in the Samel's Field site area (Table 3.1).

The Samel's site is reported as a "base camp" with a "...short but intense occupation by a fairly large group of people..." (Cleland and Ruggles 1996: 94), and is summarily described as follows:

"This site, unlike so many early sites, represents more than a temporary camp or locality related to a specific set of extractive or procurement activities. The full complement of tools for working hide, bone, wood, and lithic materials indicates both base camp and more sedentary occupation (95)."

Additionally, there is no evidence of storage pits, and the only identified archaeological feature associated with the LPI occupation is a hearth (Cleland and Ruggles 1996: 75). Given the foregoing descriptions of the site, chronology, environment, and archaeological assemblage, it appears these characteristics are most closely associated with the "mapping on" of a forager "residential site", from which procurement and extractive forays were intensively carried out on a short term basis (Binford 1980: 15). This interpretation is further evidenced by the dominant presence of Norwood chert in the assemblage which is local, but outcrops in the bed of Whiskey Creek which is approximately 32 km (or 20 mi) northeast of the site (Cleland and Ruggles 1996: 75-77). Of course, the Norwood could have been procured enroute to the Samel's Field Site, depending upon the mobility pattern employed by the Samel's Field LPI group. Additionally, the lithic raw material profile possesses a major element of Bayport chert, in both the formal and informal elements, which source location is likely located on the eastern side of Michigan about 161km (or 100 mi.) distant (1996: 75). In reviewing the Average percents of Hunting, Gathering, and Fishing as provided in Table 3.1, and considering the known LPI environmental, subsistence and settlement systems, as well as Binford's *ET*-Settlement Pattern table (Binford 1980: Table 2, 14), important observations and questions immediately emerge. Of particular note in Table 3.1 is the subject of fishing as part of the subsistence and settlement pattern for an Average *ET* of 10.9°C for 10,000 B.P. in the upper Great Lakes region.

Table 3.1 Ethnographic Forager/Collector *ET* and Subsistence Patterns

Group	*ET* (^{0} *C.*)	Hunting %	Gathering %	Fishing %
Nunamiut	9.8	87	3	10
Caribou Inuit	10.0	50	10	40
Naskapi	10.0	70	10	20
Chipewyan	10.3	60	0	40
Slavey	10.6	50	10	40
Ojibwa	10.7	40	30	30
Mistassini Cree	10.8	50	20	30
Blackfoot	11.4	80	20	0
Montagnais	11.6	60	20	20
Assiniboine	11.7	70	20	10
Crow	13.0	80	20	0
Average	10.9	63.36%	14.81%	21.81%

(After Kelly 1995: Table 3-1, 67-69)

It was previously noted in this study that there are no indications of a defined fishing technology among LPI assemblages; although, given the poor preservation of floral/faunal remains throughout the region during the Early Holocene period, most of that technology would not have been preserved if produced in such raw material media as bone, wood, and fibrous vegetation. Kuehn (1998: 470), in arguing the potential for a fishing technology to have been possessed by LPI groups, uses faunal records of the Sucices Site and Deadman Slough Site; and, further potential evidence (which is not very compelling) by referencing netsinkers recovered in semi-association with the LPI lanceolates of the Gorto Site reported by Buckmaster and Paquette (1988: 115). Yet, the faunal profiles of the Deadman Slough and Sucices sites do not reveal any compelling faunal evidence of a definitive "fishing" technology: Deadman Slough Site - Fish N=2 of N=1,415 faunal remains; and, Sucices Site - Fish N=1 of N=480 for Total faunal remains (Kuehn 1998: Table 3, 466-467). Still, and more importantly to both Kuehn and this research, the faunal records of these sites both reveal a very diverse profile with both woodland and wetland-associated species (including white-tailed deer, porcupine, black bear, turtle, beaver, bird, mussel, and fish) being heavily represented: Deadman Slough - N=314 of N=1,415 Total (which includes N=250 of Taxon indeterminate) ∴ 26% of Total (adjusted for identified species) are woodland/wetland associated species; and, Sucices Site - N=290 of N=480 Total (which includes N=51 of indeterminate mammal and N=53 Taxon indeterminate) ∴77% (adjusted for identified species) are woodland/wetland associated species. The Deadman Slough site is a "Minoqua", or the later shouldered LPI Scottsbluff type point site; whereas, the Sucices Sites has elements of both the early LPI unshouldered Plainview point and a Scottsbluff point preform [sic] which indicates some potential for both early and later LPI occupation (Chapter 4). Therefore, these faunal data can be employed as a comparative tool for other upper Great Lakes LPI sites of similar environs, within reasonable limits.

In discussing the ethnographic groups that were used in Table 3.1, it is clear that there is no clear correlation between these groups, as a whole, and the LPI groups as portrayed by the archaeological and paleoecological records. The primary point of departure is the impact of fishing, as a part of the subsistence and settlement patterns, on the ethnographic groups which is virtually absent from the LPI records.

Yet, as just discussed, wetland resource extraction may easily play as significant a role for LPI groups, as fishing does for modern ethnographic groups. Therefore, given the average percent values for hunting/gathering/fishing in Table 3.1, and the archaeological and paleoecological data, it appears that if "fishing" percents (or, preferably, wetland resource gathering) were combined with "gathering" in the above table, a potentially more reasonable picture of LPI subsistence and settlement patterns would emerge. Specifically, 63% hunting and 37% gathering at an average *ET* of 10.9°C (Table 3.1).

In reviewing Binford's model, the table he uses reveals interesting intersections between *ET* and settlement and subsistence patterns of ethnographic groups which have been categorized as Fully Nomadic, Semi-Nomadic, Semi-Sedentary, and Sedentary (Binford 1980: Table 2, 14). By employing the calculated average *ET* of 10.9°C. from Table 3.1, Binford's model reports these intersections: Fully Nomadic = 11.1%, Semi-Nomadic = 46.6%, Semi-Sedentary ≐ 26.6%, and Sedentary = 15.4% (Binford 1980: Table 2, 14). The Semi-Nomadic settlement pattern dominates the four named strategies at the intersection of this *ET*.

Summary

Given the foregoing analysis, it appears that LPI groups, particularly in the ecotonal area of Lake Michigan and Lake Huron, reasonably fit within the Semi-Nomadic settlement pattern, which is certainly towards the forager end of Binford's settlement and subsistence continuum. The Samel's Field Site assemblage reflects a short term residential site with evidence of diverse activities being carried out by the LPI occupants such as lithic raw material procurement; lithic, wood/bone tool manufacture and, maintenance; and, hunting-gathering, with faunal hide processing. As predicted by Binford's model, this assemblage can be considered moderate-grained as a result of the diverse known and unknown activities carried out at the site location, but which were relatively few and of a short duration for a residential site.

Significantly, it is noted that there are no floral or faunal remains for the Samel's Field site assemblage. Consequently, only the hide polish found on a single scraper provides information on potential faunal exploitation and use. Still, if marshes and wetlands are part of the resource base being used by LPI populations, as indicated in the Wisconsin sites (Deadman Slough and Sucices), then some substantial amount of gathering activities are likely being undertaken at the site as well.

Yet, mobility distances remains high among these LPI groups whose "mapping on" strategy positions them relative to subsistence resources that are rapidly changing with a trajectory towards a more rich, diverse, and widely distributed environment. Late Paleoindians continue exploiting the retreating boreal forest habitats, and the large faunal resources (caribou, moose, elk) of their predecessors, the Early Paleoindians. But, new woodland and wetland/marsh habitats are developing in a mosaic pattern across the landscape embedded within the migrating closed Spruce/Fir and Pine Forests in a ecotonal belt that, through time, expands northward populating valleys, river bottoms, and lake shores, and thereby opening new biomes for productive habitation by these LPI peoples.

These changes, then, are observed in the archaeological record. According to Meltzer (1989), mobility may be quantified (in minimal terms) as a direct measure of distance using the distances between known lithic raw material source locations and archaeological site locations (Meltzer 1989 :37).

These site to source distances in the upper Great Lakes LPI data are wide ranging and include 800km (Knife River Flint - southwestern North Dakota to Quetico Park, Ontario); 600km (Hixton Silicified Sandstone - central Wisconsin To Quetico Park, Ontario); 400km (Hixton Silicified Sandstone - central Wisconsin to the Gorto Site, near Marquette, Michigan); and, 161km (Bayport Chert outcrop at Au Gres, Michigan To Samel's Field site at Traverse Bay, Michigan), with numerous distances in all the subregions at <100km.

It is also noted that Upper Mercer chert at the early Paleoindian Gainey site, located in east central lower Michigan, is a lithic raw material from Ohio which is about 400km distance (Shott 1986: 152; Simons 1981).

Consequently, wide-ranging mobility patterns are not highly unusual in the upper Great Lakes region. Of note here, therefore, is that we observe no appreciable change in the large territories covered between the Early Paleoindian and Late Paleoindian traditions. Indeed, if anything, the Late Paleoindian patterns may be larger than their Early Paleoindian predecessors in this region.

Still, consideration for the potential effects of exchange in lithic raw material profiles of a site must be recognized, particularly for the Knife River Chalcedony material of North Dakota with an 800km distance. Additionally, the smaller 161km distance for the Southern LPI groups (Samel's Field Site) is not necessarily unexpected considering population pressures to the south by the immigrating woodland-associated Early Archaic groups and with the north, east, and west terrestrial boundary of the Great Lakes, particularly at 10, 000 B.P., as the lakes were still above modern levels initiating their regression from higher Lake Algonguin levels.

Therefore, a 400km mobility range of LPI forager group settlement patterns for the Northern and Western subregions does not appear inappropriate. Considering the newly opened and developing biomes, following the retreat of the ice, that were available for LPI immigrations, there certainly appears adequate environmental and cultural impetus to sustain these large 400 km mobility patterns. Also considering the observed increased floral and faunal diversity, and the potential increased reliance on collecting, there is the concomitant potential for reduced frequencies of site relocations by LPI groups, even though distances do not appear to change.

The Cultural Ecological theory contributed to defining the subsistence and settlement system of LPI groups likely operating in the upper Great Lakes region. This was accomplished by employing Binford's Forager-Collector model which quantified and characterized environmental factors revealing a predominately forager subsistence pattern but as a semi-nomadic settlement system which is facilitated through expedient technologies.

Unfortunately, these theoretical and methodological approaches are constrained in their application. Specifically, the theoretical underpinnings, as originally constructed by Steward (1955), places technology at the core of identification and explanation of culture as adaptation. Additionally, the roles of the individual and/or family choices in the process of sociocultural adaptation are subsumed under the rubric of group selection. Thus, a more broad conceptualization of types of sociocultural behaviors and the role of the individual/family is more general in its potential for both application and explanation in an ecological framework.

A more general ecological approach is taken with the research into style and exchange which recognizes the significance of both the individual/family as well as sociocultural behaviors, other than technology, which are considered active components in a theory of culture as adaptation. Consequently, the issue of how LPI groups likely operated within these large mobility patterns is more thoroughly dealt with through stylistic and exchange analyses of the LPI lanceolates in Chapters 4, 5, and 6.

Conclusions

In this study, then, a regional LPI settlement and subsistence system emerges that is semi-nomadic and composed of a dominant foraging strategy (63%) with, however, a decidedly greater role for collecting (37%) than previously assumed for the Early Holocene period. Proposed mobility patterns of up to 400 km do not appear to have diminished from Early Paleoindian patterns of the region, except potentially in northern lower Michigan where patterns of as little as 200 km are revealed. Certainly, theses settlement and subsistence behaviors may be somewhat variable across both time and space as a consequence of responses to the period's dramatic environmental changes.

CHAPTER 4

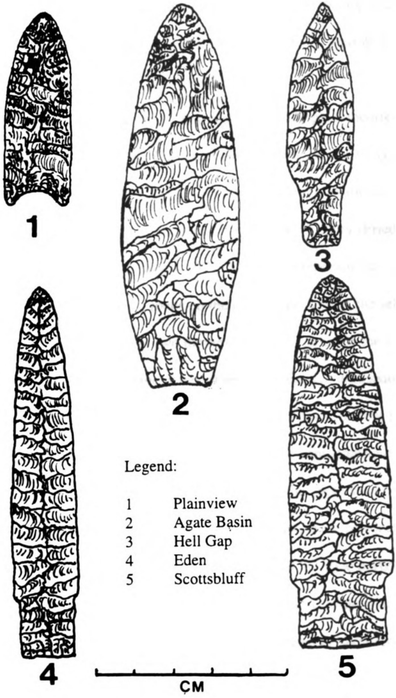
STYLE

THEORY AND METHOD

Introduction

The highly variable material and non-material responses to physical, social, and environmental demands allow human forager-collector systems the rich cultural diversity demonstrated in both the archaeological and ethnographic records (Bettinger, 1991; Eggan, 1937; Kelly, 1995; Lee and Devore, 1968; Service, 1958). Given that this tremendous cultural diversity is clearly evidenced, both spatially and temporally, theories of human social and symbolic behavior have developed providing a uniform means for proposing explanations, within a testable framework, across the full range of cultural constructions (Carr 1995; Cooley, 1902; Friedrich 1970; Goffman, 1959; Mead, 1934; Sackett 1982; Bettinger 1991; Voss & Young 1995; Kelly 1995; Whallon 1968; Wiessner 1983; Wobst 1977). Consequently, specific aspects of present and past societies can be interpreted through an appropriate application of anthropological-archaeological theories of style in material culture. This research design, then, provides a basis for investigations into upper Great Lakes Late Paleoindian (LPI) regional mobility patterns by applying these high-level and middle-range theories of style to the lithic component of their material culture. Included within the scope of this study is an attempt to ascertain the stylistic/structural interrelationships using the distinctive projectile points of the LPI lithic tool traditions (Plano) which are typical of the LPI lithic assemblages of the upper Great Lakes region (Figure 4.1).

Figure 4.1 LPI Lanceolate Types



In discussing style and lithics, past analytic difficulty has centered on the nature of microstylistic variation and the relationship of this variation to significant dimensions of social and cultural organization (Sackett 1982; Voss 1982:46). The methodology employed in this study requires a middle range approach in the application of high-level theories in style to the difficulties inherent in lithic analysis (Voss & Young 1995; Carr 1995; Whallon 1968; Wobst 1977; Wiessner 1983).

This study builds on advances in general archaeological theories of style over the past two decades (Hegmon 1992; Carr and Neitzel 1995). Particularly applicable, with some modification, is Voss and Young's construction of the relationship between style and the self (1995). In this work, elements of Interaction Theory (Friedrich 1970), Information Exchange Theory (Wobst 1977: 321), and Emblemic Style (Wiessner 1983: 257) have been combined with a focus on the two dimensions of the self as developed through social interaction. These two dimensions of self include the social self (or reactive dimension of self) and the personal self (or proactive dimension of self), as the bridging element in this holistic theoretical construct (Voss & Young 1995: 78-80). The problems of application of the Voss/Young approach to lithic tools are twofold: the interpretation of stylistic visibility (1995: 92-94), and the application of raw material usage in stylistic expression (Carr 1995: 157-159). Both these problems present obstacles that must be addressed. In part, it is to these issues that the style portion of this study is directed. A basic conceptual difficulty in (and criticism of) lithic stylistic investigation essentially resides in our ability to identify those attributes of variation which are considered stylistic as opposed to functional and morphological (Sackett 1982). This difficulty, however, may be somewhat mitigated against by the assertion that some artifact attributes can be shared between the realms of style and function. In fact, it can be said that much of what is termed stylistic (except formal fine art) owes its origins to some form of functional design embellishment. Exhibiting functional origins, however, does not mean that those attributes of variation considered stylistic are analytically inseparable from their functional counterparts. And, finally, controlling for the morphological effects of use and wear on lithic tool appearance, e.g., resharpening, must also be considered in a stylistic analysis. Therefore, it is assumed that the stylistic expressions within the lithic material culture of Late Paleoindians provides insights into the patterned behaviors of distinct groups within the upper Great Lakes region and, therefore, establishes a basis for interpreting group mobility patterns. Yet, as pertains to this study, it is also important to acknowledge that we can only reasonably surmise the contexts within which the lithic artifacts actually exhibited the full range of their meaning. Also, it is understood that lithics were only a single element of LPI material culture. Yet, it is assumed in this study that lithic tools were a significant element of LPI material culture.

Methodology and Middle Range Theory

The methodology employed in this portion of the study is designed to inductively develop a list of visible attributes proposed to exhibit the lithic tools' stylistic properties and then, using Voss and Young's theory of "Style and the Self", refine and analyze the list of stylistic attributes and ultimately test several hypotheses which are designed to predict LPI stylistic behavior. Of direct concern to development of a robust explanatory construction in this study is the consideration of a contextual understanding of artifacts and their visibility as addressed in Christopher Carr's "Unified Theory of Artifact Design" which provides a well-developed and structured means of ascertaining attribute visibility (Carr 1995: Table 7-1, 174-175). The issue of visibility is at the center of stylistic theoretical developments over the past three decades and requires serious treatment in any stylistic analysis (Hardin 1977; Hill 1977; Sackett 1982; Washburn 1983; Whallon 1968; Wiessner 1983; Wilmsen 1973; Wobst 1977; Voss 1982; Voss and Young 1995). To define attribute visibility, consideration of "*...attribute size, attribute number, the degree of contrast between alternative attribute states, and comprehendibility (Voss and Young 1995: 92)*" is undertaken in this study.

The two selected areas of artifact stylistic investigation in this study are that of lithic raw material and certain other nominal scale and ordinal scale hafting element design attributes among the different point forms of the Late Paleoindian period (Table A.1). Of significance are the basic assumptions which underlay this study as follows:

Assumptions

For purposes of this element of the study, the following assumptions have been made with regard to LPI lifeways and environment, and are based on current understandings and observations by the community of past and present anthropological, archaeological researchers:

- Lithic raw material quarrying activity from primary resources was widely practiced as the dominant lithic procurement strategy among Late Paleoindians of the upper Great Lakes region (Arthurs 1987; Buckmaster & Ruggles 1991; Cleland & Ruggles 1992; Dawson 1983; Ellis & Deller 1990; Fitting 1966; Julig, Pavlish, & Hancock n.d.; Lee 1955; Meyer 1970; Peterson 1973; Porter 1961; Reid 1980; Simpson 1982; Wendt 1985).

- The Late Paleoindian forager and collector groups were organized into highly mobile egalitarian social systems exhibiting informal geographic boundary maintenance with a high subsistence reliance on the natural and social environments, thus indicating a higher potential for an anucleated social structure within their socially (not politically) defined geographic boundaries (Yellen 1978; Maxwell 1985: 53-54).
- Environmental intelligence (information) was a socioeconomic commodity thus supporting the incentive for intergroup interaction (Maxwell 1985: 13; Wobst 1977).
- Both intragroup and intergroup social contact was not rigidly proscribed (Damas 1968: 112-113; Maxwell 1985; Woodburn 1968: 105-107).
- The consistent exploitation of a specific distinct lithic raw material over time will produce an observable direct association between that raw material and the social group wherein it dominates the lithic assemblage profile (Ellis & Spence 1998).
- It may be assumed that the protected basal area of lithic projectile points will preserve more of the original stylistic characteristics than the other point elements which may be subject to the substantial effects of use wear and resharpening. This also applies to finished point forms ready for hafting but cached or carried unhafted for future use.
- Identified prehistoric lithic raw material resource locations, and the presence of those distinct lithic raw materials as a dominant element in a lithic tool assemblage, provides a direct measure of the distance between the source and the archaeological site, and a tether point of minimum distance in the range of

mobility (or contact with other groups via exchange) of the archaeological sociocultural group being studied (Ellis and Spence 1998).

- Where mobility and intergroup flexibility are high due to unpredictable resources, such as is assumed in the case of upper Great Lakes Late Paleoindians (Chapters 2 and 3), a lithic raw material that is dominant within a specific group's lithic assemblage will be highly visible at the level of intergroup social interaction, which allows for extended verbalized dialogue at normal conversational sound levels and within easy viewing distance (Butzer 1982: 241-243, Wiessner 1983: 258-273; Yellen 1977).
- The visibility of lithic projectile point attributes is exhibited hierarchically with the highest being raw material, the second being form or shape, and the lower being surfacial flaking patterns and other nuances of microstylistc behavior (Carr 1995; Voss 1982; Voss & Young 1995).

The first level of investigation is the identification of those qualitative and quantitative variables of projectile point form considered to be stylistic, as contrasted to those of function. To begin, as evidenced in the archaeological record for the Early Holocene, there was a significant increase during the Paleoindian period in the diversity of lithic projectile hafting designs. New hafting designs (including stemmed, side-notched, and bifurcated points), along with an increased range of lanceolate hafting modifications, gave rise to pronounced variation both between and within new and pre-existing tool types (Justice 1987: 30-66). The diversity evidenced in these new point forms during the Early Holocene are thought to have been heavily influenced by the functional dictates of an increasingly diverse economy necessitating a broader range of tool form designs (Quimby 1960: 41). Even though this may be a reasonable assertion for tool type hafting designs, it does not adequately explain the wide range of diversity observed within single lithic tool types all of which participate within the realms of both utilitarian and non-utilitarian uses (Shott 1986: 76-79). It may be asserted, then, that among Late Paleoindian groups, variations in hafting element designs within type categories were subject to intensified stylistic expression during the Early Holocene period. This assertion is especially significant since it argues that the range of variability that is visibly demonstrated within each lithic projectile point type (e.g., stemmed, side-notched, bifurcated, and the variety of lanceolate modifications) gains its impetus from stylistic expression as opposed to functional dictate. Additionally, two points are significant to this assertion: First, as regards the assumption that the haft (or basal area) preserves more of the original stylistic characteristics, in as much as the haft of a lithic tool is usually protected within the hafting device during use, the normal effects of tool-use morphology, such as fracturing, chipping and resharpening, are much greater along the working surfaces and edges than the hafted area. And secondly, as regards haft visibility, the numerous caches of unhafted lithic projectile points identified in the archaeological record indicates that LPI groups did not immediately haft all projectile points produced, but rather cached and carried numbers of unhafted finished points as ready replacements for broken or worn out points providing reasonable access to visibility of fully finished lithic tool forms at most any time. This assertion, then, is significant to the issue of ascertaining original stylistic expression for behavioral interpretation.

Briefly, and in further support of a stylistic interpretation of hafting elements, it is significant to note that projectile point basal fluting, as a functional characteristic of hafting technology, is clearly the dominant hafting design present in the archaeological record in North America prior to emergence of the Late Paleoindian and Early Archaic tool traditions (ca.10,000 B.P.). Still, differing fluted point hafting designs (e.g., Clovis, Folsom, and Cumberland) are evidenced in the material record. Therefore, although the fluted hafting technology was rather homogeneous, there was still visible variation within hafting element designs at the microstylistic level (e.g. Holcombe, Gainey, Crowfield, Barnes, Debert, Redstone, Ross County) (Justice 1987:6-30). Consequently, the use of a stylistic theory with a lithic-based dataset can provide fertile ground for constructing and testing hypotheses about human behavioral patterns (Close 1978; Wilmsen 1974).

Of particular interest in this study is the amount of basal form attribute variability expressed both within and between the different projectile point types, as well as among and between the different lithic assemblages. The premise underlying this level of analysis is that the tool type is most reflective of cultural socialization processes as may be represented in the cultural tool tradition; whereas, individual input by the social and personal self, as both a reactive and proactive actor in a social group, will be more likely expressed in the microstylistic variations (or the "nuances of style") of that basic form (Voss 1982: 45). Therefore, the microstylistic variance should be more of a reflection of the social and personal self and the social context within which the self is operating.

> *"According to this view, the self is composed of social categories and evaluative attributes. Both influence our behavioral choices, including our stylistic behavior, and our evaluations of the responses that others give to our behavior (Voss and Young 1995:79-80)."*

Consequently, it is suggested that the collective variation of individual stylistic attributes within each hafting element design type is visibly distinguishable and is that which demonstrates the most sensitivity to microstylistic investment and preservation through time. Some examples of individual stylistic design attributes, used collectively to define an "eared variant" of a Scottsbluff III type point (Justice 1987: 46-49), are the nominal scale presence/absence observation of basal "ears" and cross section shape (e.g., diamond-shaped, lenticular, etc.). According to Voss (1982: 46), it is also necessary to consider continuous scale measurements for a valid microstylistic comparative analysis which includes such attributes as the angle and width of shouldering, cross section thickness, hafting lateral edge length, basal width, concavity/convexity, surfacial flaking orientation, and point length and width. This is the approach that has been taken in this study.

It is at this level of artifact analysis that interaction and information exchange is most likely evidenced (Voss 1982: 46). Consequently, all hafting nominal scale and continuous scale attributes, such as were given for the Scottsbluff III point, that are considered visually characteristic of a particular point form are identified and measured for comparison in this study (Table A.1).

One such form attribute included is that of surfacial treatment of finished formal projectile points. This level of lithic artifact analysis is most productive when there is evidence of a distinct uniform pattern in the flake scar orientation of the tool type such as the collateral parallel pressure flaking pattern of the Plano tool tradition (Justice 1987:30-34 & 46-51).

The functional counterpart of the surfacial flaking attribute is the tool thinning process. It can be reasonably argued that the overwhelming majority of the thinning process is actually executed during the percussive flaking stage of lithic tool reduction sequences and not the final pressure flaking stage. In addition, that the projectile point is most likely fully functional prior to the application of any finishing surfacial pressure flaking. Also, there is little apparent functional gain which could be derived from the removal of such a small quantity of surfacial lithic material during the final pressure flaking process. This is especially significant when considering that the risk for tool production failure (or breakage) increases significantly during the final stages of lithic tool manufacture. Therefore, given the uncertain functional advantage of this attribute, it seems more reasonable to assert that the impetus for the final surface treatment of these lithic projectile points derives more from motivations of the social and personal self as a stylistic expression than that of a functionally oriented determinative. Also, directly related to this attribute, is that of the haft cross-section. Obviously, in lithic reduction, as material is removed from the haft surface, a thinner, cross-section results. Therefore, the finished shape, symmetry, and thickness of the haft cross-section are stylistically influenced. The final level of lithic stylistic attribute selection is lithic raw material. This attribute may be viewed as potentially participating in stylistic expression at two levels: intragroup and intergroup. Interestingly, given attribute visibility, this attribute may possess the greatest potential for discerning information exchange and interaction of any other single lithic attribute. Still, given the present body of stylistic theory and method, there remains the challenge of isolating those properties in lithic raw material proposed to be stylistic as distinct from those of function. The problem, however, may be resolvable using the two levels of intragroup and intergroup stylistic expression in a contextual framework as a unified hierarchical approach to deducing the stylistic utilization of raw material.

The key underlying assumption to this approach is that when prehistoric groups selected a specific lithic raw material for quarrying as part of their procurement and production strategy, it was a choice derived from bridging the functional and stylistic realms in their decision-making as conditioned by contextual sociocultural and natural constraints. The selection, procurement, and continued use of a distinct lithic raw material, by highly mobile social groups, can be a visible means of imbuing that distinct material with a specific social investment (or meaning) which can be reified through intragroup and intergroup behaviors. For example, by socially selecting a distinct lithic raw material for dominant lithic resource use, the group is proscribing the use of other raw materials. Assuming it is a spatially discrete (sole source) lithic resource which is repeatedly exploited, the group is also effectively adding a tethering point in its mobility pattern and, thereby, establishing a visible spatial association between the group, the resource, and resource location. By standardizing the group's lithic assemblage to a distinct type of lithic raw material, one of the most functionally significant and contextually visible elements of their preserved material culture, a direct intragroup association with that distinct material will become visible to other groups who normally operate within their sphere of social interaction. This means that at the intragroup level, the use of a homogeneous lithic raw material may be ascribed to the processes of enculturation and socialization with the social and personal self as predominately a proactive actor. This interpretation of selective raw material use as a proactive action is also supported by certain shared group activities:

- The selection and predominant use of a specific and distinct raw lithic material over time was a conscious choice as evidenced from the wide range of alternative raw material choices that were available (Buckmaster and Paquette 1988; Clark 1989; Cleland and Ruggles 1996; Salzer 1974);
- raw material uniformity within assemblages indicates a deliberate process of intragroup sharing, instruction, and learning in raw material source locations, quarrying technology, and the idiosyncracies of specific raw materials in tool manufacturing processes;
- and, the unique physical properties of the selected raw material also provides a visible uniformity and aesthetic character to the group's lithic tool assemblage. This visible aesthetic character, then, is also integrated and uniquely shared at the intragroup level and can be visibly associated at the intergroup level as not simply an exotic raw material, but, more significantly, a material preferred by, and associated with, members of other distinct regional groups.

Consequently, there is significant impetus for some level of cognitive focus required by these activities which would prescribe the proactive action of the social and personal self as opposed to a reactive action at both the intragroup and intergroup levels (Sackett 1982 & 1985; Voss and Young 1995; Wiessner 1983).

As mentioned earlier, another problem to be addressed in this middle range construction is that of visibility (Carr 1995; Voss and Young 1995; Wobst 1977). The concept of visibility, as a criterion for selecting artifact classes which are thought to actively participate in information exchange, may be adequately addressed by lithic raw material and artifact point forms on the basis of the sociocultural context within which the artifacts exhibited meaning (Carr 1995: 190-191). An example of this approach is the following observation pertaining to visibility and stylistic attribute diffusion:

> *"Consequently, highly visible attributes tend to reflect communication among more distant parties, whereas less visible attributes tend to reflect more stable interaction networks among artisans and kinpersons, who work closely together (Carr 1995: 154)."*

The strength of this observation can best be assessed by its potential explanatory power for lithic style analysis. It seems that if this is a valid observation at all, then it should be applicable to specific classes of artifacts that are thought to possess a stylistic element as defined by the contextual framework within which they exhibited meaning.

The following are the minimum criteria that must be met in order for intragroup level analysis of lithic raw material style to progress:

1) The raw material source must be accessible, plentiful, and reliable;

2) a specific raw material must dominate an element of the material profile of a lithic assemblage providing a clearly visible uniformity; and,

3) the visible raw material physical attributes must be distinct.

Provided the foregoing criteria are met, the next level of raw material analytical criteria to be considered is at the intergroup level:

1) There must be more than one group in the geographic region that fulfill the foregoing intragroup level criteria; and,

2) intragroup lithic raw material profiles must be compared/contrasted with intergroup lithic raw material profiles.

Provided the two levels (intragroup and intergroup) of criteria are met, it is possible to assess lithic raw material stylistic behavior. In order to use lithic raw material stylistically, some potential etic meaning must be associated with the lithic material's single visible qualitative attribute; its distinctiveness (Carr 1995: 173). It is in the context of its design, manufacture, use, distribution, and observation that etic meaning is proposed to have been ultimately derived.

At the intragroup level, the selection, production (including instruction and learning), use, distribution, and observation of selected dominant lithic raw material may be ascribed to the processes of enculturation and socialization with the social and personal self as predominately a proactive actor (Carr 1995; Sackett 1982 & 1985; Voss and Young 1995).

At the regional or intergroup level, the procurement, production, use, distribution, and observation of exotic raw material that is directly associated with other regional groups' lithic raw material profile, may also be ascribed to the proactive behavior of the social and personal self with social affiliation and interaction as the cognitive focal point and purpose (Friedrich 1970; Voss and Young 1995; Whallon 1968; Wiessner 1983; Wobst 1977).

Hypotheses About Style

The following hypotheses are constructed based on the foregoing assumptions and with the goal of identifying, isolating, and interpreting the stylistic components of the lithic assemblages of the upper Great Lakes Late Paleoindians:

1) Distinctive lithic raw material that is dominant within a specific sociocultural group's tool assemblage will be visibly distinct from the raw material that is dominant in other regional lithic assemblages.

2) The intrasite lithic tool stylistic variation will be less than the intergroup stylistic variation.

3) If a lithic raw material has a stylistic dimension, then its occurrence should covary with the other dimensions of lithic style.

4) If there is significant sociocultural interaction between LPI groups in the upper Great Lakes region, and if lithic raw material has a significant stylistic dimension, then the lithic raw material profiles of these interacting groups will contain some elements of each others dominant lithic raw material.

5) A high correlation will exist between the amount of intergroup lithic stylistic similarity and the physical geographic distance between the groups with the spatially nearest groups exhibiting the highest correlation in lithic stylistic similarity.

Models and Methods

It should now be understood that the theoretical underpinnings to theories of style used in this study are based in the behavioral areas of social/symbolic interaction at both individual and group levels (Carr 1995; Voss and Young 1995). At the high theoretical level, Voss and Young (1995) propose archaeological behavioral expectations with the self as the central actor and focus which is developed out of the body of social theory known as Symbolic Interactionism (Cooley 1902; Mead 1934; Goffman 1959). At the middle-range theoretical level, Christopher Carr (1995) provides a methodological tool to bridge the empirical world of archaeological data to the theoretical world of human behaviors with his hierarchy of attribute design and intersections of attribute visibility and distribution. As mentioned earlier, Voss and Young (1995), through Carr's middle-range approach, have developed a holistic means of understanding information exchange, social interaction, individuality, and symbolic structures of meaning, by focusing on the self who, as both a reactive and proactive actor integrates these differing aspects of the self through varied stylistic behaviors (Conkey 1982; Hodder 1982; Sackett 1985; Whallon 1968; Wiessner 1983; Wilmsen 1973; Wobst 1977; Voss 1982; Voss and Young 1995:95). Consequently, both the intensity and distribution of these discrete and measurable stylistic behaviors reveals much about the intensity and distribution of social interaction and information exchange of past archaeological cultures (Carr 1995; Voss and Young 1995).

To provide an objective measure of group interaction and mobility within this stylistic theoretical framework, the Distribution and Visibility Interaction model as proposed by Voss and Young is employed (1995: 92-94):

> *"These two attribute characteristics, distribution and visibility, relate directly to the two major aspects of the self: the individual as part of the social group, implying spatial context; and the individual as actor, implying motivated attempts at interaction management (Voss and Young 1995: 92)."*

Therefore, in this model, the interpretations of regional patterning are developed through identifying the intersections of the two variables of stylistic attributes including: Visibility, which is coded as either high or low based on the archaeologist's interpretation of the use and contexts of viewing; and, the Distribution of the design attributes which are classified as discrete, clinal, or random based on the archaeologically observable frequencies and geographic locations of the attribute occurrences. The following, then, represents the six regional patterns possible at the various intersections of these two variables and their interpretations:

High-Visibility Attributes with a Discrete Distribution:

This distribution pattern "reflects the relationship of the individual with ...operational society and culture" and represents "...the spatial extent of the society and culture". This "pattern encompasses the involvement of the self with general reference relationships and with abstract values" (Voss and Young 1995: 93).

This pattern of stylistic expression, then, reveals intragoup interaction spheres and intergroup social boundaries. It is significant to note that the only *High Visibility* attribute in this research dataset is proposed to be lithic raw material. Consequently, the patterned intersection of this attribute with its distribution is significant to our understanding of social boundaries for the LPI groups operating in the upper Great Lakes region. The reason for coding this attribute as *High Visibility* is simply the observation that in the context of these egalitarian forager and collector systems, the distinct lithic raw material of these rather large lanceolate points was both selected and repetitively used by these groups; and, would be observable as components of hafted weapons and tools at a reasonable distance during contact with other groups or strangers. This is not intended to imply that the lithic raw material of these points were the only means or material culture available to LPI peoples to reflect the spatial extent of their society; but rather, a potentially highly significant element of their material culture that likely played a distinct role in their shared culture.

High-Visibility Attributes with a Clinal Distribution:

The interpretation of this pattern is "that it indicates the presence of a social boundary of some significance and the lack of sharing of specific stylistic attributes and meanings between groups". The attributes, then, "will tend to reflect interaction intensity between groups, very much like low-visibility attributes which reflect specific interaction patterns within a group" (Voss & Young 1995: 93).

This intersection of attribute visibility and distribution, then, elevates recognition of this attribute on a regional basis as reflecting a direct and meaningful association with a particular group. Consequently, the intensity of interaction between groups can be measured by the occurrence of this attribute in assemblages of other defined groups. Again, the observations and assumptions of the role of lithic raw material discussed above applies to this intersection as well.

High-Visibility Attributes with a Random Distribution:

There are two major interpretations of this pattern. The model of the self predicts "the pattern may indicate individual creativity in the development of styles". The other interpretation of this pattern is "...that the archaeologist has erroneously assessed the visibility of the attribute relative to the context of object use" (Voss & Young 1995: 93). Consequently, a thorough review of the context of use and visibility is required to appropriately interpret this pattern (Carr 1995: 190-191).

Interpretation of this intersection, then, hinges upon the nature of the attribute and its ability to retain and communicate significant cultural meaning, as expected of a *High Visibility* attribute, while being subject to individual stylistic expression; or, deducing that there has been an interpretive error by the archaeologist. Again, with lithic raw material as the only proposed *High Visibility* attribute in this dataset, the interpretation of the occurrence of this attribute intersection is quickly discernable.

Low-Visibility Attributes with a Discrete Distribution:

Three interpretations of this pattern are offered: First, proactive, within-group processes: In this interpretation the attribute expresses the elements of within-group cooperation, interaction, and solidarity; second, the interpretation that the attribute expresses socially passive and isochrestic processes: In this case, the amount of attribute visibility may be accounted for by small-scale, individual-group interaction and/or by less conscious use of style. Finally, the interpretation that the pattern results from coding a clinally distributed attribute as a two-state variable (Voss & Young 1995: 93-94).

The issue of whether the interpretation of an attribute's visibility-distribution intersection is a proactive assertion of style or a process of isochrestic variation may be considered in terms of the artifact class and it's manufacture and functional uses wherein these attributes find expression. In the case of this study, the LPI lithic projectile points are the sole class of artifacts considered. The broadest context of the *Low Visibility* attribute is likely their manufacture, and visibility would likely have been confined to family and small intragroup interaction. Whereas, while functional use would still mostly be visible within the small group/family, it may also be visible to outside groups through either planned or chance encounters. Still, given the various media of material culture that was available to LPI peoples for implementing such proactive stylistic behaviors as communicating intragroup solidarity, cooperation, and interaction, the lithic projectiles *Low Visibility* stylistic components are likely more an expression of isochrestic variation (Sackett 1982). Therefore, it appears more reasonable to assert that the *Low Visibility* nuances of stylistic expression for these LPI point attributes derives from "...small-scale individual-group interaction and/or by the less conscious use of style." (Voss and Young 1995: 94).

Low-Visibility Attributes with a Clinal Distribution:

"This pattern almost certainly reflects the impact of specific reference relationships and their intimate society and culture [Hsu 1985:29-30] upon the individual. It indicates specific interaction patterns in small groups (Voss & Young 1995: 94)."

This intersection of attribute visibility and distribution, then, provides a marker of both intra-group and inter-group interaction. This is indicated by the occurrences of attribute design elements that are homogeneous to the former and heterogeneous to the later in consideration of all the design elements' expressions. Therefore, given the artifact class and the *Low Visibility* of the attribute, the occurrence of this pattern at the inter-group level is indicative of interaction at the individual and/or family levels. In a forager-collector system, this may be an indication of either an anucleated social structure (Maxwell 1985; Yellen 1976) and/or a case of overlapping mobility patterns by different groups.

Low-Visibility Attributes with a Random Distribution:

"This pattern...can indicate creativity and artistic license [Carr and Rosenthal 1986; Carr 1995: Table 7-2]. Attributes with this pattern can also reflect individual competency in expressive behavior (Voss and Young 1995:94)."

In both explanations of this pattern it is noted that individual personal stylistic expression is the root interpretation. Therefore, attributes exhibiting this pattern do not reveal either intra-group or inter-group interactions. Rather, these are reflections of individual creative, artistic, and idiosyncratic behaviors in the design and manufacturing processes, with an emphasis on the later skills.

Conclusions

This research is directed towards discerning elements of the sociocultural systems of the upper Great Lakes Late Paleoindians. Patterns in human behaviors are revealed at both the individual and group levels by studying raw material procurement, design choice, and production trajectories of LPI lanceolate points. Voss and Young's (1995) approach places the individual at the center of this process where the convergence of cultural knowledge, beliefs, and practices with individual interpretations, goals, needs, and skills finds expression through the material culture. In this case, LPI lithic projectile points provide the medium for that expression. Therefore, the patterns in these human-modified stones, if properly treated, can reveal patterns in prehistoric human behaviors.

As indicated by the structure of the foregoing patterns, and according to Voss and Young (1995: 94), the key to the successful application of this model is dependent upon the accuracy of the archaeologist's interpretation of an attribute's visibility. A further cautionary note is Carr's observation on the significance of context in getting to issues of interpreting attribute visibility (Carr 1995: 190-191). Significantly, however, the model provides a methodological link at the intersections of artifact stylistic attribute visibility and distribution that are ascribable to levels of sociocultural behaviors (e.g., social interaction, information exchange, isochrestic variation, iconological and emblemic style) as mediated through individual stylistic expression. In subsequent chapters this model is applied to the LPI data.

CHAPTER 5

STYLE - DESCRIPTIVE ANALYSIS

Introduction

This analysis of lithic style has been constructed using the model proposed by Voss and Young (1995) as discussed in Chapter 4, Style - Theory and Method. The analysis proceeds from the initial selection of stylistic attributes used in the study, and through the various methods employed in establishing the continuous scale measurements and nominal scale observations selected for analysis. The various analytic techniques employed (e.g., INAA/XRF tests and quantitative methods) are then reported and discussed. Finally, the results of the analysis and the consequent inferences and conclusions are provided.

Attribute Selection

In terms of analysis, those attributes that are proposed to contain and retain stylistic messages in this study at various hierarchical levels of visibility, and which have been the subject of physical and statistical analysis include as the highest visibility attribute, raw material; as moderate visibility the attributes of form; and, at the lowest visibility, surfacial flaking (Carr 1995: 174). More specifics on each attribute measured are provided as follows:

High Visibility Attribute - Raw Material:

This attribute presents the most rigorous challenge in terms of its stylistic property. It is at this juncture that the use of ethnographic, archaeological, and contextual data must be relied upon as providing an adequate level of credibility to develop previous assertions. The data presently available indicates that:

1) selected lithic raw material types typically dominate the formal lithic site assemblages of Late Paleoindians of the upper Great Lakes region; and,

2) other expedient, accessible and good quality sources of lithic raw material were widely distributed in primary and secondary contexts throughout the study region, including vast ranges of bedrock outcrops, stream bed lithic material, and recently deposited glacial till, but were not selected for use (Brown 1984; Buckmaster & Paquette 1988; Clark 1989; Farrand & Drexler 1985; Greenman & Stanley 1942; Leverett & Taylor 1915; Luedtke 1976, Chapman & Putnam 1984).

To ascertain the credibility of these assertions, the lithic raw material represented in all studied assemblages is analyzed for its stylistic properties. This part of the analysis focuses on the formal elements of the lithic assemblages, the LPI projectile points, excluding preforms. The stylistic attributes analyzed in this portion of the study include those macroscopically visible attributes that collectively provides the stylistic quality of a visibly distinctive raw material:

1) Nominal scale attribute of raw material typology are listed as follows:

The lithic raw material sources and the lithic raw materials that are represented in the upper Great Lakes Late Paleoindian tool assemblages provide the basis for the application of the stylistic model. It is significant to note that of the entire lithic sample in this study (N=105), >71% of the raw materials are traceable to a specific geographic location, >12 % are produced on locally available and ubiquitous lithic material (quartz and cherts), and >16% are produced from unknown raw material resources (Table 5.1).

Table 5.1 Lithic Raw Material

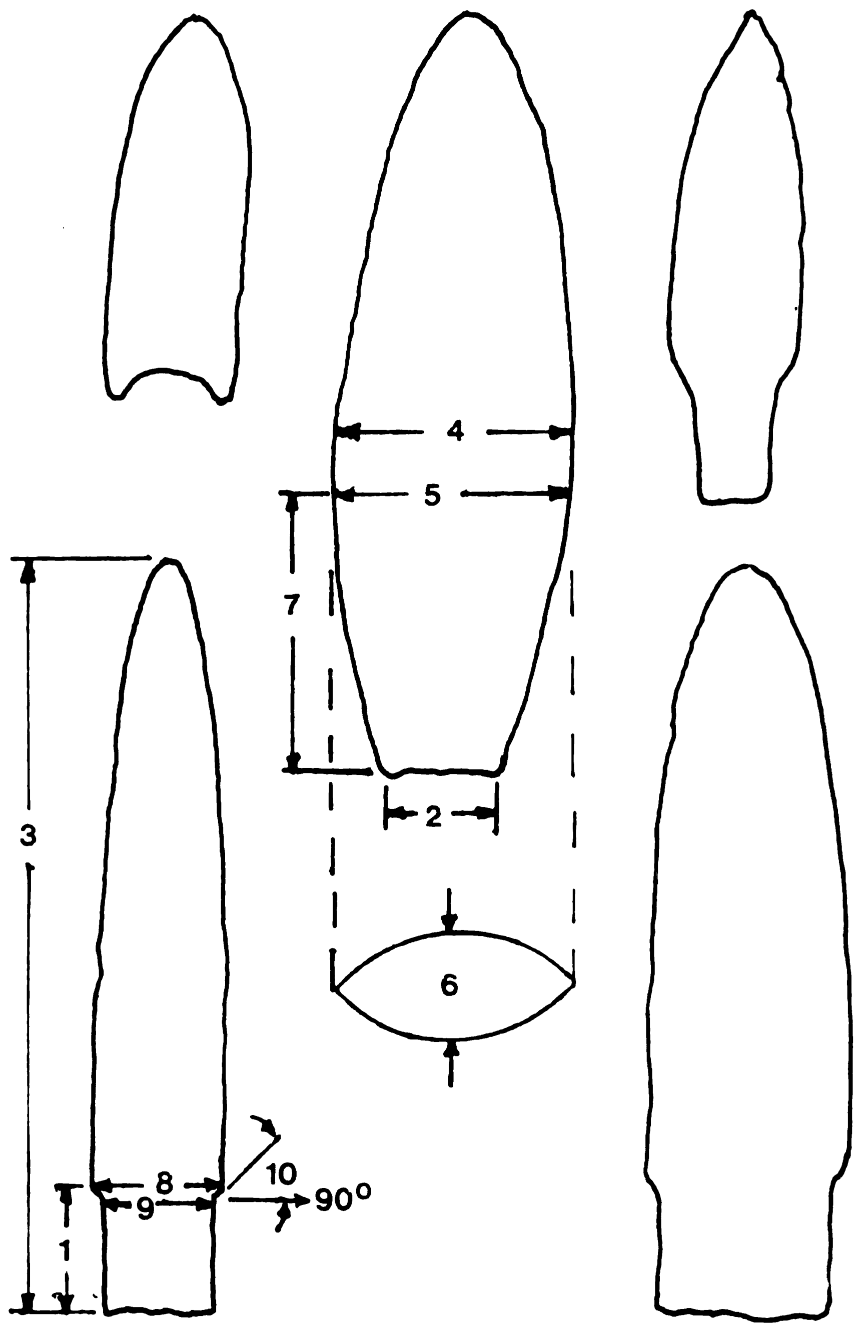
RAW MAT'L	LOCATION	REFERENCES	PROPORTION
Bayport Chert	Southern Subregion - Pt. Au Gres and Vaughn's Quarry, Arenac Co., MI; and, Bayport, Huron Co., MI.	Luedtke1976:197; Cleland and Ruggles 1996: 75-77.	N=11 (10.4%)
Norwood Chert	Southern Subregion - Fritz Trail, Charlevoix, Co., MI	Luedtke 1976: 257; Cleland and Ruggles 1996: 75-77.	N=8 (7.6%)
Hixton Silicified Sandstone	Western Subregion - Silver Mound, Jackson Co., WI	Behm 1984; Brown 1984; Boszhardt 1993.	N=25 (23.8%)
Knife Lake Siltstone	Northern Subregion - Quetico Park, Ontario Province, Canada	Dawson 1983; Fox 1980	N=7 (6.6%)
Jasper-Taconite	Northern Subregion - Thunder Bay Ontario Province, Canada	Julig 1984; Julig, Pavlish, and Hancock 1988.	N=13 (12.3%)
Sheguiandah Quartzite	Eastern Subregion - Manitoulin Island and George Lake, Ontario Province, Canada	Greenman & Stanley, 1942; Lee 1953 & 1954.	N=8 (7.6%)
Knife River Chalcedony	Northern Subregion- North Dakota (sw corner)	Frison and Stanford 1982	N=3 (2.8%)
Unidentified	All Regions	N/A	N=17 (16.1%)
Other Local Materials	All Regions	N/A	N=13 (12.3%)
TOTAL	All Regions		N=105 (100%)

Figure 5.1 Continuous Scale Measurements

Legend:

1& 7 = Haft Length
2 = Base Width
3 = Length
4 = Width
5 = N/A
6 = Thickness
8 = Shoulder Width
9 = Between Shoulder Width
10 = Shoulder Angle

Figure 5.1 Continuous Scale Measurements (continued)



During the course of this research other raw materials were identified, but none exhibited either the intensity and distribution characteristics of direct quarrying within the studied tool assemblages and are assumed to have been accessed through either exchange interactions or direct procurement from secondary expedient raw material resources, e.g., glacial till.

Raw material resource locations were determined through a combination of research, sample comparison to Michigan State University Archaeological Consortium in-house lithic comparative collections, and through INAA/XRF analysis of archaeological quarry sites for Hixton Silicified Sandstone, Mesnard Quartzite, Agibik Quartzite, Sheguiandah Quartzite, and Thunder Bay Jasper -Taconite. Lithic samples from other sites included debitage from the Renier Site, Wisconsin and the Baby Lake Site, Michigan were also analyzed using INAA/XRF testing and are determined to be Hixton silicified sandstone derived from the Silver Mound resource in Wisconsin (Appendix C). The INAA/XRF tests, then, are relied upon to provide the objective relative continuous scale data needed on raw material compositions, resource locations, and archaeological distributions. Additionally, within each raw material typology are additional multistate nominal scale attributes that macroscopically establishes the distinctive character each raw material exhibits:

2) Nominal scale attribute of the color;

3) Nominal scale attribute of the luster (high gloss, waxy, and dull);

4) Nominal scale attribute of the texture (coarse, medium, and smooth);

5) Nominal scale attribute of the visual physical structural character (e.g. banded, layered, marbled, solid, etc.); and,

6) Nominal scale attribute of the density/transparency (opaque, translucent,

transparent).

Low Visibility - Point Basal Form Treatment:

Because of the variability in design and manufacture, and the tendency towards minimal retouch, the basal elements will likely best reflect the stylistic component of the lithic artifacts. In view of the range of variability both within tool types and between tool types, it will be necessary to compare all significant nominal scale and continuous scale measurements of the basal elements that give visible (and potentially) stylistic definition to the basal form. Given Voss and Young's (1995) model discussed in Chapter 4, and the nature of a Haft element to be obscured from view when in use within a hafted tool, it is appropriate that these variables of Haft form be considered *Low-Visibility.* The specific elements analyzed include the following (Figure 5.1):

1) continuous scale attributes of the length of lateral edges from the base to the intersection of blade shoulder or termination of lateral grinding in millimeters (as applicable);

2) continuous scale attributes of the width at the base, the shoulders or termination of lateral grinding (as applicable), and between the shoulders in millimeters;

3) nominal scale attributes of basal form which include: concave, straight, and convex;

4) nominal scale attributes of the haft lateral edges include straight, expanding, and contracting;

5) nominal scale attributes of shoulder form including straight, angled, and rounded;

6) nominal scale basal design including the presence/absence of basal ears;

7) continuous scale attribute in the length of the projectile point measured between the proximal and distal ends;

8) continuous scale attribute of width of the projectile point measured at the widest point between the lateral edges of the specimen;

9) nominal scale attribute of known point typology; and,

10) continuous scale attribute measurement of thickness of the base at its thickest cross-section.

Low Visibility - Point Base Facial Surface Treatment:

It is also necessary to consider another *Low-Visibility* attribute exhibited on the point basal component which extends across the bi-facial surfaces of the points. In the LPI lanceolate point types a key attribute to classification is the flaking pattern exhibited. The parallel collateral pressure flake style is a diagnostic feature of these LPI points (Frison and Stanford 1982: 195; Justice 1987). Again, using Voss and Young's criteria (Chapter 4), the Flaking Orientation attribute and the Flaking Pattern attribute are considered *Low-Visibility* in that only upon close scrutiny of the points is this attribute observable. In the analysis, then, both the nominal scale and continuous scale observations and measurements (respectively) are included as follows (Figure 5.2):

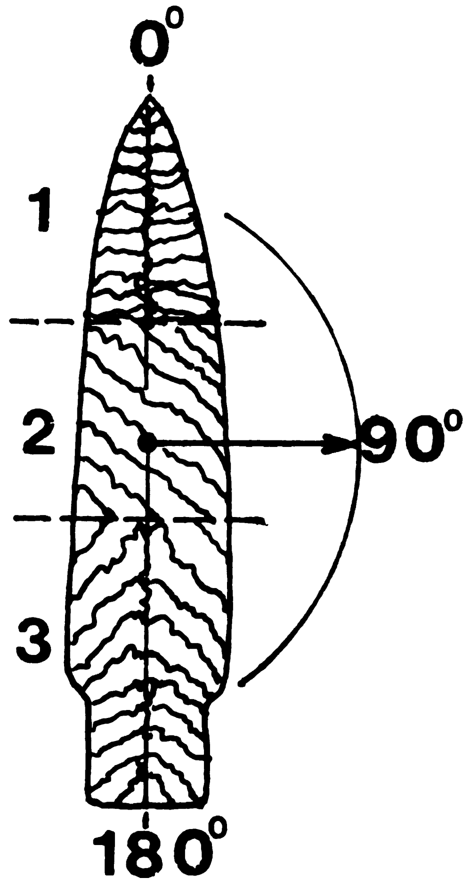
1) nominal scale attributes in the orientation and organization patterns of surfacial flake scars including the categories of collateral parallel, collateral transverse, random/unaligned, oblique collateral parallel transverse, chevron collateral parallel, and oblique random; and,

2) continuous scale attribute in the Flaking Orientation of surfacial flake scars including measurement in degrees from the proximal and distal axis to the lateral edges.

Figure 5.2 Flaking Patterns and Flaking Orientation

<u>Legend</u>

1 = Collateral Parallel
2 = Obilque Collateral Parallel Transverse
3 = Chevron Collateral Parallel
4 = *Random: Exhibits no uniform pattern
*(Not Represented)



The data are derived from a very sparse LPI material record of the upper Great Lakes Region. Direct on-site data collection of known LPI projectile points was made during 1993-1994, which included access to institutions and private collections in Michigan (upper and lower peninsulas), southern and northern Ontario, Canada, Minnesota, and Wisconsin. Having excluded informal lithic material (debitage, scrapers, gravers, preforms, etc.) from this study, only 105 LPI point forms were available to be included (Appendix A).

Although this is a highly constrained data set, this sample includes all the largest known LPI site assemblages (Brohm, Cummins, Renier, Gorto, Samel's, Sheguiandah, and George Lake), as well as all other points from different sites that were known and available for study at the time of data collection (early 1994) within the upper Great

Lakes region. Therefore, given that this sample represents all the LPI assemblages that were available and/or known in the upper Great Lakes region, and that the geographic location of all these sites is widely distributed across the region, and that the full complement of known LPI projectile point typologies are present (providing a wide range of diversity), it was determined that an adequate sample has been obtained by which productive investigation of the sociocultural behaviors of regional identity, group mobility, and exchange on a larger regional scale could be carried out.

The interpretive challenges of a small data set are particularly notable at the level of ratio scale and continuous scale attribute analysis. In this study, for example, a small quantity of outliers in almost all attribute categories may exert a pull on statistical calculations which, in larger data sets, could be well within an acceptable range of standard deviation. Also, dropping the statistical outliers and re-calculating the statistic is in some instances ill-advised given the small sample for any given attribute where, in particular, missing values have further reduced available data for such analysis. Still, an advantage of the small data set is that a thorough analysis of actual attribute variations (e.g. standard deviations, variance, etc.) is much more directly ascertainable and accomplished. Significantly, Voss and Young (1995: 94) stress the need for both continuous scale and nominal scale attributes analysis. In the case of stylistic analysis and small data sets, the value of nominal scale attribute analysis, if comprehensive, can be significant. Consequently, this study includes both nominal scale and continuous scale data which are presented in table form in Table A.1. The table, however, presents the data under abbreviated continuous scale headings and coded nominal scale descriptions. These attribute headings and nominal scale codes are detailed in the Base Data Legend of Appendix A, Table A.1.

As discussed earlier, the point base/haft element, as the focus of this stylistic study, is reduced to the visible attributes of its form and raw material which are identified and measured (Table A.1). While typological categories are employed as a useful organizing and descriptive tool at early stages in the analysis, it is more important to note that the continuous scale data is also employed as an organizing tool and that the continuous scale data is heavily relied upon for the analysis and interpretation.

A significant consideration of this study is the understanding that based on the known point typologies of shouldered and unshouldered lanceolates, there are two rather distinct temporal phases within the Late Paleoindian period (10,000 B.P. to 8,000 B.P.) of early (10,000 B.P. to 9,000 B.P.) and middle to late (9,000 B.P. to 8,000 B.P.). Salzer (1974) also noted the temporal association, albeit different (9,000 to 7,000 B.P.), and termed examples of these points Flambeau (Unshouldered) and Minoqua (Shouldered) phases of the LPI period; although, Salzer's classifications were not as typologically widely lumped as used in this study. The known archaeological record has, to date, placed the unshouldered Agate Basin and Plainview type points within the earlier temporal phase (10,000 to 9,000 B.P.) with the shouldered varieties of Hell Gap in the middle phase, and Scottsbluff and Eden within the middle to later phases of the Late Paleoindian period (9,000 B.P. to 8,000 B.P.) (Cleland & Ruggles 1996; Fox 1975; Frison 1974; Frison & Stanford 1982; Frison & Todd 1987; Irwin-Williams, Irwin, Agogino and Hayes 1973; Justice 1987; Mason & Irwin 1960; Quimby 1960; Ross 1992; Salzer 1974).

Additionally, it is noted that Early Archaic side-notched points are also lightly distributed through three of the four areas of the region and in association with the lanceolate forms (Buckmaster & Paquette 1988; Lee 1953 & 1954; Mason & Irwin 1960;

Ross 1992). Because of the association with the lanceolate assemblages, the side-notched points are also analyzed on a nominal scale basis. It is noted that the sample is very small (i.e., N=8 points) and in this study is more regionally informative at the nominal scale level rather than at the continuous scale level analysis.

Given the point variation among LPI assemblages of the upper Great Lakes, the data collected for continuous scale attributes included 23 metric measurements and 8 multistate nominal scale attribute categories. These original attributes were then used, collapsed, or deleted within the analysis to improve the analytic efficiency of the selected stylistic attributes. An example of deleting and collapsing attributes is where the original data included six continuous scale variables including Grinding Lateral Edge Length - left, Grinding Lateral Edge Length - right, Grinding Base Width, Base Width, Haft Length - left, and Haft Length - right, which were collapsed to two attributes, "Base Width" and "Haft Length" (Table A.1). The attribute of Haft Length was measured for the shouldered points by measuring the stem lateral edges between the base and the shoulder; whereas, the lateral edge grinding measurement was used for the unshouldered lanceolates. Since, in all cases, basal grinding extended along the entire width of the base and was, therefore, redundant to the base width measurement; and, since marginal basal grinding more likely derives from functional and reduction-related considerations, and does not carry sufficiently visible stylistic characteristics, the analysis which employed the base width attribute and the base grinding attribute was dropped. In the cases where Grinding or Haft Length-left and Grinding or Haft Length-right measurements differed, the greater length of the two was selected and used as the single attribute "Haft Length" (Appendix A, Table A.1).

Continuous Scale Data

All continuous scale attribute measurements used in this study are shown in metric or degrees (angle) and the methods of measurement are depicted in Table A.1. Further, the continuous scale attribute measurements were taken in metric scale using a Mitutoyo Digimatic Caliper Series 500-351, Model CD-6"P, except flake scar orientation and shoulder angles. The degrees of orientation and angle were measured for each artifact by using a Portland Navigational Plotter, cat. no. 0655.35 (1070). The attributes and their respective definitions as used in this study are listed as follows:

- The Width attribute is the metric measurement of the widest point between the two lateral edges on the specimen.

- The attribute of Shoulder Width is the measurement of the total width between the lateral edges of both the shoulders.

- Between Shoulder Width is the measurement of the width between the lateral edges of the stem where it intersects the shoulder.

- Base Width is the measurement of the base (proximal) edge between the lateral edges.

- Basal Concavity is measured as the negative (-) distance between the deepest point of the concavity and the imaginary basal lateral line established between the two corners of the base.

- Basal convexity is measured as the positive (+) distance between the farthest point of the convexity and the imaginary basal lateral line established between the two corners of the base.

- Width Above the Base is the width of the haft 2 to 5 mm above the base. This measurement is most useful for quantifying basal projections (or ears) in continuous scale data form.

- Length is measured as the greatest distance between the distal and proximal ends of the point.

- Width is measured as the greatest distance between the lateral edges of the point.

- Thickness was measured as a cross-section of the thickest point on the specimen.

- Shoulder Angle is the measurement in degrees from 0 to 180 of the shoulder in relation to the point centerline axis between the distal and proximal ends.

- Flake Scar Orientation is also measured in degrees from 0 to 180 aligning the centerline of the flake scar channel in relation to the point longitudinal axis between the distal and proximal ends (Figure 5.2). In this case, the degrees of orientation of the flaking pattern is measured for all flake scars from three flake scars above the hafting element (if possible) to the base. Then all flake scar orientation measurements are used to establish a mean degree of flake scar orientation. The width of the flake scars is held constant to account for variations in lithic raw material, flaking tools, and human idiosyncratic behaviors.

While in some cases complete points were not available and basal fragments were included, the basal element was the focus of the study and therefore provided the needed and appropriate data. Therefore, although the Length and Width attributes are given in all cases, there is no distinction made between complete or fragment in recording either of these measurements. There is available in the data set a nominal scale observation of Artifact Condition which is either complete (= 1) or a fragment (= 2). Yet, as previously mentioned, in as much as the focus of this study is directed at the basal portion of the points, the attributes of both Length and Width are not employed in the analysis.

Nominal Scale Data

The nominal scale data are a qualitative classification of attributes into categories organized by visible and observable attribute expression which operate as a macroscale analytic tool within this study. The nominal scale attributes and their definitions are listed as follows except Raw Material which was provided earlier in this Chapter:

- Location: An upper Great Lakes regional subdivision of the geographic study area into Northern, Eastern, Southern, and Western was constructed as an analytical tool (Figure 1.1). Although these geographic subdivisions appear to impose conceptual boundaries in data analysis, the data are analyzed at both sub-regional and regional levels. This approach obviates concerns for analytical integrity.

- Point Type: This nominal scale attribute includes classified projectile points (Figure 4.1) (Justice 1987), unclassified general typologies, as well as classifications of collapsed typologies based on general temporal-cultural associations. The significant temporal association is between early Unshouldered LPI lanceolates such as Agate Basin, Plainview, and Midland (10,000 B.P. to 9,000 B.P.) and later Shouldered Lanceolates such as Hell Gap, Scottsbluff, and Eden (9,000 B.P. to 8,000 B.P.) (Frison 1974; Frison and Stanford 1982; Salzer 1974). The Notched points, however, are more culturally associated with the woodland adapted groups of the southern and eastern woodlands which extends throughout the Early Holocene period (10,000 B.P. to 8,000 B.P.). Both conditions allows for an analytically productive means of collapsing point types into categories that are both temporally and culturally affiliated. Therefore, the following Table 5.2 provides the typologies and collapsed classifications used in this study and corresponds with the data organization in Table A.1:

Table 5.2 LPI Lanceolate Point Types

DESCRIPTION	POINT TYPE (1 thru 13)	COLLAPSED TYPE A = Shoulders, B=No Shoulders, C=Notched
Scottsbluff (All Variants)	1	A
Agate Basin	2	B
Hell Gap	3	A
Eden	4	A
Side Notched	5	C
Bifurcated	6	C
Lanceolate	7	B
Plainview	8	B
Midland	9	B
Unknown	10	B
Stemmed Lanceolate	11	A
Hi-Lo	12	B
Manitoba	13	C

- Basal Edge Shape: 1 = Straight, defined by no appreciable variation (i.e., concavity or convexity) along linear axis of basal edge; 2 = Convex, defined by observable protrusion (convexity) along linear axis of basal edge; 3 = Concave, defined by observable indentation (concavity) along linear axis of basal edge.

- Haft Lateral Edge Shape: Observable symmetry of both lateral edges of the haft area produces three major categories: 1 = Straight, defined by no appreciable variation in haft width between the lateral edges of the haft area from the distal to proximal ends; 2 = Expanding, defined by an observable symmetrical increase of haft width between haft distal and proximal ends with a marked increased width at the base; 3 = Contracting, defined by an observable symmetrical decrease of haft width between haft distal and proximal ends with a marked decreased width at the base.

- Flaking Pattern: Both regularities and irregularities in flaking patterns of LPI projectile points have produced six (6) categories of observable flaking patterns on the obverse and reverse faces of the points recorded in this study: 1= Collateral Parallel - This flaking pattern is produced when flake scars uniformly extend laterally from the medial ridge of the projectile point to the point's lateral edges with flake scar ridges and channels running parallel and adjacent to each other; 2 = Collateral Parallel Transverse - This flaking pattern is produced when flake scars uniformly extend laterally across the faces of the point from lateral edge to lateral edge with no discernable termination at the medial ridge with flake scar ridges running parallel and adjacent to each other; 3 = Irregular - This flaking pattern does not exhibit regularities in flaking direction, size, and/or character; 4 = Oblique Collateral Parallel Transverse - This flaking pattern is a variant of flaking pattern #2 with an observable uniform acute angularity in the flake scar orientations extending across the point faces; 5 = Chevron Collateral Parallel - This flaking pattern is a variant of flaking pattern #1 with an observable divergent acute angularity of flake scars extending (at an angle) in both directions from the medial ridge to the lateral edges; and, 6 = Oblique Irregular - This flaking pattern is a variant of flaking pattern #3 with the added distinct acute angularity of most observable flake scars.

- Artifact Condition: This attribute identifies each point's condition of being either, 1 = Whole Point, or 2 = Basal Fragment.

Analysis

Typologies are useful in this study for organizing the data into gross common categories and classifications to mitigate the effects of comparing "apples to oranges" in the analysis, thereby controlling for known temporal and cultural association. In particular, as previously mentioned, unshouldered lanceolates (e.g., Agate Basin, Plainview, Hi-Lo, Midland) are a class of Plano points associated with the early Late Paleoindian period (10,000 B.P. to 9,000 B.P.); whereas, shouldered lanceolates are associated with the middle to later Late Paleoindian period (9,000 B.P. to 8,000 B.P.). Also, the side-notched and bifurcated points are associated with the contemporaneous Early Archaic traditions of the eastern and southern woodlands as compared to the Plano-type lanceolates of the upper Great Lakes region.

This does not mean, however, that analysis of continuous scale attributes is confined to strict point typologies. The recorded zero (0) measurement or missing value of such continuous scale attributes as shoulder width, shoulder angle, notch width, and notch angle can also operate to exclude unshouldered lanceolates from the shouldered or side-notched points analyses. Likewise, it is noted that comparison of measurements of base width, haft length, or flake scar orientation, without some typological or class sorting device, does not differentiate between point types and, thereby, potentially sacrifices control of temporal/cultural association. Note, however, that given the size of the data set, the problems posed by these analytical constraints are not insurmountable. This analysis, then, undertakes the task of studying the data from an unconstrained cross-cultural, cross-temporal, and inter-regional basis which is ultimately refined through visible, logical, and deductive steps. Nominal scale attributes such as raw material types, or hafting lateral edge shape, and typological or classificatory groupings are also analytically employed as informative elements in this study. To this end, the statistics software program "SYSTAT for windows, Version 5" is used.

The first step employed in this analysis is the development of descriptive statistics for each nominal scale and continuous scale attribute, thereby, revealing attribute integrity and variability across the data set. This initial analytic step is employed at differing levels to accommodate identification of categories and classifications of attributes, point types, and geographic units that are of significant use in collapsing the data into fewer, but larger, analytic units.

Unshouldered Lanceolate Analysis

As previously mentioned, the temporal and geographic subdivisions of this analysis have been constructed along logical considerations of existing data (Frison and Stanford 1982; Ross 1992; Salzer 1974) with the 4 geographic regions of Eastern, Northern, Western, and Southern (Figure 1.1) and the temporal control by lanceolate types including unshouldered (B = Early) and shouldered (A= Late) and Notched © = Late). It is within this diagnostic framework that initial analysis of the descriptive statistics proceeds with first the unshouldered (B) type lanceolates that are associated with the early LPI expression in the upper Great Lakes, then followed by the shouldered (A) type, and finally the notched (C) type both associated with the mid to later LPI period. Therefore, we shall begin by consideration of the Unshouldered Lanceolate forms:

Attribute - Flake Orientation - Type B

Table 5.3 Flake Orientation - Type B

Description	All Regions	Eastern	Northern	Western	Southern
N of Cases	58	4	26	10	18
Minimum	42.0 deg.	90.3 deg.	42.0 deg.	82.6 deg.	80.7 deg.
Maximum	127.8 deg.	96.9 deg.	127.8 deg.	104.0 deg.	108.9 deg
Range	85.8 deg.	6.6 deg.	85.8 deg.	21.4 deg.	28.2 deg.
Mean	94.4 deg.	92.1 deg.	97.9 deg.	89.0 deg.	92.8 deg.
Variance	166.2 deg.	10.1 deg.	294.3 deg.	34.5 deg.	65.1 deg.
Std. Dev.	12.9 deg.	3.2 deg.	17.2 deg.	5.9 deg.	8.1 deg.
Std. Error	1.7 deg.	1.6 deg.	3.4 deg.	1.9 deg.	1.9 deg.
Skewness	-0.3 deg.	1.1 deg.	-0.9 deg.	1.7 deg.	0.7 deg.
Kurtosis	4.1 deg.	-0.7 deg.	2.6 deg.	2.4 deg.	-0.1 deg.
Sum	5473.2 deg.	368.5 deg.	2544.5 deg.	890.4 deg.	1669.8 deg.
C.V.	0.1 deg.	0.0 deg.	0.2 deg.	0.1 deg.	0.1 deg.
Median	91.5 deg.	90.7 deg.	95.6 deg.	88.2 deg.	90.6 deg.

This *Low Visibility* attribute considers only those LPI projectile points that exhibit some level of uniform flaking pattern to assess a general degree of angularity by adding the total degrees of flake scars measured and dividing the sum by the total count of flake scars measured for each projectile point thereby arriving at a simple Mean measurement for this attribute. The following analysis, then, considers the patterns revealed on both a regional and sub-regional basis:

While raw material variation and individuals' knapping skills and idiosyncracies certainly exert some influence over the ability to finely execute flaking patterns, the use of pressure flaking techniques wherein both the flaking tools and the projectile points can be easily oriented to produce any desired flaking angle, coupled with holding flake scar dimensions (except angle) constant, does provide sufficient control in outcomes to establish a reasonably sound basis for statistical analysis. In reviewing these data, then, degrees in Flaking Orientation (Table 5.3), several points of interest emerge:

1.) The Eastern sample is extremely small (i.e., 4 points), but it does express an element of the early unshouldered LPI projectile points of the Eastern upper Great Lakes region as represented at one site, Sheguiandah. Still, caution is required in the level of analysis that may be appropriate to the data and, more importantly, its interpretive uses in the analysis. To begin, it is noted that flake scar orientation among the Eastern points tends to a right angle to the proximal/distal axis of the point centerline (90 degrees) with a slight downward angle (<1degree) tendency, from the distal towards the proximal end, as indicated by the Median of 90.7 degrees or Mean of 92.1 degrees. In referring to the base data (Table A.1) it is noted that three of the four points are measured between 90.3 and 91.0 degrees with a single point at 96.9 for the Flake Orientation attribute. It is noted that both the Variance of 10.1 degrees and the Standard Deviation of 3.2 degrees are the lowest of these values among the four sub-regions. But, it is also noted that the low sample (N=4) for the Eastern sub-region is not a representative sample of the population which may explain the lower variation. Still, all four points are classified in the nominal scale data as either 1 = Collateral Parallel or 2 = Collateral Parallel Transverse, evenly divided at two each (Table A.1 and Figure 5.2). This indicates that the scale of angularity is so small that neither the acute angular nominal scale classifications of "oblique" nor "chevron" are applicable. Additionally, in reviewing the Box and Whisker graphical representation of these data (Appendix B Figure 5.1), the effects of a small sample and low variation of the Eastern sub-region sample are clearly depicted. In referring to Photo No. 2 (Appendix D), you will note the similarities in flaking patterns of points B, C, and E with F displaying a greater degree of angle; however, you will also note other attributes of these points that do not, at first glance, support any far reaching conclusions on overall point similarities. Still, as a Low-Visibility attribute, there may be more to say regarding these data after further and more robust analysis.

2.) The Northern sub-region sample of N=26 exhibits the widest range of measurements (85.8 degrees) within the entire region, with a mean of 97.9 degrees, a variance of 294.3 degrees, and a standard deviation of 17.2 degrees. This indicates that the Northern sub-region exhibits substantial variation in this attribute, far exceeding that of the other sub-regions. Yet, it is also noted that the Northern sub-region also represents the largest sample (26 points) of the study region, which is derived from a very diverse and widely distributed data base (i.e., numerous geographically dispersed sites/find spots). Still, in expressing a mean of 97.9 degrees and a median of 95.6 degrees in the angle of flake scar orientation, it appears that there may be a sub-regional preference for a more acute angular flaking pattern than that of the other sub-regions. Also, the large variation expressed in this Northern data for the Flake Orientation attribute are likewise observable in the diverse unshouldered projectile point designs of this sub-region (Appendix D, Photo Nos. 3-13). Again, as was the case in the Eastern sub-region, by studying the Box and Whiskers graph of this attribute (Appendix B Figure 5.1), the variation for this attribute in the Northern sub-region is clearly noted as compared to the other sub-regions with a single outlier (Appendix D, Photo No. 8-A), which is nearly 20 degrees outside the nearest interquartile range of the lowest quartile. Therefore, to better assess this attribute, analysis in terms of continuous scale properties will be further compared with the nominal scale Flake Pattern attribute and for co-variability with other attributes which is undertaken later in this study.

3.) The Western sub-region offers some interesting insights into the data for the Flake Orientation attribute. This sub-region offers another view on data base diversity since 8 of the 10 points included are from different sites. Yet, in analyzing the descriptive statistics, it is noted that a different pattern of variation emerges as compared to the Northern sub-region, but not quite as uniform as the Eastern. First, little difference (<1 degree) is noted between the Mean (89.0 degrees) and the Median (88.2 degrees) with a Variance of 34.5 degrees; and, the Standard Deviation of 5.9 degrees. Interestingly, of the four sub-regions, only the Western has a Mean/Median flaking orientation <90 degrees (Table 5.3, Appendix B Figure 5.1). Also, there is a single far outlier in the Western data with a Mean Flake Orientation of 104 degrees, which is identified in the Box and Whisker Plot, and further identified in the Stem and Leaf Diagram.(Appendix B Figure 5.1, Appendix B Figure 5.1B, Appendix A, Table A.1: Case 57, and Appendix D, Photo No. 18C). Interestingly, this single outlier is the Unshouldered Lanceolate produced on the Northern sub-region exotic material, Knife Lake Siltstone. Still, the nominal scale observations do not classify any of these points as exhibiting either "oblique" or "chevron" acute angled flake orientations which has been directly and strongly associated with the Northern sub-region sample (Appendix A, Table A.1). Consequently, a closer study of this variable, as compared to the other attributes, is required to test the strength of any potential relationships. And, the lanceolate produced on Knife Lake Siltstone (Appendix A, Table A.1, Case 57; Appendix D, Photo No. 18C) shall also be monitored throughout this analysis for any other attribute deviations from the standard distribution and these, if any, to be considered further.

4.) The Southern sub-region data base is the second largest sample of the sub-regions with 18 points; on the other hand, it is represented in its entirety by one site location (Samel's Field). Consequently, it could be reasonably expected that the variation among unshouldered lanceolates of a single site location would be somewhat less than that of the diverse data base of the Northern and Western sub-regions; and, while it is certainly true of the Northern area, such is not necessarily the case of the Western area for this attribute. In the case of the Southern sub-region, it is noted that the Mean Flake Orientation angle of 92.8 degrees, the Median of 90.6 degrees, and a Variance of 65.1 suggests greater overall variance for the Southern sub-region as opposed to the Western sub-region. But, the Southern data are based on 18 projectile points as opposed to 10 projectile points for the Western data. Additionally, in reviewing the Box and Whiskers plot and the Stem and Leaf diagram (Appendix B Figure 5.1; Appendix B Figure 5.1C) it is found that there are two values outside the upper quartile at 108.7 degrees and 108.9 degrees that affects both Mean and Variance measures (Table 5.3; Appendix D, Photo Nos. 30B and 30C). Consequently, it is necessary to further study this attribute, as compared to the other attributes, both within and between the sub-regions. Additionally, although at this early juncture in the analysis a too in-depth interpretation is largely spurious, it should be observed that both the Means and Medians of the Southern and Eastern flaking orientations are very closely aligned. Therefore, this observation also necessitates further analysis to test the strength of any substantive interpretations.

Summary of Flake Orientation Attribute Analysis

While nothing definitive has been shown at this juncture in the analysis, the Flake Orientation attribute appears most uniform in the patterns among the Southern, Western, and the Eastern sub-regions with no clear relationship yet established between the subregions for this attribute as graphically presented in both the Box and Whiskers Plot and Histograms (Appendix B Figure 5.1; Appendix B Figures 5.1D-5.1G). Another significant observation to this analysis, is the marked dissimilarity both among the Northern points and between the other sub-regions as compared to the Northern points. In every descriptive statistic provided, we find the Northern sub-region maintains the widest disparity in the angle of the flake scar orientation, including a vastly larger amount of variation. Of course, the Northern sub-region's data set is much larger and more prone to wider variation. Yet, the amount of dissimilarity in this attribute between the Northern points is noteworthy. Consequently, the analysis shall continue to identify and assess any trends or patterns that may continue or emerge.

<u>Attribute - Flaking Pattern - Type B</u>

Table 5.4 Flake Pattern - Type B

Flk.Pattern	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1	26	2	8	4	12
2	17	2	5	6	4
3	1	0	0	0	1
4	12	0	11	0	1
5	2	0	2	0	0
Total (N=)	58	4	26	10	18

This nominal scale attribute classifies the observable states of the continuous scale attribute of Flaking Orientation (previously analyzed) into meaningful categories of unified expression considering not just flaking angle, but the various distinctive patterns flaking style exhibits in the upper Great Lakes LPI.projectile points. Additionally, to fully understand the Flake Pattern attribute, it is necessary to remember that Flake

Orientation is a ratio-scale attribute using the Mean degree of angle as computed from all visible flake scar measurements of the LPI projectile haft area. In other words, while one or two flake scars might exhibit a high degree of angularity, and therefore influence the continuous scale Mean degree of Flake Orientation to a higher degree of angle acuteness, the point may still be recorded in its nominal state as a less acutely angled pattern (e.g., attribute states 1 or 2 in Table 5.4) based upon a unified observation of the collective visible Flake Pattern.

Therefore, as discussed earlier in this chapter under the heading "Nominal Scale Data", there are four different nominal scale states recorded for this study in lithic style. These four states are as follows: 1 - Collateral Parallel - a flaking pattern that exhibits a unified alignment of flake scars that extend in both directions from the medial ridge of the point to the lateral edges at an angle of about 90 degrees from the distal/proximal ends but are not uniformly aligned transversely across the point faces; 2 - Collateral Parallel Transverse - a flaking pattern that exhibits a unified alignment of flake scars that appear to extend transversely across the face of the point from lateral edge to lateral edge without a readily discernable re-alignment at the medial ridge and is oriented at about 90 degrees from the distal/proximal ends; 3 - Random/Unaligned - a flaking pattern that does not exhibit dominant parallel collaterally aligned uniformity in flake scar orientation; and, 4 - Oblique Collateral Parallel Transverse - the same characteristics as #2, but instead of a 90 degree angle, the flake scar angle exhibits an acute angle between lateral edges.

The following analysis of this attribute compares the expression of these nominal state classifications both within and between the sub-regions (Table 5.4). It is important to build upon our analysis of the continuous scale attribute of Flake Orientation. We shall consider, then, if these nominal scale attributes co-vary, to sufficient extent, with the continuous scale attribute previously analyzed.

The nominal scale analysis begins with some general observations about the data. It is noted that of the entire Region (N=58), 43 points (or 74%) are classified as either 1 or 2 in the nominal scale classifications which does indicate some general regional uniformity in the degree of flake angle and the uniformity of the flaking pattern. Additionally, it is noted that the Eastern, Western, and Southern samples all exhibit this very clear pattern preference of 1 and 2; however, the Northern sample appears to exhibit a dual-state character between states 1-2, (N=13 or 50%), and states 4-5, the more acute angle of the Oblique Collateral Parallel Transverse state (N=11 or 42%) and Chevron (N=2 or 8%). The Northern sub-region observed dual-state for the nominal scale Flaking Pattern attribute, which (between patterns 1-2 and 4-5) is defined by acuteness of flaking angularity, then, could explain the Northern sub-region "wider variation" of the continuous scale analysis of Flaking Orientation discussed previously. To gain further insight into the character of sub-region Flaking Orientation, Histograms of each sub-region is provided in Appendix B Figures 5.1D through 5.1G. The Northern sub-region continuous scale data does exhibit a slight bi-modal character with a definite grouping between 90 and 100 degrees and another over 100 degrees (Appendix B Figure 5.1D). The Western sub-region, on the other hand, is extremely tightly grouped in the area between 85 to 90 degrees showing very little variation (Appendix B Figure 5.1E). The Southern sub-region does exhibit more variation than the Western sample, but does not exhibit the bi-modal character of the Northern sample (Appendix B Figure 5.1F). Additionally, there is a distinctly dominant element of Flaking Pattern type 1 in the Southern sample that is not evidenced in the other 3 regions with only a 28% (N=5) representation of Transverse flaking (Table 5.4). Also, the Eastern material (for information purposes only) exhibits a dominant 90 to 92 degree flaking orientation (Appendix B Figure 5.1G) but displays a 50/50 split between Flaking Patterns 1 and 2 (Table 5.4). As further insight into this nominal scale analysis, we also note that among the sub-regions both the Western and Northern samples exhibits the Transverse characteristic to a much greater extent than the other sub-regions as indicated by the distributions in the nominal scale flaking patterns of 2 and 4 (Table 5.4).

Summary of Flaking Pattern Attribute - Unshouldered Type B

The nominal scale analysis of the Flaking Pattern attribute has revealed some interesting patterns among and between the sub-regions: First, the Northern sub-region exhibits a somewhat bi-modal character between states of this attribute with a decided acutely angled and transverse flaking pattern as one dominant expression of the attribute, and a more lateral flaking orientation without the Transverse pattern as the other dominant nominal state; second, the Western sub-region while slightly favoring a Transverse flaking pattern (N=6 or 60%), does not exhibit the acutely angled flaking pattern (N=0) as expressed in the Northern sample (N=12); and, the Southern sub-region sample exhibits a clearly dominant #1 flaking pattern with the flake channels running collaterally in each direction from the medial ridge to the lateral edges and are not transverse nor acutely angled (N=12 or 67%) and only one point in the sample displaying a #4 acutely angled flaking pattern. The Eastern sub-region, similar to the Western, exhibits no acutely angled flaking patterns. Therefore, each of the sub-regions exhibit flaking patterns unique to each sub-region, except the Eastern sub-region which sample is too small to seriously evaluate, with the most overlap in the #1 flaking pattern (Table 5.4). Again, whether these differences are significant or not will be tested later in the study.

Attribute - Thickness - Unshouldered Type B

The *Low-Visibility* attribute of thickness in projectile points is considered an element of form that can also participate in stylistic expression and is, therefore, subject to analysis:

Table 5.5 Thickness - Type B

Description	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
N of Cases	57	4	26	9	18
Minimum	4.9 mm	6.6 mm	5.1 mm	7.2 mm	4.9 mm
Maximum	11.9 mm	7.8 mm	11.9 mm	9.1 mm	8.4 mm
Range	7.1 mm	1.2 mm	6.9 mm	1.9 mm	3.5 mm
Mean	7.4 mm	7.0 mm	7.8 mm	8.0 mm	6.6 mm
Variance	2.1 mm	0.3 mm	3.1 mm	0.5 mm	1.0 mm
Std. Dev.	1.5 mm	0.5 mm	1.8 mm	0.7 mm	1.0 mm
Std. Error	0.2 mm	0.3 mm	0.3 mm	0.2 mm	0.2 mm
Skewness	0.9 mm	1.0 mm	0.8 mm	0.4 mm	-0.5 mm
Kurtosis	1.3 mm	-0.8 mm	-0.1 mm	-1.1 mm	-0.6 mm
Sum	422.3 mm	28.1 mm	202.2 mm	72.4 mm	119.6 mm
C.V.	0.2 mm	0.1 mm	0.2 mm	0.1 mm	0.2 mm
Median	7.2 mm	6.9 mm	7.2 mm	8.0 mm	6.8 mm

As in the case of the Flaking Orientation attribute, the Thickness attribute is analyzed by sub-region and across the entire study region:

1) The Eastern sub-region, with its small sample of four projectile points, continues to exhibit the least amount of variation in its data among the sub-regions with a Mean of 7.0 mm, a Median of 6.9 mm, and a Variance of only 0.3 mm (Table 5.5). It is interesting to note that both the mean and the median are most closely shared with the Southern sub-region. Yet, the small Variance of 0.3 mm and a Standard Deviation of 0.5

mm of the Eastern sub-region is most closely shared with the Western sub-region with a Variance of 0.5 mm and Standard Deviation of 0.7 mm. Still, both the Eastern and Western sub-regions are the smallest samples of 4 and 9, respectively, and the lack of variation may derive from this small sample. But, as pointed out in the Flaking Orientation attribute, the Western sample has a tremendous geographic dispersion of projectile point site locations in its small sample. Finally, among the sub-regions, the Northern sub-region data are not sharing the most similarities to the Eastern thickness attribute; but, it is noted that both the Mean and Median thickness measurements between the Eastern and Northern samples are <1 mm in difference.

2) The Northern data exhibits the most variation of all the sub-regions in the attribute of thickness with a Variance of 3.1 mm, and a Standard Deviation of 1.8 mm (Table 5.5). This same variation in the data was noted in the Flaking Orientation attribute. It should also be noted that while this variation in the Northern data are being observed in the thickness attribute, the Mean and Median measurements of the Northern sub-region are closer to the Eastern and Southern data than they are to the Western data. Interestingly, the Northern Thickness attribute Mean of 7.8 mm is closest to the Western Mean of 8.0 mm, while the Northern Median of 7.2 is closest to the Eastern Median of 6.9 mm and the Southern Median of 6.8 mm, yet further from the Western Median of 8.0. As is indicated by this analysis, variation within the Northern data has a greater effect on the Median; whereas, the very little variation in the Western data has produced the same measurement (8.0 mm) for both Median and Mean.

3) The Western sample expresses a Thickness Mean of 8.0 mm with a Median of 8.0. These are the largest Mean and Median of all the sub-regions with the Northern sub-region being the closest with a Mean of 7.8 mm and a Median of 7.2 mm (Table 5.5). Significantly, however, the diverse Western sample exhibits a remarkably small amount of variation in its data with a Variance of only 0.5 mm, and a Standard Deviation of 0.7 mm. Given the restricted variation and more pronounced thickness of Western LPI points, the Thickness attribute may possess a more robust explanatory characteristic as the analysis proceeds. Consequently, like the Eastern sub-region, the potential trend seen developing in the Western sub-region continuous scale data is one of similarity as opposed to the Northern sub-region's high variation.

4) The Southern sub-region data exhibits moderate variation in the thickness attribute with a Variance of 1.0 mm and a Standard Deviation of 1.0 mm (Table 5.5). As discussed in the foregoing Eastern sub-region Thickness attribute analysis, of interest is the closely shared Means and Medians of these two sub-regions, i.e., Southern and Eastern. Between all the sub-regions, the Thickness Mean of 6.6 mm and Median of 6.8 mm for the Southern sub-region and the Eastern Mean of 7.0 mm and Median of 6.9 are the closest. Therefore, as in the case of the Flaking Orientation attribute analysis, it is again noted that these two sub-regions (Southern and Eastern) are closely sharing attribute means and medians. This observation will be further considered as the analysis progresses.

Summary of Thickness Attribute - Unshouldered Type B

It has been determined that the sub-region exhibiting the greatest thickness in its LPI projectile points is the Western sample. While the Southern sub-region exhibits the thinnest cross-section for its projectile points, the Eastern points are very close to the

Southern with <0.5 mm difference between their Means and <0.04 mm between their medians. The Northern data are continuing to be characterized by a wide range of variation and are second in thickness to the Western projectile points. Histograms are provided to graphically represent the distribution of this attribute's values within each sub-region for the Unshouldered Lanceolate Type B (Appendix B Figures 5.2D-5.2F).

<u>Attribute - Base Width - Type B Unshouldered Lanceolates</u>

Table 5.6 Base Width - Type B

Description	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
N of Cases	58	4	26	10	18
Minimum	6.8 mm	12.7 mm	7.7 mm	11.4 mm	6.8 mm
Maximum	37.1 mm	25.4 mm	37.1 mm	28.8 mm	19.4 mm
Range	30.3 mm	12.7 mm	29.5 mm	17.4 mm	12.6 mm
Mean	17.3 mm	18.1 mm	19.3 mm	18.3 mm	13.8 mm
Variance	28.6 mm	29.7 mm	32.3 mm	26.5 mm	9.0 mm
Std. Dev.	5.3 mm	5.5 mm	5.7 mm	5.1 mm	3.0 mm
Std. Error	0.7 mm	2.7 mm	1.1 mm	1.6 mm	0.7 mm
Skewness	0.9 mm	0.5 mm	0.7 mm	0.7 mm	-0.0 mm
Kurtosis	1.9 mm	-1.1 mm	2.3 mm	-0.3 mm	0.5 mm
Sum	1004.9mm	72.5 mm	501.5 mm	182.9 mm	248.0 mm
C.V.	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.2 mm
Median	16.2 mm	17.2 mm	20.6 mm	17.1 mm	13.7 mm

The third attribute of the continuous scale data to be analyzed is the base width which is classified as a *Low-Visibility* attribute for this stylistic analysis. The above data are analyzed by sub-regions and for the whole region as follows:

1) The Eastern sub-region offers interesting variation in the Base Width attribute. It is noted that two of the four points included (Appendix D, Photo No. 2) are complete

while the remaining two base fragments are as long as the two complete points. In other words, two of the points are about ½ to 2/3 the length of the remaining two. Secondly, there are plainly three different point types among the unshouldered variety including Upper Great Lakes variants of Agate Basin, Plainview, and a generalized expanding-base Lanceolate. This wide variation of an attribute in such a small sample (N = 4), for the first time in this analysis, is reflected in the continuous scale data of the Eastern sub-region (Table 5.6). It is noted that accompanying a Mean of 18.1 mm is a Variance of 29.7 mm with a Standard Deviation of 5.5 mm. While this variance distribution introduces concerns to be considered, upon further analysis, it is found that three of the four sub-regions demonstrate significantly uniform Standard Deviations of 5.5 mm Eastern, 5.7 mm Northern, 5.1 mm Western. The Southern sub-region Standard Deviation of 3.0, a single site (Samel's Field) like the Eastern's Sheguiandah site, also include different unshouldered point types, but the larger sample (N = 18) provides an opportunity for developing a more normal distribution about the Mean. The Eastern sub-region sample of N=4 was too small to perform a meaningful Stem and Leaf Diagram, and the Box and Whiskers contribution is that there were no significant outliers indicated for the Base Width attribute (Appendix B Figure 5.3). A Histogram was included to provide a graphical distribution of the Eastern values (Appendix B Figure 5.3L).

2) The Northern subregion projectile point base widths exhibit the widest range of variation among the four sub-regions. While observing the Mean of 19.3 mm, it is noted that there is a Variance of 32.3 mm. Still, as discussed above, the Standard Deviation is 5.7 mm which is very close to the SDs of both the Eastern and Western sub-regions. Remembering the projectile point type diversity and dispersed site locations across space in the Northern sub-region, it can be observed that, for this attribute and at this stage in

the analysis, base width variation is greater than the foregoing attributes of Flake Orientation and Thickness. Additionally, in reviewing the Box and Whiskers graph of the Northern data (Appendix B Figure 5.3), it is noted that a single outlier of 37.1 mm (Appendix D, Photo No.10H) imposes considerable influence on the Mean, and that the Stem and Leaf diagram (Appendix B Figure 5.3.A) and the Histogram (Appendix B Figure 5.3I) reveal fully half of the Northern point base widths range within 2mm (between 19 to 21 mm) with both the Median and Upper Hinge at 21mm. Still, however, it remains that the Northern sub-region demonstrates the widest variation and that this variation may have subregional significance to the Northern subregion.

3.) The Western subregion sample of N=10 also offers an interesting range of Variation for the Base Width attribute. The Mean of 18.3 mm has a Variance of 26.5 and a Standard Deviation of 5.1. As was noted in both the Eastern and Northern sub-regions, the wider variation in this attribute for these sub-regions is a relatively shared characteristic as opposed to the Southern sub-region. It should be noted, however, in both the cases of the Northern and Western sub-regions, the samples are drawn from a much more diverse data base than that of the Southern sub-region (Samel's Field Site) while the low sample of the Eastern sub-region (N=4) imposes analytic constraint upon its ability to be relied upon in developing robust interpretive insights. Upon review of the Box and Whisker plot (Appendix B Figure 5.3) for the Western sub-region, the plot reveals a larger distance between the Maximum measurement and the Upper Hinge as compared to the lower measurement and the Lower Hinge. Additionally, the larger box indicating a greater internal distribution of values as compared to the Western sub-region. Further, the Stem and Leaf Diagram (Appendix B Figure 5.3B) reveals a very dispersed character to the Base Width attribute in the Western sub-region with 6 of the N=10 sample between 14 to 19 mm. The Histogram also graphically represents the distribution of values for this sub-region sample (Appendix B Figure 5.3J). Yet, in reviewing these data, it is useful to note that the Base Width Means for all three of the Western, Northern, and Eastern sub-regions are within 1mm of each other (between 18.1 mm and 19.3 mm) and are the largest means of the region; whereas, the Southern sub-region Base Width Mean of 13.8 mm is certainly different with a much reduced Mean Base Width.

4) The Southern sub-region sample (N=18) exhibits the least variation with a Mean of 13.8 mm, a Variance of 9.0, and a Standard Deviation of 3.0 and the narrowest Mean width of all the sub-regions. As previously mentioned, this sub-region sample is drawn exclusively from one site, Samel's Field, which has revealed a very clear uniformity in the Base Width attribute as compared to the variability observed in this attribute among the other sub-regions as demonstrated in the Histogram (Appendix B Figure 5.3K). Additionally, it is noted that a lanceolate variant called the Samels Lanceolate Point with a contracting haft being typical of this type (Cleland and Ruggles 1996: 66-67) (Appendix D, Photo Nos. 29-33) dominates the collection sample. Unlike the other sub-regions, the Stem and Leaf diagram reveals an almost textbook symmetry to the distribution curve for this attribute (Appendix B Figure 5.3C) while the upper and lower outliers identified in the Box and Whiskers Plot (Appendix Figure 5.3) are almost equal in range to the quartile and interquartile boxes of the other sub-regions.

<u>Summary of Base Width Attribute - Unshouldered Type B</u>:

Significantly, it appears that variation in base designs of unshouldered lanceolates imposes wide-ranging continuous scale measurements of this *Low-Visibility* attribute as indicated among the Eastern, Northern, and Western sub-region samples, although at differing scales. Yet, this extensive variation within sub-region samples may in itself offer insights into base width design which may be considered through further study of variations among types of unshouldered projectile points (e.g., Agate Basin, Plainview, Midland). Still, even with the wide variation within the samples of each of the three more northerly sub-regions, their Mean widths are notably similar with <1 mm separating their Means which are between 18 mm to 19 mm. Whereas, the Southern sub-region sample exhibits marked uniformity in expression of the base width attribute (Appendix B Figure 5.3C) with a much smaller Base Width Mean of 13.8 mm (Table 5.6). Yet, the Southern sub-region sample does not demonstrate the wider variation in unshouldered lanceolate types as does the more northerly sub-regions. This lack of variation may be accounted for by the fact that the Southern sub-region sample is taken from one site, Samel's Field, which demonstrates a decided preference for a single unshouldered lanceolate type, Samels Lanceolates (or Agate Basin-like). Consequently, for a further and more complete insight into this attribute and its expression within the unshouldered lanceolates of the study region, we must consider the sub-region samples at a more intensified level. Therefore, since the Agate Basin-like points of the Southern sub-region (N=11) dominate that sample, a closer study of the Agate Basin points of the three other sub-regions is necessary to reduce the effects of multiple projectile point types on the sub-region's sample profiles.

In the continued analysis of the Base Width attribute, it is noted that the sub-region samples are reduced in quantity, but there is an increased expectation for a more robust comparison of base width stylistic nuances both within and between the sub-regions. The Agate Basin type points among the sub-region samples are distributed as follows: Eastern N=2; Northern N=10; Western N=5; and Southern N=11. The Box and Whisker plot provides a visualization of the sub-region variation for Agate Basin type points (Appendix B Figure 5.3D). It is noted that, generally, there still remains greater variation among the Northern and Western samples for the base width attribute than that of the Southern sample. Interestingly, however, the Stem and Leaf diagrams of this variable reveals a different perspective on sub-region using the Base Width Median (Appendix B Figures 5.3E through 5.3H): Eastern = 14mm; Northern = 15mm; Western = 19mm; and Southern = 14mm. As expected, by comparing more closely related typological elements of the sub-region Unshouldered lanceolate samples (i.e., the Agate Basin point forms) a stronger comparison of the base width attribute is possible. It is interesting to note that the Southern, Eastern, and Northern sub-region Median base widths are now within 1mm of each other while the Western sub-region median is distinctly larger by between 4 to 5mm. While no conclusions can yet be developed, there does appear to be some interesting shared and dissimilar characteristics among and between the sub-region samples.

Attribute - Haft Length - Unshouldered Lanceolates

Table 5.7 Haft Length - Type B

Description	All Regions	Eastern	Northern	Western	Southern
N of Cases	57	4	26	9	18
Minimum	14.5 mm	14.5 mm	14.8 mm	18.8 mm	21.0 mm
Maximum	50.0 mm	50.0 mm	48.0 mm	49.1 mm	44.9 mm
Range	35.5 mm	35.5 mm	33.2 mm	30.3 mm	23.9 mm
Mean	31.7 mm	33.2 mm	32.5 mm	34.6 mm	28.8 mm
Variance	72.6 mm	289.8 mm	58.7 mm	89.1 mm	45.0 mm
Std. Dev.	8.5 mm	17.0 mm	7.7 mm	9.4 mm	6.7 mm
Std. Error	1.1 mm	8.5 mm	1.5 mm	3.1 mm	1.6 mm
Skewness	0.3 mm	-0.1 mm	0.1 mm	0.1 mm	0.8 mm
Kurtosis	-0.3 mm	-1.8 mm	0.2 mm	-0.6 mm	-0.2 mm
Sum	1806.5 mm	132.8 mm	844.3 mm	311.0 mm	518.4 mm
C.V.	0.3 mm	0.5 mm	0.2 mm	0.3 mm	0.2 mm
Median	31.9mm	34.2 mm	32.2 mm	32.3 mm	26.7 mm

1) The Eastern sub-region sample (N=4) possesses both the Maximum and Minimum measurements of the Haft Length attribute among all the sub-regions (Table 5.7). Additionally, with a Variance of 289.8 mm and a Standard Deviation of 17.0 mm, the small Eastern sample easily exhibits the widest variation for this attribute among all the sub-regions. The single point of interest in this sample is that the Northern sub-region also exhibits a similar character to the wide range between Maximum and minimum measurements in the sample with the Haft Length Means of both samples, Eastern Mean of 33.2 mm and Northern Mean of 32.5 mm, <1mm in difference. Yet, the Standard Deviation for the Northern sub-region is only 7.7 mm as compared to the 17.0 mm of the

Eastern sub-region sample. Given the obvious problems the Eastern sub-region sample presents (both size and variation), further comment on its characteristics would not be productive and is not, therefore, further developed.

2) The Northern sub-region sample is the largest among the sub-regions with N=26 for the Haft Length attribute (Table 5.7). At first glance at the descriptive statistics it is noted that a large variation may be present with the Range of 33.2 mm (14.8 mm Minimum to 48.0 mm Maximum); however, as indicated in the previous discussion of the Eastern sub-region, with a Variance of 58.7 mm the Standard Deviation is only 7.7 mm indicating less variation than at first inferred for a Mean of 32.5 mm (Table 5.7). To explore this attribute further we first turn to the Box and Whisker plot (Appendix B Figure 5.4) which identifies three outside values that, when considered, reveals a lesser distribution of Haft Length attribute values for the Northern sub-region sample. These three outside values include two beyond the upper outer fence (or beyond 1.5 Hspreads of the upper hinge) and one below the lower outer fence (or beyond 1.5 Hspreads of the lower hinge). The two larger Haft Length values are expressed in Cases #20 (Appendix D, Photo No. 5A) and #45 (Appendix D, Photo No.10H) measured at 44.8 mm and 46.8 mm, respectively (Appendix A, Table A.1). The lower outlier is Case #23 (Appendix D, Photo No. 5F) measured at 14.8 mm (Appendix A, Table A.1). In reviewing the outliers it is noted that 3 different types of Unshouldered projectile points are represented; however, both the lower value expressed in Case #23 and the upper value expressed in Case #45 are produced of the same raw material, Jasper Taconite (Appendix A, Table A.1). Within the remaining Northern sub-region sample (adjusted: N=23), there are 14 projectile points between the lower hinge of 28mm and the upper hinge at 35mm as noted in the Stem and Leaf diagram (Appendix B Figure 5.4A). Interestingly, there is

a smaller concentration of points (N=5) that measure between 22mm to 25mm within the Northern Sample almost providing a bi-modal distribution. Still, considering that 4 points with values greater than 35mm are also represented, the Mean of 32.5 mm and Median of 32.2 mm appears reasonably robust in representing the Haft Length attribute of the Northern sub-region sample.

3.) The Western Sub-region sample (N=9) appears to exhibit the greatest variation of the remaining three sub-regions being considered in this attribute analysis, i.e., Northern, Western, and Southern. Given a Western sub-region Haft Length attribute Mean of 34.6 mm (only 2 mm greater than the Northern sub-region Mean) a Variance of 89.1 mm with a Standard Deviation of 9.4 mm is noted (Table 5.7). The Western Median of 32.3 mm, however, is almost the same as the Northern Median of 32.2 mm (Table 5.7). In reviewing the Box and Whisker plot (Appendix B Figure 5.4), it is noted that while the Western sample does not exhibit outliers, the small sample has nearly the same range as the Northern sample that had both upper and lower outliers. Looking at the Stem and Leaf diagram (Appendix B Figures 5.4B and 5.4A), it is found that while the distribution of values between the hinges is within 8mm for both the Western and Northern sub-regions, that the Western sample is more widely distributed between the hinges with the Northern sample being more centrally distributed about the Mean. In this case, then, possibly the small sample size of the Western sub-region (N=9) has limited ability to develop a strong central tendency, or, if the Western sample is relied upon as representative, variation is greater for the Haft Length attribute in the Western sub-region. Significantly, we are reminded of the almost identical Medians of the Northern and Western sub-region samples, so that assuming the small Western sample is still representative may not be entirely without merit. Consequently, the analysis shall proceed under the assumption that an acceptable sample is represented in the Western sub-region data.

4) The Southern sub-region Unshouldered lanceolate Haft sample (N=18) provides an interesting basis for further comparison as its derived from one site, as opposed to multiple sites which is the case for the Western and Northern sub-regions. To begin, the Mean is 28.8 mm with a Variance of 45.0 mm and a Standard Deviation of 6.7 mm (Table 5.7). Both the Mean and, apparently, the attribute variation of the Southern sub-region Haft Length sample are less than that of the other sub-regions (Table 5.7). The Box and Whisker plot indicates that there are no outside values and that a greater percentage of the sample is between the hinges than that of the Northern and Western sub-regions with a decided skewing of the Median towards the lower hinge (Appendix B Figure 5.4). The Stem and Leaf diagram provides further insight into the attribute data by revealing that there are no values below 21mm and that 11 values of the N=18 sample are between 21 mm to 28 mm (Appendix B Figures 5.4A and 5.4B). Additionally, in assessing the skewness, the Lower Hinge is 24 mm with the Median at 27 mm, while the Upper Hinge is 34 mm. There is some variation among values of the Haft Length attribute of the Southern sub-region, but it is not as great as in the other sub-regions; and, the Haft Length Median is also >5 mm less than the other sub-regions' Medians.

<u>Summary of Haft Length Attribute:</u>

It was determined that the Eastern sub-region small sample (N=4) and extremely wide variation (Variance = 289.8 mm and Standard Deviation of 17.0 mm) was unreliable for further analytic comparison within the Haft Length attribute. The Northern (N=26) and Western (N=9) samples provided almost identical Medians (32.2 mm and 32.3 mm, respectively), and very close Means with the Western sub-region displaying the widest

Variance and Standard Deviation of the three sub-regions analyzed. Additionally, between the Western and Northern sub-region samples, the Range of measurements is of some interest. Although the Northern sub-region sample exhibits the widest Range of measurements for the attribute Haft Length (33.2 mm) if we consider the smallest Northern Case (14.8 mm) is an outlier, then both the Maximum and the Minimum measurements recorded are well within the Range of the Western sub-region. The Southern sub-region sample (N=18) exhibited a substantially smaller Haft Length Mean and Median (>5 mm smaller than the Western and Northern samples) with the lowest Variance of 45.0 mm and Standard Deviation of 6.7 mm. Significantly, the Southern sub-region sample has again demonstrated (rather consistently) similar small variation of the Unshouldered lanceolate attributes including the Haft Length. As discussed in the Southern sub-region analysis, this sub-region sample is derived from one site location (Samel's Field Site) and, therefore, may be expected to exhibit less variation than those samples drawn from geographically dispersed multiple site locations such as in the case of both the Northern and Western sub-regions. Importantly, as the analysis proceeds and following further tests of variance, if the homogeneous trend continues within the Southern sub-region sample, it may also provide a very useful analytic and comparative tool for regional intragroup and intergroup stylistic behaviors of the period.

Attribute - Haft Lateral Edge Shape - Unshouldered Type B

This nominal scale, Moderate Visibility, attribute is recorded in three observable states for the entire region: 1 = Straight, 2 = Expanding, and 3 = Contracting. The Straight lateral edge (#1) was recorded when the width at the top of the Haft area was the same (or very close) to the Base Width measurement, thereby producing a visibly Straight line (i.e., relatively no angle) between the Base and top of the Haft area. The Expanding lateral edge (#2) was recorded when the Width of the Base was greater than the Width at the top of the Haft area. The Contracting lateral edge (#3) was recorded when the Base Width was lesser than the top of the Haft Width. Obviously, the continuous scale variables of Base Width, Haft Length, and Width are combined in this nominal scale attribute to provide the three observable states recorded.

Table 5.8 Haft Lateral Edge Shape - Type B

Descriptions	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1 Straight	1	0	1	0	0
2 Expanding	4	1	2	1	0
3 Contracting	53	3	23	9	18
Total (N=)	58	4	26	10	18

The uniformity of this nominal scale attribute throughout the entire region is quite remarkable. As has been noted previously, attribute and/or attribute states, both between and within sub-regions, has been rather consistent in variation. In this attribute, the Contracting Haft Lateral Edge is the clearly dominant state (N=53 or 91%) shared by all sub-regions with no variation at all in the Southern sub-region (Table 5.8). Additionally, the extremely low incidence of either Straight or Expanding Haft Lateral Edges (N=5) provides a decided uniformity to the entire Region's LPI Unshouldered Lanceolates in the Hafting Lateral Edge configuration that may be of particular interest in analyzing the Shouldered Lanceolates relative to stylistic expression and change through time. As pertains to the Unshouldered lanceolate Regional analysis, however, the lack of variation in this attribute expression makes any further observations non-productive which is clearly evidenced in the Histogram's graphical representation of the Eastern, Northern, and Western sub-regions' sample distributions, and the "no variance" distribution of the

Southern sample for the Contracting Haft shape (Appendix B Figures 5.5A through 5.5C). Therefore, in summation, it has been found that the Unshouldered Lanceolates of upper Great Lakes LPI were typically produced with Contracting lateral edges of the haft area..

Attribute - Base Shape (Concave, Convex, Straight) - Unshouldered

In analyzing the projectile base, there are three nominal scale states of this variable including straight, convexity, and concavity (coded as 1, 2, and 3, respectively, Appendix A) which are included in this study. In view of the lack of variation from the straight (or 0.0 mm continuous scale data) base shape between the sub regions (Appendix A), it was determined that a continuous scale analysis would not be productive for this study. Therefore, the following are the nominal scale data and analysis for the base shape variable identifying the Base Straight variable (or 1) as the shape that exhibits a straight line between the two corners of the base (recorded as 0.00 in the continuous scale data); the Base Convexity variable (or 2) (recorded as a +0.00 measurement in the continuous scale data); and, the Base Concavity variable (or 3) exhibiting a concave base (recorded as a -0.00 measurement in the continuous scale data).

Table 5.9 Base Shape - Type B

Base Shape	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1 - Straight	30	2	11	2	15
2 - Convex	11	0	3	6	2
3 - Concave	17	2	12	2	1
Totals (N=)	58	4	26	10	18

In reviewing the Base Shape attribute data, some interesting trends are expressed (Table 5.9). To begin, we see that the Eastern sub-region sample (N=4) shows a 50/50 split between either concave or straight base shapes which character is most closely paralleled by the Northern sample; however, this small sample is not substantial enough, in either quantity or distribution, to be representative and is not considered further in this analysis; although, a Histogram is presented that graphically depicts the Eastern distribution of this nominal scale attribute (Appendix B Figure 5.6A). Of the three types of base shapes classified (1, 2, and 3) we find that the remaining three sub-regions each exhibit substantively different preferences which sets each sub-region apart from the remaining two. The Northern sub-region sample (N=26) exhibits a nearly equal distribution between straight and concave base shapes for a total of 23 cases with only three remaining cases exhibiting a convex base shape which is illustrated in the Histogram (Appendix B Figure 5.6B). This fairly equal division of base shape is only shared with the small Eastern sample. The Western sub-region sample (N=10) stands alone in both its dominance of Convex base shape cases (60%) and the equal distribution between the remaining 4 cases (or 40%) between Straight and Concave as indicated in the Histogram (Appendix B Figure 5.6C). In the case of the Western sub-region sample, although it is small (N=10), the wide distribution of its data sources suggests that it is representative of the population for purposes of this analysis. The Southern sub-region sample (N=18), on the other hand, is highly characterized by Straight base shapes with only 1 concave base and 2 convex bases recorded as indicated in the Histogram (Appendix B Figure 5.6D). As mentioned previously, the Southern sample, while not derived from widely distributed sources such as the Northern and Western samples, is derived from a single site location which may reflect a bias of either this site sample, or the site population's preference for base shape style. This analysis, however, proceeds from the assumption that the Southern sample is representative of the population and that, therefore, the base shape preference is that which is shared among the population.

Summary - Base Shape Attribute - Unshouldered

Given the foregoing analysis, it is noted that the Northern, Western, and Eastern sub-region samples each exhibit base shape characteristics that are specific and unique to each sub-region and are different between sub-regions (Appendix B Figures 5.6A through 5.6D). Further, we find that variation for the base shape attribute is greater among the Northern and Western sub-regions than the Southern sub-region. Still, it is noted that the data for the Northern and Western sub-regions are from more widely distributed sources as opposed to the single site location for the Southern sample. Consequently, this attribute will be studied further in comparison to all other Unshouldered lanceolate attributes considered so far in this analysis. The analysis of the Unshouldered Lanceolates will be further considered through employment of appropriate inferential statistical calculations following analysis of the descriptive statistics of Raw Material for Unshouldered Lanceolates and the Shouldered Lanceolate projectile points.

Attribute - Raw Material - Unshouldered Type B

Table 5.10 Raw Material - Type B

Raw Mat'l.	All Regions	Eastern	Northern	Western	Southern
1	4	4	0	0	0
3	9	0	9	0	0
5	4	0	3	1	0
6	2	0	2	0	0
10	7	0	1	6	0
11	7	0	0	0	7
12	10	0	0	0	10
14	13	0	10	2	1
15	1	0	1	0	0
16	1	0	0	1	0
Totals (N=)	58	4	26	10	18

To begin the Raw Material analysis, it is significant to note that each of the 4 sub-regions possesses identifiable lithic raw material/s that dominate each sub-region's raw material profile, which is locally available, and is either absent (or present in extremely small quantities) in other sub-regions raw material inventory (Tables 5.1 and 5.10). Additionally, to ensure critical elements of the Raw Material data were traceable to specific geographic resources, INAA/XRF testing was initiated for both resource samples and site samples which, in all cases, confirmed previous and present associations and identifications of raw material resource and distribution (Appendix C; Table 5.1). These associations having been acceptably confirmed through the INAA/XRF testing, allowing this Raw Material analysis to proceed in a robust fashion (Appendix C).

1) First, the Eastern sub-region exhibits only the locally available Sheguiandah Quartzite for the unshouldered lanceolate with no exotic lithic raw material present, and no variation, in the unshouldered Raw Material sample. The Sheguiandah Quartzite raw material ranges between a very light gray to medium gray color; the luster (or light reflective properties) is glossy; the texture is between smooth to medium; the physical structure is solid with some intrusive iron stain mottling; and, the density is translucent. This quartzite material would be very difficult to macroscopically differentiate between the quartzites of the western upper peninsula, e.g., Mesnard Quartzite (Buckmaster & Ruggles 1991; Greenman 1943; Greenman & Stanley 1942). Unfortunately, the small sample (N=4) does not possess the integrity to adequately represent the Eastern population beyond the foregoing simple observations.

2) The Northern sub-region sample (N=26) offers the widest range of variation among all the sub-regions with six different classifications represented as indicated in the Histogram (Appendix B Figure 5.7A; Table 5.10; Appendix C) (Julig, Pavlish & Hancock 1988). The single largest quantity of raw material, 10 recorded, was classified as Unidentified which category includes even more diversity than one type of unidentified lithic raw material and is likely procured from the glacial till. The second largest quantity was 9 unshouldered lanceolates produced of Jasper Taconite, a locally available material that is black with some red jasper marbling; the luster is glossy; the texture is smooth; the physical structure is predominately solid with some slight marbling; and, the density is opaque. The next largest quantity were 3, made of Knife Lake Siltstone (again, locally available) that is black in color; the luster is dull; the texture ranges between medium to fine; the structure is solid; and the density is opaque. Both the Jasper Taconite and the Kife Lake Siltstone are regionally distinctive in their

respective macroscopic properties. Interestingly, two lanceolates were made of the exotic material named Knife River Chalcedony (nearest known source is in North Dakota) and a distinctive high quality lithic material, although caution is needed to avoid confusion with Hudson Bay Lowland (HBL) chert. One point was produced on Hixton Silicified Sandstone, an exotic from Silver Mound Wisconsin which properties are described in the following Western sub-region analysis; and, finally, one point made of a Silurian chert with sources widely distributed throughout the region. While we see a clear use of locally available raw material in the black and red colored Jasper Taconite, and the black colored Knife Lake Siltstone (approximately 46%), it is also clear that there is a much greater tendency towards variation in the lithic Raw Material's used in the Northern sub-region than in any other of the sub-regions. Additionally, there is a distinct absence of quartz and/or quartzite material in this sample (except the one Hixton point) with a much greater presence of cherts, siltstone, and jasper taconite. This variation appears to be in keeping with the variation exhibited in other unshouldered lanceolate attributes of the Northern sub-region as analyzed in the foregoing continuous scale data.

3) The Western sub-region sample (N=10) also exhibits some variation in its character with four different kinds of raw material identified as indicated in the Histogram (Appendix B Figure 5.7B; Table 5.10) (Boszhardt 1993; Brown 1984). Yet, unlike the Northern sub-region, there is a defined dominant presence of locally available material with both Hixton Silicified Sandstone 6 or (60%) which is a white to dark orange color; the luster is a high gloss; the texture is smooth; the physical structure is solid with highly infrequent mottling by mineral intrusions; and it's density is translucent. There is Galena Chert, 1 (or 10%), present in the sample and an additional 2 (or 20%) of the sample being Unidentified, and one point (or 10%) made of the exotic black lithic

material, Knife Lake Siltstone, from the Northern sub-region. Additionally, it is interesting to note that the Raw Material variability in the Western sample is less than the Northern sample, but appears to be in accordance with the level of variability among other attributes of the unshouldered lanceolates for the Western sample. Most importantly, the Raw Material profiles of both the Western and Northern sub-regions appear different in both their material profile and macroscopic (or visual) character.

4) The Southern sub-region Raw Material sample (N=18) for unshouldered lanceolates displays the least variation of the sub-regions excluding, of course, the Eastern sub-region as also indicated in the Histogram (Appendix B Figure 5.7C; Table 5.10) (Luedtke 1976). This sample exhibits two dominant raw materials, Bayport Chert, an exotic from the eastern shores of the lower peninsula near Au Gres and Saginaw Bay, which ranges between a light to very dark blue/gray color; the luster is between waxy and dull; the texture is medium to coarse with frequent crystalline and/or fossil inclusions; the visual physical structure is often concentrically banded moving from light to dark shades as the nodule material is exposed by reduction sequences from the cortex (almost white) to the center (sometimes almost blue/black); and the density of Bayport Chert is opaque. The other prominent raw material is the locally available Norwood Chert that is pale grey or tan in color; the luster is dull to waxy; the texture is fine to medium; the visual physical structure is finely laminated; and, the density is opaque. The more distant Bayport Chert dominates the sample with 12 (or 67%) and the local Norwood Chert occurs in 7 points (or 39%), with only 1 unshouldered projectile point made of unidentified material, probably procured from the plentiful glacial till. Each of these materials are macroscopically distinctive from the other. Consequently, as in the previous analyses of the Southern sub-region, the uniformity of the raw material sample

is striking in its contrast to the variability of the other sub-regions and in its co-variability with the continuous scale variables of the Southern sub-region. Additionally, the prominent dual-state occurrence of the exotic Bayport Chert and the local Norwood Chert produces an interesting effect for further analysis in this study of style and mobility.

Summary - Raw Material Attribute - Unshouldered Type B

It is interesting to note that the nominal scale attribute of lithic Raw Material appears to co-vary in a rather discrete fashion with the continuous scale attributes of the respective sub-regions. Also interesting to note is the distinctly different raw material types and their individual properties (e.g., color) which also appears to provide some very visible and discrete differences in the sub-regional LPI Unshouldered Lanceolate projectile point profiles. The significance of this intra-site attribute co-variability, and the robustness of this nominal scale attribute analysis, will require additional assessment when we further engage the inferential statistical methods and hypotheses testing. At this point, however, the patterns observed appear to indicate some substantial uniformity both within sub-region samples and differences between sub-region samples.

Attribute - Width - Unshouldered Type B

Width is a continuous scale attribute measured at the widest point between the lateral edges of a specimen. It is recognized that some specimens are fragments while others are complete; therefore, for purposes of this study, we analyze each condition (i.e., complete and broken) as well as the combination of both. This approach is intended to reveal any potential problems in the data which need to be controlled in the analysis. Still, in that the focus of this study is the haft or basal area of the projectile point, and the projectile fragments contained in this study are the base fragments with fractures predominately occurring either at or just above the haft area, the basal fragments are considered appropriate and sufficient for our analytic requirements.

Table 5.11 Width - Type B

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	57	4	26	9	18
Minimum	16.4 mm	19.7 mm	21.7 mm	23.3 mm	16.4 mm
Maximum	40.9 mm	26.9 mm	40.9 mm	37.6 mm	26.4 mm
Range	24.5 mm	7.1 mm	19.3 mm	14.2 mm	9.9 mm
Mean	24.4 mm	23.2 mm	25.8 mm	28.6 mm	20.6 mm
Variance	21.1 mm	14.6 mm	14.6 mm	20.2 mm	8.3 mm
Standard Dev	4.6 mm	3.8 mm	3.8 mm	4.5 mm	2.9 mm
Std. Error	0.6 mm	1.9 mm	0.7 mm	1.5 mm	0.7 mm
Skewness	1.0 mm	0.0 mm	2.6 mm	0.9 mm	0.1 mm
Kurtosis	2.5 mm	-2.0mm	7.6 mm	-0.2 mm	-0.8 mm
Sum	1390.5 mm	92.8 mm	670.4 mm	257.0 mm	370.4 mm
C.V.	0.2 mm	0.2 mm	0.1 mm	0.2 mm	0.1 mm
Median	24.0mm	23.1 mm	25.0mm	27.5 mm	21.3 mm

This table combines all Complete projectile points and base or haft Fragments contained in the study. The Eastern sub-region sample, while not considered sufficient for population representation nor for serious consideration in this analysis, does exhibit a Mean (23.2 mm), Variance (14.6 mm), and Standard Deviation (3.8 mm) all of which are very close to that of the Northern sub-region (Table 5.11).

The Northern, Western, and Southern sub-regions all exhibit different characteristics for the Width attribute as indicated in the Box and Whisker Plot (Appendix B Figure 5.8). The Northern sub-region is the largest sample at N=26; however, the Mean of 25.8 mm, the Variance of 14.6 mm, the Standard Deviation at 3.8 mm, and the Median at 25.0 mm are all less than the Western sample, but greater than the Southern sub-region sample. In reviewing the Box and Whisker Plot and the Stem and Leaf Diagram for the Northern sub-region it becomes clear that two upper quartile outside values (one of which is far outside at 40.9 mm) certainly influenced the Northern sample Mean (Appendix B Figures 5.8 and 5.8A). Therefore, in terms of size differences and given the effects of outside values, the amount of difference between the Means and Medians of these sub-regions is of particular interest. The Western sample also exhibits an upper quartile outside value at 37.6 mm, which is close to the Northern far outside value and explains the relatively even shifts between their respective Means and Medians (Appendix B Figures 5.8, 5.8A and 5.8B). The Western Mean of 28.6 mm and Median of 27.5 mm are greater than both the other two sub-regions with the Northern sample being less by 2.8 mm (Mean) and 2.5 mm (Median), and the Southern sample being less than the Western sample by 8.0 mm (Mean) and 6.2 mm (Median) (Table 5.11; Appendix B Figures 5.8B and 5.8C). So that ranking the sub-region Mean sizes from largest to smallest with 28.6 mm for the Western sample, 25.8 mm for the Northern sample, and 20.6 mm for the Southern sample does indicate a potentially important difference that will require further testing later in the analysis.

Also, it is noted that variation across the Width attribute can be arranged by sub-region in the same way and with the same results as the Mean and Median (Table 5.11). The Western sample (N=9) has, by far, the greatest Variance at 20.2 mm with a Standard Deviation of 4.5 mm. The Northern sample (N=26) with a Variance of 14.6 mm and Standard Deviation of 3.8 mm is less than the Western sample, but greater than the Southern sample. The Southern sub-region (N=18) exhibits the least variation with a Variance of 8.3 mm and a Standard Deviation of 2.9 mm.

At the beginning of this attribute analysis, the issue of complete versus basal fragment effects on the continuous scale analysis was raised. The following Table 5.11.1 compares, by Region and Sub-regions, the breakdown of Complete (1) and Fragment (2) LPI projectile points, using the most significant descriptive statistics to our analysis. In the Table, **All** = All Regions, **N** = Northern, **W** = Western, **S** = Southern, and **1** = Complete or **2** = Fragment, respectively. Note that the Eastern sub-region was omitted from this further review due to its lack of sufficient sample. It should also be noted that the measurements listed are in millimeters and were taken using the same equipment, methods, and techniques.

<u>Complete vs. Fragment Comparison - Width Attribute - Unshouldered Type B</u>

Table 5.11.1 Complete vs. Fragment Comparison - Width Attribute - Type B

INFO	**All - 1**	**All - 2**	**N - 1**	**N - 2**	**W - 1**	**W - 2**	**S - 1**	**S - 2**
N =	39	18	18	8	7	2	12	6
Mean	24.5mm	24.3mm	25.9mm	25.7mm	29.2mm	26.5mm	20.4mm	20.9mm
Median	24.0mm	24.1mm	24.6mm	25.0mm	27.5mm	26.5mm	20.0mm	21.7mm
Varinc	26.2mm	11.1mm	19.2mm	5.3mm	21.9mm	19.4mm	10.0mm	6.0mm
Std.D.	5.1mm	3.3mm	4.4mm	2.3mm	4.7mm	3.1mm	3.2mm	2.4mm

To begin, it is noted that the Complete (1) projectile points are at least double the quantity of the Fragments (2) in the Region and in each sub-region (Table 5.11.1). As a reminder, the only measurements of concern to this analysis are in the haft (or basal) area so that fragments refer to those with an intact base and would include those with tip breakages, although this distinction is of no analytic significance to this study. Width attribute Means and Medians of both Complete and Fragment projectile points can be arranged by size from greater to smaller with the Western measurements being greatest, the Northern measurements less than the Western but greater than the Southern sample, and the Southern sample being the smallest of the three sub-regions in both Complete (1) and Fragment (2) categories. Additionally, the differences between the Means for the sub-regions are sufficient to note some potential significance.

The Variance and Standard Deviation for Complete (1) projectile points, like the Means and Medians, can be arranged based upon greater to smaller with the Western sample the greatest Variance and Standard Deviation, the Northern with the second greatest Variance and Standard Deviation, and the Southern sample with the substantially less amount of Variance and the least Standard Deviation. In all the foregoing cases of Means, Medians, Variance, and Standard Deviation this table (Table 5.11.1) reproduces the same findings as the Combined 1 and 2 table analyzed above (Table 5.11). Still, for the Fragment (2) category, there is a slight repositioning between Southern and Northern samples in the Variance and Standard Deviation with the Southern sample now displaying greater Variance and Standard Deviation than the Northern sample, but by less than ½ a mm for each.

<u>Summary - Width Attribute - Unshouldered</u>

Given the results of the foregoing analytical exercise which tested the effects of Complete vs Fragment LPI projectile point conditions on the descriptive statistics contained in this study, it is apparent that while there are some very minor effects noted in the Fragment (2) category, that they appear negligible in their effect on the outcome of the analysis (Table 5.11.1). In short, the findings of the Combined Complete and Fragment (Table 5.11) Width analysis, at the beginning of the Width attribute analysis were almost entirely reproduced in both the individual Complete (1) and Fragment (2) comparative analysis. Therefore, the analysis shall proceed using the Combined Table format to avoid unnecessary and unproductive splitting of attribute analyses.

The results of this attribute analysis revealed a potentially robust difference between the sub-regions for the Width attribute while also identifying some potential patterned variation both among and between sub-regions. This attribute will require further study in the context of the other attributes for analysis of any potential larger patterns of co-variability and similarity.

Summary - Unshouldered Lanceolate Analysis

The continuous and nominal scale descriptive statistical analyses of the LPI Unshouldered Lanceolate have revealed some interesting observations that will aid in the further study of this data. To provide some insights into these analyses, a table (Table 5.12) has been developed which includes a summary of the Means and Standard Deviations of the Continuous Scale attributes and a Presence/Absence of Nominal Scale categories with **bolded** numbers to indicate the dominant category/s exhibited and organized by Sub-regions and the Region.

Table 5.12 Unshouldered Lanceolate Comparison

Attribute	All Regions	Eastern	Northern	Western	Southern
1-Flake Orientation	94d /sd12.9	92.1d /sd3.2	97.9d/sd17.2	89.0d /sd5.9	92.8 /sd8.1
2-Flake Pattern	1,2,3,4,5	1 & 2	1,2,4, & 5	1 & 2	1,2,3,4
3-Thick-ness	7.4 / sd1.5	7.0 / sd0.5	7.8 / sd1.8	8.0 / sd0.7	6.6 / sd1.0
4-Base Width	17.3 / sd 5.4	18.1 / sd5.5	19.3 / sd5.7	18.3 / sd5.2	13.8 / sd3.0
5-Haft Length	31.7 / sd8.5	33.2 / sd8.5	32.5 / sd7.7	34.6 / sd9.4	28.8 / sd6.7
6-Haft Shape	1,2,3	2 & 3	1, 2, 3	2 & 3	3
7-Base Shape	1,2, & 3	1 & 3	1, 2, & 3	1, 2, & 3	1, 2, & 3
8-Raw Material	**14 & 12**	**1**	**14 & 3**	**10 & 14**	**12 & 11**
9-Width	24.4 / sd 4.6	23.2 / sd3.8	25.8 / sd3.8	28.6 / sd4.5	20.6 / sd2.9

An important observation throughout this analysis has been that the Southern sub-region sample appears to consistently exhibit variations of the above attributes, except Haft Lateral Edge Shape, that are distinctly different than the other sub-regions. Additionally, as only a single site is represented in the Southern sample, it offers an opportunity to observe the data for individual attributes both comparatively as well as within the sample at sub-regional and Regional levels. In analyzing the nominal scale attribute Haft Lateral Edge Shape, the Contracting Stem state of this attribute has been revealed as a commonly shared characteristic throughout the Region's LPI Unshouldered lanceolates. The underlying observation here is that, given the theoretical underpinnings of this stylistic analysis and the context of the Southern sample, the Southern sub-region sample should exhibit less variation within its assemblage and more variation between its assemblage and that of the other sub-regions. In point of fact, that is what appears to occur. Although this difference has not been statistically measured, upon close scrutiny of the descriptive statistics employed in this analysis, there does appear to be substantial reason for this observation. Further statistical analysis will be employed to test this observation and further extend the explanatory power of the Southern sub-region data in this study.

The Unshouldered Lanceolate analysis has revealed certain patterns and observations that will require further testing later in this study. These patterns and observations are summarized as follows:

1. Flake Orientation - The three main sub-regions of this study (Northern, Western, and Southern) each exhibits a different continuous scale Mean with the Northern at 97.9 degrees, the Western at 89.0 degrees, and the Southern at 92.8 degrees. Additionally, it is noted that the small Eastern sample Mean of 92.1 degrees is most closely aligned with the Southern sub-region; however, this observation is statistically insignificant due to the small sample of the Eastern sub-region (N=4). Another interesting element of this analysis is that the Northern and Western Means for the Flake Orientation attribute are different by 8.7 degrees, indicating some potential difference requiring a further statistical test for significance. Another area of interest is the variation both within and between the sub-regions. The Northern sub-region sample exhibits a Standard Deviation (sd) of 17.2 degrees, the largest sd of all the sub-regions by 9.1 degrees, which indicates the greatest amount of variation within a sub-region sample for the Region. The

Standard Deviations for the Western and Southern sub-regions are 5.9 degrees and 8.1 degrees, respectively, with only a 2.2 degree difference. In both the Mean and Variation, then, there are indications of three distinctly different patterns for the Northern, Western, and Southern sub-regions that will require further statistical testing for appropriate interpretation.

2. The nominal scale Flake Pattern attribute reveals interesting sub-regional characteristics based upon observations of the occurrence of various states of this attribute. It is observed that the three major sub-regions of this study (Northern, Western, and Southern) each exhibits a different dominant Flake Pattern state: The Northern sample exhibits a dual-state character (states 1 and 4) that is not shared with any other sub-region; the Western sub-region dominant attribute state is 2, which is different from any other sub-region; and the Southern sub-region exhibits a clearly dominant attribute state 1, which is only shared with the Northern sample. The Eastern sample was evenly divided between states 1 and 2. Importantly, this nominal scale Flake Pattern attribute provides some insights into the continuous scale Flake Orientation attribute particularly as applies to the Northern sample. Wide variation in Flake Orientation of the Northern sample has been previously noted. The Flake Pattern attribute identifies a dual-state occurrence for the Northern sample with one of these states' characteristics being acuteness of the flake angle (i.e., Flake Orientation). Therefore, it will be important to further analysis that this duality, and the difference in Means and states be measured for significance.

3. The Thickness attribute analysis revealed the Southern sub-region sample as exhibiting the least Mean of 6.6 mm, while the Northern and Western Means of

7.8 mm and 8.0 mm, respectively, were <0.2 mm apart, but at least 1.2 mm thicker than the Southern sample Mean. Again, the Western sample displays the least variation with a Standard Deviation of 0.7 mm, the Northern sample exhibits the most variation with a Standard Deviation of 1.8 mm, and the Southern sample variation is in between with a Standard Deviation of 1.0 mm. The most important points of observation are that the Southern sample Mean appears to be both less variable and thinner, overall, than the other sub-regions, excluding the Eastern sample with a Mean of 7.0 mm and a Standard Deviation of 0.5 mm, and that the greatest variation is still in the Northern sub-region and the least is in the Western sub-region. The Thickness attribute appears to co-vary with the Flake Orientation and Flake Pattern attributes. Therefore, it appears that a pattern of sub-regional attribute behavior may be emerging. Still, the significance of these observations has not yet been determined and will require further testing later in this analysis.

4. The Base Width attribute is, again, indicating a much smaller Mean for the Southern sub-region at 13.8 mm as compared to the very similar Means of 19.3 mm for the Northern sample and 18.3 mm for the Western sample (or 1 mm difference). The Northern sample again displays the greatest variation with the Standard Deviation of 5.7 mm; however, the Western Standard Deviation of 5.2 mm indicates a very similar amount of variation. The Southern sample exhibits the least variation with a 3.0 mm Standard Deviation. The small Eastern sample Mean and Standard Deviation are both very close to the Northern and Western measurements with a Mean of 18.1 mm and a Standard Deviation of 5.5 mm. Interestingly, once again it is noted that the Southern sub-region Mean is much smaller (4.5 mm) than the Nearest Base Width Mean of 18.3 of the Western

Sample. Also, the Northern sample exhibits the largest Mean and widest variation for the Base Width attribute. These observations appear to continue the co-varying trend between attributes within each sub-region which tends to underscore potential important differences. The statistical significance of these differences, however, will be established later in this analysis of upper Great Lakes LPI projectile point style.

5. The continuous scale attribute of Haft Length does illustrate some change between the Western and Northern samples Means with the Western Sample now having the largest Mean of 34.6 mm, and the Northern having the next largest Mean of 32.5 mm. Still, the Southern sample exhibits the least Haft Length Mean at 28.8 mm. The variation among the sub-region samples follows the same pattern as the Means with the Western having the greatest variation with a Standard Deviation of 9.4 mm, the Northern sample at 7.7 mm, and the Southern sample with the least variation at 6.7 mm. The Eastern sample is again nearest to the Northern and Western sub-regions with a Mean of 33.2 mm and a Standard Deviation of 8.5 mm. It is observed that in all the LPI projectile point size measurements considered thus far, the Southern sub-region sample is smaller by reasonably large margin. It will be extremely informative in testing the strength of these differences as a collectivity later in this analysis. In this single attribute's case, however, it is important to note that there are only 5.8 mm separating the smallest and the largest Means which, without statistical testing, does not inform us of the level of significance.

6. The nominal scale attribute of the Haft Lateral Edge Shape basically combines the continuous scale measurements of Base Width, Haft Length, and Width and

collapses these measurements into three different observable states including, 1. Straight, 2. Expanding, and 3. Contracting. While there was some small amount of each of these states exhibited in varying degrees among the sub-regions, all sub-region samples were clearly dominated by the Contracting Haft Lateral Edge Shape (Table 5.8). Consequently, this nominal scale attribute will not reveal any important information relative to discovering significant levels of difference.

7. The nominal scale observations of the Base Shape attribute provides three different observable states including, 1. Straight, 2. Convex, and 3. Concave. Unlike the Haft Lateral Edge Shape attribute, there are some particularly interesting observations of this attribute that emerges. First, the Southern sub-region possesses a distinctly uniform preference for the Straight Base Shape at 15 (or 83%) observed of N=18. The Western sample indicates a preference for the Convex Base Shape at 6 observed of N=10 (or 60%) with the remaining sample evenly split between states 1 and 3. The Northern sample exhibits an interesting dual-state characteristic with almost identical frequencies between 11 (or 42%) observed Straight and 12 (or 46%) observed Concave, with only 3 (or 12%) observed Convex of N=26. Unfortunately, the continuous scale measurements of Convexity (+X mm) and Concavity (-X mm) with 0.00 as the Straight state provided extremely little variation for useful inclusion in this analysis. Therefore, the observations of this nominal scale attribute, along with the Flake Pattern nominal scale attribute, will be further considered following the inferential statistical analysis portion of this study.

8. The nominal scale Raw Material attribute is extremely informing regarding both intra-subregion and inter-subregion types and occurrences. First, the Southern

sub-region sample is dual-state between Bayport Chert (exotic) at N=10 and Norwood Chert (local) at N=7 with Bayport Chert dominating with a sub-region total Raw Material count of N=18. The colors of these materials runs between light tan/grey to dark brown/grey with the Norwood Chert producing a prominent finely laminated (or layered) structure and the Bayport with a more concentrically banded structure. The Northern sample also produces a dual-state dominant occurrence of both Unidentified (but, widely variable) lithic material (N=10), and the locally available Jasper Taconite (N=9). Interesting among the Northern raw materials is the Hixton Silicified Sandstone Unshouldered Lanceolate, located in Quetico Park, Northern Ontario, which is only known to outcrop in central-lower Wisconsin, and which exhibited the Oblique Transverse flaking pattern associated with the Northern sub-region sample (Appendix D Photo No. 10G). The Western sample is dominated by one pseudo-quartzite material, Hixton Silicified Sandstone, which outcrops at the Silver Mound in lower-central Wisconsin. In the case of the Western sub-region raw materials, of particular note is the occurrence of a single Unshouldered Lanceolate produced on the exotic material, Knife Lake Siltstone, from the Quetico Park area of Northern Ontario (Appendix D Photo No. 18C). Additionally, one Hixton Silicified Sandstone Unshouldered Lanceolate, an exotic raw material from south-central Wisconsin, was found in the Quetico Park area of Northern Ontario and exhibited the oblique flaking pattern associated with the Northern sub-region sample. The entire Eastern sample was produced on the locally available Sheguiandah Quartzite and, as an unrepresentative sample, will not be discussed further here nor included in the inferential statistical analysis. Certainly, the raw material profiles of the Northern, Western, and Southern sub-regions will need to be further considered in the continuing analysis.

9. The continuous scale Width attribute also provided further insights into the developing sub-regional Unshouldered Lanceolate attribute profiles, trends, and patterns. The Width attribute in the Southern sample continued the trend of the smallest of the Means in the entire region at 20.6 mm which is <5.2 mm from the next smallest Mean of the Northern sample, and by exhibiting the smallest variation with a Standard Deviation of 2.9 mm. As was the case in the Haft Length attribute, the Western sub-region sample again produces the largest Mean of 28.6 mm; but, in this Width attribute, instead of the Northern sub-region, the Western sample exhibits the widest variation of the Region with the Standard Deviation of 4.5 mm. Still, and again, similar to the Haft Length attribute there is little separating the Western Mean and Standard Deviation from the lesser Northern sub-region with a Mean of 25.8 mm (or 2.8 mm difference) and a Standard Deviation of 3.8 mm (or 0.7 mm difference). What will be determined later in the inferential statistical analysis, will be the significance of these differences, if any, in terms of populations.

Finally, there appears to be some distinct trends among the data of the upper Great Lakes Early Late Paleoindian Unshouldered Lanceolates that may be assignable to differing patterns of mobility and interaction on a sub-regional basis. The Southern sub-region certainly appears to exhibit the greatest differences in its sample from the other sub-regions; however, there are also some very distinctly different attribute trends between the Northern and Western sub-region's samples that, in any event and following further analysis, will offer significant insights into the mobility and interaction patterns of the Early Late Paleoindians of the upper Great Lakes.

Shouldered Lanceolate Analysis

At this point, it is important to remember that the analytic segregation of Unshouldered and Shouldered Lanceolates is necessary to maintain integrity of the stylistic analysis as directly correlated to the sub-regions and the temporal division of Early Late Paleoindian (Unshouldered) and Mid to Late Late Paleoindian (Shouldered and Notched). Given the extremely small shouldered sample of both the Southern and Eastern sub-regions, the focus of the Shouldered Lanceolate analysis is on the Northern and Western sub-region samples with the other data being reported as information only.

Attribute - Flake Orientation - Shouldered Type A

Table 5.13 Flake Orientation - Type A

Description	All Regions	Eastern	Northern	Western	Southern
N of Cases	36	3	10	21	2
Minimum	77.2 deg.	86.9 deg.	77.2 deg.	86.7 deg.	81.6 deg.
Maximum	117.3 deg.	94.2 deg.	113.7 deg.	117.3 deg.	90.7 deg.
Range	40.2 deg.	7.3 deg.	36.6 deg.	30.6 deg.	9.1 deg.
Mean	91.9 deg.	90.6 deg.	93.5 deg.	91.9 deg.	86.1 deg.
Variance	55.6 deg.	13.4 deg.	100.5 deg.	43.8 deg.	41.0deg.
Std. Dev.	7.5 deg.	3.7 deg.	10.0 deg.	6.6 deg.	6.4 deg.
Std. Error	1.2 deg.	2.1 deg.	3.2 deg.	1.4 deg.	4.5 deg.
Skewness	1.7 deg.	-0.1 deg.	0.6 deg.	2.9 deg.	0.0 deg.
Kurtosis	4.1 deg.	-1.5 deg.	0.2 deg.	8.5 deg.	-2.0 deg.
Sum	3309.5 deg.	271.9 deg.	935.2 deg.	1930.1 deg.	172.3 deg.
C.V.	0.1 deg.	0.0 deg.	0.1 deg.	0.1 deg.	0.1 deg.
Median	90.6 deg.	90.8 deg.	92.0 deg.	89.8 deg.	86.1 deg.

1) The Northern sub-region sample (N=10) is drawn from a sufficiently well-distributed data base to provide a reasonable basis for its use as representative of the population (Table 5.13). To begin, the Northern sub-region flake orientation attribute exhibits the greatest degree of angularity with its Mean of 93.5 degrees which is 1.6 degrees more angular than the Western sample of 91.9 degrees. While this difference in Means appears to be rather insubstantial, both the Variance and Standard Deviation are a different matter. The Northern Variance is 100.5 degrees with a Standard Deviation of 10.0 degrees. Both the Variance and Standard Deviation for the Northern sub-region are substantially greater than the Western sub-region sample, as indicated in the Western analysis that follows. Therefore, it appears that there is more variation within the Northern sub-region sample for the Flake Orientation attribute than within the Western sub-region. Yet, upon reviewing the Box and Whisker Plot (Appendix B Figure 5.9), it is quickly observed that the Northern sample exhibits three outliers, one of which is a far upper outlier (113.7 degrees; Appendix D, Photo No. 7F), while the other two outliers are split with one as an upper outlier (106.0 degrees; Appendix D, Photo No. 13A) and the other is a lower outlier (77.2 degrees; Appendix D, Photo No. 4C). Still, when the Stem and Leaf Diagram is reviewed, it is noted that there is no strong central tendency, given the wide distribution of the sample values (N=10) with no single measurement being repeated in the diagram (Appendix B Figure 5.9A). The Stem and Leaf Diagram, then, indicates that, depending upon the Western sample distribution, there does appear to be a great deal of variation in the Northern sub-region sample. Consequently, before reasonable assertions regarding comparisons of variation can be offered, the Western sample data must be held to the same level of scrutiny.

2) The Western sub-region sample (N=21) is the largest sub-regional sample (Table 5.13). As noted in the Northern sub-region analysis, the Western sub-region Mean degree of angularity for flake scar orientation is 91.9 degrees, which is less than the Northern by 1.6 degrees; however, the Variance of 43.8 degrees is 56.7 degrees less than the 100.5 degrees of the Northern sample with a Western Standard Deviation of 6.6 degrees and a Northern Standard Deviation of 10.0 degrees. Of interest here is that the amount of variation (while possessing more than double the sample size) for the Western sample appears to be much less than that of the Northern sample. Yet, upon review of the Box and Whisker Plot, it is noted that the Western sample also exhibits three outliers, except all three are outside the upper quartile, with one being a far upper outlier at 117.3 mm (Appendix B Figure 5.9; Appendix D, Photo No. 22C). The remaining outliers are at 98.4 degrees (Appendix D, Photo No. 20B) and 95.3 degrees (Appendix D, Photo No. 20C). Interestingly, these last two points (Appendix A, Table A.1, Cases 60 & 61), while being outside values, appear to share many stylistic characteristics as evidenced in Photo No. 20, specimens B and C (Appendix D). Still, upon referring to the Stem and Leaf Diagram, it is found that there is, in fact, a very strong central tendency about the Median of 89.8 degrees with 16 values expressed between 86.7 degrees and 91.5 degrees of the entire Western sample of N=21 (Appendix B Figure 5.9B). Consequently, there does appear to be more uniformity in the Flake Orientation attribute for the Western sub-region than for the Northern sub-region.

<u>Summary - Flake Orientation Attribute - Shouldered Type 'A'</u>

The foregoing analysis has revealed two factors: First, the Northern sub-region sample of Shouldered Lanceolates (Type A) exhibits the most acute degree of Flake Orientation angularity for the region with a Mean of 93.5 degrees and Median of 92.0

degrees. Yet, the Western Mean is 91.9 degrees (or 1.6 degrees <Northern Mean) and the Median is 89.8 degrees (or 2.2 degrees <Northern Median). To provide some graphical depiction of the distributions for the Western and Northern samples, Histograms are included in Appendix B Figures 5.9C and 5.9D. Therefore, the significance of these Mean/Median differences must be tested further; but, they do not appear to be substantial. Second, the difference in attribute sample variation between the Northern and Western sub-regions does appear substantial. While it is recognized that the Northern sample is small, it is still important to note the widely distributed values. In fact, both the Northern sample Variance of 100.5 degrees and the Standard Deviation of 10.0 degrees are much greater than the Western Variance of 43.8 degrees and the Standard Deviation of 6.6 degrees. Therefore, this attribute will require further statistical analysis before there can be confidence in the significance of these observations. Additionally, as was evidenced in the Unshouldered Lanceolate analysis of this attribute, there must be some consideration given to the nominal scale Flake Pattern attribute and the various states it exhibits, which can serve to further organize the Flake Orientation continuous scale observations.

Attribute - Flaking Pattern - Shouldered Type A

This is the nominal scale attribute that combines the continuous scale attribute of Flaking Orientation within different observable patterned states or flaking patterns which are the same as in the Unshouldered Lanceolate analysis (Table 5.14; Figure 5.2). The states of this attribute are as follows: 1 - Collateral Parallel; 2 - Collateral Parallel Transverse; 4 - Oblique Collateral Parallel Transverse; and 5 - Chevron Collateral Parallel. The remaining states of this attribute, 3 - Random/Unaligned and 6 - Oblique Unaligned are not present in this sample, an issue which will also be further considered later in this analysis. In considering these data, then, there will also be a further discussion of the previous Shouldered (Type A) continuous scale Flake Orientation attribute analysis and the information these analyses reveals. Also, as in the case of the Flake Orientation attribute analysis, both the Eastern and Southern sub-regions are omitted from significant analysis due to insufficient samples in both sub-regions , but their data are included for information purposes ONLY.

Table 5.14 Flaking Pattern - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
1	16	2	5	7	2
2	17	1	3	13	0
4	2	0	1	1	0
5	1	0	1	0	0
Total (N=)	36	3	10	21	2

The focus of this analysis is the Western and Northern sub-region samples. As presented in Table 5.14, the Western sub-region sample is clearly dominated by the Transverse flaking pattern (#2) without an acute angular flaking orientation (N=13 or 62%). Whereas, the Northern sample slightly favors the Collateral Parallel flaking pattern (#1) (N=5 or 50%) with the Transverse pattern (#2) second (N=3). Significantly, there are only 3 points in the entire region exhibiting an acute flaking angle with N=2 (or 20%) in the Northern sample and N=1 in the Western sample.

In reviewing the continuous scale analysis for Flake Orientation, it is observed that there was greater variability in this attribute among the Northern sample than in the Western sample. Interestingly, we find that this observation is still valid for this nominal scale attribute with both the number of attribute states recorded for each region (Northern exhibits 4 states and Western exhibits 3 states). Furthermore, the distribution of the recorded states is greater among the Northern sub-region than the Western sub-region.

Summary - Flaking Pattern - Shouldered Type A

After reviewing both the continuous and nominal scale data, there appears to be a distinctly different character to the Flaking Patterns between the Northern and Western sub-regions. The Western sub-region exhibits the least variation and a decided emphasis on the #2, Collateral Parallel Transverse pattern (N=13) with a single substantive alternative pattern of the #1, Collateral Parallel type (N=7) and, in general, a nominal amount of acute angularity in the flaking pattern. The Northern sample, however, exhibits much greater variation in the sample with a small emphasis on the #1, Collateral Parallel pattern (N=5) with a somewhat lesser presence of the #2, Collateral Parallel Transverse pattern (N=3), and a slightly greater amount of flake angle acuteness. Again, further analysis of this nominal scale attribute is needed in conjunction with the further continuous scale analysis of the Flake Orientation attribute.

Attribute - Thickness - Shouldered Type A

The Thickness attribute in the Shouldered Lanceolates exhibits some differences between sub-regions. The Western sample has the largest Mean of 9.5 mm and Median of 9.6 mm, while there is a fairly reduced Thickness among the Northern sample, which possesses a Mean of 7.7 mm and a Median of 7.5 mm (Table 5.15). The Box and Whiskers Plot indicates an upper outlier value for the Western sample at 11.8 mm with a heavier concentration of values at the upper end of the scale as depicted by the slightly skewed Median location in the Box (Appendix B Figure 5.10).

Table 5.15 Thickness - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	36	3	10	21	2
Minimum	6.0 mm	6.3 mm	6.0 mm	7.5 mm	6.7 mm
Maximum	11.8 mm	7.9 mm	11.4 mm	11.8 mm	9.5 mm
Range	5.8 mm	1.6 mm	5.4 mm	4.3 mm	2.8 mm
Mean	8.7 mm	7.1 mm	7.7 mm	9.5 mm	8.1 mm
Variance	2.5 mm	0.7 mm	3.1 mm	1.2 mm	3.9 mm
Std. Dev.	1.6 mm	0.8 mm	1.8 mm	1.1 mm	2.0 mm
Std. Error	0.3 mm	0.5 mm	0.6 mm	0.2 mm	1.4 mm
Skewness	-0.1 mm	-0.1 mm	0.8 mm	0.4 mm	0.0 mm
Kurtosis	-0.7 mm	-1.5 mm	-0.2 mm	0.0 mm	-2.0 mm
Sum	315.0 mm	21.4 mm	77.5 mm	199.8 mm	16.2 mm
C.V.	0.2 mm	0.1 mm	0.2 mm	0.1 mm	0.2 mm
Median	9.0 mm	7.2 mm	7.5 mm	9.6 mm	8.1 mm

In reviewing the Box and Whisker Plot for the Northern data, however, there is wide variation, with a concentration of values at the lower end of the scale where the Median and Box are located (Appendix B Figure 5.10). To further investigate these observed Median differences, Stem and Leaf Diagrams for both the Northern and Western sub-regions were evaluated (Appendix B Figures 5.10A and 5.10B, respectively). The Western data do display a larger concentration of values located at the upper quartile, with the Median of 9.6 mm and the Upper Hinge at 9.9 mm (Appendix B Figure 5.10B). The Northern data also confirms the observation that there is a concentration of values at the lower quartile with the Minimum value at 6.0 mm and the Lower Hinge at 6.1 mm (Appendix B Figure 5.10A). Both these sub-regions' sample distributions are further graphically represented in the Histograms provided for the

Northern sample in Appendix B Figure 5.10C, and the Western sample in Appendix B Figure 5.10D. Additionally, it must be noted that these Thickness distributions reveal some regional differences, with the Northern sample of N=10 displaying the widest variation (Appendix B Figures 5.10, 5.10A, 5.10B, 5.10C and 5.10D).

Summary - Thickness Attribute - Shouldered Type A

Based on the Thickness attribute analysis, there are two major observations: First, the Western sample exhibits the thickest Mean/Median of the Region at 9.5 mm/9.6 mm, respectively, with a decided concentration of values at the upper quartile area. Additionally, the lower Mean/Median of the Northern sub-region at 7.7 mm/7.5 mm is the result of a concentration of lower values towards the lower quartile area of the sample. These observations identify the potential for this Thickness attribute to reflect some level of substantial difference between the Northern and Western sub-region samples. Still, further inferential statistics will need to be analyzed prior to making any assertions of significance. These will be addressed later in this stylistic analysis.

Attribute - Base Width - Shouldered Type A

The Base Width attribute forced a research decision regarding fractured bases. The decision was made to not record Base Widths for those cases that did not have complete (or nearly complete) bases. Therefore, the Western population of N=16 is a direct product of this condition. Still, however, the analysis proceeded with what is believed to be representative samples of the populations for the Northern and Western sub-regions ONLY.

Table 5.16 Base Width - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	31	3	10	16	2
Minimum	10.9 mm	17.8 mm	10.9 mm	16.6 mm	11.5 mm
Maximum	30.9 mm	26.0 mm	26.8 mm	29.9 mm	30.9 mm
Range	20.0 mm	8.2 mm	15.9 mm	13.4 mm	19.5 mm
Mean	22.8 mm	22.1 mm	19.3 mm	25.3 mm	21.2 mm
Variance	28.9 mm	17.0 mm	27.2 mm	11.7 mm	189.2 mm
Std. Dev.	5.4 mm	4.1 mm	5.2 mm	3.4 mm	13.8 mm
Std. Error	1.0 mm	2.4 mm	1.7 mm	0.9 mm	9.7 mm
Skewness	-0.7 mm	-0.2 mm	-0.0 mm	-1.0 mm	0.0 mm
Kurtosis	-0.5 mm	-1.5 mm	-1.1 mm	0.8 mm	-2.0 mm
Sum	706.8 mm	66.4 mm	193.5 mm	404.6 mm	42.4 mm
C.V.	0.2 mm	0.2 mm	0.3 mm	0.1 mm	0.6 mm
Median	24.8 mm	22.7 mm	19.0 mm	25.6 mm	21.2 mm

The Base Width attribute appears to be distinctly larger in the Western sub-region sample, with a Mean of 25.3 mm and a Median of 25.6 mm, as compared to the Northern Mean of 19.3 mm and Median of 19.0 mm (Table 5.16). Additionally, it is noted that this variation appears greater in the Northern sample, with a Variance of 27.2 mm and a Standard Deviation of 5.2 mm, than in the Western sample with a Variance of 11.7 mm and a Standard Deviation of 3.4 mm. In referring to the Box and Whiskers Plot, it should be noted that the Northern data displays no outside values, but the fairly large distance between the Upper and Lower Hinges indicates a weakly developed central tendency and a relatively wide distribution of recorded values (or large variance) (Appendix B Figure 5.11). The Western box indicates that there is a lower quartile outside value that could have reduced the Mean and increased the Variance which will require a more in-depth analysis (Table 5.16; Appendix B Figure 5.11). The outlier is a Hell Gap type lanceolate produced on Hixton Silicified Sandstone with substantial lateral edge grinding (Appendix A, Table A.1, Case #53; Appendix D, Photo No. 16A). Given the heavy grinding, it is not unreasonable to observe a smaller Base Width on these points. Interestingly, these points also have weakly defined shoulders that may manifest itself as an outside value later in other attributes, particularly in the shoulder area. In reviewing the Stem and Leaf Diagram for the Northern sample it is noted that there are equal numbers of values above and below the Median (Appendix B Figure 5.11A). This distribution supports the observation of greater variance for the Northern sample, albeit with a weak central tendency. The Western sample Stem and Leaf Diagram, however, indicates a strong central tendency about the Median with a tighter grouping of values at the upper quartile and a more dispersed grouping around the lower quartile (Appendix B Figure 5.11B). The value distributions for both the Northern and the Western sub-region samples are represented in the histograms (Appendix B Figures 5.11C an 5.11D).

Summary - Base Width Attribute - Shouldered Type A

This attribute, similar to the foregoing, indicates some distinct areas of difference between the Northern and Western samples that will require further analysis. In short, the Western sample possesses a substantially wider Base Width Mean of 25.3 mm and a Median at 25.6 mm which is larger than the Northern sample by 6.0 mm for the Mean and 6.6 mm for the Median. It is also apparent that the variation is greater among the Northern sample than the Western sample. In both of these observations there appears to be a pattern emerging that will require further observations of the remaining attributes.

Attribute - Haft Length - Shouldered Type A

Table 5.17 Haft Length - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	36	3	10	21	2
Minimum	12.6 mm	20.5 mm	12.7 mm	12.6 mm	21.7 mm
Maximum	44.2 mm	23.9 mm	43.4 mm	44.2 mm	31.8 mm
Range	31.6 mm	3.5 mm	30.7 mm	31.6 mm	10.2 mm
Mean	21.7 mm	21.6 mm	23.5 mm	20.5 mm	26.7 mm
Variance	53.1 mm	4.0 mm	98.8 mm	39.8 mm	51.5 mm
Std. Dev.	7.3 mm	2.0 mm	9.9 mm	6.3 mm	7.2 mm
Std. Error	1.2 mm	1.1 mm	3.1 mm	1.4 mm	5.1 mm
Skewness	1.5 mm	0.7 mm	0.6 mm	2.5 mm	0.0 mm
Kurtosis	2.6 mm	-1.5 mm	-0.5 mm	7.8 mm	-2.0 mm
Sum	782.8 mm	64.9 mm	234.7 mm	429.8 mm	53.5 mm
C.V.	0.3 mm	0.1 mm	0.4 mm	0.3 mm	0.3 mm
Median	20.8 mm	20.5 mm	24.3 mm	20.4 mm	26.7 mm

The Haft Length continuous scale attributes indicates that the Northern sub-region exhibits both the largest Mean, at 23.5 mm, and Median at 24.3 mm, as well as again displaying the widest variation (Table 5.17). The Western sample Mean of 20.5 mm and Median of 20.4 mm, although less, appears to be well within the Northern Standard Deviation of 9.9 mm (Table 5.17). Yet, the Northern sample Variance of 98.8 mm combined with the 9.9 mm Standard Deviation does indicate a much wider variation within the sample than the Western sub-region Variance of 39.8 mm and a Standard Deviation of 6.3 mm (Table 5.17). In reviewing the Box and Whisker Plot, it is obvious that the variation is much greater in the Northern than in the Western sample, and that the upper quartile is exerting some pull on the Median which is likely due to some value concentrations in the upper quartile (Appendix B Figure 5.12). Also, in the Western data, it is noted that a far upper outlier is revealed at a Haft Length of 44.2 mm (Appendix B Figure 5.12). To further assess these observations the Stem and Leaf Diagrams were reviewed which reveals more finite information on the internal distribution of the sample values for the Northern and Western sub-regions (Appendix B Figures 5.12A and 5.12B). In consulting the Northern sample Stem and Leaf Diagram, a picture of some bi-modality emerges for the Haft Length attribute (Appendix B Figure 5.12A). There appears to be a concentration of 4 points (40% of the N=10) between 12.7 mm (the minimum value) and 14.2 mm (the Lower Hinge), then another concentration of values between 24.1 mm and the Upper Hinge at 28.9 mm (Appendix B Figure 5.12A). To clarify this observation graphically, a Histogram was reviewed for the Haft Length attribute of the Northern sample (Appendix B Figure 5.12C). The Histogram reveals that the Lower Hinge group (N=4) of values are expressed within a 5 mm band between 10 mm to 15 mm, and that the next values are evenly expressed between 20 mm to 30 mm (N=4) with no values recorded between 15mm to 20 mm (Appendix B Figure 5.12C). There remain two additional values widely distributed above the 28.9 mm Upper Hinge between 30mm and 45mm (Appendix B Figure 5.12A). Consequently, there appears to be some validity to the bi-modal observation of the Northern sample along with the wider variation. The Western sample Stem and Leaf Diagram confirms that a concentration of values is present at the Upper Hinge area, with the Median at 20.4 mm and the Upper Hinge at 21.7 mm (Appendix B Figure 5.12B). In fact, within 2mm of the Lower and Upper Hinges, and about the Median, there are a total of 18 values (or 86%) of the Western sample (N=21) (Appendix B Figure 5.12B). Therefore, studying the Histograms for both the Northern and Western samples reveals that the distribution of the Western sample appears to be more evenly and widely distributed than the slightly bi-modal distribution of the Northern sample (Appendix B Figures 5.12C and 5.12D).

Summary - Haft Length Attribute - Shouldered Type A

Analysis of the Haft Length attribute revealed that the longest Haft Length Mean/Median of 23.5 mm/24.3 mm, respectively, is found within the Northern sample. Yet, these Northern Mean/Median measurements are derived from a widely distributed sample which develops a rather weak central tendency with a Variance at 98.8 mm and a Standard Deviation at 9.9 mm which is more than double the Variance and a third higher than the Standard Deviation of the Western sample. It is important to note that throughout the analysis, so far, there appears to be patterns and trends developing in the data that reveals potentially important differences between the Northern and Western sub-regions. Yet, many more attributes must be analyzed within the Shouldered Type A Lanceolate data before these emerging trends become potential set and observed patterns. Therefore, the Haft Length attribute will require further statistical analysis to establish any robust observations about significance.

Attribute - Shoulder Width - Shouldered Type A

Table 5.18 Shoulder Width - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	35	3	10	20	2
Minimum	3.3 mm	20.7 mm	15.3 mm	24.8 mm	21.4 mm
Maximum	40.3 mm	29.8 mm	38.7 mm	38.3 mm	40.3 mm
Range	37.0 mm	9.1 mm	23.4 mm	13.6 mm	18.9 mm
Mean	28.1 mm	24.3 mm	26.3 mm	30.6 mm	30.8 mm
Variance	53.3 mm	23.7 mm	58.1 mm	12.5 mm	178.4 mm
Std. Dev.	7.3 mm	4.9 mm	7.6 mm	3.5 mm	13.4 mm
Std. Error	1.2 mm	2.8 mm	2.4 mm	0.8 mm	9.4 mm
Skewness	-1.1 mm	0.6 mm	0.2 mm	0.2 mm	0.0 mm
Kurtosis	2.1 mm	-1.5 mm	-1.1 mm	-0.6 mm	-2.0 mm
Sum	982.9 mm	72.8 mm	263.4 mm	612.0 mm	61.7 mm
C.V.	0.3 mm	0.2 mm	0.3 mm	0.1 mm	0.4 mm
Median	29.1 mm	22.3 mm	25.9 mm	30.4 mm	30.8 mm

The Shoulder Width attribute appears to follow some of the earlier trends with the Western sample exhibiting the widest Mean at 30.6 mm and Median at 30.4 mm (Table 5.18). Also, the Northern sample appears to display the greatest variation with a Variance of 58.1 mm and a Standard Deviation of 7.6 mm (Table 5.18). The Northern sample Mean of 26.7 mm and Median 25.9 mm are less than the Western Mean and Median by 3.9 mm and 4.5 mm, respectively. The Western Variance of 12.5 mm and Standard Deviation of 3.5 mm are both more than 100% lower than the Northern sample's Variance and Standard Deviation, thereby indicating a substantially lower amount of variation within the Western sample (Table 5.18). The Box and Whisker Plot provides a look at the structure of the data and helps direct further analysis (Appendix B

Figure 5.13). In this case it is noted that there are no outliers identified in either the Northern or Western samples (Appendix B Figure 5.13). Also, observe that the Western sample has exactly twice the sample size of the Northern sample (N=20 and N=10, respectively), while simultaneously exhibiting half the value distribution that is observed in the Northern sample, indicating much greater variation within the Northern sample than in the Western sample (Appendix B Figure 5.13). Also of interest are the Median locations in the center of the Boxes for both the Northern and Western samples indicating relatively equal distributions of values on both sides of the Medians for both (Appendix B Figure 5.13). In order to confirm these preliminary observations, the Stem and Leaf Diagrams were reviewed for both the Northern and Western sub-regions (Appendix B Figures 5.13A and 5.13B). In reviewing the Northern Stem and Leaf Diagram it is found that the Minimum value in the distribution is 15.3 mm and the Maximum value is 38.7 mm providing 23.4 mm's of distribution in the sample (Appendix B Figure 5.13A). The Western sample has a Minimum value of 24.8 mm and a Maximum value of 38.3 mm providing 13.5 mm's of value distribution in the sample (Appendix B Figure 5.13B). Again, it appears that the variation within the Northern data are greater than in the Western sample (Appendix B Figures 5.13A and 5.13B). It is also noted that for the Northern sub-region, N=6 (or 60%) of the sample values are located between 2 mm's beyond the Upper and Lower Hinges of 32.3 mm and 20.2 mm, respectively (Appendix B Figure 5.13A). Whereas, in the Western sample, N=17 (or 85%) of the sample values are located in the same area as the Northern sample (Appendix B Figure 5.13B).

This observation is important for two reasons: First, it provides the Western sample Median a stronger central tendency than the Northern sample Median; and, secondly, it further specifies the distribution of values around the Median for both subregions thereby providing a more confident assessment of the variation both within and between the sub-regions. Finally, the Histograms for the Northern and Western sub-region samples were reviewed for any sample distribution anomalies and/or patterns best observed in a graphical representation (Appendix B Figures 5.13C and 5.13D). In reviewing the Northern sample's Histogram it is found that the values observed are almost equally distributed between 15 mm and 40 mm (Appendix B Figure 5.13C). Interestingly, there appears to be a slightly bi-modal distribution of values in the Western data with one mode between 28 mm to 30 mm, and the other between 32 mm to 34 mm (Appendix B Figure 5.13D). Still, however, there are very few values involved in producing this slight bi-modal effect, which does not support developing a very confident assessment regarding its importance (Appendix B Figure 5.13D).

Summary - Shoulder Width Attribute - Shouldered Type A

This analysis of the Shoulder Width attribute has revealed interesting differences between the Northern sub-region and Western sub-region samples. It was determined that the Western sample exhibits both the Largest Mean and Median (30.6 mm and 30.4 mm, respectively) with a well-defined central tendency. The Northern sub-region still exhibits the widest variation and weakest central tendency. In both of these observations the previous trends and emerging patterns among the Shouldered Lanceolates continues. Again, the degree of significance of these observations are yet to be determined.

Attribute - Between Shoulder Width - Shouldered Type A

Table 5.19 Between Shoulder Width - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	36	3	10	21	2
Minimum	12.7 mm	18.0 mm	12.7 mm	16.8 mm	20.4 mm
Maximum	31.8 mm	24.6 mm	28.9 mm	31.8 mm	29.8 mm
Range	19.1 mm	6.6 mm	16.2 mm	15.0 mm	9.5 mm
Mean	22.9 mm	20.6 mm	21.7 mm	23.6 mm	25.1 mm
Variance	15.7 mm	12.316 mm	30.5 mm	7.9 mm	45.0 mm
Std. Dev	4.0 mm	3.5 mm	5.5 mm	2.8 mm	6.7 mm
Std. Error	0.7 mm	2.0 mm	1.7 mm	0.6 mm	4.7 mm
Skewness	-0.3 mm	0.6 mm	-0.3 mm	0.4 mm	0.0 mm
Kurtosis	0.3 mm	-1.5 mm	-1.3 mm	3.0 mm	-2.0 mm
Sum	824.1 mm	61.8 mm	217.1 mm	494.9 mm	50.2 mm
C.V.	0.2 mm	0.2 mm	0.3 mm	0.1 mm	0.3 mm
Median	23.6 mm	19.3 mm	22.9 mm	23.6 mm	25.1 mm

The Between Shoulder Width attribute measured the width of the Haft Stem at the intersection of the Shoulders (Figure 5.1). The largest Mean and Median for this attribute, excluding the Southern N=2 sample, is developed within the Western sample at 23.6 mm for both Mean and Median (Table 5.19). The Northern Mean of 21.7 mm and Median of 22.9 mm, however, are very close to these Western values (Table 5.19). This indicates little difference between the Means and Medians of the Northern and Western samples. Also, in considering the value distributions for the Western and Northern sub-region samples, it is noted that the Northern sample appears to exhibit a great deal more variation with a Variance of 30.5 mm and a Standard Deviation of 5.5 mm compared to the Western sample's Variance of 7.9 mm and Standard Deviation of 2.8 mm (Table

5.19). In an effort to gain insight into the structure of the Northern and Western samples, the Box and Whisker Plot was reviewed and revealed some interesting information (Appendix B Figure 5.14). First, the Northern sample distribution does not indicate the presence of any outside values (Appendix B Figure 5.14). Secondly, the Northern sample displays a much wider distribution of values than the Western sample, particularly considering the N=10 Northern sample as opposed to the N=21 Western sample, which can negatively affect the central tendency of the Northern sample thereby weakening the Median's robustness as a comparative tool. Thirdly, the Northern sample's Median bar in the interquartile range is somewhat skewed towards the Upper Hinge, indicating a concentration of higher values around the Median and towards the Upper Hinge (Appendix B Figure 5.14). Fourthly, the Western sub-region sample exhibits one far upper outlier value of 31.8 mm and one lower outlier at 16.8 mm (Appendix B Figure 5.14). In considering these outliers, they are both Shouldered Lanceolates but of differing types: Case #53 (Appendix A, Table A.1), Photo No. 16A (Appendix D), is the far upper outlier which is the same Hell Gap lanceolate produced on Hixton Silicified Sandstone that was the Western lower outlier for the Base Width attribute; whereas, the lower outlier (Appendix A, Table A.1, Case #58; Appendix D, Photo No. 19A) is an Eden type lanceolate, also produced on Hixton Silicified Sandstone, which are known for their overall slender widths and length/width ratios (Appendix B Figure 5.14). A fifth observation is that the Western Interquartile and Median are skewed towards the Upper Quartile, indicating a heavy concentration of close values at the upper end of the sample distribution (Appendix B Figure 5.14). Finally, the Western sub-region N=21 sample, while being more than double that of the Northern N=10 sample, exhibits about 1/4 the distribution exhibited by the Northern sample, thereby indicating much less variation within the Western sample than in the Northern sample (Appendix B Figure 5.14). The Stem and Leaf diagrams for both the Northern sub-region and the Western sub-region confirms those observations regarding the Median and the variation (Appendix B Figures 5.14A and 5.14B). In terms of the slightly skewed Median and variation in the Northern sample, it is observed in the Stem and Leaf diagram that the values are both widely and rather evenly distributed across the sample except at the upper end, where 5 values are observed within a 3 mm bracket above the median and around the Upper Hinge, with the remaining 5 values distributed below the median and within an 8 mm bracket (Appendix B Figure 5.14A). Therefore, the heavier concentration of values at the upper end of the sample exerted some pull on the Median towards the upper quartile (Appendix B Figure 5.14A). The Western Stem and Leaf diagram indicates there are 17 values (or 81% of the sample N=21) located within a bracket of 1 mm beyond the Upper and Lower Hinges and that all of the sample, except the two outliers fall within a 5.3 mm range (Appendix B Figure 5.14B). The importance of these observations of the Western sample is that both the Mean and Median exhibit strongly defined central tendencies and that the two outliers have somewhat inflated the Standard Deviation to indicate a potentially greater variation than is actually being observed in the sample distribution (Appendix B Figure 5.14B). Finally, Histograms were consulted to identify patterns or trends in the graphical representation of the sample distributions for both the Northern and Western sub-regions (Appendix B Figures 5.14C and 5.14D). In the Northern sample histogram it appears that some bi-modality may be present; yet, the histogram has partitioned the sample in 5mm bars which doesn't necessarily reveal the even distribution of the values observed in the Stem and Leaf diagram between 15 mm and 20 mm (Appendix B Figures 5.14A and 5.14C). The Northern histogram does, however, indicate the heavier concentration of values between the 25 mm to 30 mm points (Appendix B Figure 5.14C). The Western sample Histogram does, however, more accurately reflect the sample distribution in that the values are so closely related that the histogram bars are reporting 2mm intervals rather than the 5 mm's of the Northern sample (Appendix B Figure 5.14D).

Summary - Between Shoulder Width Attribute - Shouldered Type A

The trend that has been observed throughout the analysis appears to continue within the Between Shoulder Width attribute. The Western Mean/Median (B.S.Width) of 23.6 mm/23.6 mm, respectively, is only slightly larger than the Northern sample Mean/Median of 21.7 mm/22.9 mm, respectively, but it is a great deal more robust than the Northern Mean/Median (Table 5.19). Also, the variation within the Northern sample (N=10) is much greater than that of the Western sample (N=21) with no outside values exhibited, a Variance of 30.5 mm, and a Standard Deviation of 5.5 mm (Table 5.19). Consequently, this attribute analysis reveals some good potential for important differences between the samples that remain to be tested. Therefore, further inferential statistical analysis will be undertaken for this attribute later in this study.

Attribute - Shoulder Angle - Shouldered Type A

Table 5.20 Shoulder Angle - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	34	3	10	19	2
Minimum	20.0 deg.	20.0 deg.	21.5 deg.	53.5 deg.	32.5 deg.
Maximum	110.0 deg.	90.0 deg.	79.5 deg.	110.0 deg.	82.0 deg.
Range	90.0 deg.	70.0 deg.	58.0 deg.	56.5 deg.	49.5 deg.
Mean	70.8 deg.	61.7 deg.	51.4 deg.	83.8 deg.	57.3 deg.
Variance	590.4 deg.	1358.3 deg.	421.8 deg.	228.6 deg.	1225.1 deg.
Std. Dev.	24.3 deg.	36.9 deg.	20.5 deg.	15.1 deg.	35.0 deg.
Std. Error	4.2 deg.	21.3 deg.	6.5 deg.	3.5 deg.	24.8 deg.
Skewness	-.0.7 deg.	-0.6 deg.	-0.4 deg.	-0.3 deg.	0.0 deg.
Kurtosis	-0.3 deg.	-1.5 deg.	-1.2 deg.	-0.2 deg.	-2.0 deg.
Sum	2406.2 deg.	185.0 deg.	513.6 deg.	1593.1 deg.	114.5 deg.
C.V.	0.3 deg.	0.6 deg.	0.4 deg.	0.2 deg.	0.6 deg.
Median	78.3 deg.	75.0 deg.	58.1 deg.	85.0 deg.	57.3 deg.

The Shoulder Angle attribute provides a continuous scale measurement of the degree of angle of the shoulder as measured from the distal/proximal (or longitudinal) axis of the shouldered projectile points (Figure 5.1). It is first observed that the Western sub-region sample displays the most acute shoulder angularity, at a Mean of 83.8 degrees and a Median of 85.0 degrees (or a 1.2 degree difference) (Table 5.20). The Northern sample exhibits a fairly large difference between its Mean and Median of 51.4 degrees and 58.1 degrees, respectively (or 6.7 degrees), which indicates a wider distribution of values within the Northern sample as compared to the Western sample (Table 5.20). In observing the Variances and Standard Deviations of the Northern and Western sub-regions, the previously observed comparative distribution of sample values appears to be supported. The Northern Variance of 421.8 degrees and Standard Deviation of 20.5 degrees are both greater than the Western sample, but with a reduced difference between the Standard Deviations being observed (Table 5.20). In both samples, there appears to be a large amount of variation given these statistics. Yet, upon reviewing the Box and Whisker Plot, it is quickly noted that the Northern sample exhibits no outside values, whereas the Western sample exhibits two upper outliers and two lower outliers (Appendix B Figure 5.15). Also, it is noted that the size of the interquartile range in the Western sample is about half that of the Northern sample, again indicating greater variation in the Northern sample than in the Western sample (Appendix B Figure 5.15). The Western outliers include Case # 51 (Appendix A, Table A.1), Photo No. 16C (Appendix D) and Case # 82 (Appendix A), Photo No. 27A (Appendix D) as the 2 upper outside values (57.1 degrees and 53.5 degrees, respectively); and, Case #71 (Appendix A, Table A.1, Table A.1), Photo No. 23A (Appendix D) and Case #77 (Appendix A, Table A.1, Table A.1), Photo No. 25A (Appendix D) (109.0 degrees and 110.0 degrees, respectively) (Appendix B Figure 5.15). Given these outliers in the Western sample, the Standard Deviation cannot be assumed to be reflective of the sample's actual dispersion about the Mean since the Standard Deviation is calculated by squaring the differences from the Mean to each value which includes those "outside values" previously identified, thereby providing a potentially big effect on the Standard Deviation. Therefore, the Stem and Leaf Diagrams of both the Northern and Western samples were consulted which provides a detailed analysis of the values within the interquartile range and the dispersion of these values around the Median (Appendix B Figures 5.15A and 5.15B). The Northern Median within the interquartile range is rather skewed towards the upper quartile (Appendix B Figure 5.15). The Stem and Leaf diagram reveals that 7 values of the N=10

sample are located around the Median and the Upper Hinge (or Quartile) thereby exerting the pull of the Median towards the Upper Hinge within the interquartile range (Appendix B Figure 5.15A). The remaining 3 values are somewhat removed from the Median and concentrated around the Lower Hinge producing what may be a Main and Subsidiary Mode distribution of values (Appendix B Figure 5.15A). In referring to the Northern Histogram, there does appear to be a Main Mode at the Median and Upper Hinge area with a smaller Subsidiary Mode located at the Lower Hinge of the distribution (Appendix B Figure 5.15C). The Western distribution appears to be quite different, with its Median being just slightly skewed towards the Upper Quartile, but very robust in the amount of values distributed around the Median with 10 values of the19 within the interquartile range, 5 values distributed on each end of the Upper and Lower Hinges (2 in the Lower Hinge area and 3 in the Upper Hinge Area) and 4 outside values, 2 on the outside of each of the Upper and Lower Hinges leaving, what would appear to be a somewhat normal curve with a strong central tendency and slightly extended tails (Appendix B Figure 5.15B). The Western sample Histogram also appears to support the observation of the somewhat normal distribution of the Western sample, especially as compared to the Northern sample (Appendix B Figure 5.15D).

Summary - Shoulder Angle Attribute - Shouldered Type A

The Shoulder Angle attribute analysis has revealed that this attribute appears to be following the previously analyzed attribute trends of the Shouldered Type A lanceolates as the Western sample is displaying the most robust central tendency and the largest Mean/Median (83.8 degrees and 85.0 degrees, respectively), while the Northern sample displays the widest variation in the sample values with the largest Variance and Standard Deviation (421.8 degrees and 25.5 degrees, respectively), and a less robust central tendency, with a smaller Mean/Median (51.4 degrees and 58.1 degrees, respectively) (Table 5.20; Appendix B Figures 5.15 and 5.15A through 5.15D). It is noted that as a single attribute, across the entire region, there is a great deal of variation within and between the attribute samples (Appendix B Figure 5.15). This variation is not unexpected given the variation in shouldered lanceolate sub-types including those that have an extremely weakly defined shoulder such as Hell Gap; the very small and variably angled shoulders of the Eden; and, the sometimes very angular and variable shoulders of the Scottsbluff lanceolates (Figure 4.1). Therefore, this attribute analysis does contribute to the previously observed developing pattern of attribute expressions that appear to be different between the Northern sub-region and the Western sub -region. Consequently, inferential statistical testing will be undertaken for this attribute later in the analysis to further explore these issues of significance, populations, and Null Hypothesis testing for the Northern and Western sub-region samples.

Attribute - Width - Shouldered Type A

Table 5.21 Width - Type A

Descriptions	All Regions	Eastern	Northern	Western	Southern
N of Cases	36	3	10	21	2
Minimum	16.0 mm	22.1 mm	16.0 mm	25.3 mm	21.4 mm
Maximum	40.3 mm	30.6 mm	38.9 mm	38.3 mm	40.3 mm
Range	24.3 mm	8.5 mm	23.0 mm	13.0 mm	18.9 mm
Mean	29.9 mm	25.1 mm	27.5 mm	31.7 mm	30.8 mm
Variance	38.3 mm	22.7 mm	68.4 mm	15.4 mm	178.4 mm
Std. Dev.	6.2 mm	4.8 mm	8.3 mm	3.9 mm	13.4 mm
Std. Error	1.0 mm	2.8 mm	2.6 mm	0.9 mm	9.4 mm
Skewness	-0.3 mm	0.7 mm	0.1 mm	-0.1 mm	0.0 mm
Kurtosis	-0.7 mm	-1.5 mm	-1.3 mm	-1.2 mm	-2.0 mm
Sum	1077.7 mm	75.3 mm	275.3 mm	665.4 mm	61.7 mm
C.V.	0.2 mm	0.2 mm	0.3 mm	0.1 mm	0.4 mm
Median	30.4 mm	22.6 mm	26.9 mm	32.3 mm	30.8 mm

As with other variables, the Width attribute also appears to follow the previously established patterns for the Northern and Western sub-regions (Table 5.21). In reviewing the descriptive statistics can be observed that the Western sample exhibits the largest Mean/Median of 31.7 mm and 32.3 mm, respectively, with the Northern sub-region displaying a smaller Mean/Median of 27.5 mm and 26.9 mm, respectively (Table 5.21). This difference in Means/Medians for the Northern and Western sub-regions equals 4.2 mm (or 13%) difference between Means and 5.4 mm (or 17%) difference between Medians (Table 5.21). The Variance and Standard Deviation of the two sub-regions are the greatest for the Northern sub-region at 68.4 mm and 8.3 mm, respectively, and much less for the Western sub-region with a Variance of 15.4 mm and a Standard Deviation of

4.4 mm (Table 5.21). This difference in Variance and Standard Deviation of the two sub-regions equals 53 mm (or 77%) for the difference in Variances and 4.4 mm (or 53%) for Standard Deviations (Table 5.21). As has been observed throughout the analysis, Variance and Standard Deviation measurements are not always a true reflection of variation within samples. Therefore, the Box and Whisker Plot was consulted to observe the overall distribution of values both within and between sub-regions, and to identify potential outliers that can heavily influence both the Variance and Standard Deviation (Appendix B Figure 5.16). It is first observed that there are no outliers identified for any of the sub-region samples (Appendix B Figure 5.16). It is also observed that the Northern sample's Median appears to be near the center of the interquartile range with a very slight skewing towards the Lower Hinge (Appendix B Figure 5.16). Consequently, this Median, with fairly equal Upper and Lower Quartiles, appears to be a normal representative Median value with no apparent heavy concentrations of Upper or Lower values to skew the Median within the interquartile range (Appendix B Figure 5.16). Additionally, however, it can be seen that the distribution of Northern sample values appears to be almost twice that of the Western sample distribution (Appendix B Figure 5.16). This observation supports the earlier comment regarding the Northern sample's large Variance and Standard Deviation; that the Northern sample has much greater variation than the Western sample (Appendix B Figure 5.16). Also, the Western sample displays a relatively equal distribution with some visible skewing of the Median towards the upper Hinge (Appendix B Figure 5.16). This distribution and Median indicates a relatively normal distribution, but with a much reduced distance between the Maximum and Minimum values of the sample than that of the Northern sample, and a slight concentration of values towards the Upper Hinge area of the interquartile range

(Appendix B Figure 5.16). The smaller distribution of values within the Western sample also indicates a more robust central tendency and Median in the Western sample, especially considering that the Western sample size (N=21) is more than double that of the Northern sample (N=10) (Appendix B Figure 5.16; Table 5.21). To satisfy proper and established analytic protocols for the sample distributions, the Stem and Leaf diagrams were consulted for each sub-region to gain insights into the actual distribution of the sample's individual values (Appendix B Figures 5.16A and 5.16B). The Northern sub-region sample displays a Minimum of 16.0 mm and a Maximum of 38.9 mm providing a Range of 22.9 mm; whereas the Western sub-region sample displays a Minimum of 25.3 mm and a Maximum of 38.3 mm providing a range of 13.0 mm (Appendix B Figures 5.16A and 5.16B; Table 5.21). The Northern Lower Hinge is 20.2 mm with the Upper Hinge at 35.1 mm and the Median at 26.9 mm (Appendix B Figure 5.16A). In the case of the Northern sample the distribution of values is wide with at most 2 mm separating the occurrence of each value with 6 values (of an N=10 sample) occurring at the median and towards the Lower Hinge (Appendix B Figure 5.16A). This slight difference in the value distribution explains the very slight skew of the Median towards the Lower quartile, as was observed in the Box and Whisker Plot (Appendix B Figure 5.16). In referring to the Northern sample Histogram, the distribution at the lower end appears uniform between 15 mm and 30 mm, until between 30mm to 35 mm there is a drop in the frequency of values, then between 35 mm to 40 mm there is a marked increase in the frequency distribution until its Maximum (Appendix B Figure 5.16G). So that 60 % of the distribution is fairly evenly distributed below 30 mm, and 30%, are concentrated between 35 mm to 38.9 mm (Maximum) (Appendix B Figure 5.16G). Given this Northern sample distribution, it could be suggested that a Main and Subsidiary mode distribution of values are exhibited; however, the even and wide distribution of the values from the Median through the Lower Quartile (N=6) does not argue for a well-developed central tendency that would be highly desirable for developing a bi-modal (or Main and Subsidiary Mode) observation (Appendix B Figure 5.16G). If a Main and Subsidiary Mode is the most reasonable explanation of an observed distribution, then there may be some question of the appropriateness of a single measure of central tendency (i.e., the Mean or Median). In reviewing the Western sample's distribution, there appears to be a more well-defined Main and Subsidiary distribution identifiable in the histogram (Appendix B Figure 5.16H). The Main Mode would be between 32 mm to 38.3 mm, and the Subsidiary Mode would be between 25.3 mm and 32 mm (Appendix B Figure 5.16I). In an effort to gain further insight into this potential Main and Subsidiary Mode distribution, the Western sample has been split between values < and > 32 mm, which, according to the Western sample Histogram, is the visible breakpoint between the two modes (Appendix B Figure 5.16H). Interestingly, the 32 mm breakpoint divides the sample into almost equal halves (i.e., < 32 mm sample is at N=10, and > 32 mm at N=11) (Appendix B Figures 5.16B and 5.16H).

Table 5.21.1 Width - Western Bi-Modal Comparison - Type A

Descriptions	Original	Main Mode	Sub- Mode
N of Cases	21	11	10
Minimum	25.3 mm	32.3 mm	25.3 mm
Maximum	38.3 mm	38.3 mm	31.3 mm
Range	13.0 mm	6.0 mm	6.0 mm
Mean	31.7 mm	34.9 mm	28.1 mm
Variance	15.4 mm	3.4 mm	3.9 mm
Std. Dev.	3.9 mm	1.8 mm	2.0 mm
Std. Error	0.9 mm	0.6 mm	0.6 mm
Skewness	-0.1 mm	0.3 mm	-0.0 mm
Kurtosis	-1.2 mm	-0.8 mm	-1.1 mm
Sum	665.4 mm	383.9 mm	281.5 mm
C.V.	0.1 mm	0.1 mm	0.1 mm
Median	32.3 mm	34.3 mm	28.5 mm

In reviewing the re-calculated descriptive statistics of the Western sample for the Main Mode (N=11 for values >32 mm) and for the Subsidiary Mode (N=10 for values <32 mm) some very interesting observations emerge (Table 5.21.1). The Main Mode Mean of 34.9 mm and Median of 34.3 mm, with a Variance of 3.4 mm, and a Standard Deviation of 1.8 mm; whereas, the Subsidiary Mode Mean is 28.1 mm with a Variance of 3.9 mm and a Standard Deviation of 2.0 mm (Table 5.21.1). In having established two separate Means, the re-calculated descriptive statistics reveals that both Main and Subsidiary Modes each have developed a strong central tendency about the Mean with vastly reduced Variance and Standard Deviation for the Western sample (Table 5.21.1). In the original uni-modal Western sample's descriptive statistics, the Variance is 15.4 mm with a 3.9 mm Standard Deviation (Table 5.21.1). In reviewing the re-calculated

Main and Subsidiary Modes' Box and Whisker Plots (Appendix B Figures 5.16C and 5.16D), and Stem and Leaf diagrams (Appendix B Figures 5.16E and 5.16F) it is noted that the Median has skewed towards the Lower Hinge in the Main Mode interquartile range; whereas, the Median has skewed towards the Upper Hinge in the Subsidiary Mode interquartile range. Both these skews by the Main and Subsidiary Mode Medians indicates that the original Median of 32.3 did have a sufficient amount of values nearby to make the central tendency fairly robust (Table 5.21.1; Appendix B Figures 5.16C and 5.16D). Yet, the re-calculated Means, Variances, and Standard Deviations still provide a much more robust central tendency for both the Main and Subsidiary Modes (Appendix B Figures 5.16E and 5.16F). This reduced variation within the Main and Subsidiary Modes of the Western sample is identified in the histograms (Appendix B Figures 5.16I and 5.16J) which now displays the graph with 1mm intervals in lieu of the 2 mm intervals of the original Histogram (Appendix B Figure 5.16H), and is now more uni-modal in the shape of the distribution with longer tails on the lower end for the Subsidiary Mode, and on the Upper end for the Main Mode, thereby reflecting the previously identified skews.

After considering the foregoing observations based on analysis of the descriptive statistics, much has been potentially revealed. Yet, as pertains to this potentially important bi-modality, a large question still must be considered which relates to the Western sample at both regional and small local (or site) scales. To properly effect this consideration, a further analysis of the specific cases within these proposed duo-modes was undertaken to identify any potentially important patterns. The following Table 5.21.2 provides a summary of the case data for both visual and geographic identification which is organized between the Main and Subsidiary Modes for the Width attribute:

Table 5.21.2 Width - Bi-Modal Comparison By Case - Type A

Main Case	Main Photo	Main Site	Sub. Case	Sub. Photo	Sub. Site
#49	#14 A	Deer Lk.1	#51	#16 C	20MQ40-1
#53	#16 A	20MQ68-1	#58	#19 A	20MQ39-1
#59	#20 A	20MQ39-2	#61	#20 C	20MQ39-4
#60	#20 B	20MQ39-3	#63	#21 A	20MQ39-6
#62	#20 D	20MQ39-5	#64	#21 B	20MQ39-7
#65	#21 C	20MQ39-8	#67	#22 A	20MQ39-10
#66	#21 D	20MQ39-9	#68	#22 B	20MQ39-11
#71	#23 A	20MQ39-14	#69	#22 C	20MQ39-12
#72	#23 B	20MQ39-15	#78	#25 B	Renier-5350
#77	#25 A	Renier-5354	#82	#27 A	Wisc.-GrBa
#79	#25 C	Renier-5351			

In reviewing these cases, two observations are immediately clear: First, the Main Mode cases are generally an overall larger shouldered lanceolate than the Subsidiary Mode lanceolates, with the exception of the Eden point which is a long, narrow shouldered lanceolate (Case #58 [Appendix A, Table A.1], Photo No.19A [Appendix D], Table 5.21.2); and secondly, since both the Main Mode and the Subsidiary Mode samples are evenly derived from almost the identical sites, it is highly unlikely that these are Modes derived from the effects of different populations. Instead, it appears that either the differences in these modes are so small that there is no real significance to the proposed bi-modality and what is actually being observed is a normal distribution of highly variable lanceolates, or that a sub-classification of smaller versus larger lanceolates needs to be considered for an even more fine grained analysis of this attribute and possibly other attributes exhibiting this distribution. Still, until the inferential statistical tests have been undertaken, it is not productive to move beyond the basic observations of the descriptive statistics. Therefore, further analysis of this attribute will be undertaken later.

Summary - Width Attribute - Shouldered Type A

At one level, the Width attribute analysis has revealed a similar pattern to the other attributes of this study. It is noted that the Western sample displays the largest Width Mean/Median at 31.7 mm and 32.3 mm, respectively, for a difference between the Northern and Western Means/Medians of 4.2 mm and 5.4 mm, respectively. There is overall less variation in the Western sample than the Northern sample with a Northern Variance of 68.4 mm and a Standard Deviation of 8.3 mm for a difference of 53.0 mm and 4.4 mm, respectively. At another level, a potential bi-modality, with Main and Subsidiary characteristics, is observed in the Western sample distribution that will require further statistical analysis for significance and inference.

Attribute - Base Shape - Shouldered Type A

In reviewing the above nominal scale data for the Base Shape attribute, it is observed that the Northern sample has been reduced to N=8 due to basal fractures (Table 5.22). Therefore, the analysis of this attribute will only provide acceptable observations for the Western sample (N=20) and a brief comparative observation regarding the Northern sample.

Table 5.22 Base Shape - Type A

Base Shape	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1 = Straight	21	3	2	14	0
2 = Convex	6	0	3	3	2
3 = Concave	6	0	3	3	0
Total N=	33	3	8	20	2

First, it is observed that there is a very clear dominant frequency of the Straight Base Shape attribute state within the Western sample with N=14 Straight Base observations of the N=20 sample (Table 5.22). Additionally, it is noted that the occurrences of the Convex and Concave Base Shapes in the Western sample are equal at N=3 each indicating no clear sub-preference to the Straight Base Shape (Table 5.22). Interestingly, the Northern sample shows a nearly even distribution between the three states of this attribute, thereby indicating wide variation within the Northern sample with no dominant Base Shape being observed (Table 5.22). In fact, of the three Base Shape states, it is observed that the Straight Base Shape state is the least frequent state recorded for the Northern sub-region at N=2 (Table 5.22). Still, although this Northern sub-region sample is small, it is worth noting the nearly equal multi-state Base Shape occurrences does exhibit the same pattern as the other Northern sample attributes analyzed in this study, wherein wide variation has been a rather consistently observed pattern.

Summary - Base Shape Attribute - Shouldered Type A

Briefly, the Western sub-region sample favors the Straight Base Shape with no observed preference for either alternative states of Convex or Concave base shapes. The Northern sample (N=8) displays no clear preference for any specific Base Shape with nearly equal occurrences of all attribute states indicating wide variation in the Base Shape attribute. This observation of the Northern sample attribute expression does coincide with the wide variation observed throughout the analysis for the Northern sub-region attributes.

Attribute - Lateral Edge Haft Shape - Shouldered Type A

Table 5.23 Lateral Edge Haft Shape - Type A

Descriptions	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1 Straight	9	1	4	4	0
2 Expanding	20	2	1	16	1
3 Contracting	7	0	5	1	1
N=Totals	36	3	10	21	2

The nominal scale attribute of Lateral Edge Haft Shape displays some interesting and, potentially, very important observations regarding the attribute states' occurrences and distributions both within and between samples (Table 5.23). The Northern sample displays a duo-state character to the attribute with a very slight dominance of the Contracting - Lateral Edge Haft Shape state (N=5), which is nearly equaled by the occurrences of the Straight state of this attribute (N=4) (Table 5.23). The Western sample, on the other hand, is clearly dominated by the Expanding - Lateral Edge Haft Shape state (N=16), with the next highest occurring state being "Straight" (N=4), and only 1 "Contracting" - Haft Shape occurring in the Western sample (Table 5.23). This nominal scale attribute considers three different observable states of the Haft Lateral Edge Shape, thereby collapsing the continuous scale attributes of Between Shoulder Width and Base Width to these nominal state observations (Tables 5.16, 5.19 and 5.23). Given the continuous scale basis for these nominal scale observations, there should be adequate correlation to predict the continuous scale attributes' analytic outcome. In this case, then, with the nominal scale's "clearly dominant Expanding Lateral Edge Haft Shape", the Western sample's continuous scale Between Shoulder Width Mean/Median should be less than the Western sample's Base Width Mean/Median (Tables 5.16 and

5.19). The Western sample Between Shoulder Width Mean is 23.6 mm and the Median is also 23.6 mm (Table 5.19); and, the Western sample's Base Width Mean is 25.3 mm and the Median is 25.6 mm (Table 5.16). Therefore, with the narrower width Mean/Median located at the juncture of the Haft and Shoulder (or Between Shoulders) and the wider Mean/Median located at the Base Width, the prediction of the nominal scale observation of a dominant "Expanding Lateral Edge Haft Shape" is confirmed.

The Northern sample's duo-state distribution with the "Contracting" and "Straight" attribute states occurring at an almost equal frequency, predicts the inverse of the Western sample Means/Medians for the continuous scale attributes of Between Shoulder Width and Base Width. Therefore, in the case of the Northern sample, the Between Shoulder Width Mean/Median should be larger than the Base Width Mean/Median. The Northern Between Shoulder Mean is 21.7 mm and the Median is 22.9 mm (Table 5.19); and the Northern sample's Base Width Mean is 19.3 mm and the Median is 19.0 mm (Table 5.16). Therefore, with the larger width located at the Between Shoulder Width and the smaller width located at the Base Width, the prediction of the nominal scale observations for the larger Width at the juncture of the Haft and Shoulders, and the narrower width at the Base Width is confirmed.

Summary - Lateral Edge Haft Shape Attribute - Shouldered Type A

Based on the foregoing nominal scale attribute analysis for Lateral Edge Haft Shape, the Western sample displays a single-state dominance of the Expanding - Lateral Edge Haft Shape, while the Northern sample displays a dominant, and nearly equal, duo-state distribution of both the Contracting and Straight - Lateral Edge Haft Shape (Table 5.23). Additionally, the analysis observed that the continuous scale attributes of Between Shoulder Width and Base Width analyses confirms the nominal scale observations.

Attribute - Raw Material - Shouldered Type A

The nominal scale Raw Material attribute profile for the Northern and Western sub-regions reveals distinctly different Raw Material use patterns (Table 5.24). The Northern sub-region displays the most variation in its raw material distribution, but with only one recognized exotic raw material present (N=1) (#6 Knife River Chalcedony) which derives from the Northeastern North Dakota area. Locally available Jasper Taconite slightly dominates the Northern sample's Raw Material (N=4), but Knife Lake Siltstone (N=3), also a locally available raw material, is the second most frequent raw material in the sample (N=10) (Table 5.24). Importantly, there is no identifiable raw material source in the Northern Shouldered Lanceolate sample deriving from the Western sub-region.

Table 5.24 Raw Material - Type A

Raw Mat'l.	**All Regions**	**Eastern**	**Northern**	**Western**	**Southern**
1 Sheg'dah	3	3	0	0	0
3 Jasper Tac.	4	0	4	0	0
5 K.L. Siltstn	3	0	3	0	0
6 K.R. Chal.	1	0	1	0	0
10 Hixton	18	0	0	18	0
11 Norwood	1	0	0	0	1
12 Bayport	1	0	0	0	1
14 Unident.	4	0	2	2	0
16 Quartz(w)	1	0	0	1	0
N=Totals	36	3	10	21	2

The Western Shouldered Lanceolate sample also does not display any source identifiable Raw Material from the Northern sub-region (Table 5.24). The Western sample's Raw Material distribution is clearly dominated by Hixton Silicified Sandstone (#10) (N=18), with the remaining (N=3) raw material available from sub-regional raw material resources (Table 5.24). As an aside, although the samples are too small for rigorous analysis, it is noted that the Eastern sub-region sample (N=3) exhibits only one raw material which is locally available, Sheguiandah Quartzite; and that the Southern sample (N=2) exhibits two raw materials, Norwood and Bayport, both available in the Lower Peninsula of Michigan, but on opposite (West and East, respectively) sides of the state (Table 5.1; Table 5.24). It should be noted that in both the Northern and Western Raw Material samples, the dominant raw materials observed are only those which are locally available and visibly distinctive (Table 5.1).

Summary - Raw Material - Shouldered Type A

The Raw Material attribute analysis revealed several points of interest to this study (Table 5.24). The Northern sample (N=10) displays the most variation with a dominant duo-state distribution of sub-regionally available Raw Material including Jasper Taconite (N=4) and Knife Lake Siltstone (N=3), with the one appearance of the exotic raw material, Knife River Chalcedony, from the northeastern North Dakota area (Table 5.1; Table 5.24). Conspicuously absent is any raw material identified as deriving from the Western and/or Eastern sub-regions. The Western raw material distribution (N=21) is heavily dominated by only the sub-regionally available Hixton Silicified Sandstone (N=18) with no occurrence of any identified exotic raw materials (Table 5.24). These observations, then, may be robust in terms of their analytic power for considering further inferential statistics and nominal scale observations for the LPI Shouldered Lanceolate samples.

Summary - Shouldered Lanceolate Analysis

The continuous and nominal scale descriptive statistical analyses of the LPI Shouldered Lanceolates have revealed interesting observations that will require further study of this data. To provide some insights into these analyses, a table (Table 5.25) has been developed which includes a summary of the Means and Standard Deviations of the Continuous Scale attributes and a Presence/Absence of Nominal Scale categories with **bolded** numbers to indicate the dominant category/s exhibited by frequency of observations and organized by Sub-regions.

The Flake Orientation and Shoulder Angle continuous scale attributes are measured in degrees (d), and the remaining continuous scale attributes are measured in millimeters (mm). Also, it is noted that the summary values reported for the Unshouldered Lanceolates have been included in this table as a single reference point for both the Unshouldered and Shouldered Lanceolates. This combination has been provided to provide some low-level comparisons of attribute changes both within and between sub-regions as well as changes through time. Once again, it is important to remember that the necessity of splitting this analysis into the Unshouldered and Shouldered Categories is based on the recognition of a temporal shift between the Early - Late Paleoindian period (or Flambeau Phase after Salzer 1974: 43) of the Unshouldered Lanceolates (10,000 B.P. to 9,000 B.P.) to the Middle and Late - Late Paleoindian period (or Minoqua Phase after Salzer 1974) of the Shouldered Lanceolates (9,000 B.P. to 8,000 B.P.).

Table 5.25 Summary Comparison - Types A and B

Attribute	Northern A	Northern B	Western A	Western B	Southern B
1-Flake Orientation	93.5d/sd10.0	97.9d/sd17.2	91.9d/sd6.6	89.0d/ sd5.9	92.8d/ sd8.1
2-Flake Pattern	**1,2**,4,5	**1**,2,**4**, & 5	**1,2**,4	1 & **2**	**1**,2,3,4
3-Thick-ness	7.7/sd1.8	7.8 / sd1.8	9.5/sd1.1	8.0 / sd0.7	6.6 / sd1.0
4-Base Width	19.3/sd5.2	19.3 / sd5.7	25.3/sd3.4	18.3 / sd5.2	13.8 / sd3.0
5-Haft Length	23.5/sd9.9	32.5 / sd7.7	20.5/sd6.3	34.6 / sd9.4	28.8 / sd6.7
6-Shoulder Width	26.3/sd7.6	N/A	30.6/sd3.5	N/A	N/A
7-Shoulder Angle	51.4d/sd20.5	N/A	83.8d/sd15.1	N/A	N/A
8-Between Shoulder	21.7/sd5.5	N/A	23.6/sd2.8	N/A	N/A
9-Width	27.5/sd8.3	25.8 / sd3.8	31.7/sd3.9	28.6 / sd4.5	20.6 / sd2.9
10-Base Shape	1, **2, 3**	1, 2, **3**	**1**, 2, 3	2 & **3**	**3**
11-Haft Shape	1, 2, **3**	**1**, 2, & **3**	1, **2**, 3	1, **2**, & 3	**1**, 2, & 3
12-Raw Material	**3 & 5**	**14 & 3**	**10**	**10 & 14**	**12 & 11**

The Northern and Western Shouldered Lanceolates (Type A) appear to offer numerous differences in the attributes analyzed (Table 5.25). To begin, the Northern sample exhibits the largest Mean/Median measurements for only two of the continuous scale attributes, i.e., Haft Length and Flake Orientation. The Western sample, in contrast, displays the largest Means/Medians for all other continuous scale attributes. The

Northern sample is the most variable and displays the largest Standard Deviations for all of the continuous scale attributes (Table 5.25). The nominal scale attributes also reflect these differences in that each of the sub-regions (i.e., Northern and Western) exhibit different dominant nominal states of each nominal scale attribute (Table 5.25). Therefore, to summarize, it is noted that the Western sub-region Shouldered Lanceolates are thicker, they are wider at all width measurements, and they have a more acute Shoulder Angle than the Northern Shouldered Lanceolates. The Western points also exhibit much less variation than the Northern sub-region. The nominal scale attributes of the Western sub-region sample exhibits the Type 1 (Collateral Parallel Transverse) state of the Flaking Pattern attribute; Type 1, or Straight, is the most frequently occurring state of the Base Shape attribute; the Haft Lateral Edge Shape state of Expanding is the most frequently occurring; and, Hixton Silicified Sandstone is, by far, the most frequently occurring Raw Material. The Northern sample Haft Length Mean/Median is longer by about 3 mm; but, the Standard Deviation is greater by 3.3 mm for the Northern sample. In fact, wide variation is a consistent pattern in the Northern sub-region sample (Table 5.25). The nominal scale attributes indicate that the Northern sample exhibits the most frequent occurrences of Flaking Pattern 1 (Collateral Parallel); the Base Shape is also highly variable with no clear dominant shape, but both Convex and Concave are equally present with Straight Base Shapes the least occurring; the Haft Lateral Edge Shape is predominately Contracting; and, Jasper Taconite dominates the Raw Material frequencies, with Knife Lake Siltstone second in its frequency of occurrence (Table 5.25). The character of each sub-region's Shouldered Lanceolates is the collection of these attribute differences; however, the descriptive statistical analysis, which is the basis of these observed differences, does not establish the statistical significance of these observations. The analysis, so far, has provided a baseline for further inferential statistical testing yet to be explained. This further statistical testing is the next step in this analysis.

Unshouldered and Shouldered Analysis - Summary

In reviewing the foregoing summary information, some differences in shared attributes are considered between the Shouldered (Type A) and Unshouldered Lanceolates (Type B) which should have some temporal significance (Table 5.25). To begin, the continuous scale Flake Orientation Mean/Median angle is greater in the Northern sample than in the Western sample for both Type A and Type B Lanceolates; the angle is more acute in the Northern Type B (Unshouldered) than the Northern Type A (Shouldered); and, the Western Type A (Shouldered) is more acute than the Western Type B (Table 5.25). This indicates reverse trajectories for the Flake Orientation attribute between sub-regions over time. While the flaking angle is becoming less acute through time in the Northern sub-region, it is becoming only slightly more acute in the Western sub-region.

The Flaking Pattern attribute follows the same trend as the Flaking Orientation attribute with the Northern Type B sample displaying a high frequency of the Oblique Transverse Collateral Parallel (Type #4), but a highly reduced frequency among the Type A, Shouldered, Northern sample with a much greater frequency of the Type #1 , Collateral Parallel (Table 5.25). The Western sample, on the other hand, exhibits some continuity in the #2 type state, Collateral Parallel Transverse, of the Flaking Pattern attribute between the Type A (Shouldered) and the Type B (Unshouldered) Lanceolates (Table 5.25). This indicates reverse developments for the Flake Orientation attribute between sub-regions over time. While the Flaking angle is becoming less acute through time in the Northern sub-region, it is becoming only slightly more acute in the Western sub-region.

Interestingly, the Northern Type A continuous scale attribute of Thickness is within 0.10 mm of being identical at a Mean of 7.7 mm to the Northern Type B Lanceolate with a Thickness Mean of 7.8 mm, with both Types A & B exhibiting identical Standard Deviations of 1.8 mm (Table 5.25). The Western sample, however, indicates a greater Mean Thickness of 9.5 mm and greater variation with a Standard Deviation of 1.1 mm for the Type A compared to the earlier Type B with a 8.0 mm Mean Thickness and 0.7 mm Standard Deviation (Table 5.25).

Another attribute that does not change in the Northern sample is the Mean Base Width at 19.3 mm which is the same for both Type A & B. This variation appears still too high with a highly similar Standard Deviation of 5.2 mm (Type A) and 5.7 mm (Type B) (Table 5.25). The Western sample, however, exhibits a great deal of change between the Type A and Type B Lanceolates (Table 5.25). The Western sample Base Width Mean for the Type A is 25.3 mm with a Standard Deviation of 3.4 mm, and the Type B Mean is 18.3 mm with a Standard Deviation of 5.2 mm (Table 5.25). This indicates that, in the Western sample, the Base Width Mean increases through time and there is less variation exhibited.

The Haft Length attribute in the Northern Type A sample is substantially shorter at a Mean of 23.5 mm than the Type B Mean of 32.5 mm which is also accompanied by an increase in variation with the Standard Deviation for Type A at 9.9 mm, and 7.7 mm for the Type B (Table 5.25). The Western sample also exhibits a much Shorter Haft Length for the Type A Lanceolate with a Mean of 20.5 mm, compared to the Type B Mean of 34.6 mm accompanied by a reduced variation with the Type A Standard

Deviation of 6.3 mm and the Type B Standard Deviation of 9.4 mm (Table 5.25). This indicates that while Haft Lengths were reduced throughout the region and appear relatively similar between sub-regions, that variation increased in the Northern sub-region with Type A, while it decreased in the Western sub-region Type A.

The appearance of formal shoulders at the Haft element is a change that occurs across the Region somewhere around 9,000 B.P. and is diagnostic of the Type A "Shouldered' Lanceolates which means that Shoulders were not exhibited on Type B Unshouldered LPI Lanceolates during the 10,000 B.P. to 9,000 B.P. timeframe. Therefore, Shoulder-related continuous scale measurements are omitted from further scrutiny in the Type A/Type B comparison.

The Width attribute in the Northern Sample increases in both width and variation from the Type B Mean of 25.8 mm and Standard Deviation of 3.8 mm, to the Type A Mean of 27.5 mm and a Standard Deviation of 8.3 mm (Table 5.25). In the Western sample the Mean also increases, with Type A at 31.7 mm, from the Type B Mean of 28.6 mm. The variation in the Western sample, however, decreases with the Type A Standard Deviation of 3.9 mm and the Type B Standard Deviation of 4.5 mm, albeit a small increase (Table 5.25). These observations indicate that both the Northern and Western sub-regions experience an increase in the Width attribute with the Northern sample experiencing an increased amount of variation and the Western sub-region experiencing a decreased variation over time from the Type B (Unshouldered) to the Type A (Shouldered).

The nominal scale Base Shape attribute for the Northern sub-region sample exhibits an amount of change between the Type A and Type B Lanceolates in that both types exhibit some variation with Type B exhibiting an equally distributed duo-state frequency of attribute states 1 & 3, Straight & Concave; whereas, Type A variation is such that between the three states (Straight, Convex, & Concave) there is no observed dominant frequency (Table 5.25). The Western sample, however, displays a change from the State #2 - Convex Base Shape for Type B Lanceolates to State #1 - Straight Base Shape for Type A Shouldered Lanceolates. These observations indicate changes over time in Northern sub-region from a duo-state Base Shape (Straight & Concave) to a wider variation in base shapes with no clear dominant shape emerging. In the Western sub-region there is a change from the Type B Convex Base Shape to the Type A Straight Base Shape.

The nominal scale Haft Shape attribute exhibits the highest frequency of the Contracting Haft state in the Northern sub-region for both the Type B Unshouldered and the Type A Shouldered Lanceolates; whereas, the Western sub-region changes from the Type B Contracting Haft to the Type A Expanding Haft Shape, reversing the Haft Shape trajectories for the sub-regions.

In the Raw Material attribute, it is observed that the Northern sample while still maintaining a high frequency of the Jasper Taconite within both Type B and Type A Lanceolates, the Type A Lanceolate now exhibits second raw material Knife Lake Siltstone; whereas, the Western sample exhibits Hixton Silicified Sandstone as the single highest frequency of any other raw material. It is also noted that in the Type B, Unshouldered, analysis, there was some occurrences of local Western Raw Material in the Northern sample, and some local Northern Raw Material occurred in the Western sample; however, in the Type A analysis, it is noted that there are no occurrences of exotic material in the Western sample, and the only exotic raw material in the Northern sample derives from the North Dakota area (Knife River Chalcedony). Additionally, the

Unidentified category of Raw Material diminishes in both the Northern and Western sub-regions between Type B and the emergence of Type A lanceolates.

Conclusions

This descriptive statistical analysis provides a basis for both elimination of further unproductive attribute inquiry, as well as delimitation of those attributes that warrant closer scrutiny. Those continuous scale stylistic attributes that demonstrate the most promise for stylistic analysis will, therefore, be further considered in Chapter 6. Significantly, this analysis demonstrates that raw material selection appears to operate as a stylistic variable within LPI tool assemblages across all geographic subregions and, further, that this variation in selection is evidenced through time.

MOBILITY, STYLE, AND EXCHANGE AMONG UPPER GREAT LAKES LATE PALEOINDIANS

VOLUME II

By

David Lee Ruggles

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Anthropology

2001

CHAPTER 6

STYLE AND EXCHANGE - INFERENTIAL ANALYSIS

Introduction

In the preceding chapter (Chapter 5), analysis of the descriptive statistics provided insight into the structure of the data, and revealed those elements which expresses the potential to inform about lithic style. The previous analysis, then, provides the basis for the further analysis and final testing of the hypotheses at the center of this research. Therefore, in this chapter, further analysis of the statistical significance of these previous observations shall first be undertaken. The statistical results are then used to test the hypotheses constructed to reveal the regional character of upper Great Lakes Late Paleoindian lithic style, and its implications for interpreting patterns in upper Great Lakes LPI mobility and exchange.

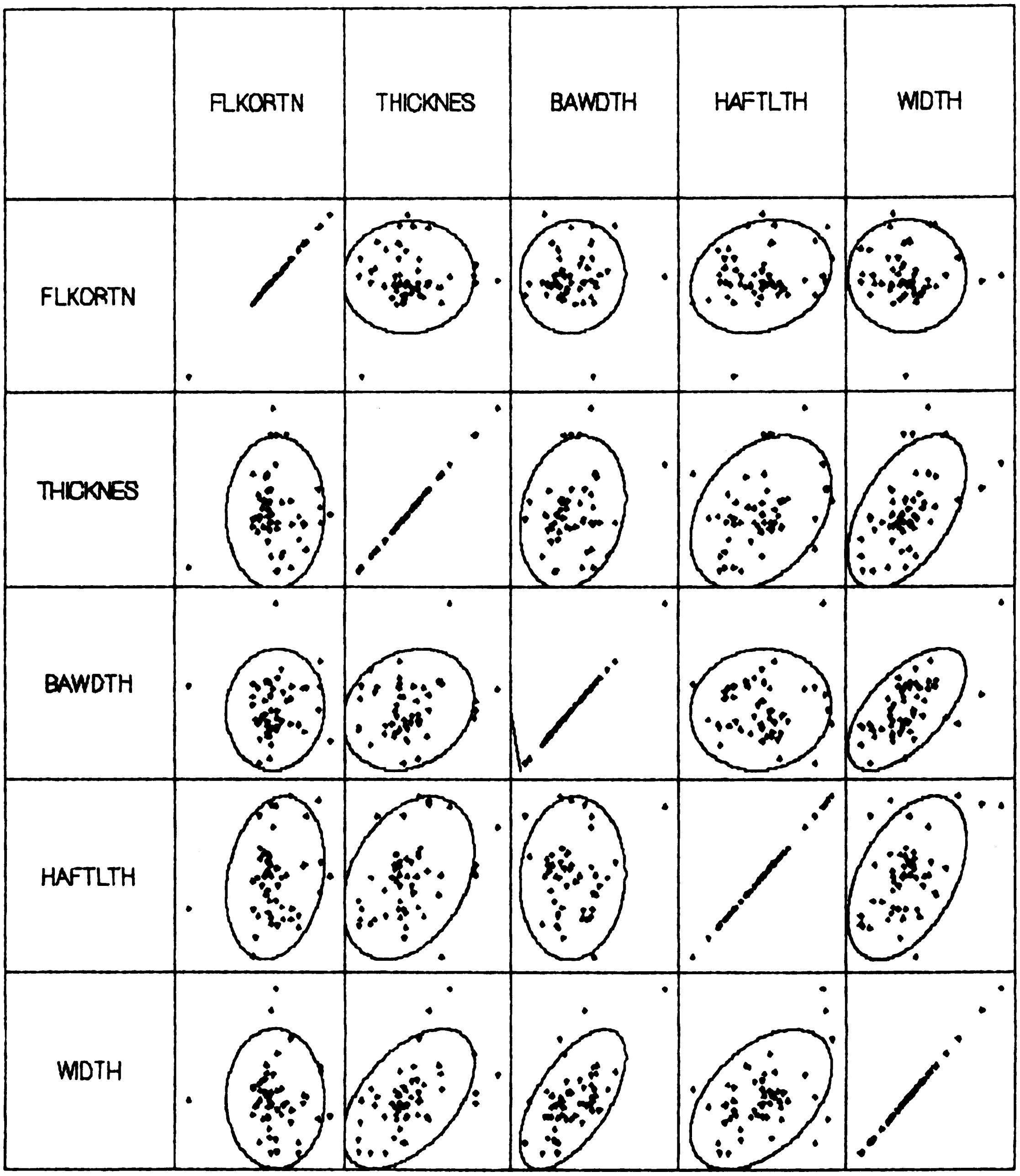
Stylistic Analysis

This part of the study proceeds along the same analytic dimensions as the descriptive statistical analysis (Chapter 5), i.e., beginning with the Early Unshouldered Lanceolates (Type B), followed by the Late Shouldered Lanceolates (Type A), then concluding with an in-depth geographical and temporal comparison for issues of style, mobility, and exchange. Both the continuous scale and nominal scale data are tested for normality, significance, and, ultimately, testing hypotheses.

The continuous scale variables to be considered in the inferential statistical analysis includes Flaking Orientation, Thickness, Width, Basal Width, and Haft Length. The nominal scale variables include Raw Material, Haft Lateral Edge Shape, Base Shape, and Flaking Pattern. The Raw Material attribute will also be used in the analysis of exchange. The geographic sub-regions of concern for the Early Unshouldered Lanceolates includes the Northern, Western, and Southern subregions with the Eastern subregion omitted because of too small a sample (N=4). The initial testing includes analyzing the organization of the data by defining any bivariate relationships, which are graphically revealed using Scatterplot, and including the data from all three of the aforementioned sub-regions (Figure 6.1). This Scatterplot uses a Gaussian confidence ellipse, .90 probability value, to graphically present potential sample attribute correlations and their relative strengths. Centered on the sample means of the X and Y variables, the ellipse's major axes are determined by the unbiased sample standard deviations of X and Y and its orientation is determined by the sample covariance between X and Y (Systat 1992: 314) (Figure 6.1). Still, the Scatterplot is not a robust analytic tool, it merely provides a graphical representation of the data which is used to identify potential relationships between variables without considering the statistical significance of those relationships; although, covariance can be used inferentially.

The Scatterplot results reveal some potentially significant relationships between the attributes across the region (Figure 6.1). The Flake Orientation attribute appears to display very little correlation with the other attributes except Haft Length, which is very slight. The Thickness attribute appears to offer some correlation potential between the attributes of Width and Haft Length, with Width displaying the highest correlation.

Figure 6.1 Scatter Plot - Type B



The Base Width attribute appears to exhibit the strongest correlation with the Width attribute. This potential correlation is not surprising considering that the nominal scale, Contracting state of the Haft Lateral Edge Shape attribute dominates throughout the entire Region. The Haft Length attribute appears to express its highest correlation with the Width attribute and secondly, with the Thickness attribute. The Width attribute exhibits the most potential correlations of all attributes with the highest being Base Width, second highest being Thickness, and third being the Haft Length (Figure 6.1). Based on the analysis of this Scatterplot, some further study of these potential correlations and their significance is undertaken. Also, the attribute distributions indicate the type of statistical tests best suited to analysis of the data.

Nonparametric Statistics

Significantly, as was noted in the descriptive statistical analysis of Chapter 5 and as can be seen in the Figure 6.1 Scatterplots, the sample distributions do not typically exhibit characteristics of normality considering the small sample sizes, the wide distribution, and the obvious outliers among the sample variables. It is recognized that parametric statistics are the most robust in their explanatory power for normally distributed populations, whereas nonparametric statistics are specifically designed to test distributions which are not normal (Earickson and Harlin 1994: 225). In considering the nonparametric equivalent of the t-test, for example, statisticians have studied and compared the outcomes and made the following observation (Earickson and Harlin1994:225-226).

> *"With non-normal data from a continuous distribution, the efficiency of the rank tests relative to 't' never falls below 85% in large samples and may be much greater than 100% for distributions that have long tails. Since they are relatively quickly made, the rank tests are highly useful for the investigator who is doubtful that the data can be regarded as normal (Snedecor and Cochran 1989: 144)."*

At this point, it is important to remember that <u>only</u> the Null Hypotheses (*Ho*)are tested throughout this study, not the Alternative Hypotheses (*H1*).

<u>Null Hypothesis</u>

The first consideration in this analysis is establishing the Null Hypothesis (*Ho)* for normal population distribution across samples of Haft stylistic variables which is stated as follows:

- *Ho*: there is no difference between the expected sample distribution of upper Great Lakes LPI Lanceolate Haft element variables and the observed distribution.
- *H1*: there is a significant difference between the expected sample distribution of upper Great Lakes LPI Lanceolate Haft element variables and the observed distribution.

In this study, I follow the convention in archaeological statistical inquiry for the non-parametric tests to be conducted using a 95% confidence interval, or level of significance of α =.05, which should be sufficient to avoid a Type 1 error of rejecting the null hypothesis when it is actually true (Shennan 1997: 53-54). Yet, it is notable that when using nonparametric statistics, it is not uncommon to identify those variables which are technically outside the ∝.05 level of significance (or rejection region), but are close enough to be considered, albeit at a slightly lesser level than those variables exhibiting significance within the ∝.05 level.

Kolmogorov-Smirnov One-Sample Goodness-of-Fit Test

To initiate the inferential statistical analysis, the first area of concern is the goodness-of-fit of the observed sample distributions to the theoretical (or expected) distributions. Is this truly a case of a non-normal cumulative probability distribution? As mentioned earlier, the statistics computer program SYSTAT for Windows, Version 5, is used in computing the inferential statistics in this study. Given the issue of normality and the non-normal distribution observed in this data, the first test selected to be employed within this inferential statistical framework is the non-parametric test Kolmogorov-Smirnov One Sample Goodness-of-Fit Test (K-S) using the standard normal distribution which has been further standardized through the Lilliefors test (SYSTAT 1992: 495-496). The Lilliefors Test standardizes the listed variables, then tests whether the standardized versions are normally distributed. Significantly, the SYSTAT version of the Lilliefors Test incorporates changes to the tables after finding that some Lilliefors table values were incorrect, "...consequently, the SYSTAT approximation uses the corrected values. The approximation discussed in Dallal and Wilkinson and used in SYSTAT differs from the tabled values by less than .01 and by less than .001 for $p<.05$ (SYSTAT, Statistics 1992: 718)". Given the shape of the sample distributions (including outliers) revealed in Chapter 5 and in Figure 6.1, a test needed to be selected that both standardizes and is sensitive to the distribution shape. The normal K-S one-sample test assumes the variable being tested has been randomly sampled from a standard normal, uniform (0 to 1), or chi-square (with stated degrees of freedom) population (SYSTAT, Statistics 1992: 495-496). The normal K-S test, then, pays attention to the location, scale, and shape of the distribution; whereas, the Lilliefors test only pays attention to the shape of the distribution which is of most concern for these samples and this analysis.

The K-S one-sample Lilliefors Test includes analysis of the five continuous scale attributes previously identified (Flake Orientation, Thickness, Base Width, Haft Length, and Width) which are considered both across the Region (N=54) and within each of the three sub-regions (Northern [N=26], Western [N=10], and Southern [N=18]).

Regional - Unshouldered Lanceolate: K-S One-Sample (Lilliefors) Test

Table 6.1 K-S One-Sample (Lilliefors) Test - Type B (Regional)

Attribute	N of Cases	Max. Differences	Probability (2-tail)
Flake Orientation	54	0.164	0.001**
Thickness	53	0.127	0.032**
Base Width	54	0.098	0.208
Haft Length	53	0.090	0.333
Width	53	0.120	0.056**

** Denotes Non-normal distribution

In reviewing Table 6.1, it is noted that the observed distribution for 3 of the 5 selected Regional variables are non-normal distributions. Variables Flake Orientation (p=.001), Thickness (p=0.032), and Width (p=0.056) are all within the $\propto$.05 region of rejection. Also, the remaining two variables, Base Width (p=0.208) and Haft Length (p=0.333), are certainly on the weaker side of a normal distribution. This observed non-normal sample distribution among lanceolate attribute values is not, however, necessarily unexpected. Remember that the Unshouldered Lanceolate category in this study was established by lumping different unshouldered lanceolate types (e.g., Agate Basin, Midland, Plainview, etc.) into a single broad group sharing temporal associations distinctly different from the Shouldered Lanceolate types, and consider that the samples in this study are relatively small. Consequently, given that Unshouldered Lanceolate sub-types do exhibit diagnostic diversity, some outliers as well as generally wider variation were predictable for this category's statistical behavior. Considering the non-normal distribution, therefore, it is appropriate that the inferential statistical analysis proceeds within a nonparametric framework. Further, the individual subregions' samples are also analyzed independently to gain insights into the data structure for normality.

Finally, the observed sample's non-normal distribution for the Unshouldered Lanceolates (N=54) is predominately within the region of rejection at a $\propto .05$. Therefore, the Null Hypothesis, *"Ho*: there is no difference between the expected sample distribution of upper Great Lakes LPI Lanceolate Haft element variables and the observed distribution.", can be rejected. And, the alternative hypothesis can be considered.

Northern Subregion - Unshouldered Lanceolate: K-S One-Sample (Lilliefors) Test

Table 6.2 KS One-Sample (Lilliefors) Test - Type B (Northern)

Attribute	N of Cases	Max. Differences	Probability (2-Tail)
Flake Orientation	26	0.155	0.109
Thickness	26	0.168	0.057**
Base Width	26	0.163	0.074
Haft Length	26	0.153	0.118
Width	26	0.236	0.001**

**Denotes Non-normal distribution

To gain insights into the Regional data structure, the K-S One-Sample (Lilliefors) Test is further performed on a subregional basis. Therefore, similarities and differences in sample distribution shapes between the subregions becomes more specifically ascertainable. The Northern subregion K-S test clearly indicates that the attributes of

Width (p=0.001) and Thickness (p=0.057) are non-normally distributed, and that the Base Width attribute probability of 0.074 is also very close to a non-normal distribution (Table 6.2). Additionally, this sub-region sample of N=26 is the largest among the sub-region samples. Further, it is noted that the non-normality of this subregion sample distribution is closely aligned with the Regional attribute distributions for Width and Thickness as revealed in Table 6.1. It should also be observed that of the 5 variables considered in the Northern K-S Test, the highest value provided is that for Haft Length of p=0.118. This indicates that the observed distributions outside the ∝.05 level of significance exhibit a decided tendency towards the non-normal distribution for all Northern subregion attributes.

Western Subregion - Unshouldered Lanceolate: K-S One-Sample (Lilliefors) Test

Table 6.3 K-S One-Sample (Lilliefors) Test - Type B (Western)

Attribute	N of Cases	Max. Differences	Probability (2-Tail)
Flake Orientation	10	0.282	0.024**
Thickness	9	0.192	0.502
Base Width	10	0.191	0.417
Haft Length	9	0.151	1.000
Width	9	0.188	0.546

**Denotes Non-normal distribution

The Western subregion K-S test indicates that the Flake Orientation attribute is non-normally distributed, and that the remaining 4 attributes are normally distributed (Table 6.3). Also, it should be noted that the Flake Orientation variable was determined to be normally distributed (albeit weakly) in the Northern subregion K-S Test (*p=0.109*), but non-normal in the Region K-S Test (*p=0.001*) (Table 6.2). It is further noted that the

Western sub-region displays the smallest sample (N=9 & 10) of the three subregions considered within this regional analysis. Additionally, the Haft Length attribute is normally distributed at *p=1.000*, while the remaining attributes range around the *p=0.500* area, which is certainly within the normal distribution range, but still exhibiting some non-normally distributed characteristics in the observed distribution. Therefore, the Western sub-region sample, while predominately normally distributed, as a subregion of a non-normally distributed Region, will continue to be included within the non-parametric analytic framework for analytic and comparative purposes.

<u>Southern Subregion - Unshouldered Lanceolates: K-S One-Sample (Lilliefors) Test</u>

Table 6.4 K-S One-Sample (Lilliefors) Test - Type B (Southern)

Attribute	N of Cases	Max. Differences	Probability (2-Tail)
Flake Orientation	18	0.204	0.045**
Thickness	18	0.182	0.119
Base Width	18	0.151	0.348
Haft Length	18	0.174	0.157
Width	18	0.137	0.510

**Denotes <u>Non-normal</u> distribution

The Southern subregion sample distribution non-normality is similar to the Western subregion sample. It is noted that, in both subregions, the Flake Orientation attribute is non-normally distributed; whereas, the remaining attributes are notably on the weaker side of a normal distribution, particularly in the cases of Thickness (*p*=0.119) and Haft Length (*p*=0.157) (Table 6.4). These observations of non-normality (and near non-normality) are perhaps even more interesting for the Southern region considering that the sample is drawn from a single site; Samel's Field.

Kruskal-Wallis One-Way Analysis of Variance and Mann-Whitney U Test (or NPAR T-test)

The Kruskal-Wallis (K-W) test is the nonparametric equivalent of the parametric one-way ANOVA which " ...involves combining values for the subsamples and ranking them, but keeping track of the ranks for each subsample..." and operates as an extension of the Mann-Whitney U test of medians for more than two independent samples (Earickson and Harlin1994:234-235). A median-based test, the Mann-Whitney U test is a robust non-parametric alternative to the t-test when two samples are compared which are both unequal in size and are non-normally distributed, such as the samples in this study. The Region sample includes all 3 subregions which are tested using the K-W test of variance, and the subregion samples are tested in pairs using the Mann-Whitney U test, both to determine significant differences at $\alpha 0.05$. Therefore, to establish the research test, the Null Hypothesis and Alternative Hypothesis are stated as follows:

- *Ho*: The populations represented by the three subregion samples of the upper Great Lakes region do not differ with respect to the expression of LPI Unshouldered Lanceolate hafting styles.
- *H1*: The populations represented by the three subregion samples of the upper Great Lakes Region are significantly different with respect to the expression of LPI Unshouldered Lanceolate hafting styles.

The next step in this analysis is to run the subject tests using the 5 stylistic variables for the upper Great Lakes, LPI Unshouldered Lanceolates.

K-W One-Way Analysis of Variance

Table 6.5 K-W One-Way Analysis of Variance - Type B (Regional)

Attributes	Northern	Western	Southern	*df*	K-W Stat.	*P*-Value
Flake Ortn	26	10	18	2	8.604	*p=0.014**
Thickness	26	9	18	2	10.980	*p=0.004**
Base Wdth	26	10	18	2	14.890	*P=0.001**
Haft Lngth	26	9	18	2	3.811	*P=0.149*
Width	26	9	18	2	27.432	*P=0.000**

* Significant Difference at $\propto 0.05$

After reviewing the K-W test results, it is clear that there are statistically significant differences between the subregion sample variances of 4 of the 5 variables included in the analysis (Table 6.5). In fact, it is noted that all 4 of these attributes are significantly different at a level $\geq \propto 0.01$ which indicates that these differences are statistically robust. Obviously, the variation between the subregion samples for 4 of the 5 variables is significantly greater than the variation within each subregion sample. Haft Length is the only variable with a variance that is not significantly different among the subregion samples. To gain further insights into the subregional character of these differences, the Mann-Whitney U test is employed by comparing the subregions as pairs in a two-sample test of Medians in the following three tables.

Mann-Whitney U Tests:

Table 6.6 Mann-Whitney U-Test - Northern to Western Comparison - Type B

Attribute	Northern	Western	X2 Apprx.	*df*	U Statistic	*P*-Value
Flake Orientation	26	10	6.113	1	200.000	*p=0.013**
Thickness	26	9	1.849	1	81.000	*p=0.174*
Base Width	26	10	0.281	1	145.000	*p=0.596*
Haft Length	26	9	0.321	1	102.000	*p=0.571*
Width	26	9	4.003	1	64.000	*p=0.045**

*Significant Difference at ∝0.05

The Northern to Western Mann-Whitney U test has identified statistically significant differences for two *Low-Visibility* variables, Flake Orientation *(p=0.013)* and Width *(p=0.045)* (Table 6.6). It should also be noted that the Thickness variable, while not statistically significantly different, appears to display more differences than similarities *(p=0.174)*. Also, it is interesting to observe the similarities between the subregion samples for both the Base Width *(p=0.596)* and Haft Length *(p=0.571)* variables.

The outcome of this procedure reveals that the Western Unshouldered Lanceolates are generally wider than the Northern points; and, that the Northern LPI Unshouldered Lanceolates exhibit a more oblique flaking pattern than the Western sample. Therefore, there are significant differences between the Western and Northern subregions for these *Low-Visibility* stylistic variables, which means that the Null Hypothesis is rejected, and the Alternative Hypothesis is considered for the Northern to Western subregional U test.

Table 6.7 Mann-Whitney U-Test - Northern to Southern Comparison - Type B

Attribute	Northern	Southern	X2 Apprx.	*df*	UStatistic	*P*-Value
Flake Orientation	26	18	3.739	1	315.000	*p=0.053**
Thickness	26	18	4.416	1	322.000	*p=0.036**
Base Width	26	18	13.513	1	388.000	*p=0.000**
Haft Length	26	18	2.635	1	302.000	*p=0.105*
Width	26	18	20.790	1	425.000	*p=0.000**

*Significant Difference at ∝0.05

The Northern to Southern U test indicates that there are statistically significant differences at the ∝0.05 level for 4 of the 5 analyzed attributes. Also, the Haft Length attribute with a p-value of 0.105 also indicates a high degree of difference, albeit not statistically significant. This difference is not especially surprising considering that the Southern sample is geographically very distant from the Northern subregion, and with the glacial upper Great Lakes intervening between their locations, and that the Southern sample is derived from one site location as opposed to the widely dispersed Northern sample. Also, note that both the Base Width and Width attributes are significantly different at a level ≥ ∝0.0001 which are highly significant differences. Obviously, given the extent of these differences among LPI Unshouldered Lanceolates, there are significant differences in the Width dimensions of the haft form or shape.

Table 6.8 Mann-Whitney U-Test - Western to Southern Comparison - Type B

Attributes	Western	Southern	*X2* Apprx.	*df*	UStatistic	*P*-Value
Flake Orientation	10	18	3.147	1	53.000	*p=0.076*
Thickness	9	18	11.876	1	148.000	*p=0.001**
Base Width	10	18	6.954	1	145.000	*p=0.008**
Haft Length	9	18	2.709	1	113.000	*p=0.100*
Width	9	18	15.280	1	157.000	*p=0.000**

*Significant Differences at ∝0.05

Interestingly, the Western to Southern U test nearly reproduces the Northern to Southern U test with 3 of 5 of the same attributes statistically significantly different, and nearly 4 with Flake Orientation at a *p=0.076* (Table 6.7 and Table 6.8). Additionally, it is noted that the significance levels of Thickness (*p=0.001*), Base Width (*p=0.008*), and Width (*p=0.000*) are all ≻∝0.01. Again, this emphasizes the differences in these visible attributes of form (or shape) and elevates their usefulness as sensitive measures of stylistic variation in LPI Unshouldered Lanceolates.

<u>Summary</u>

At a Regional scale, it has been determined that there are statistically significant differences between the subregions for all the LPI Unshouldered Lanceolate attributes except Haft Length at a ≥ level of ∝0.05; in fact 4 of the 5 variables are statistically significantly different at a level ≥∝0.01 (Table 6.5).

At the subregional scale, it has been determined that the Flake Orientation attribute is most significantly different between the Northern and Western *(p=0.013)* samples than either the Northern and Southern *(p=0.053),* or Western and Southern *(p=0.076).* Considering the nearer geographic proximity of the Northern and Western subregions, it is especially interesting to note the statistically significant difference in this low-visibility attribute between these two subregions. Additionally, the moderate-visibility attribute of Width also sets the Northern and Western subregions apart with a statistically significant difference of $p=0.045$. Finally, based upon geographic proximity and the opportunity for population interaction, it is reasonable to observe that the greatest frequency of significant differences are between the Northern and Southern samples with 4 out of 5 attributes significantly different at $\alpha 0.05$. And, the greatest amount of similarity is between the Northern and Western samples with 2 of the 5 attributes significantly different at $\alpha 0.05$. While the Western and Southern samples are in the middle ground of similarity, with 3 of the 5 variables significantly different at not only $\alpha 0.05$, but also at $\alpha 0.01$.

Considering all the foregoing, then, the Null Hypothesis (*Ho)* can be rejected and the Alternative hypothesis*(H1)* can be considered:

- *Ho*: The populations represented by the three subregion samples of the upper Great Lakes region do not differ with respect to the expression of LPI Unshouldered Lanceolate hafting styles.
- *H1*: The populations represented by the three subregion samples of the upper Great Lakes Region are significantly different with respect to the expression of LPI Unshouldered Lanceolate hafting styles.

The next step in this analysis is to analyze the issue of similarity by establishing the nonparametric correlation coefficients measures as produced in Spearman Rank Correlations.

Spearman Correlation Coefficients

Among the various nonparametric correlation measures available for rank order data, the Spearman rho is closest to the Pearson correlation since it is computed on the same data as Pearson, but after converting them to ranks (SYSTAT, Statistics 1992: 73). Therefore, the Spearman's rank correlation coefficient is obtained using an expression similar to the Pearson's product-moment correlation:

$$r_s = 1 - \frac{6\sum D^2}{n(n^2 - 1)}$$

Using the foregoing expression to derive correlation coefficients, a matrix of Spearman Correlation Coefficients (r_s) is produced which is interpreted in the same fashion as the Pearson Matrix Correlation Coefficients (r_p). The matrix values vary between +1 and -1, with a 0 indicating that "...neither of the two variables can be predicted from the other by using a linear equation (SYSTAT, Statistics 1992: 70)". A correlation of 1 allows a perfect prediction by linear equation of one variable by the other variable; whereas, a -1 indicates the same except for its being a negative value for the line slope (70). While the matrices are used to represent the correlation coefficient between paired variables, these do not reveal if the Spearman Correlation Coefficients are significant at the $\propto 0.05$ level. To establish statistical significance, the *t*-test is used to establish the critical value of *t* for each coefficient in the sample which is computed as follows and then compared to the *t* Distribution Table.

$$t = r \Big/ \sqrt{1 - r^2} \bullet \sqrt{n - 2}$$

To begin, this portion of the analysis begins with establishing the Null and Alternative Hypotheses:

- *Ho*: There is no correlation in the population samples of the upper Great Lakes LPI Unshouldered Lanceolates.
- *H1*: There are correlations in the population samples of the upper Great Lakes LPI Unshouldered Lanceolates.

Table 6.9 Matrix of Spearman Correlation Coefficients - Region (Northern, Western, and Southern) - Type B

Attributes	Flake Ortn.	Thickness	Base Width	Haft Lth.	Width
Flake Ortn.	1.000				
Thickness	-0.116	1.000			
Base Width	0.089	0.173/*t=1.254*	1.000		
Haft Lth.	0.091	0.348/*t=2.651**	-0.058	1.000	
Width	-0.093	0.549*	0.580*	0.355*	1.000

* Significant Correlation at ∝*0.05*

Given that n=53 - 2 or n = 51, at the significance level of ∝*0.05*, a Critical Value ≥t = *2.000* is needed to establish statistical significance. Using the previously provided computation for arriving at *t*, the lowest correlation coefficient in Table 6.9 that is statistically significant is the Haft Length to Thickness coefficient of 0.348, which computed = 2.651. The next lowest coefficient is Base Width to Thickness at 0.173

which computed = 1.254 and is not statistically significant at a critical value of 2.000 for $\propto 0.05$ level of significance. Therefore, the remaining correlation coefficients that are statistically significant must exceed the Haft Length/Thickness coefficient of 0.348. In reviewing Table 6.9, it is found that the correlation coefficients for the paired variables of Width/Thickness (0.549), Width/Base Width (0.580), and Width/Haft Length (0.355) are all >0.348 and are, therefore, statistically significant at the $\propto 0.05$ level.

These correlations are not necessarily surprising considering the observations made during the descriptive statistical analysis that the common nominal scale trait shared by the subregions was a dominance of the contracting haft lateral edge form (Chapter 5). Interestingly, those paired variables displaying statistically significant correlation are those moderately visible attributes of haft form (e.g., Haft Length, Width, Base Width), and the low-visibility Thickness attribute which may derive more of its significance from the functional realm as opposed to the stylistic realm of tool production. The Flake Orientation variable indicates no (or very weak) correlation between subregions on a Regional scale, which is a *Low-Visibility* attribute; however, at the subregional scale, this variable statistically develops as fairly discrete (Tables 6.5, 6.6, and 6.7).

Continuing the established analytic protocol of this study, the subregions are compared in pairs to gain further insights into the strength of these Regional correlations at the subregional level. Given the geographic locations of these subregions, it is important to establish a more finite interpretation of correlation with particular interest in the Northern and Western subregions with their close proximity.

Table 6.10 Matrix of Spearman Correlation Coefficients - Subregions (Northern and Western) - Type B

Attributes	Flake Ortn.	Thickness	Base Wth.	Haft Lth.	Width
Flake Ortn.	1.000				
Thickness	-0.144	1.000			
Base Width	0.102	-0.038	1.000		
Haft Lth.	0.324/*t=1.968*	0.306	-0.226	1.000	
Width	-0.096	0.431/*t=2.746**	0.304	0.288	1.000

* Significant Correlation at ∝0.05

Given that n = 35 - 2 (or n = 33), at the significance level of ∝0.05, the Critical value ≥ $t = 2.042$ is needed to establish statistical significance for a strong correlation between paired variables. As indicated in Table 6.10, there is only one statistically significant correlation between the Northern and Western subregions which is for the paired variables of Width/Thickness ($t = 2.746$). Interestingly, while the close geographic proximity of these two subregions might initially imply that a higher correlation between stylistic variables should occur, it is found that these correlations are not statistically significant in all cases but one. The implications for this lack of correlation will be discussed further in the summary following the analysis of the remaining two correlation matrices.

Table 6.11 Matrix of Spearman Correlation Coefficients - Subregions (Northern and Southern) - Type B

Attributes	Flake Ortn.	Thickness	Base Width	Haft Lth.	Width
Flake Ortn.	1.000				
Thickness	-0.046	1.000			
Base Width	0.158	0.100	1.000		
Haft Lth.	0.048	0.322*	-0.048	1.000	
Width	-0.021	0.447*	0.624*	0.307/*t=2.090**	1.000

* Significant Correlations at ∝0.05

Given that n = 44 - 2 (or n = 42), at the significance level of ∝0.05, the Critical value ≥ *t = 2.021* is needed to establish statistical significance for a correlation. The paired variables of Width/Haft Length have the lowest correlation coefficient (*t=2.090)* within the matrix that is significant at a level of ∝0.05 (Table 6.11). In reviewing the matrix, then, it is noted that 4 different sets of paired variables have correlation coefficients that are statistically significant at the ∝0.05 level. Beyond the Width/Haft Length paired variables just mentioned, these additional three include Haft Length/Thickness (0.322), Width/Thickness (0.447), and Width/Base Width (0.624) (Table 6.11). It is noted that these same 4 paired variables match those statistically significant as identified in the Region - Matrix of Spearman Correlation Coefficients (Table 6.9). At this point it is important to note that the Northern and Southern subregions obviously share a greater overall correlation between the sample variables than does the Northern and Western subregions even though they are geographically contiguous. This insight introduces very interesting potentials for interpreting group interaction, mobility, and stylistic expression which will be discussed in further detail later in this analysis.

Table 6.12 Matrix of Spearman Correlation Coefficients - Subregions (Western and Southern) - Type B

Attributes	Flake Ortn.	Thickness	Base Width	Haft Lth.	Width
Flake Ortn.	1.000				
Thickness	-0.270	1.000			
Base Width	-0.206	0.458*	1.000		
Haft Lth.	-0.305	0.418/*t=2.300**	-0.037	1.000	
Width	-0.428	0.769*	0.623*	0.485*	1.000

* Significant Correlations

Given that n = 27 - 2 (or n = 25), at the significance level of ∝0.05, the Critical value ≥ *t = 2.060* is needed to establish statistical significance for a correlation. Exhibiting 5 statistically significant correlations, the Western and Southern subregions share the most correlations for paired variables of the subregions and the Region as a whole. Yet, the glacial Great Lakes separate these two subregions, thereby presenting significant obstacles to both direct interaction and mobility given the dominant terrestrial-based theories of LPI group mobility. Still, it is important to note that these significant correlations are not only the most abundant at 5, but also the strongest correlations among the subregions, as well as across the Region.

Summary

After analyzing all the foregoing Spearman Correlation Coefficients, it has been determined that the Null Hypothesis (Ho: There is no correlation in the population samples of the upper Great Lakes LPI Unshouldered Lanceolates) can be rejected, and that the Alternative Hypothesis (H1: There are correlations in the population samples of the upper Great Lakes LPI Unshouldered Lanceolates) can be considered.

As evidenced in the analysis, there are very interesting observations regarding the significant correlations between subregions and across the entire region. In analyzing these data it is important to remember that the Spearman correlation coefficient is not comparing absolute continuous-scale measurements of variables between subregions, but rather it is measuring the linear correlation of covariance between two ranked variables along the x/y axis (Shennan 1997: 140). In short, statistically significant correlations can be viewed as a strong measure of specific similarities between subregion samples for paired variables.

First, it's observed that there are no significantly strong correlations among the subregions between the Flake Orientation variable and any of the remaining four variables (Thickness, Base Width, Haft Length, and Width). This lack of correlation may have been somewhat predictable when considering that the U-test identified statistically significant differences between the subregions (except Western and Southern) and across the entire region for the Flake Orientation attribute (Tables 6.6, 6.7, and 6.8). This is largely due to the predominately Oblique flaking pattern orientation (Mean = 97.6°/Median = 95.6°) of the Northern subregion sample (Chapter 5, Table 5.3).

Another important observation is that the two subregions that are contiguous to each other (Northern and Western), and therefore more physically accessible to each other, share only one statistically significant correlation which is between the Width and Thickness variables ($t=2.746$) (Table 6.10). Yet the Width variable, according to the Mann-Whitney U test, exhibits a statistically significant difference of $p=0.045$ at a $\propto 0.05$

level between the Northern and Western subregions (Table 6.6). The Thickness variable, on the other hand, was not statistically significantly different between these two subregions, but also did not display strong similarity with a U-test value of only $p=0.174$ at the $\propto 0.05$ level (Table 6.6). Also, in the K-W One-way Analysis of Variance for the three subregions, it was found that there was a significant difference for the Thickness variable between the subregions with a K-W value of $p=.004$ at a $\propto 0.05$ level (Table 6.5). Additionally, the K-S test found that the Northern sample is non-normally distributed for both the Width and Thickness variables; whereas, the Western sample is normally distributed for these two variables (Table 6.2). Consequently, it can be inferred that the *Low-Visibility* attribute of Width, between these two subregions, is definitively more informative of intergroup differences and intragroup similarities; whereas, the *Low-Visibility* attribute of Thickness is only weakly developed as a measure of similarity and may owe more of its variation to functional dictates rather than stylistic expression.

It is also important to consider the correlations between the Northern subregion and Western subregion with the Southern subregion. The immediate question that emerges is, why are there many more statistically significant correlations between the more geographically separated subregions, i.e. Northern to Southern = 4, Western to Southern = 5, than between the adjacent Northern and Western subregions?

First, it is noted that 3 of the 5 correlations between the Western and Southern subregions and 2 of the 4 correlations between the Northern and Southern subregions are between the Thickness variable and other variables. As discussed above, the Thickness variable may actually gain more of its impetus in production through functional dictates and material constraints as opposed to stylistic design or embellishment.

Secondly, the Contracting state of the Haft Lateral Edge Shape nominal scale variable, which derives from the collective observation of Width to Base Width shape, is the state of this variable that is commonly shared between the three subregions (Chapter 5, Table 5.8). Therefore, that the Width to Base Width correlation is strong between the Northern to Southern and Western to Southern subregions is not a surprise. In that wide variation was most pronounced in the Northern and Western subregions for both the Base Width and Width variables, with a statistically significant difference for the Width variable, and no statistically significant difference for the Base Width variable, it is also no surprise that these two subregions would not necessarily demonstrate strong correlations.

Finally, it was noted that, in both the Mann-Whitney U-Tests and the K-W One-Way Analysis of Variance, there was no significant difference between the subregions for the Haft Length variable. Consequently, while haft shape (including Haft Length) is rather consistently Contracting between all subregions, the difference is in both scale and variation of Width and Base Width variables. The Southern sample exhibits a significantly smaller Width and Base Width than both the Northern and Western samples; whereas, the Western sample also exhibits a significantly greater Width than the more widely variable Northern sample. Additionally, the dominant oblique flaking pattern of the Northern subregion is significantly different than both the Western and Southern subregions. Additionally, with a $p=.076$ value for the Western to Southern U-Test, there is nearly a statistically significant difference at the $\propto 0.05$ level indicating important differences between all three subregions for the Flake Orientation attribute. In short, there are important *Discrete* differences in 4 of the 5 variables between the subregions which are also exhibited differently between the subregions.

Table 6.13 Raw Material Distributions - Unshouldered Lanceolates - Type B

Raw Mat'l.	All Regions	Source Loc.	Northern	Western	Southern
1- Shgdah.	4 (Eastern)	Manitoulin Is	0	0	0
3-Jspr.Tcnte.	9	Thunder Bay	9 (H-D)	0	0
5-K.L.Sltstn.	4	Quetico Park	3 (H-C)	1 (H-C)	0
6-K.R. Chal.	2	North Dakota	2 (H-D)	0	0
10-Hixton SS	7	Wisconsin	1 (H-C)	6 (H-C)	0
11-Norwood	7	NW Lwr. MI	0	0	7 (H-D)
12-Bayport	10	E Lwr. MI	0	0	10 (H-D)
14-Unident.	13	Unknown	10 (H-C/R)	2 (H-C/R)	1 (H-C/R)
15-Silurian C	1	Upper GL	1 (H-D)	0	0
16-Galena C	1	S. Wisconsin	0	1 (H-D)	0
Totals (N=)	58	0	26	10	18

The nominal scale variable of Raw Material requires appropriate analysis of its distribution and use in considering its stylistic properties and abilities to inform of LPI sociocultural behaviors of mobility and exchange (Table 6.13). The Unshouldered Lanceolate Raw Material profile offers interesting insights into the Northern and Western subregional expression of this variable.

A striking observation regarding the raw material distribution is the obvious lack of overlapping distributions between subregions for the identified raw materials and known sources, except for the Northern sample (Table 6.13). The Southern subregion has no elements in its raw material profile that can be traced to sources in the other subregions, and exhibits only one specimen of raw material classified as "unidentified".

The Western subregion sample displays one specimen of Knife Lake Siltstone, with its known source located in Quetico Park, Ontario (Northern subregion) and 2 specimens of "unidentified" raw material sources, with the remainder of the sample produced on material found in Wisconsin (i.e., Hixton Silicified Sandstone and Galena Chert) (Figure 1.1). The Northern sample also exhibits no overlap of identified raw material from the Southern subregion, and only one specimen produced of material exclusively sourced from the Western subregion, Hixton Silicified Sandstone. Interestingly, however, the Northern sample also exhibits 2 specimens made of material from North Dakota (Knife River Chalcedony) and 10 specimens made from materials classified as "unidentified", with the remaining 14 specimens made of locally available lithic raw material (e.g., Jasper Taconite and Knife Lake Siltstone).

Given the observed preferences of upper Great Lakes LPI groups for quarrying specific raw materials for the formal lanceolate projectile points component of their lithic assemblages, the appearance of such a large amount of unidentified raw material in the Northern sample poses important questions regarding the Northern sample and, simultaneously, produces some characteristics not observed in the other subregions with particular attention to the adjacent Western subregion.

First, there is the substantial weight of empirical and statistical evidence for the upper Great Lakes LPI dominant practices of both quarrying preferred lithic raw materials for use in Lanceolate production, and transporting these preferred materials over long distances. Therefore, it is reasonable to assert that a portion of the unidentified raw materials of the Northern subregion are elements which have been simply isolated through processes of discard, loss, and/or caching from what was originally a larger assemblage of like raw materials procured from exotic source locations. Of course, this observation is conditioned by the understanding that other local sources of unidentified lithic raw material, such as glacial till cherts, were also likely expediently procured and used, as a secondary direct procurement strategy.

As a *High-Visibility* variable in this data set, lithic raw material provides the most significant potential for identifying stylistic social boundaries and intergroup interaction (Voss and Young 1996: 92). In studying the raw material data, there is some evidence of a *clinal* distribution between the Northern and Western subregions identified by the occurrences of Western Hixton Silicified Sandstone in the Quetico Park area of the Northern subregion (n=1), and Northern Knife Lake Siltstone among the Northern Wisconsin materials (n=1), both locations in the general area of the northwestern and southwestern edges of Lake Superior, the proposed boundary of the Northern/Western subregions. This interpretation of Raw Material distributions, then, places the Northern sub-regions stylistic regional pattern as ***High-Visibility with a Clinal Distribution*** with the Western subregion (Chapter 5). Given such an extremely small occurrence of these definitive *clinally-distributed* raw materials (N=2) overlapping between the Northern and Western subregions, however, perhaps ***High-Visibility with a Discrete Distribution*** is more descriptive of both these subregion samples in terms of their relationships.

The more compelling support for a *Clinal Distribution* in the Northern subregion sample is both the occurrences of Knife River Chalcedony (N=2) and, significantly, the Unidentified category (N=10) which also likely derives, in some part, from exotic lithic sources. Comparing the Northern and Western subregion samples, the Raw Material occurrences and distribution of the Northern subregion is reflective of the Spearman

Correlation Coefficients observations which found only one statistically significant correlation between the stylistic variables of Width and Thickness, as discussed above.

Summary - Unshouldered Lanceolate Analysis

The outcome of the Unshouldered Lanceolate analysis has provided the diagnostic tools to address issues of style, mobility, and exchange. The stylistic analysis reveals that the early LPI Unshouldered Lanceolates stylistic variables exhibit significant differences and correlations between subregions.

The various intersections of the stylistic variables of form (Width, Thickness, Base Width, Haft Length, and Flake Orientation) and Raw Material, between the Northern, Western, and Southern subregions provides the basis of this analysis. It has been determined that while all three subregions share in displaying a rather uniform Contracting Haft form, the scale and variation of this form is specific to each subregion.

The Northern and Western subregions display two significantly different variables of Flake Orientation and Width with the Northern sample exhibiting a more Oblique Flaking Pattern than either the Western sample or the Southern Sample; and, the Western sample exhibiting a significantly greater Width than either the Northern or Southern samples (Tables 6.6 and 6.8). Haft Length, however, is not significantly different between any of the three subregions (Tables 6.6, 6.7, and 6.8). Interestingly, given their adjacent geographic proximity, there is only one statistically significant correlation between two variables of the Northern and Western sub-regions, Width and Thickness. In fact, the K-W Variance test revealed that there are significantly different variances for 4 of the 5 stylistic variables of form between the three subregions (Table 6.5). The Raw Material analysis reveals that there is a distinctly different character to the Northern and

Western subregions Raw Material occurrences and distribution, but *Clinal Distribution* is present between these two subregions for sources located within each others subregion. Additionally, a very large element of the Northern Raw Material profile is "unidentified" which provides a very good potential for greater amounts of exotic raw materials being introduced to the Northern subregion as compared to the adjacent Western subregion and/or greater usage of non-quarried, expediently procured, locally available lithic raw material (e.g., glacial till).

The Southern sample displays the most U test significant differences of Lanceolate form between the other subregions with 4 of 5 significantly different variables with the Northern sample and 3 of 5 variables significantly different with the Western sample. Also, the Southern subregion Raw Material profile is distinctly different in type and *Discrete* in its distribution from the other two subregions. Given the Southern subregion's geographic buffering from the other two subregions by the Great Lakes, this analytic outcome is no surprise. Still, it does provide strong support for the explanatory power of the stylistic model's analytic approach being employed in this study.

Shouldered Lanceolate Analysis

The Shouldered Lanceolate analysis follows the same statistical testing procedure as implemented in the Unshouldered Lanceolate analysis. Again the lack of adequate Shouldered Lanceolate samples for the Eastern, and now the Southern, subregions necessitates their exclusion from this portion of the analysis.

Table 6.14 Region (Western and Northern) - Shouldered Lanceolate: K-S One-Sample (Lilliefors) Test - Type A

Attribute	N of Cases	Max. Differences	Probability (2-tail)
Flake Orientation	30	0.239	0.001**
Thickness	30	0.095	0.927
Base Width	25	0.196	0.042**
Haft Length	30	0.189	0.010**
Width	30	0.079	0.725
Shoulder Width	29	0.128	0.234
Betwn. Shldr. Wdth.	30	0.154	0.046**
Shoulder Angle	28	0.154	0.170

**Denotes Non-Normal Distribution

The Null hypotheses for all statistical tests remain the same for the Shouldered Lanceolates as they are for the Unshouldered Lanceolates.

Null Hypothesis

The first consideration in this analysis of Shouldered Lanceolates is establishing the Null Hypothesis for normal population distribution across samples of Haft stylistic variables which is stated as follows:

- *Ho*: there is no difference between the expected sample distribution of upper Great Lakes LPI Lanceolate Haft element stylistic variables and the observed distribution.
- *H1*: there is a significant difference between the expected sample distribution of upper Great Lakes LPI Lanceolate Haft element stylistic variables and the observed distribution.

In reviewing the K-S One-Sample Test, it is noted that 4 of the 8 variables (Flake

Orientation, Base Width, Haft Length, and Between Shoulder Width) are non-normally distributed at the ∝0.05 level (Table 6.14). Also, it should be pointed out that both the Shoulder Width and Shoulder Angle variables are very close to being non-normally distributed at the ∝0.05 level. In fact, only 2 variables (Thickness and Width) are normally (or near normally) distributed. Given the non-normal shape of these distributions, the Null Hypothesis (Ho) can be rejected, and the Alternative Hypothesis (H1) can be considered. Consequently, the nonparametric statistical approach to analysis will be continued throughout the Shouldered Lanceolate analysis. This examination of sample distribution normality is also conducted relative to each subregion (i.e., Northern and Western) to observe the distributions of normality/non-normality within the data.

Northern Subregion - Shouldered Lanceolate: K-S One-Sample (Lilliefors) Test

Null Hypothesis

The Null Hypothesis and Alternative Hypothesis for the K-S (Lilliefors) Test are stated as follows:

- *Ho*: The populations represented by the three subregion samples of the upper Great Lakes region do not differ with respect to the expression of LPI Unshouldered Lanceolate hafting styles.
- *H1*: The populations represented by the three subregion samples of the upper Great Lakes Region are significantly different with respect to the expression of LPI Unshouldered Lanceolate hafting styles.

Table 6.15. K-S One-Sample (Lilliefors) Test - Type A (Northern)

Attribute	N of Cases	Max. Differences	Probability (2-tail)
Flake Orientation	10	0.276	0.029**
Thickness	10	0.174	0.605
Base Width	10	0.138	1.000
Haft Length	10	0.219	0.203
Width	10	0.134	1.000
Shoulder Width	10	0.110	1.000
Betwn. Shldr.Wdth.	10	0.228	0.153
Shoulder Angle	10	0.203	0.314

**Denotes Non-Normal Distribution

The Northern subregion only exhibits one non-normally distributed variable at the $\alpha 0.05$ level, Flake Orientation (Table 6.15). Remarkably, Base Width, Width, and Shoulder Width are perfectly normal in their distributions (i.e., $p=1.000$), with Thickness also exhibiting a solid normal distribution at the $p=0.605$ *level.* Haft Length, Between Shoulder Width, and Shoulder Angle, on the other hand, are also normally distributed, but notably on the weaker side of normality (Table 6.15). Given the non-normal distribution of the Region overall (Table 6.14), it appears that the Western subregion must exhibit greater non-normality than the Northern sample. It should be noted that given the non-normal distribution of the Flake Orientation variable, the Null Hypothesis *(Ho)* can be rejected and the Alternative Hypothesis *(H1)* can be accepted. Further, the statistical testing shall proceed within the non-parametric framework.

Western Subregion - Shouldered Lanceolate: K-S One-Sample (Lilliefors) Test

Table 6.16 K-S One-Sample (Lilliefors) Test - Type A (Western)

Attribute	N of Cases	Max. Differences	Probability (2-tail)
Flake Orientation	21	0.287	0.000**
Thickness	21	0.125	0.541
Base Width	16	0.188	0.138
Haft Length	21	0.258	0.001**
Width	21	0.112	0.754
Shoulder Width	20	0.212	0.019**
Betwn. Shldr.Wdth.	21	0.223	0.008**
Shoulder Angle	19	0.188	0.075

**Denotes Non-Normal Distribution

As was indicated in the Northern sample K-S analysis (Table 6.15), the Western subregion sample K-S test indicates that 4 of 8 variables are non-normally distributed at a $\propto 0.05$ level (Flake Orientation, Haft Length, Shoulder Width, and Between Shoulder Width) (Table 6.16). Additionally, the Shoulder Angle variable is nearly non-normal in its distribution at the $\propto 0.05$ level with a $p=0.075$ value. Further, the Base Width value of $p=0.138$ is certainly on the weaker side of normality in its distribution as well. Noteworthy is the point that in the Northern subregion, Shoulder Width exhibits a perfectly normal distribution ($p=1.000$) (Table 6.15); whereas, in the Western subregion the value of $p=0.019$ indicates the opposite with a very non-normal distribution and nearly at the $\propto 0.01$ level (Table 6.16). Certainly, the Western sample is convincingly non-normal in its distribution and, therefore, again indicates that the Null Hypothesis (Ho) can be rejected and the Alternative Hypothesis (H1) can be considered as re-stated following the Northern K-S One-Sample (Lilliefors) Test analysis (Table 6.15).

K-W One-Way Analysis of Variance

The Null Hypothesis and Alternative Hypothesis for both the K-W One-Way Analysis of Variance and the Mann-Whitney U Test are stated as follows:

- *Ho*: The populations represented by the three subregion samples of the upper Great Lakes region do not differ with respect to the expression of LPI Unshouldered Lanceolate hafting styles.
- *H1*: The populations represented by the three subregion samples of the upper Great Lakes Region are significantly different with respect to the expression of LPI Unshouldered Lanceolate hafting styles.

Table 6.17 K-W One-Way Analysis of Variance - Type A (Regional)

Attributes	Northern	Western	Southern	*df*	K-W Stat.	*P*-Value
Flake Ortn	10	21	2	2	1.747	*p=0.418*
Thickness	10	21	2	2	8.920	*p=0.012**
Base Wdth	10	16	2	2	6.913	*P=0.032**
Haft Lngth	10	21	2	2	2.335	*P=0.311*
Width	10	21	2	2	1.774	*P=0.412*
Shldr Wdth	10	20	2	2	1.597	*p=0.450*
Btwn Shldr	10	21	2	2	0.321	*p=0.852*
Shldr Angl	10	19	2	2	14.004	*p=0.001**

* Significant Difference at $\propto 0.05$

After reviewing the K-W test results, it is clear that there are statistically significant differences between the subregion sample variances of 3 of the 8 variables included in the analysis (Thickness, Base Width, and Shoulder Angle) (Table 6.17). In fact, it is noted that two of these attributes are significantly different at a level ≥ *∝0.01* which indicates that these differences are statistically robust while the third is significantly different at the *∝0.03* level. Therefore, the variation between the subregion samples for 3 of the 8 variables is significantly greater than the variation within each subregion sample.

The *Low-Visibility* Thickness variable has previously been the subject of speculation in this study for its stylistic property as opposed to its functional property (Tables 6.5, 6.6 and 6.17). In the Unshouldered K-W test there was a significant difference at *∝0.05* for the Thickness variable *(p=0.004)* across the Region, but the U-test did not support this significance between the Western and Northern subregions which is discussed further in the following U-test.

The Shoulder Angle variable also indicates strong potential for *Discrete Distributions* within both the Northern and Western subregions with a significant difference of *p=0.001* at the *∝0.05* level of significance. In that the Shoulder element and its dimensions were not part of the Unshouldered Lanceolate attribute list, there can be no temporal analysis of stylistic nuances between the early and late LPI Lanceolate expressions. This variable, however, is also further analyzed in the following U-test to determine the level and types of stylistic differences that are observed.

The Between Shoulder Width variable in the K-W variance test, as revealed in Table 6.17, indicates an extremely strong similarity between the subregion's samples with a value of *p=0.852*. Therefore, in comparing the Between Shoulder Width to the Base Width, it appears that the significant difference lies in the shape of the haft lateral edges (Expanding, Contracting, and Straight and/or Eared Variant) as determined by the Base

Width variable *(p=0.032)*. This observation will be further developed in the following U-test.

Therefore, the Null Hypothesis can be rejected and the Alternative Hypothesis can be considered. The significant differences, then, are important to identifying subregional stylistic variables that are *Discrete*, *Clinal,* and *Random* for their respective distributions (Chapter 5). It should also be noted that the Southern subregion only possesses 2 Shouldered Lanceolates in its sample which has minimal effects between the outcomes of the K-W Variance Test and the Mann-Whitney U-test. To further explore any insights into the subregional character of these differences, the Mann-Whitney U test is employed by comparing the Western and Northern subregions as pairs in a two-sample test of Medians in the following table.

<u>Mann-Whitney U Test:</u>

Table 6.18 Mann-Whitney U Test - Type A (Western to Northern Comparison)

Attributes	Western	Northern	*X2* Apprx.	*df*	U Statistic	*P*-Value
Flake Orientation	21	10	0.679	1	124.500	*p=0.410*
Thickness	21	10	8.265	1	37.000	*p=0.004**
Base Width	16	10	7.805	1	27.000	*p=0.005**
Haft Length	21	10	0.945	1	128.000	*p=0.331*
Width	21	10	1.716	1	74.000	*p=0.190*
Shoulder Width	20	10	1.517	1	72.000	*p=0.218*
Between Shoulder	21	10	0.075	1	98.500	*p=0.784*
Shoulder Angle	19	10	13.012	1	16.500	*p=0.000**

* Significant Difference at $\alpha 0.05$

As was discussed in the K-W test analysis (Table 6.17), the results of the Mann-Whitney U Test parallels the outcome of the K-W test with slight variations in the statistical calculations with the absence of the Southern subregion sample (N=2) (Table 6.18). Also, the same variables (Thickness, Base Width and Shoulder Angle) are identified as exhibiting statistically significant differences between the subregions at the $\propto 0.05$ level (Table 6.18). Significantly, in the cases of all three of the variables displaying a statistically significant difference at the $\propto 0.05$ level, it is noted that these differences have statistically increased with the omission of the Southern subregion from the Median-based U-test.

In the Unshouldered Lanceolate analysis, the U-test between the Western and Northern subregions noted no significant difference between these subregions for the Thickness variable, although similarity was notably weakly defined with a value of $p=0.174$ (Table 6.6). Obviously, the Thickness variable does display interesting characteristics within this stylistic analysis as we now note that the Thickness of Shouldered Lanceolates have become statistically significantly different between the Northern and Western subregions with a value of $p=0.004$ at the significance level of $\propto 0.05$. Therefore, this *Low-Visibility* variable now exhibits a *Discrete Distribution* within the Northern and Western subregions.

The *Low-Visibility* Shoulder Angle variable was identified as potentially significant in the Descriptive Statistics analysis Chapter 5 (Table 5.20), where a sizeable difference appears between the Means/Medians of the Northern and Western subregions for this variable. It is noted that the Western sample reveals a shoulder angularity that is more acute than the Northern sample by >30° (Table 5.20). The U-test reveals that there is indeed a statistically significant difference for the Shoulder Angle variable between the Northern and Western subregions with *p=0.000* at a significance level of *∝0.05*. Given this statistically robust significant difference, there is ample justification for noting a *Discrete Distribution* for this *Low-Visibility* variable.

The Base Width variable U-test *(p=0.005)*, following the K-W test, has increased its significant difference from that revealed in the K-W test *(p=0.032)* which included the Southern subregion (n=2) (Tables 6.17 and 6.18). Consequently, the Base Width variable is statistically significantly different between the Northern and Western subregions. In short, the Western subregion sample Base Width is significantly wider than that of the Northern sample which provides a distinctly different character to the Haft Lateral Edge shape between these two subregions. Significantly, the Western subregion Shouldered Lanceolates display an Expanding Haft Lateral Edge shape, while the Northern sample displays a Contracting to slightly Straight Haft Lateral Edge shape. Again, given the robust difference in the Base Width variable between the Northern and Western subregions, this variable can be classified in this stylistic study as *Low-Visibility* with a *Discrete Distribution.* Therefore, in view of these significant differences, the Null Hypothesis (Ho) can be rejected and the Alternative Hypothesis (H1) can be considered

As pertains to the significantly different stylistic elements of the Shouldered Lanceolates with *Low-Visibility* and a *Discrete Distribution*, it has been determined that the Western points display an Expanding Haft Stem with more acutely defined Shoulder Angles (Mean 83.8°/Median 85.0°) and a thicker cross-section than the Northern sample (Tables 5.20 and 6.18). Specifically, that the Northern subregion sample displays a Contracting to slightly Straight Haft Stem with generally weakly developed Shoulder

Angles (Mean 51.4°/Median 58.1°) and a thinner cross-section (Tables 5.20 and 6.18).

In reviewing the remaining *Low-Visibility* variables of Shouldered Lanceolate form, some further observations are important to note. The variables of Width *(p=0.190)*, Shoulder Width *(p=0.218)*, and Haft Length *(p=0.331)*, while not exhibiting any statistically significant difference, are apparently more different than they are similar at the *∝0.05* level which may exhibit more of a *Clinal Distribution* for these *Low-Visibility* variables. Flake Orientation *(p=0.410)* and Between Shoulder Width *(p=0.784)*, on the other hand, are certainly more similar, particularly Shoulder Width, which also introduces some interesting observations of stylistic variable behaviors across space and through time between these two subregions which will be discussed further during the stylistic-temporal comparisons of LPI Lanceolate form changes through time.

Spearman Correlation Coefficients

To begin, as was the case in the Unshouldered analysis, this portion of the analysis also necessitates establishing the Null and Alternative Hypotheses:

- *Ho*: There is no correlation in the population samples of the upper Great Lakes LPI Shouldered Lanceolates.
- *H1*: There are correlations in the population samples of the upper Great Lakes LPI Shouldered Lanceolates.

Table 6.19 Matrix of Spearman Correlation Coefficients-Type A (Northern &Western)

Attrbts	Fl Orn	Thikns	Bs Wth	Hft Lth	Shld W	B ShW	ShldA	Width
Fl. Orn	1.000							
Thikns	-0.054	1.000						
BsWth	-0.125	0.534*	1.000					
Hft Lth	-0.224	0.372	0.038	1.000				
ShldW	0.027	0.422*	0.494*	0.326	1.000			
B ShW	-0.137	0.508*	0.494*	0.534*	0.807*	1.000		
Shld A	-0.109	0.159	0.394	-0.432	0.186	-0.120	1.000	
Width	0.042	0.559*	0.548*	0.357	0.852*	0.804*	0.173	1.000

* Significant Correlations at $\propto 0.05$

Given that n=24 - 2 or n = 22, at the significance level of $\propto 0.05$, a Critical Value $\geq t = 2.074$ is needed to establish statistical significance for a positive correlation. Using the previously provided computation for arriving at t, the lowest correlation coefficient in Table 6.19 that is statistically significant is the Shoulder Width to Thickness coefficient of 0.422, which computed = 2.327. The next lowest coefficient is Shoulder Angle to Base Width at 0.394 which computed = 2.010 and is not statistically significant at a critical value of 2.074 for $\propto 0.05$ level of significance. Therefore, the remaining correlation coefficients that are statistically significant must exceed the Shoulder Width/Thickness coefficient of 0.422.

In reviewing Table 6.19, it is found that the correlation coefficients for the paired variables of Width/Thickness (0.559), Between Shoulder Width/Thickness (0.508), Shoulder Width/Thickness (0.422), Base Width/Thickness (0.534), Width/Base Width (0.548), Between Shoulder Width/Base Width (0.494), Shoulder Width/Base Width (0.494), Between Shoulder Width/Haft Length (0.534), Width/Shoulder Width (0.852), Between Shoulder Width/Shoulder Width, and Width/Between Shoulder Width (0.804) are all ≥0.422 and are, therefore, statistically significant at the ∝*0.05* level.

Of these 11 statistically significant correlations, 3 very strong correlations indicate a statistically strong similarity between the Northern and Western LPI Shouldered Lanceolate samples especially for Width/Shoulder Width (0.852), Between Shoulder Width/Shoulder Width (0.807), and Width/Between Shoulder Width (0.804) (Table 6.19). The remaining 8 Spearman rho coefficients, with a significant correlation at the ∝*0.05* level, also demonstrate strong similarities between the subregions for the respective combinations of variables exceeding the 0.422 Spearman coefficient benchmark.

The analysis has provided the basis for the Null Hypothesis to be rejected and the Alternative Hypothesis to be considered.

Raw Material - Shouldered Lanceolate - Type A

Table 6.20 Raw Material - Type A (Regional)

Attribute	Region	Northern	Western
1 Sheg'dah	0	0	0
3 Jasper Tac.	4	4 H-D	0
5 K.L. Siltstn	3	3 H-D	0
6 K.R. Chal.	1	1 H-D	0
10 Hixton	18	0	18 H-D
11 Norwood	0	0	0
12 Bayport	0	0	0
14 Unident.	4	2 H-C/R	2 H-C/R
16 Quartz(w)	1	0	1
Totals	31	10	21

It is found that the Northern subregion sample is dominated by two raw material resources with occurrences in Shouldered LPI Lanceolate form that are ubiquitous throughout the Northern subregion, Taconite and Knife Lake Siltstone, with the exotic raw material, Knife River Chalcedony, also being present (Table 6.20). Whereas, the Western subregion LPI Lanceolate sample is dominated by one lithic Raw Material (Hixton Silicified Sandstone). Conspicuously absent from the Northern subregion LPI Lanceolate sample is the Hixton Silicified Sandstone raw material dominating the Western subregion sample (N=18) which, likewise, is devoid of the Northern subregion's Taconite and Knife Lake Siltstone (Table 6.20). Additionally, both subregions exhibit an equally minor occurrence of "Unidentified" Raw Material (N=2, each). Therefore, it can be inferred that quarrying of preferred lithic raw material for LPI Shouldered Lanceolates remains a dominant practice for Regional lithic procurement strategies and that the stylistic classification of the Shouldered Lanceolates is *High-Visibility/Discrete Distribution*. Of course, sampling error could certainly explain these raw material sample profiles; however, LPI Shouldered Lanceolates produced of each raw material and widely and deeply distributed within and between each subregion is needed to change the stylistic intersection of *Visibility* and *Distribution*. More significantly, the distribution of this variable is in accordance with the *Discrete* distribution of the LPI Shouldered Lanceolate *Low-Visibility* stylistic variables of form (or shape) for both the Northern and Western subregions that were statistically determined to be significantly different, (i.e., Base Width, Shoulder Angle, and Thickness) (Table 6.20).

Summary - Shouldered Lanceolate Analysis

The LPI Shouldered Lanceolate analysis has provided a revealing discussion of the stylistic expression of Northern and Western subregions. Through this analysis of style, the ability to consider the dimensions of upper Great Lakes Regional LPI mobility patterns has developed.

It has been determined that the *High-Visibility/Discrete distribution* of Base Width, Thickness, Shoulder Angle, and Raw Material stylistic variables offer robust significant differences between the subregions for the LPI Shouldered Lanceolates. In summation, the Western subregion sample populations use, design, and manufacture Haft stems that are predominately expanding with more acutely executed shoulder angles than their Northern counterparts. Additionally, accompanying this expanding base design of the Western sample is a Thicker cross-section which may functionally operate to reduce fracturing of the stem at the narrower juncture intersecting the Shoulders. Finally, the distinctly different *High-Visibility* Raw Materials of the opaque, black or darkly-colored Jasper Taconite and Knife Lake Siltstone of the Northern subregion, and the translucent, white to orange lightly-colored Hixton Silicified Sandstone of the Western subregion, further sets these two population samples at differing ends of the Regional Raw Material profile. The combined significantly different stylistic variables between these subregions for LPI Shouldered Lanceolates, offers compelling statistical evidence for appropriate application of the stylistic theoretical model cited in Chapter 5. This exercise will be performed in Chapter 7, Synthesis and Conclusions.

Summary - Unshouldered and Shouldered - Inferential Statistical Analysis

This portion of the analysis is centered on the stylistic changes through time for upper Great Lakes LPI Lanceolates. These stylistic-temporal changes are useful in observing changes in social patterns of group interaction, mobility, and exchange. It is beneficial at this point to remember that the underpinnings of the stylistic analysis of these LPI Unshouldered and Shouldered lanceolates is to reasonably discern the nature and intensity of interactions both among and between groups to develop a reasonable means of inferring group interaction spheres and boundaries. Significant group interactions being proposed as potentially discernable based upon measures of similarities/dissimilarities in stylistic design, manufacture, and raw materials of the LPI lanceolates (Chapter 4). Significantly, in comparing the Shouldered and Unshouldered Lanceolates, where changes over time are observable through stylistic trends across the upper Great Lakes region, the deduced variables of interest are the 4 continuous scale (and rank order) Flake Orientation, Thickness, Base Width, Width, and the 1 nominal scale Raw Material that were included in both the Shouldered analysis and Unshouldered.

Flake Orientation:

At the subregional scale, it has been determined that the *Low-Visibility* Flake Orientation attribute for Unshouldered Lanceolates is most significantly different between the Northern and Western *(p=0.013)* (Table 6.6). This is largely due to the predominately Unshouldered Oblique flaking pattern orientation (Mean = 97.6°/Median = 95.6°) of the Northern subregion sample as compared to the Western sample (Mean = 89.0°/Median = 88.2°)(Chapter 5, Table 5.3). Later, among the Shouldered Lanceolate samples, it is observed that the U test between the Western and Northern subregions statistically indicated no significant difference *(p=0.410)* for the Flake Orientation variable (Table 6.18). Therefore, the Northern sample indicates a stylistic shift from the *Discretely Distributed* Oblique flaking pattern of the early Unshouldered Lanceolates, to the more *Clinally-distributed* near right-angle (e.g., 90°) flaking pattern of the later Shouldered Lanceolates (Mean = 93.5/Median = 92.0) (Table 5.13). Finally, the Western sample exhibits very little change in flake orientation between the Shouldered (Mean = 91.9°/Median 89.8°) and Unshouldered (Mean = 89.0°/Median = 88.2°) samples. This indicates that this variable has remained a more widely shared attribute among Western groups through time; and, that the Northern subregion groups came to share this common flaking pattern more widely later in time (Tables 5.3 and 5.13). Therefore, the Flake Orientation variable has changed through time in its stylistic Visibility-Distribution classification from a *Low-Visibility/Discrete Distribution* to a *Low-Visibility/Clinal Distribution.*

Thickness:

The *Low-Visibility* Thickness variable, while, statistically, not significantly different in the earlier Unshouldered Lanceolates, appears to display more differences than similarities with a U test value *(p=0.174)* that nears the significance level of $\propto 0.05$ (Table 6.6). The Western sample displays generally more Thickness in the Unshouldered Lanceolate cross-section (Mean = 8.0 mm/Median = 8.0 mm) as compared to the Northern sample (Mean = 7.8mm/Median = 7.2mm) (Table 5.5). In the later Shouldered sample, the Thickness variable does statistically exhibit significant differences at the $\propto 0.05$ level for the Western subregion sample (Mean = 9.5 mm/Median = 9.6mm), as compared to the Northern sample (Mean = 7.7mm/Median = 7.5mm) (Table 5.15).

Interestingly, the trend towards a generally thicker cross-section among the Western subregion sample, as opposed to the Northern sample, that was originally identified in the Unshouldered Lanceolate analysis, continued gaining through time until it has become statistically significantly different in the later Shouldered Lanceolates; whereas, the Northern sample has remained rather uniform in its Thickness through time. Yet, previous observations have considered that these trends in the Thickness variable are possibly more functionally-based, rather than stylistically-oriented. Still, a statistically significant correlation *(0.534)* did develop between the Base Width and Thickness variables of the Shouldered Lanceolates that is not identified in the early Unshouldered Lanceolate points, with both variables also statistically significantly different at the $\propto 0.05$ level for the Northern-Western U test (Tables 6.19 and 6.18). Given the established trend towards a Thicker cross-section through time in the Western sample, as well as the highly increased significant correlations between the various Width-oriented variables and Thickness in the Shouldered Lanceolates (Table 6.18), the Thickness variable appears to have developed a rather robust stylistic significance between the subregions which appears to be highly correlated with the larger expanding (and eared) hafting widths of the Western subregion. This means a change has occurred through time in the stylistic Visibility-Distribution classification from a *Low-Visibility/Clinal Distribution* to a *Low-Visibility/Discrete Distribution* for the Thickness variable.

Base Width:

The *Low-Visibility* Base Width variable in the Unshouldered U test analysis did not exhibit significant differences between the Northern and Western subregion samples *(p=0.596)* (Table 6.6); and, there were there no statistically significant correlations between the Base Width variable and any other variables (Table 6.10). The Shouldered U-test, on the other hand, did reveal a robust significance difference for the Base Width variable between the Northern and Western subregions *(p=0.005)* (Table 6.18); and, a statistically significant correlation between the Width variable *(p=0.548)* and two of the Shoulder-oriented variables (Between Shoulder Width, *p=0.494,* and Shoulder Width, *p=0.494*) (Table 6.19). In fact, some time following the Middle of the LPI period (9,000 to 8,000 B.P.), the Base Width variable appears to have become a significant element in designs of the LPI Shouldered Lanceolates including, in relation to the Haft Stem and Shoulder juncture, the Expanding and Eared variants of the Western subregion, and the Contracting and Straight variants of the Northern subregion. In short, the Western subregion Shouldered sample Base Width is significantly wider than that of the Northern sample which, as previously mentioned, provides a distinctly different character to the Haft Lateral Edge shape between these two subregions. Significantly, the Western subregion Shouldered Lanceolates display an Expanding Haft Lateral Edge shape (including Eared variants), while the Northern sample displays a Contracting to slightly Straight Haft Lateral Edge shape. Therefore, given the robust difference in the Base Width variable between the Northern and Western subregions for the LPI Shouldered Lanceolates, the Visibility-Distribution classification in this study has changed through time from a *Low-Visibility/Clinal Distribution* variable to a *Low-Visibility/Discrete Distribution* variable.

Width:

The *Low-Visibility/Discrete Distribution* attribute of Width also sets the Northern and Western subregions apart with a U test significant difference of *(p=0.045)* for the LPI

Unshouldered Lanceolates (Table 6.6). There is only one Spearmans rho significant correlation, however, which is between the Width and Thickness variables of the Unshouldered Lanceolates (Table 6.10). Interestingly, later in time, the Width variable no longer displays a significant difference between the Northern and Western subregions with a U test that has changed from the early Unshouldered significantly different *($p=0.045$)* to the not significantly different Width of the Shouldered Lanceolates *($p=0.190$)* (Tables 6.6 and 6.18). Still, there remains much difference in Widths between the Western and Northern samples with a U test *$p=0.190$*. Also, Spearmans rho correlations have increased through time from just the Width to Thickness of the Unshouldered Lanceolates (Table 6.10) to the Width and Thickness, Width to Base Width, and two Shoulder-oriented correlations (Width to Shoulder Width and Width to Between Shoulder Width) of the Shouldered Lanceolates (Table 6.19). Therefore, given the robust difference in the Width variable between the Northern and Western subregions for the LPI Unshouldered Lanceolates and the no significant difference of the Shouldered Lanceolates for this variable, the Visibility-Distribution classification has changed through time from a *Low-Visibility/Discrete Distribution* variable to a *Low-Visibility/Clinal Distribution* variable.

Raw Material:

A striking observation regarding the *High-Visibility* Raw Material distribution is the change in overlapping distributions between the Northern and Western subregions for the identified raw materials and their known sources between the early Unshouldered Lanceolates and the Later Shouldered Lanceolates (Tables 6.13 and 6.20). Perhaps equally striking is the change in the "Unidentified" category of Raw Material, particularly in the Northern sample (Tables 6.13 and 6.20). As discussed in the Raw Material analyses, The Unshouldered Western subregion sample displays one specimen of Knife Lake Siltstone, with its known source located in Quetico Park, northwestern Ontario (Northern subregion) and 2 specimens of "unidentified" raw material sources, with the remainder of the sample produced on material found in Wisconsin (i.e., Hixton Silicified Sandstone and Galena Chert). The Northern sample also exhibits no overlap of identified raw material from the Southern subregion, and only one specimen produced of material exclusively sourced from the Western subregion, Hixton Silicified Sandstone. Interestingly, however, the Northern sample also exhibits 2 specimens made of material from North Dakota (Knife River Chalcedony) and 10 specimens made from materials classified as "unidentified", with the remaining 14 specimens made of locally available lithic raw material (e.g., Jasper Taconite and Knife Lake Siltstone). This distribution of Raw Materials, then, produces a stylistic classification of *High-Visibility/Clinal Distribution* (Chapter 5) for the early Unshouldered Lanceolates for both the Northern and Western subregions.

The distribution of *High-Visibility* lithic Raw Material for the later LPI Shouldered Lanceolates samples changes to *Discrete,* with no overlap (or *Clinal*), occurrences of "known" raw materials (Table 6.20). It is found that the Northern subregion sample is dominated by two known raw material resources which occurrences in LPI Unshouldered and Shouldered Lanceolate form are ubiquitous throughout the Northern subregion, Jasper-Taconite and Knife Lake Siltstone, with the exotic raw material, Knife River Chalcedony, also being present in both early and later lanceolates. The Western subregion LPI Shouldered Lanceolate sample is dominated by one lithic

Raw Material, Hixton Silicified Sandstone. Conspicuously absent from the Northern subregion LPI Shouldered Lanceolate sample is the Hixton Silicified Sandstone raw material which dominates the Western subregion sample (N=18) and, likewise, is devoid of the Northern subregion's Taconite and Knife Lake Siltstone (Table 6.20). Additionally, both subregions exhibit an equally minor occurrence of "Unidentified" Raw Material (N=2, each). Therefore, the distribution of this variable is in accordance with the *Discrete* distribution of the LPI Shouldered Lanceolate *Low-Visibility* stylistic variables of form (or shape) for both the Northern and Western subregions that were statistically determined to be significantly different, (i.e., Base Width, Shoulder Angle, and Thickness) (Table 6.18).

In summary, the *High-Visibility* attribute of Raw Material has changed in its distribution through time from the early Unshouldered Lanceolate *Clinal Distribution* (10,000 to 9,000 B.P.) to the later Shouldered *Discrete Distribution* (9,000 to 8,000 B.P.) for both the Northern and Western subregions. The stylistic significance of this observation is that the variable of Raw Material exhibits the same stylistic trends through time and subregionally as the continuous scale stylistic attributes. Specifically, as noted in the case of the Northern and Western subregions, the early Unshouldered lanceolate *High-Visibility Clinal Distribution* of Raw Material indicates a broader potential pattern of interaction between LPI populations of these two subregions during the earlier part of the LPI/Early Archaic period. This was also the case for all *Low-Visibility* stylistic attributes, except Flake Orientation which displayed a *Discrete Distribution* for the LPI Unshouldered lanceolates. Whereas, the Raw Material variable of the Unshouldered lanceolates displays a *Discrete Distribution* for both the Western and Northern subregions.

The Unidentified category of Raw Materials has substantially changed in the Northern samples from the early Unshouldered occurrences of N=10, to the Shouldered occurrences of N=2, with no change in the Western sample of N=2 in both the Unshouldered and Shouldered Lanceolate samples (Tables 6.13 and 6.20). Both the changes in the Northern lithic raw materials and the stasis of the Western lithic raw materials offers fertile ground for further discussion.

To begin, the changes observed in the Northern raw material profile through time may be linked to several conditions: 1) Sampling error is possible given the small sample and must be considered; 2) the direct Raw Material procurement technique of quarrying continued throughout the LPI/Early Archaic period until its dominance is such that expedient procurement of lithic raw materials from varied sources is no longer widely practiced; 3) that accessibility and frequency of use of the known local outcrop sources for Jasper Taconite and Knife Lake Siltstone has increased among LPI groups to the extent that other lithic sources are no longer exploited; 4) that, through time, exchange of lithic materials diminishes between subregions and from outside the region; 5) and, that the stylistic significance of local lithic Raw Material increased significantly through time.

The Western subregion, on the other hand, displays no change in the occurrence of Unidentified lithic raw materials (N=2) throughout the LPI/Early Archaic Period. This raw material profile, therefore, implies significant stability in lithic raw material procurement strategies for LPI groups operating in the Western subregion and provides strong support for the expression of the stylistic properties of lithic Raw Material. It also implies very little potential for significant developments of lithic raw material egalitarian exchange systems.

Therefore, there are two different stylistic expressions of lithic Raw Material between the Northern and Western subregion LPI populations through time. The Northern subregion LPI groups, while exhibiting a developing distinct preference for specific local lithic quarry sources in the early LPI/Early Archaic period, do appear to employ exchange, direct procurement from distant unknown lithic resources, and/or expedient procurement from unknown local resources (e.g., glacial tills, streambeds, outcrops) strategies at a fairly substantial level (N=10 or 38%) in their raw material use patterns (Table 6.13). Yet, later in time, the favored local quarry resources come to clearly dominate the LPI Northern assemblages with a great deal more potential stylistic significance being exhibited. Whereas, the Western subregion LPI populations appear to have maintained the high level of stylistic significance for raw material selection and use throughout the LPI/Early Archaic Period. In fact, the potential develops for Western and Northern subregion LPI groups to have underscored the stylistic significance of their respective *High-Visibility* lithic Raw Materials as the Northern LPI groups came to more strongly exhibit their locally discrete lithic raw material choices. Significantly, then, these lithic Raw Material data do exhibit the relatively same stylistic behaviors, through time, as do the other proposed continuous scale stylistic attributes of the LPI lanceolate point forms. Therefore, there are significant dimensions of LPI behavioral patterns such as social interaction and group mobility that can be reasonably inferred from these data.

Still, prior to inferring conclusions from the foregoing Raw Material analysis alone, there needs to be a direct comparison to the other proposed stylistic attribute behaviors to properly assess the stylistic properties, dimensions, and implications of these data and analysis. This is performed by employing the stylistic model used throughout the analysis (Voss and Young 1995).

Summary - Stylistic Analysis

To summarize, the Southern subregion Unshouldered lanceolate sample is most significantly different among all the subregions, i.e., Northern and Western. Additionally, the Raw Materials of local Norwood and exotic Bayport cherts are discretely distributed within the region for the Southern sample. Therefore, the lithic assemblage displays no indication of either direct or indirect social interaction between the Southern subregion and the other upper Great Lakes subregions. Additionally, the comparatively narrow Unshouldered lanceolate style of the Southern subregion display *discrete* distributions of all the stylistic variables, including Raw Material, except haft length. Therefore, the Southern subregion LPI groups' mobility patterns do not display a north and west, or trans-lake, trajectory. Rather, it appears that the mobility patterns are restricted to the northern Lower Peninsula of Michigan with a possible west to east pattern based on source locations of Bayport and Norwood Cherts and their dominant occurrences in the lithic assemblage. This study, then, reveals that during the early LPI/Early Archaic period, LPI group mobility patterns of northern lower Michigan were bounded by the glacial Great Lakes to the north and west with spheres of social interaction available to the south, and to the east through Port Huron, and later Saginaw Bay, to Ontario. The exchange portion of this study that follows will further analyze the issue of lithic Raw Material and its implications for egalitarian exchange in the Southern subregion.

The Northern and Western subregions offer the most fertile comparative ground for application and testing of the stylistic model. To begin, it was noted in the analysis that the Northern and Western Unshouldered lanceolates (early LPI) lithic assemblages exhibited two significantly different stylistic variables of Flake Orientation (*Low-Visibility and Discrete distribution)* and Width (*Low-Visibility and Discrete distribution*), with both subregions displaying the same *High-Visibility and Clinal distribution* intersections for the known lithic Raw Material resources of their subregions. Yet, in the Raw Material variable, it was also revealed that the Northern sample Unidentified Raw Material category was 38% of the total assemblage. Whereas, the Western subregion sample only displayed 20% Unidentified lithic Raw Materials. Later, in the Shouldered analysis we found that the Northern Unidentified category had dropped to 20%; and, the Western Unidentified category had dropped to 9.5% of the total assemblage. Of significance here is that the early LPI groups who inhabited the Northern and Western subregions displayed some stylistic expressions in their lithic assemblages that provide the ability for behavioral inference.

First, it is noted that there appears to be different LPI groups who are occupying the Northern and Western subregions. It also appears that while some of the new immigrants to the Northern subregion are likely from the Western Plains and possibly the Southern Minnesota-Wisconsin areas, most of the new inhabitants arrived from the High Plains and the more northwestern areas of North America. Their stylistic affinities appear strongest east to west across Wisconsin and Minnesota and onto the western Plains for the west with significant differences developing at the northern boundaries near Duluth, Minnesota. The same east to west pattern is expressed in the Northern samples with diminished stylistic similarities towards the south. Yet, the remaining stylistic variables that do not demonstrate any significant differences and the *Clinal Distribution* of the lithic Raw Materials indicates that the north-south stylistic boundary was not a rigid social boundary. Consequently, there are some observations regarding social interaction and mobility that can be reasonably inferred for the early LPI/Early Archaic period.

During the early LPI/Early Archaic period of the Western and Northern subregions, mobility patterns and group/individual interactions overlapped at the extreme western edge of the Lake Superior region. The more homogeneous Western Raw Material profile indicates that the groups in the Western subregion had already initiated some regularity in their subsistence and settlement patterns; whereas, the Northern sample indicates a more unsettled pattern with a high percentage of Unidentified, and possibly exotic, Raw Materials, as well as flaking patterns. The distinction between the unidentified raw material being exotic or local to the area is important, with different interpretations for each occurrence, which should be the subject of future study. Considering that this early period is the initial human occupation of recently deglaciated biomes, particularly in the Northern subregion, it is interesting to note how well the stylistic analysis reveals the wider variability of the Northern sample, as opposed to the Western sample, as would be expected in the initial peopling of the Northern subregion. Simply stated, it appears that numerous small groups likely initially immigrated into the Northern subregion from areas to the west and northwest. Populations in the Western subregion interacted with these immigrating groups, but continued their west to east settlement and subsistence patterns south of Lake Superior into the later Shouldered lanceolate LPI/Early Archaic period. Meanwhile, the Northern LPI populations also continued developing strategies using the same west to east trajectories for their settlement and subsistence patterns which becomes more pronounced after the southern tip of Lake Agassiz diminishes and no longer necessitates southward terrestrial circumnavigation, thereby reducing potential for regular and/or sustained interaction with their southern neighbors. Yet, as previously revealed, given the stylistic clinal distribution and similarities of the Northern and Western early LPI assemblages, inter-group interaction was likely of a reasonably moderate level with loosely defined and overlapping mobility patterns at the western end of Lake Superior. Yet, observable later stylistic divergence of Northern and Western assemblages, indicates that this moderate level of social interaction appears to diminish throughout the LPI/Early Archaic period.

The stylistic analysis of the later LPI Shouldered lanceolates reveals the development of two different LPI stylistic expressions for the Northern and Western subregions. The Western subregion sample exhibits thicker haft stems with expanding/eared bases and more acutely executed shoulder angles than their northern neighbors. Additionally, the *High-Visibility* Raw Material distributions for both subregions are now *Discrete* with no significant overlapping occurrences between the subregions. Also, the Unidentified Raw materials, as noted above, has diminished in both assemblages to the extent that both the Northern and Western subregional populations appear to favor quarrying known local outcrops of lithic raw materials within their subregions, almost to the exclusion of other lithic sources. The stylistic significance of this observation also serves to support the assertion that there is a demonstrated use of lithic Raw Material as a *High-Visibility* marker within the upper Great Lakes LPI material culture. Considering the foregoing, there are observable changes in the patterns of social interaction and mobility that can be identified.

The Northern LPI groups have come to establish a settlement and subsistence system that now incorporates the area north of the western tip of Lake Superior to the eastern areas of Thunder Bay and Lake Nipigon Ontario. Since Lake Agassiz has diminished in its southern limits, the Rainey River basin and up to the western edge of the Lake of the Woods in Manitoba, Canada, likely describe the western trajectory of mobility patterns for the Northern subregion LPI groups. Significantly, where previous overlapping Northern and Western LPI group mobility patterns had provided a basis for inferring some moderate level of social interaction, along the far western areas of Lake Superior, the inverse is now apparent.. Specifically, the increased stylistic dissimilarity and discrete distributions of lithic Raw Materials indicates a diminished level of interaction and a more intensified expression of social boundaries. Therefore, it appears that later in time, as the LPI groups of the Northern subregion established regular subsistence and settlement patterns incorporating the northern shore of the Lake Superior region, their mobility patterns diminished towards the southern limits of their subregion with intensified mobility on an east to west trajectory. Likewise, the Western LPI groups developed more definite northern boundaries towards the western end of Lake Superior and also continued development of an east to west trajectory in their mobility patterns. The effects of these changes would have produced a clinal area at the very western edge of Lake Superior that would have provided a social buffer between the two subregions as well as an area for occasional intergroup social interactions. It is significant to remember that these proposed developing social boundaries between the Northern and Western LPI groups are stylistically inferred. Study of egalitarian exchange within and between these subregions provides further insights into potential patterns of social interaction.

Egalitarian Exchange and Lithics of the Upper Great Lakes Region

A basic assumption in social scientific inquiry is that all human societies, both present and past, share in common the goal to provide its members with the necessities of life within their respective environments. Of course, as has been demonstrated throughout human history and prehistory, access to these necessities has not always been equally distributed among a society's members. Therefore, among forager and collector systems, egalitarian exchange strategies can provide buffers for individuals, families, and groups against the dynamic forces of both the natural and social spheres of their environments. Consequently, considering the variation and variability in these dynamic forces confronting different groups, the means developed and articulated by societies to resolve these issues (including exchange systems) is likewise highly variable in content, intensity, and frequency; as well as varying both spatially and temporally.

The lithic Raw Material data for this study in Exchange are summarized in Tables 6.13 and 6.20. Categories of identified Raw Material were selected based on previous site reports of Raw Material identifications and researcher identification through Museum comparative collections, consultations with local experts, and INAA/XRF testing.

Archaeologically, is the presence of exotic lithic raw material in a prehistoric lithic assemblage an indication of group mobility, sociocultural interaction or exchange, or some combination of both? It is this type of question which has generated the lithic exchange vs. procurement dialectic which traditionally centers on the ability to distinguish, in the material record, between lithic materials that were exchanged as opposed to directly procured from the source (Deller and Ellis 1984; Ericson 1977; Meltzer 1989; Ritchie 1965; Storck 1984; Wilmsen 1974). Typically, a greater burden of proof has been borne by those researchers positing exchange explanations, as opposed to direct procurement explanations, because it is generally accepted that highly mobile prehistoric forager/collectors transported directly procured lithic materials over large distances in the course of traveling their normal subsistence rounds, and thereby avoided relying on exchange as a means of acquiring important resources (Meltzer 1989:12).

To initiate his study of exchange, Meltzer provides a list of five functions that a system of exchange can provide social groups that would create an impetus for establishing and integrating such a system (1989: 20-21):

> 17. "Maintain ties between groups and thereby ensure reproductive success on a relatively empty [Pleistocene] landscape [Wobst 1974, compare Hayden 1982:118].
> 18. Enable a group to procure 'unusually important' items not available in a home territory [Dalton 1975:102; Ford 1972:22].
> 19. Maintain interaction among bands as a form of economic insurance or 'buffer' [Spielmann 1986:284]. In times of resource stress, this permits groups to gain access to resources from other, less depleted territories [Ford 1972:45; Hayden 1982:117-118; Jochim 1981:210; Spielmann 1986:283-284; Wilmsen 1973:26; Yengoyan 1968].
> 20. Support a system of 'mutualism' between neighboring groups, who have distinct specialized adaptations and need the surplus products of the other to complement their own diets [Spielmann 1986:281-289]; Hassan [1981:20] apparently disputes 'mutualism' among hunter-gatherers, but on the questionable assertion that hunter-gatherer systems are 'closed'.
> 21. Underwrite or initiate social relations [Mauss 1967:3; Sahlins 1972:186]."

He goes on to note that, "The last category (5) is the most general function of exchange, and operates over the long term" (Meltzer 1989: 21).

The world of the upper Great Lakes Late Paleoindian was no different, as is evidenced in the diverse archaeological record of these early prehistoric people. Considering the initial immigration into a vast and newly opened (deglaciated) territory (10,000 B.P. to 9,000 B.P.) by different groups, Meltzer's functions 1, 2, and 3 could easily have operated to help offset the unstable natural and developing social environments. This point is particularly poignant when considering that these initial immigrating LPI groups were arriving in the Northern and Western subregions from Canada's High Plains in Manitoba and along the Rainey River drainage, as well as from the western Great Plains of the Dakotas and the Mississippi River drainages. Additionally, in the Western, Eastern, and Southern subregions, there are also developing population dynamics and pressures with the immigration of the Early Archaic woodland-adapted groups who are inhabiting the woodlands even as they migrate northward. It is, in fact, the issue of these diverse populations that also provide a basis for Meltzer's functions 4 and 5, above.

For example, the archaeological evidence for the presence of Early Archaic side-notched projectile points in direct association with LPI Shouldered lanceolate assemblages (9,000 B.P. to 8,000 B.P.) and, further, produced on "unidentified", and thus possibly exotic lithic raw materials (Buckmaster and Paquette 1988; Mason and Irwin 1960), serves to underscore the impetus for an exchange relationship not only between different LPI groups, but also between LPI and Early Archaic groups (Mason and Irwin 1960). Given that there appears to be adequate impetus for all 5 of Meltzer's functions to be effected, it then follows that there is ample basis for identification of egalitarian exchange systems in the upper Great Lakes region during the Early Holocene period. It is significant to appropriate scientific inquiry, however, that there be a substantial and direct reliance on the archaeological record in discerning such elements of prehistoric social systems as egalitarian exchange.

As mentioned in Chapter 1, the Late Paleoindian (LPI) societies of the upper Great Lakes region (10,000 B.P. - 8,000 B.P.) has remained largely obscure due to its antiquity, low visibility, and poorly preserved material record. Extremely poor preservation of LPI material culture, i.e., floral and faunal, has resulted in highly constrained, almost exclusively lithic-based, material assemblage profiles. This observation is significant and remains a caveat to any interpretation of Late Paleoindian sociocultural patterns. Still, there remains much to be discovered and interpreted from the lithic component of a past society's material culture whose technology and economy relied heavily upon the use of modified stone. Therefore, this component of the study is initially directed towards revealing patterns in LPI sociocultural interaction using the variables of lithic material source geographic location and distribution occurrences.

Eastern Subregion Exchange Analysis

To begin, as revealed earlier in the Unshouldered and Shouldered analysis, the Eastern sample displays no variation of occurrences from locally available Raw Materials indicating no formal (or testable) usage of lithic Raw Material as a medium of egalitarian exchange. Both the Sheguiandah and George Lake assemblages were wholly produced of the local Sheguiandah Quartzite materials. This observation is not intended to imply that the LPI groups who inhabited the eastern upper Great Lakes, including the Manitoulin Island and George Lake area, did not engage in egalitarian exchange systems. Unfortunately, the very low lithic assemblage sample of the sites of the Eastern subregion (N=8), in fact, precludes effective statistical analysis of these assemblages in the subregional stylistic analysis. This same problem emerges in this study of exchange systems except that it is further exacerbated by the total lack of variation with the 100% local lithic raw material profile of the subregion. Still, it can be asserted that the Eastern subregion does not display any material evidence indicative of a lithic-based egalitarian exchange system; but, rather, displays a distinct preference for direct procurement of a lithic raw material from an abundant, reliable, and predictable source. And, finally, as is common among upper Great Lakes Late Paleoindian groups, there appears to be a distinct preference for procuring a specific known lithic raw material through the process of quarrying (Sheguiandah Quartzite), as opposed to direct procurement of varied lithic raw materials through expedient access to locally and regionally abundant glacial tills and stream beds. In considering the geographic distribution of these sites and the terrestrial impediments of glacial and lake level dynamics in the west and north, it appears reasonable to assert a mobility pattern that likely moved towards the south and east of the Eastern subregion.

An enormous, and troubling, condition to this assertion of Eastern subregion mobility patterns is the potential for access/egress directly westward through the upper peninsula of Michigan. In particular, during the post 9,000 B.P. glacial Lakes Chippewa and Stanley low levels, water crossings would have been less hazardous and, therefore, less a barrier. It is important to note, however, that there are no known LPI sites west of the Marquette area in the Upper Peninsula of Michigan. Even though this lack of evidence may be due to the poor archaeological sampling of this vast area, it still does not warrant any strong assertions of this mobility pattern at present. Unfortunately, a serious impediment to establishing any baseline mobility patterns is the absence of exotic raw materials from the lithic assemblages of the Eastern subregion. Therefore, only the limited stylistic analysis may, at this point, further support the proposed south and east patterns for Eastern subregion group mobility.

Southern Subregion Exchange Analysis

The Southern subregion, as mentioned throughout this study, is 99% derived from the Samel's site lithic assemblage. The Samel's LPI lanceolate raw material profile exhibits an almost equal distribution of locally available Norwood Chert (N=8), and the exotic Bayport Chert (N=10) which source outcrops about 200km to the southeast of the Samel's site, with only one lanceolate produced of a lithic raw material that is unidentified. In fact, it should be noted that the occurrence of the non-local Bayport chert is slightly greater than that of the local Norwood chert. This raw material profile exhibits more of the characteristics of direct procurement as opposed to exchange (Meltzer 1989: 33). Again, as was the case in the Eastern subregion, the Southern subregion LPI population, as represented at the Samel's site, displays a significant reliance on specific lithic raw materials (Norwood and Bayport) and also employ quarrying techniques in their dominant procurement strategy. Additionally, the early occupation of this site (about 10,000 B.P.) also indicates that the immigrating Early Archaic woodland-adapted groups are newly arriving to the area and are likely locating in the migrating mosaic woodland habitats south of the Mason-Quimby line (Cleland, Holman, and Holman 1998). Therefore, it appears that, as yet, there has been no lithic-based exchange system established between these two differing populations of the lower peninsula of Michigan. Yet, the archaeological evidence is not conclusive in establishing that there was no formal exchange system, only that it is more suggestive of direct procurement given the substantial portion of the assemblage that is exotic. The point here is that it is not common for forager and collectors to rely upon exchange networks for such a substantial part (i.e., 53%) of their lithic material culture (Meltzer 1989). Still, these assertions do not preclude exchange in other materials that have not been preserved in the archaeological record. Additionally, the early (10,000 to 9,000 B.P.) Southern subregion LPI groups were bounded by the glacial Great Lakes to the north, west, and northeast, and the immigrating Early Archaic groups to the south. However, there are recorded LPI sites in northwestern Ohio that date to about this same time period and that also exhibit some Bayport chert within their assemblages, indicating exchange, down-the-line exchange, and/or direct procurement through mobility (Payne 1987:3-4; Prufer 1966). These observations are important remembering that the 5 functions of an exchange system, as described by Meltzer, are met by both the Eastern and Southern subregions. Therefore, while there is a distinct possibility that some exchange system was in place among the Southern subregion LPI populations and other LPI groups, as well as possibly later Early Archaic populations, there is insufficient evidence to say that it was a lithic-based exchange system.

It is assumed, therefore, that the presence of exotic Bayport chert in the Samel's lithic assemblage is a result of direct procurement and, as such, provides a minimum distance (200 km) for the group's mobility pattern which includes an northwest to southeast trajectory. Also, in as much as there are no known alternative sources of Bayport chert between the Samel's Field site and the eastern outcrops at Au Gres and/or Saginaw Bay; that only one specimen of unidentified raw material is present in the Samel's lanceolate assemblage; and, that quarrying was the common procurement technique used at both Norwood and Bayport outcrops and throughout the upper Great Lakes region; it is a reasonable assertion that Southern subregion LPI groups engaged in direct quarrying techniques of specific lithic resources as an element within their subsistence and settlement systems.

In further discussion of mobility patterns as part of settlement and subsistence systems, it is important to note that a dry land corridor once again emerges to the east linking lower Michigan and southern Ontario between 10,000 B.P. and 9,000 B.P., at the Saginaw Bay area where Bayport chert also outcrops (Luedtke 1976). This creates an ability for direct access/egress, as well as congress, for LPI populations (Figure 2.2). This corridor may be extremely important to LPI populations of the Southern subregion, especially if later during the LPI/Early Archaic period there are social boundaries fostering more proscribed interaction between the more southerly Early Archaic populations and these more northern LPI groups. Still, further archaeological evidence is needed to support this Lower Michigan and Southern Ontario LPI social interaction hypothesis.

Importantly, as an aside, this researcher recently gained access to a Samel's lanceolate-style Unshouldered LPI lanceolate point from the Banyas Site in northeastern lower Michigan (Rogersville, Michigan) courtesy of Mr. Frank J. Krist Jr. This point is produced in a lithic raw material visually identified by Mr. Krist as Onondaga chert from southeastern Ontario. If this raw material is indeed from the Onondaga chert formation of Ontario, then this would be the first known archaeological evidence for an LPI Michigan to Ontario (i.e., west to east) mobility and/or exchange pattern. Either mechanism of mobility or exchange implies contact with Ontario groups and/or resources by Southern subregion LPI populations. Still, this site is newly discovered and has yet to be fully studied and documented. Therefore, the implications this data poses for LPI studies in the upper Great Lakes must be cautiously considered until proper archaeological research and documentation has been completed.

Northern and Western Subregions Analyses

In the raw material profiles of the Northern and Western subregions there is only one occurrence of Western lithic Raw Material (Hixton Silicified Sandstone) in the early Unshouldered Lanceolate sample of the Northern subregion, and only one occurrence of the Northern lithic Raw Material (Knife Lake Siltstone) in the Western subregion, and no occurrences of either in the later Shouldered Raw Materials. Secondly, there are 2 occurrences of the exotic Knife River Chalcedony in the Northern sample and none in the Western sample of Unshouldered Lanceolates; and, only 1 occurrence in the Northern sample and, again, none in the Western sample of the later Shouldered Lanceolates of this study. In fact, the only quantity of possibly exotic raw materials is of the "unidentified" category (N=10) in the Northern sample which does not, therefore, identify source location, and which could also have been procured from locally available and abundant glacial tills. Additionally, even the non-formal assemblages of the upper Great Lakes LPI reflect very few "known" materials that are exotic to the subregional site location of occurrence. Consequently, these samples are far too small to effectively evaluate decremental fall-off from source locations of known lithic resources to isolate and effectively evaluate any formal exchange pattern (Renfrew 1977: 83). Therefore, what follows is a short descriptive evaluation of the occurrences and distributions of these known lithic materials and the possible implications these data impart.

Meltzer's proposed method of identifying lithic-based exchange systems, as opposed to most exchange models which are economically-based, appears applicable to both the context and character of upper Great Lakes Late Paleoindian lithic assemblages (Meltzer 1989: 11-39). To begin, Meltzer suggests that insufficient Paleoindian information exists to perform a regionally-based study of exchange and, therefore, restricts his model to site-based discussion (Meltzer 1989:23). Unfortunately, the present study is likewise restricted. Further, he says that a "single occupation episode" is necessary to properly identify "site-specific signatures of direct versus indirect acquisition of exotic stone" (Meltzer 199?:23). As previously noted, much of the material record in the upper Great Lakes region for Late Paleoindians is classified as "findspots" or surface collections which are extremely constrained in terms of available site-specific information, e.g. location, natural record, type and measurements of artifact and raw material. Yet, on a regional scale, we suggest that these findspot sites may collectively, in the future, provide useful information for exchange system analysis. They are, arguably, single episode depositions, as are several of the mortuary locales.

By identifying a sole source for Hixton Silicified Sandstone, this analysis of the Northern and Western subregions proceeds with a single spatial reference point from which all occurrences of Hixton can be measured, i.e. distance of occurrence to source (mi./km) (Figure 1.1). Additionally, while the single geographic reference point is extremely useful in establishing absolute distances and areal distributions for Hixton, behavioral issues related to direct procurement are, likewise, affected. Consider the potential for direct procurement through glacially-transported Hixton material deposits (Luedtke 1976: 90-92; Meltzer 1989). As indicated on the map in Chapter 1

(Figure 1.1), Silver Mound's southwesterly location in relation to Late Pleistocene/Early Holocene glaciation episodes, where glacial activity occurred north and east of the Hixton resource location, along with the selected northeasterly locations of LPI sites and findspots effectively mitigates against glacial transport as a competing explanation for Hixton occurrence north and east of Silver Mound. Therefore, we can reasonably limit the probable means of Hixton occurrence to either direct procurement from the source, or by exchange.

In this study, the known widespread prehistoric use of "Hixton" pseudo-quartzite material, both through time and across space, presents an analytic tool for preliminary assessment of a lithic-based exchange pattern (Fishel 1988: 124-138; Luedtke 1976: 41-76; Meltzer 1989). More importantly, whether or not the practice of lithic-based exchange as a significant sociocultural mechanism among the LPI is supported, the potential exists for significantly broadening the body of knowledge regarding the little known Late Paleoindian lifeways of the upper Great Lakes region.

Hixton Silicified Sandstone is probably as widely known among Great Lakes prehistory researchers as any other single lithic raw material. Indeed, there has scarcely been an archaeological report written about the Paleoindian - Early Archaic period in the Great Lakes region without some reference to "Hixton" (Boszhardt 1993; Brown 1984; Buckmaster and Paquette 1988; Fishel 1988; Julig, et. al. 1987; Mason and Irwin 1960; Porter 1961; Sackett 1968; Salzer 1974; Tankersley 1988 & 1989; Wendt 1985). Additionally, Silver Mound, located in Jackson County, Wisconsin, is the only known source of Hixton Silicified Sandstone in the upper Great Lakes region (Haywood 1987: 12; Porter 1961). To this end, this researcher has, whenever permitted, submitted samples of both the raw material source locations and site occurrences for INAA/XRF testing to determine potential for relatedness. Results of these tests are provided in Appendix C. In short, it was determined that all tested site occurrences of "Hixton"-like material did produce INAA/XRF test results significantly supporting the proposed relationships. Therefore, these site samples are assumed to have been derived from the Hixton source of Silver Mound, Wisconsin.

As an example of Meltzer's first stipulation for a "single occupation episode", the Gorto Site, located in Marquette County Michigan, the Renier Site, located at the base of the Door Peninsula in Wisconsin, and other Wisconsin and northern Ontario sites provide the LPI data for this analysis. Both Gorto and Renier sites possess discrete multiple artifact components that are interpreted as single-occupation episodes, i.e. cremation burial caches (Buckmaster and Paquette 1988: 101; Mason and Irwin 1960: 43). As identified in these respective site reports, both of these Lanceolate assemblages are produced (predominately) of the exotic Hixton Silicified Sandstone. In both of these cases the almost total exotic raw material profile, then, reflects Meltzer's direct-acquire signature - "p.c1." (Meltzer 1989: Table 2.1, 27) as the explanation best supported by the data (Buckmaster and Paquette 1988; Clark 1989: 107; Mason and Irwin 1960). This means that the later Shouldered Gorto sample was directly procured and ultimately deposited >400 km (Clark 1989:107). This observation does not preclude the possibility of varying forms of down-the-line exchange followed by social group aggregations at the site location. Still, given the very broad and extensive use of Hixton Silicified Sandstone among groups in the Western subregion, even if they were organized in an anucleated fashion, the intermittent direct access to their preferred lithic raw material would likely still remain central to their lithic procurement strategies, and integrated through their subsistence and settlement mobility patterns. Given the sizeable distance of the site from the source, the idea of overlapping mobility patterns between Northern and Western populations, particularly during the earlier Unshouldered Lanceolate period, is not without weight.

It has been suggested that even if there was some exchange of lithic raw materials, its occurrence was too low to consider a widespread Regional pattern of any observable significance. Additionally, while the formal LPI Lanceolates exclusively provided the data in this study, it is assumed that if exotic lithic raw materials are being exchanged in any significant quantity, that their occurrence would likely be greatest (or at least observable) in the formal Lanceolate tools of exchanging LPI groups/group members' lithic assemblages. Also, the strategy of long-distance direct procurement of lithic resources in mobility patterns among upper Great Lakes LPI groups is demonstrated elsewhere, other than Gorto and Deer Lake. Specifically, the Samel's Lanceolate lithic assemblage provides a clear picture of this polar strategy with the locally available Norwood Chert and non-local Bayport Chert in nearly equal quantities, yet their sources being separated by >200 km (Cleland and Ruggles 1996: 93).

The Northern subregion, with its diverse early LPI Unshouldered Lanceolate Raw Material profile, presents the most promise for future discovery of any patterns in egalitarian exchange of lithic raw materials. In using this data set, however, any purported lithic-based exchange system suffers from a distinct lack of direct evidence. In particular, given the very small and isolated occurrences of known exotic lithic raw materials in both the Northern and Western subregion samples, and the rather large known mobility patterns of the period (400km), there is nothing to preclude direct transport from sources to points of site occurrence as a causality. But, even more to the point, while there may be some low level social interactions where exchange of lithic raw materials may have occurred, it presently appears to be so slight in the archaeological record that there is no emerging "pattern" to this type of exchange that can be statistically tested. Still, based on what is known, certain observations can be offered as future hypotheses.

The occurrence of the Western Hixton raw material as an Unshouldered Lanceolate in the Northern subregion's Quetico Park area as a result of exchange (or gift) is supported by the Oblique Flaking pattern and smaller lanceolate size which is more stylistically associated with the Northern Lanceolate form. Also, the occurrence of the Northern (Quetico Park Area) Knife Lake Siltstone raw material in Northern Wisconsin (Salzer 1974) appears to be more stylistically associated with the highly variant forms of the Northern Unshouldered Lanceolate inventory which is more supportive of direct acquisition and transport from the source. In fact, the clinal area at the western edge of Lake Superior (Reservoir Lakes Complex) appears to offer the highest amounts of inter-subregional interaction both stylistically and in raw materials during the earlier Unshouldered Lanceolate phase of the LPI period between the Northern and Western subregions (Ross 1995:244; Salzer 1974; Steinbring 1974). As noted in the Shouldered analysis, however, this overlapping of raw material occurrences in the data does not extend to the later LPI Shouldered Lanceolate period. Both the Western and Northern Raw Material profiles of the Shouldered Lanceolates are *Discretely Distributed* (or nearly so) which implies an absence of evidence for formal lithic-based exchange systems to be operating at any significant scale.

Exchange Summary

In summary, the findings of this preliminary study of lithic raw material exchange for the LPI of the upper Great Lakes Region does not support either a subregional or regional lithic-based exchange systems hypothesis to explain the occurrences of exotic raw materials. The archaeological and ethnographic evidence considered indicates direct procurement from the various sources of the exotic lithic resources as the more plausible explanation. Still, more research is needed to improve both the quality and quantity of upper Great Lakes LPI archaeological samples, to further test and refine the exchange hypothesis in developing our knowledge of the richly-diverse upper Great Lakes Late Paleoindian groups.

Summary - Style and Exchange Analyses

During the early LPI explorations and immigrations into the upper Great Lakes regions (10,000 B.P. to 9,000 B.P.), small Late Paleoindian groups were migrating from their adjacent territories into these newly formed and developing biomes and ecotones. High mobility was the positioning strategy they employed to access and exploit these new natural resources.

North of Lake Superior, LPI groups likely immigrated from the High Plains of Canada at first around the southern tip of glacial Lake Agassiz inhabiting the small peninsula bordered to the east by Lake Duluth, to the north by the retreating glacier, and by Lake Agassiz to the west; and then, later, through the Rainey River drainages and into the Quetico Park, Duluth, and finally the Thunder Bay and Lake Nipigon areas. At present, given the lack of compelling archaeological evidence for a strong LPI migration continuing east of Thunder Bay/Lake Nipigon area during the LPI/Early Archaic period, it is unlikely that the LPI expression at the Sheguiandah and George Lake sites, indeed in southern Ontario, developed from a north to south migration pattern circumnavigating the northern shores of Lake Superior. Rather, it appears more likely that this area was populated from LPI migrations out of the adjacent south, east, and west than the north. In fact, it appears that with the diminished southern limits of Lake Agassiz, during the Nipigon Phase (9,500 B.P. to 8,300 B.P.) (Figure 2.3), came a more defined social boundary between the Northern and Western subregions. The evidence for this observation is the diminished occurrence of exotic lithic raw materials between these adjacent subregions and the LPI lanceolate stylistic divergence through time.

Late Paleoindian groups also migrated east and north into the upper Great Lakes from the Western Plains and adjacent southern areas, making their way into the western edges of Lake Michigan and southwestern Lake Superior. It appears that these LPI groups developed patterns using the north and west shores of Lake Michigan and south shores of Lakes Superior as their natural boundaries and, later, the western edge of the Lake Superior basin as their northern social boundary. Their mobility patterns developed through time to include the western area of the upper Peninsula of Michigan near Marquette, Michigan and possibly further east of that area. Through time, there appears to be a development of a sociocultural identity that is visibly different from that being expressed by their northern neighbors. While these differences are admittedly mostly observable at rather moderate to high levels of social interaction, the potential for a more clearly stated and visible referent of these differences is proposed as also observable in the lithic Raw Materials used by these LPI groups for their lanceolates.

The Southern LPI groups display yet another variation on forager and collector systems of the LPI/Early Archaic period. Stylistic and Exchange analyses have revealed significant patterns that are distinctly different from the other subregions of this study. It was noted that the Southern subregion LPI groups do not appear to interact with the LPI groups in the other subregions, except possibly the Eastern subregion (although archeological evidence for this exception is weak).

Finally, it was determined that there was insufficient evidence for identifying a formal and/or informal lithic-based egalitarian exchange system among LPI groups of the upper Great Lakes region. In fact, the evidence appears to be greatly in favor of direct lithic procurement from known sources at sometimes long distances as the favored procurement strategy for this resource. This insight is important for issues of mobility as a resource exploitation and positioning tactic in forager and collector settlement and subsistence strategies. By effectively eliminating the reason for occurrences of exotic raw materials through the social mechanism of egalitarian exchange, the distances between sources and site occurrences can then be used to provide a minimal measure of group mobility. This is a result of inferring that if access to exotic lithic raw material was not through the social mechanism of exchange, then direct procurement from the source and subsequent direct-carry to the site of occurrence provides the distance measure of mobility. Therefore, it was determined that the Southern subregion LPI groups mobility was likely in the 200km range. The Northern and Western subregion groups mobility patterns were likely in the 400km range and originally likely overlapped each other in the western Lake Superior area. However, later in the LPI/Early Archaic period, this overlap diminished giving way to developing social boundaries between the two subregional LPI populations.

The issue of Early Archaic notched points mixed and/or in association with LPI lanceolates has been touched upon various places throughout this study. While the sample was too small for an intensive analysis of these notched points, certain observations can be reasonably offered. In the Northern sample it is noted that the most frequent notched points occurring are typologically identified as "Manitoba" points from the High Plains of Canada found in Thunder Bay and produced on Jasper Taconite (Hinshelwood and Webber 1987: 43). This observation implies a social connection between the style source of the Canadian High Plains for the "Manitoba" notched point and its occurrence in both Thunder Bay and in Jasper Taconite. This observation acts to add further support for the proposed Northern LPI east to west mobility trajectory. Also, the exotic side-notched points of both the Renier and Gorto mortuary sites are more diagnostic of the Early Archaic woodland points found in the adjacent western and southern areas of the Western subregion. These points then also support an east to west mobility pattern for the Western subregion with indirect and/or direct social interactions with Early Archaic woodland groups. Additionally, the several notched lanceolates produced on Hixton Raw Material indicate a developing stylistic shift towards the notched styles of woodland-associated hafting expressions. This may be suggestive of intensified interaction between Western LPI groups and the adjacent Early Archaic Groups. Additionally, a bifurcated base on a lanceolate is also found in the Western subregion sample near the Marquette area of the Upper Peninsula of Michigan. It appears reasonable to assert that hafting design changes with a trajectory towards notching are potentially being expressed among the Western LPI groups. Significantly, in all these cases, the notched points are in association with the later Shouldered lanceolates of the LPI groups.

Finally, the stylistic and exchange analyses have provided insights into the remarkable diversity of upper Great Lakes Late Paleoindian lifeways. Investigations into the lithic stylistic expressions of these ancient peoples has provided productive and valuable insights into these extinct social systems, as demonstrated by the ability to infer broad LPI geography of the upper Great Lakes region, as well as discrete social interaction spheres, types, and intensities through the lithic component of their material culture. As is always the case in archaeological investigations, further research is greatly needed to further test and strengthen our frameworks of learning and understanding. There is no area of research where this fiat is more applicable than in lithic stylistic inquiry.

Conclusions

This analysis has revealed several significant observations regarding stylistic expression, exchange, and their interpretation for sociocultural behaviors of upper Great Lakes LPI populations. There are demonstrable changes in LPI mobility patterns both over time and across space. The Northern and Western patterns remain >400 km in size, but there is development of a social boundary between these groups at the western end of Lake Superior by ca. 9,000 B.P.. The Southern group apparently employs a more restricted spatial pattern (200km) than their Early Paleoindian antecedents. Additionally, there are no indications of a formal lithic-based exchange system operating in the region.

Finally, it is clear that the application of methods incorporating detailed and fine scale observation of small and widely distributed samples within the context of focused theories of style has yielded productive results. These results suggest potential for both the method as well as the questions raised for future inquiry.

CHAPTER 7

SYNTHESIS AND CONCLUSIONS

Introduction

This study was undertaken to reveal the specific social behaviors of mobility and exchange among Late Paleoindians during the Early Holocene period, between 10,000 B.P. and 8,000 B.P. in the upper Great Lakes region. The challenges to this scientific inquiry centered on the paucity of the archaeological and natural records of these past forager and collector systems. Therefore, it was determined to use the most style-rich elements of the material culture preserved in the archaeological record from this period, the LPI lithic lanceolates, to achieve these research goals. The outcome of this research has implications for general areas of ecological theory, stylistic and exchange analyses, and early prehistory of the upper Great Lakes region. Consequently, this chapter summarizes each of these topics providing the conclusions and the implications of this research.

The Theoretical Framework

The ecological framework provides an overarching and contextual means of articulating the natural world with the human social and cultural worlds through a rich array of adaptations which are a product of human choices and creations. This theoretical framework, then, provides the boundaries for the research questions which guided this study, as well as the hypotheses developed to suggest answers to these questions. Both research questions and hypotheses are re-created here:

Research Questions

1. What Late Paleoindian subsistence, settlement, and mobility adaptations are affected by the environmental changes of the early Holocene in the upper Great Lakes? How did the development of ecotones in the upper Great Lakes affect these sociocultural adaptations among upper Great Lakes Late Paleoindian populations?

2. What effects did the arrival of woodland-associated flora and fauna species have on Late Paleoindian subsistence and settlement systems?

3. How do Early Holocene Great Lakes lake level fluctuations affect the development of sociocultural adaptations between and among populations of Michigan's lower peninsula and the territories surrounding the upper Great Lakes region?

The first of the hypotheses designed to respond to these questions is stated as follows:

HYPOTHESIS A:

If: there was a shift from a faunal-intensive economy in a species-poor environment towards a mixed economy in a more species-rich environment among upper Great Lakes Late Paleoindians,

then: there should be a change in the adaptive strategies employed by Late Paleoindian sociocultural subsystems such as subsistence and settlement systems, with some diminishing of Late Paleoindian mobility patterns, accompanied by a general increase in ecofact and material culture quantity and diversity through time.

As revealed in Chapters 2 and 3, Late Paleoindians of the upper Great Lakes witnessed an enormous range of environmental change within their natural worlds, which included a shift from a species-poor to a more species-rich environment, particularly adjacent to, and south of, the Lake Superior basin. Therefore, the conditions for Hypothesis A are present. The expectations expressed in Hypothesis A, however, are not totally met by the subsequent analyses. In particular, while there may be a diminished mobility pattern expressed in the Southern subregion from around 400km to 200km, the Northern and Western mobility patterns appear to be the same or possibly larger, from around 400km to >400km. Yet, as pointed out by Binford (1980) and Meltzer and Smith (1986), a species-rich environment provides a basis for greater mobility, not less mobility, dependent upon subsistence and settlement strategies being employed by the forager and collector groups. Therefore, as observed in Chapter 3, the Southern LPI group, while exhibiting a forager adaptation are also potentially employing a collecting strategy which does offer some geographic tethering functions, thus explaining the reduced mobility patterns of these groups.

Whereas, the Northern and Western groups are proposed to be employing a stronger foraging strategy with the introduction of woodland and wetland species into the area. Finally, the expectation for an increase in ecofact and material culture quantity and diversity is also met. Certainly, in terms of diversity, it was demonstrated that a much greater array of faunal resources have been archaeologically discernable (Kuehn 1998), as well as a much wider variation of lithic tool hafting techniques and styles which develop along a trajectory of complexity throughout the Early Holocene period. The expectation for quantity increases of LPI material culture, due to population and functional increases, do not appear to be uniformly met, which may be a result of sampling error, or an incorrect expectation of LPI forager and collector subsistence and settlement systems, and their population dynamics. Specifically, there is no archaeological indication of increased population aggregations, with the possible exception of the Southern subregion. Still, even the Southern subregion LPI sample does not strongly support an increased population aggregation hypothesis.

HYPOTHESIS B:

If: Late Paleoindian populations' adaptations remained faunal-intensive, and populations that are woodland-adapted and exploiting a mixed economy immigrated into the upper Great Lakes' developing ecotones,

then: there should be little change in the material culture or archaeological faunal/floral profile of Late Paleoindian assemblages, but a change in mobility patterns should be evidenced by a general northward and westward trajectory, while a distinct immigration of Early Archaic woodland-adapted populations should be evidenced as discrete assemblages in the developing ecotones of the glacial Lake Stanley and Lake Chippewa basins with a diminished presence of Late Paleoindian assemblages.

In discussing the faunal and floral records of the Early Holocene period, as well as the LPI lithic material culture, this study suggests good evidence for some shift in the trajectories of LPI subsistence and settlement strategies towards a more mixed economy of a species-rich environment. The expectation that there should be little change in the LPI material culture and faunal/floral profiles has been determined incorrect through the various analyses in this study. It is obvious that there was an underlying assumption of population replacement rather than population change in the construction of this hypothesis. This assumption is further demonstrated in the additional expectations of this hypothesis. The suggestion of the Early Archaic woodland-adapted populations inhabiting the upper Great Lakes ecotones and replacing the LPI populations is evidenced by the archaeological expectation for discrete Early Archaic assemblages with a diminished presence of Late Paleoindian assemblages. Interestingly, there is no present evidence of such a replacement in the known archaeological record of the upper Great Lakes region of this study, excluding southern Ontario (Ellis, Kenyon, and Spence 1990: 65-80). In evidence, the exotic notched points in direct association with the Western late LPI shouldered lanceolate points, the Hixton notched and bi-furcated lanceolates, provides some basis for asserting that the LPI populations remained in their subregions throughout the Early Holocene period, rather than migrating north to be replaced by the immigrating Early Archaic woodland-adapted populations.

Consequently, even though it can be argued that the hypothesis was poorly constructed, still, by directing attention to the issue of replacement yet another element of LPI settlement and subsistence systems including mobility, has been suggested. Therefore, it can be reasonably asserted that among the LPI groups of the Western and Northern subregions, there does not appear to have been a punctuated replacement of these groups by immigrating woodland-adapted Early Archaic groups. Rather, the LPI groups of these regions, with an emphasis on the Western subregion groups, appears to have remained within the rough confines of their territories and adapted their settlement and subsistence strategies to the changes in their environments.

HYPOTHESIS C:

If: there was a shift from a faunal-intensive economy to a mixed economy among Late Paleoindian populations, and populations who are woodland-adapted, and who were also exploiting a mixed economy, immigrated into the upper Great Lakes' developing ecotones,

then: there should be generally reduced mobility patterns than those previously associated with Late Paleoindian groups with the potential for some overlapping of mobility patterns between Late Paleoindian populations and those of the woodland-adapted Early Archaic immigrants, particularly in the developing ecotones of the Lake Stanley and Lake Chippewa basins. Additionally, there should be the same types of adaptive changes evidenced in the archaeological record for Late Paleoindians as specified in Hypothesis "A".

Again, as discussed under Hypothesis A, the expectation for reduced mobility patterns as a condition of developing mixed economies from faunal-intensive economies, in retrospect, is likely a poorly constructed hypothesis, and is not met in whole by the LPI groups of the upper Great Lakes region. Additionally, it is likely that the LPI groups in the Western subregion observed earlier and more intense immigrations of woodland species than their Northern neighbors, which may have provided at some environmental impetus for development of divergent lanceolate stylistic trends that became apparent later in the Early Holocene period. The second issue raised by Hypothesis C (inter-culture contact), however, requires further discussion. A difficult issue to resolve with the extant archaeological records of the upper Great Lakes is whether LPI-notched points actually reflect direct/indirect social interaction with Early Archaic woodland groups, or are a result of independent LPI technological and stylistic developments towards new hafting modifications and notching techniques in lanceolate design and manufacture. In the Southern subregion assemblages, which are heavily skewed towards the early end of the Early Holocene period, there does not appear to be any evidence for a notching technique as an element in their lithic tool hafting technology. Given the earlier time frame of these occupations, however, this is not necessarily unexpected. Yet later, in the Early Holocene period, there is a decided mixing of notched and LPI lanceolate styles in the Northern and Western assemblages. If there had not been such exotic intrusions of both style and unidentified lithic material in the notched points as displayed in mortuary contexts of both Renier and Gorto sites, an argument for notching developments deriving independently among LPI groups would be stronger. Yet, the existence of these points, and in these contexts, calls into question such an assertion. Therefore, I suggest that there is some level of interaction between these LPI and Early Archaic groups; but, as to questions of its nature, i.e., direct or indirect interaction, frequency, and intensity, I must defer answering until future research provides us a basis for appropriate inferences.

In summary, this study has provided several contributions to our understanding of regional Late Paleoindian lifeways. Binford's systemic ecological model for studying these forager and collector systems has provided a reasonable basis for describing certain areas of social organization and function, however, much is left undiscovered and unexplained. Therefore, further issues of polity, economy, ideology, ethnicity, and social inequities remains to be examined using further and other theories of explanation. At the regional level of study, there is the tendency to oversimplify extremely complex social systems particularly by application of these ecological and systemic models. Yet, there are levels of information that each layer of research reveals about aspects of social organization which productively contributes to the whole of anthropological understanding of archaeological cultures. This study has sought to expose some of the social patterns of the upper Great Lakes Late Paleoindian societies which can be used as a foundation for further and more intensified archaeological research into this obscure period in upper Great Lakes prehistory.

Style and Exchange

Another contribution of this research is the application of archaeological analytical methods in style and exchange to ascertain certain dimensions of social organization. In particular, the issues surrounding lithic tools and the use of their design and manufacturing variability to infer patterns of social behaviors. To this end, this research methodology builds upon the foundations of the body of studies referred to as ceramic style (Friedrich 1968; Hill 1970; Longarcre 1970; Sackett 1977; Whallon 1968; Wobst 1977) and employs the focus on the individual as the central facilitator of style as developed by Voss and Young (1995). Central to this research design are the stylistic expressions of LPI lanceolate hafting forms and the various lithic raw materials used. In part, the question was whether the Raw Material variable derives from either active or passive social processes, and stylistic and/or functional, since it is significant to consider its potential social relevance both within and between prehistoric LPI groups. While the Raw Material attribute may act to embody some actively shared symbolic meaning within groups and between groups (e.g., Emblemic Style or Information Exchange), it can also exhibit root and continued expression as the "passive enculturation of craft traditions isochrestic variation" (Voss and Young 1995: 93). In either event, there are distinct geographic boundaries that are associated with its occurrence and distribution which, given the *High-Visibility* profile, underscores some personal and social formality in its procurement, use, and distribution. Additionally, the social mechanism of egalitarian exchange and its potential effects on Late Paleoindian social organization also emerges as a consideration in this analysis. Therefore, specific hypotheses were developed out of the research questions that were directed towards issues of style and exchange. These hypotheses are repeated here for ease of reference:

HYPOTHESIS D:

If: stylistic behavior is a visible referent of social group identity and is expressed in the lithic component of Late Paleoindian material culture,

then: there should be a visible stylistic homogeneity of intra-group lithic assemblages, defined by a co-variance of stylistic attributes, which will cluster as a group, distinguishable from other assemblages.

HYPOTHESIS E:

If: lithic raw material was used stylistically among upper Great Lakes Late Paleoindian groups, then: its occurrence should co-vary with the other lithic stylistic attributes of a specific lithic assemblage

The stylistic analysis of Chapters 5 and 6 provides a reasonable basis for not rejecting both of these hypotheses. The discrete/clinal behaviors of the lithic raw material displayed the same behaviors as the other identified stylistic attributes both within and between subregions.

To summarize, the Early Holocene period is proposed to have been evidenced during the 2,000 year period intervening between 10,000 B.P. and 8,000 B.P. in the upper Great Lakes region. While numerous lanceolate point forms and variants emerge during this time frame, a basic temporal division was possible with the association of Unshouldered lanceolates with the earlier Early Holocene period (10,000 B.P. to 9,000 B.P.), and the Shouldered lanceolates generally associated with the later half of this time frame (9,000 B.P. to 8,000 B.P.).

It was revealed that during the early part of the Early Holocene period of the Western and Northern subregions, mobility patterns and group/individual interactions appear to overlap at the extreme western edge of the Lake Superior region. It was inferred from the more homogeneous lithic assemblages that certain LPI groups of the Western subregion had been operating in this subregion for a longer period, thus producing a more established and uniform settlement and subsistence system than that which was developing in the Northern subregion during the earlier period. Likewise, a more diverse settlement and subsistence system among the Northern LPI groups was inferred from the stylistic heterogeneity of its assemblages. An explanation is offered that initially numerous small groups likely immigrated into the Northern subregion from adjacent areas of the south, west, and northwest while the east remained impenetrable due to the glacier's presence. It is also suggested that interaction between these two subregional groups did likely occur during this early phase. But, the Western groups appear to have continued to strengthen their previously established west to east patterns, which appears to be mostly south of Lake Superior. Meanwhile, in the north, after the glacier retreats further to the northeast and Lake Agassiz shorelines diminishes, it is proposed that there may have been a reduction in social interaction between these Western and Northern neighbors considering changes in mobility patterns. These inferences are derived from the stylistic *Clinal* distribution and similarities of the Northern and Western early LPI assemblages, as compared to the later stylistic divergence of Northern and Western assemblages, indicating that social interaction appears to diminish throughout the Early Holocene period between these two populations.

Also, it was noted that there is no stylistic indication of either direct or indirect social interaction between the Southern subregion and the other upper Great Lakes subregions. The Southern subregion LPI groups' mobility patterns appear to be restricted to the northern Lower Peninsula of Michigan with a possible west to east pattern. This study also revealed that the LPI group mobility patterns of northern lower Michigan were physically bounded by the glacial Great Lakes to the north and west and with spheres of social interaction available to the south, and then to the east through Port Huron, and later Saginaw Bay, to southern Ontario. Future study should now focus on potential interaction spheres between the LPI and/or Early Archaic groups to the south and east of northern lower Michigan LPI groups to better define these elements of LPI mobility in the southern subregion. Future LPI and Early Archaic research directions should also include application of underwater archaeological survey and testing strategies to further test and refine the hypothesis that many of the LPI and Early Archaic sites of the upper Great Lakes lay submerged under the modern lake levels of the Lake Michigan and Lake Huron basins. Finally, it was noted that there are distinctly different *High-Visibility* Raw Materials used by the Northern and Western subregions including the opaque, black or darkly-colored Jasper Taconite and Knife Lake Siltstone of the Northern subregion, and the translucent, white to orange lightly-colored Hixton Silicified Sandstone of the Western subregion (Chapter 6), which are proposed to act as further evidence of social boundary markers.

HYPOTHESIS F:

If: certain lithic raw material was used as a medium in a non-preferential egalitarian exchange system among upper Great Lakes Late Paleoindian populations,

then: the law of monotonic decrement would apply, where there is a fall-off of the frequency of the lithic raw material as effective distance increases from its point of origin, which can also be graphically represented as a normal curve with quantity as the Y value and distance as the X value.

HYPOTHESIS G:

If: lithic raw material was used as a medium in a preferential egalitarian exchange system among upper Great Lakes Late Paleoindian populations, then: the frequency:distance fall-off curve would not be normal but would be characterized as generally descending but interrupted by peaks and valleys, or deviations from the normal curve, which represent the exchanged lithic raw material occurring in frequencies and/or quantities at greater distances from the lithic source than the normal fall-off curve predicts.

Both Hypothesis F and G were not testable as stated due to the small samples available, as compared to the quantities and distributions needed to operationalize Colin Renfrew's "Law of Monotonic Decrement" (1977: 72). Still, by employing Meltzer's model to detect lithic exchange systems (1989), an important insight is gained. The findings of this preliminary study of lithic raw material exchange for the LPI of the upper Great Lakes Region does not support either a subregional or regional lithic-based exchange systems hypothesis to explain the occurrences of exotic raw materials. Direct procurement from the sources is identified as the likely dominant means of lithic procurement. This inference, however, does not preclude the potential for some limited down-the-line exchanges and/or incidental interpersonal exchanges. This is particularly important in social organizations that express patterns of anucleation in their settlement and subsistence systems.

In considering the inferred Northern and Western settlement and subsistence systems, it would appear that if exotic lithic raw material did occur that derived from each other's subregions, that it would most likely be associated with the earlier LPI explorations and immigrations of the Northern subregion. Also, it is likely that such exotic raw material occurrences would diminish later in the Early Holocene period as proposed social boundaries became more defined. Still, as I've said in Chapter 6, "...more research is needed to improve both the quality and quantity of upper Great Lakes LPI archaeological samples, to further test and refine the exchange hypothesis in developing our knowledge of the richly-diverse upper Great Lakes Late Paleoindian groups".

HYPOTHESIS H:

If: social boundary maintenance is less proscribed in areas of low and widely dispersed economic resources (e.g.,flora/fauna), and there was a general increase in these exploitable floral/faunal resources in the upper Great Lakes region during the Early to Mid-Holocene (10,000 B.P. - 8,000 B.P.),

then: there should be evidence for an intensified expression of social boundaries within a more geographically refined (or smaller) area.

As previously dealt with in the stylistic, exchange, and environmental analyses, there emerges sufficient archaeological evidence whereby this hypothesis is supported. Although it is not proposed that there was an explosion of faunal and floral richness across the LPI landscape of the upper Great Lakes, it does appear evident that species diversity did certainly increase during the Early Holocene period in this region. And, secondly, the stylistic analysis provides compelling evidence to support inference of a significant divergence of stylistic attributes of LPI lanceolates between the Northern and Western subregions, both temporally and spatially. Additionally, the exchange analysis suggests that direct procurement, and therefore social group mobility, is likely the best explanation for the distributions of lithic raw materials within the upper Great Lakes region. The raw material distribution trajectory from *Clinal* to *Discrete*, then, also supports the development of "intensified expressions of social boundaries within a more geographically refined area". Therefore, the stylistic analysis does support an inference of the development of intensified social boundaries intervening between the Northern and Western LPI groups (Figures 7.1 and 7.2). Likewise, and as previously mentioned, there are no stylistic indications of interaction between either the Eastern or Southern subregions with each other or the Northern and Western subregions. Yet, the geographic areas between the western and eastern ends of the Upper Peninsula of Michigan, the areas between Port Huron and Saginaw Bay of lower Michigan and southern Ontario, and, finally, the submerged landforms of Lakes Michigan and Huron still present more questions than answers regarding LPI settlement and subsistence systems.

Conclusions

This dissertation has provided insights into the character and dynamic nature of the paleoenvironment of the Early Holocene period including revealing patterns of Late Paleoindian lifeways in the region. To conclude this study, a discussion of these findings and the recommended direction for future research is undertaken.

During the Early Holocene (10,000 B.P. to 8,000 B.P.), the region experienced a climatic warming trend, with variable humidity rates expressed across the region, which coincided with a retreating Laurentide ice sheet and the development of a wide ecotonal area. These conditions provided a basis for LPI groups to employ adaptive settlement and subsistence strategies ranging from a species-poor environment to a species-rich environment, which included high mobility positioning strategies referred to as "mapping on". Additionally, through time, different settlement and subsistence strategies were likely employed between the Northern, Western, and Southern LPI populations including diverse and wide-ranging mobility patterns.

The arrival of woodland-associated faunal and floral resources created a basis for development of these adaptations that were somewhat different in character from the previous species-poor environment. While mobility patterns remained high (200 km to >400 km), move frequency likely lessened as greater opportunities developed for small groups to range over a wider territory exploiting a more diverse and widely distributed economic resource base. In general, the small and widely distributed archaeological record of the Early Holocene also appears to support this interpretation.

Fluctuation of Early Holocene Great Lakes water levels provided further impetus for the development of microhabitats, particularly in the ecotonal area. This developing ecotone included such changes as dramatic tributary riverine/lacustrine dynamics with associated embayments, ponding, and flooding; developing wetland and marsh habitats; immigrating deciduous forest elements; and, all with attendant immigrations of diverse woodland and wetland-associated flora and fauna. Additionally, greater terrestrial access was made possible, particularly during the Chippewa (Michigan) and Stanley (Huron) stages of the Great Lakes basins. Glacial Lake Minong (Superior) fluctuations were also important to outflow and drainage to the lower Great Lakes as well as within the Northern and Western subregion watersheds. Therefore, all of these dramatic natural environmental perturbations necessitated resident LPI populations to employ adaptive strategies diverse in their character and distributions.

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The Southern LPI groups appear to have a diminished mobility pattern from previous Early Paleoindian patterns of 400km to around 200km, and exhibit a west to east pattern largely bounded by the Great Lakes on the north, east, and west sides and, possibly, by the woodland-associated Early Archaic populations to the south. Southern LPI populations display no significant social interactions between groups from the other subregions within this study. There is potential, however, for either direct or indirect interaction between the Southern subregion LPI populations of this study and those LPI/Early Archaic populations of both southern Ontario, and possibly to the south towards the Ohio/Indiana areas.

The Northern and Western LPI groups' 400 km mobility patterns may be nearly the same distances as that of their Early Paleoindian predecessors, and possibly greater. As revealed in the forager-collector analysis (Chapter 3), the arrival of woodland faunal and floral species provided a basis for changes in LPI subsistence and settlement systems towards increases in collecting (or gathering) with a mobility pattern ranging across large territories. Mobility patterns in the Northern subregion exhibit a decided northwest trajectory which becomes more pronounced throughout the Early Holocene period as Lake Agassiz shorelines contract to the north. The Western subregion displays a 400 km pattern but its direction appears to be consistently east-southeast to west.

Stylistic and exchange analyses indicate that the Northern and Western subregions were predominately populated by groups from different areas, but with moderate interaction intensity during the initial immigrations to the Northern subregion (Figure 7.1). Later in time, however, a social boundary is proposed to have developed between the LPI populations of these two subregions. This is expressed by diminished interaction;

yet, with a narrow band of overlapping territories between the two populations at the western end of Lake Superior (Figure 7.2). The initial change in interaction patterns is seen as an effect likely facilitated by the diminished southern shoreline of glacial Lake Agassiz which, sometime between 9,000 B.P. and 8,000 B.P., provided a more northerly, and direct, terrestrial access from the northern High Plains and Lake of the Woods area (Manitoba) to the north shore of Lake Superior, through the Rainey River drainage system and the surrounding territory.

Eastern LPI groups are proposed to have an easterly to southerly trajectory in their mobility patterns with Manitoulin Island and the George Lake area the northwestern most edge of their patterns. It is cautioned, however, that while there is no archaeological evidence for a further westerly pattern into the upper peninsula of Michigan by Eastern LPI groups, a very weak archaeological record in this area affects any clear interpretations, either way.

Cultural Ecological theory contributed to a broad definition of the likely subsistence and settlement system of LPI groups in the upper Great Lakes region during the Early Holocene (Steward 1955). This was accomplished by employing Binford's (1980) Forager-Collector model which quantified and characterized environmental factors revealing a predominately forager subsistence pattern (63%), but also with a significant collecting strategy (37%). This challenges some previous views of LPI subsistence and settlement systems as specifically hunting focused. Still, this theoretical approach is constrained in its application. Specifically, the theoretical underpinnings, as originally constructed, places technology at the core of identification and explanation of culture as adaptation. Consequently, the roles of the individual and/or family choices in the process of sociocultural adaptation are subsumed under the rubric of group selection.

Voss and Young's theoretical construction of style and the self, which develops out of the school of Symbolic Interactionism, requires a more general application of ecological theory that considers individual behaviors as both creative and re-creative of sociocultural adaptations through the medium of material culture. Therefore, a more general ecological approach was taken with the research into style and exchange, recognizing the significance of both the individual/family, as well as sociocultural behaviors other than technology, which are considered active components in a more holistic theory of adaptation.

Application of the stylistic theory of "Style and the Self", as developed by Voss and Young, was undertaken using the small and widely distributed lithic component of LPI material culture and includes issues and methods of identifying significant attributes of style both in form and in lithic raw material, and establishes sound links between theory, method, and explanation. Therefore, this research revealed a further strength of this approach is its potential for revealing significant sociocultural behavioral patterns using small and non-normally distributed archaeological samples, as well as large and normally distributed samples.

Meltzer's approach to studying exchange systems employs certain broad characteristics that treat the issue of exchange vs. direct procurement of lithic raw material. Through application of this model this study revealed that there is insufficient evidence to support a hypothesis of a formal lithic-based exchange system operating between LPI groups of the upper Great Lakes region. Rather, direct procurement (and quarrying) of lithic raw materials is the suggested means of access to the raw materials used by these groups. This interpretation is further supported by the stylistic analysis, wherein lithic raw material is proposed to exhibit stylistic attributes of preferential selection. Still, both the occurrences and distributions of some lithic raw materials indicates a very limited form of exchange, perhaps down-the-line exchange (Renfrew 1977: 77) as an informal means of moving lithic raw material.

In summary, major contributions of this research are realized at both the theoretical and methodological levels. Further, by employing a combination of complementary theoretical constructs and tightly controlled methods, a very small dataset (N=105) was effectively utilized to reveal changing patterns of mobility and interaction over an extremely large region. This approach, then, potentially expands the uses of small and non-normally distributed samples to productive studies at a regional scale.

Future Research

This study suggests that future research should be undertaken along several lines of inquiry.

It has been proposed that >400 km mobility patterns were displayed among upper Great Lakes Late Paleoindians. Admittedly, as a terrestrial-based construct, this distance does appear rather large. Yet, previous upper Great Lakes Early Paleoindians are also proposed to have routinely expressed these same dimensions in their mobility patterns, i.e., 400 km (Shott 1986). The underlying question here is whether a terrestrial-based mobility model is appropriate to the conditions and geography of the LPI culture. Considering the ample water bodies present in the region throughout this period, it certainly would have been an advantage for Late Paleoindian populations to turn these water obstacles into highways. Given these known environmental conditions, it would seem that a reasonable potential exists for productive development and application of a combined terrestrial-marine model to issues of subsistence, settlement, and mobility for LPI groups of the upper Great Lakes region. Certainly, some marine-oriented approach needs to be considered in future research.

In the upper Great Lakes region, both the natural and archaeological records of the Early Holocene period are in need of directed and focused study. While preliminary research has been directed towards submerged archaeological resources of the Saginaw Bay area of Michigan (Lovis, Holman, Monaghan, and Skowronek 1994), a research strategy should be developed and employed for archaeologically sampling the area presently submerged beneath Lake Huron, between southern Ontario and the lower peninsula of Michigan. This research is important to further contributions in our understanding of proposed land-use patterns of the Early Holocene.

Focused study on the interaction between resident LPI groups and immigrating Early Archaic groups should be undertaken to better define the character and elements of this potentially significant phenomenon. The geographic areas of this further study may be most productive in the ecotonal and/or southern areas of the region.

Finally, a research strategy should be developed and employed within the eastern upper peninsula of Michigan and the eastern Superior regionto further test and rfefine our understandings of LPI settlement and subsistence systems.

Certainly, this initial research into the regional Late Paleoindian style expressions has yielded important insights into the structure of upper Great Lakes LPI adaptation. Continued testing and refinement of the explanatory devices employed, as well as marked expansion of the LPI database of the region, is necessary to further develop the body of scientific knowledge associated with these remarkable first peoples of the upper Great Lakes.

"Images in this dissertation are presented in color."

Figure 7.1 Map of Mobility Patterns 10,000 B.P. to 9,000 B.P.

Legend

••••• = Laurentide Ice Front
/ / / = Glacial Lakes
1 = Lake Agassiz - Emerson Phase (10,000 B.P.)
2 = Lakes Stanley & Chippewa Low Levels (9,000 B.P.)
3 = North Bay Outlet
4 = Glacial Lake Minong
5 = Lake Duluth
6 = Whitefish-Au Train Channels (9,900 B.P.)
S = Spruce Forest/Element
P = Pine Forest/Element
D = Deciduous Forest/Element
P = Prairie
T = Tundra
A = High Plains Mobility Pattern
B = Resident and Western
Plains Mobility Pattern

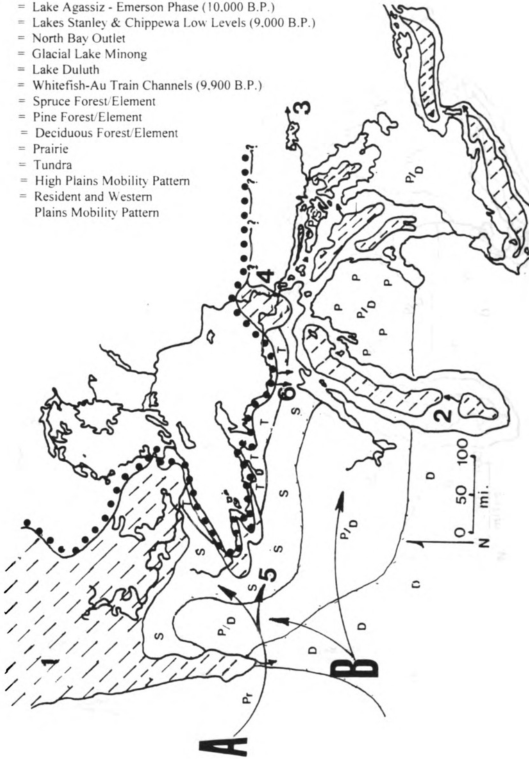
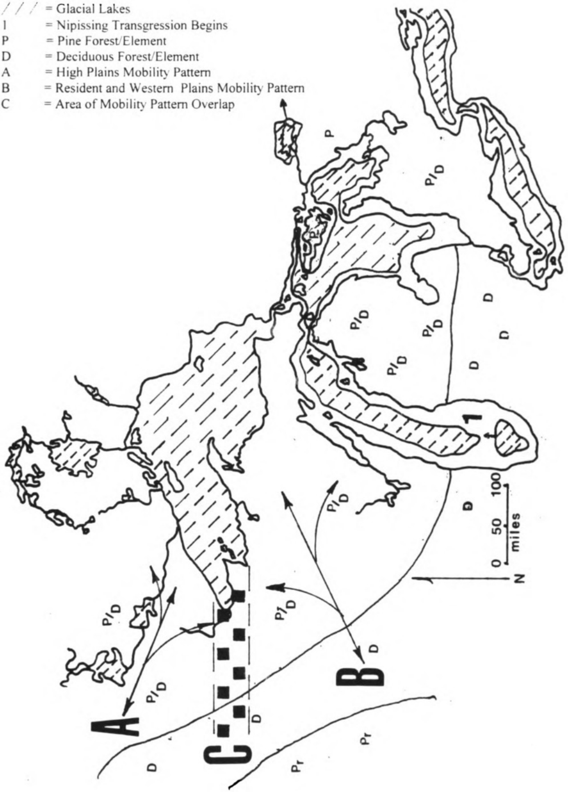


Figure 7.2 Map of Mobility Patterns 9,000 B.P. to 8,000 B.P.

<u>Legend</u>

/ / / = Glacial Lakes
1 = Nipissing Transgression Begins
P = Pine Forest/Element
D = Deciduous Forest/Element
A = High Plains Mobility Pattern
B = Resident and Western Plains Mobility Pattern
C = Area of Mobility Pattern Overlap



Appendix A

Appendix A, Table A.1
Base Data

Case #	Loc	Site	Spec.	Pt. Type	Raw Mat	Base Shp	Lat-E Shp	Flk Ptrn	Flk Ortn	Thck Nss	Ba Wdth	Haft Lth	Shldr W	Bet Shldr	Shldr A	Wdth Bs	Phot #	Bas CC	Bas CV	Wdth	Lngth
1	East	GL-1 1847	GL/3969A	A	1	1	2	1	86.88	7.94	25.98	20.49	29.81	24.58	90	0	1.A	0	0	30.6	0
2	East	GL-1 1076	GL/28289	A	1	1	2	1	90.84	6.31	22.67	23.93	22.25	19.27	75	0	1.B	0	0	22.58	0
3	East	GL-1 1932	GL/28573	C	1	3	3	4	93.5	6.58	26.98	16.05	0	0	0	0	1.C	1.92	0	30.56	0
4	East	SH-955.	SH/161.238	A	1	1	1	2	94.2	7.18	17.78	20.48	20.72	17.95	20	17.44	2.A	0	0	22.12	57.2
5	East	SH-955.	SH/161.201	B	1	1	3	1	90.4	6.63	15.63	23.31	0	0	0	0	2.B	0	0	19.71	59.84
6	East	SH-955.	SH/161.237	B	1	3	3	1	91	6.89	12.66	14.49	0	0	0	0	2.C	0.89	0	20.09	51.51
7,	East	SH-955.	SH/161.231	B	1	1	2	2	90.25	6.82	25.37	45	0	0	0	0	2.E	0	0	26.85	0
8	East	SH-955.	SH/161.226	B	1	3	3	2	96.86	7.78	18.84	50	0	0	0	0	2.F	2.31	0	26.12	0
9	Nrth	HKM-1980	HKM-1980-1	A	6	0	1	2	93.5	7.82	24.09	13.84	32.32	25.1	79.5	24.69	3.A	0	0	35.05	102.53
19	Nrth	HK-1477	HK-1477-1	A	14	0	3	1	89.18	8.12	15.34	43.39	29.52	26.25	22	16.11	3.B	0	0	31.42	88.85
11	Nrth	Rainey R	R/964.205.3	A	14	2	3	1	87.27	7.24	10.86	24.51	24.22	16.68	70	12.31	3.C	0	1.38	26.12	0
12	Nrth	Kenora	K/959.44.1	B	5	3	3	1	83.75	6.58	14.17	31.72	0	0	0	14.27	3D	2.52	0	23.82	83.87
13	Nrth	Rainey R	R/964.205.2	B	14	1	3	1	91.87	10.83	16.76	34.3	0	0	0	17.99	3.E	0	0	25.56	71.37
14	Nrth	Rainey R2	R/962.125.2	B	6	3	3	4	101.22	10.83	18.52	32.19	0	0	0	18.63	4.A	2.4	0	23.99	75.87
15	Nrth	Rainey R2	R/962.125.1	B	14	1	3	2	88.33	7.93	15.93	37.09	0	0	0	18.03	4.B	0	0	25.68	97.92
16	Nrth	Rainey R3	R/958.196.5	A	5	2	3	5	77.16	9.34	17.51	26.4	27.51	25.07	21.5	18.21	4.C	0	2.63	27.66	60.16
17	Nrth	Devlin Twp	DevlinTwp1	B	14	1	3	2	92.16	7.36	13.4	31.88	0	0	0	16.88	4.D	0	0	23.76	105.53
18	Nrth	Rainey R4	R4/964.206	B	14	2	3	5	95.57	10.78	15.2	33.74	0	0	0	12.72	4.E	0	4.53	31.3	102.29
19	Nrth	Rainey R5	R5967.242.8	B	14	2	3	1	91.12	7.91	7.67	36.2	0	0	0	9.46	4.F	0	2.36	24.17	63.85
20	Nrth	DcJi-1	Loc.2-4b	B	5	3	3	4	113.22	5.83	21.23	44.76	0	0	0	20.84	5.A	7.05	0	24.92	0
21	Nrth	DcJi-1	Loc.8-2	A	3	3	1	1	91.66	6.42	16.38	14.41	18.17	15.79	51.5	13.94	5.D	1.18	0	18.91	54.51
22	Nrth	DcJi-1	Lanceolate	B	3	3	3	4	84.08	8.21	21.01	23.4	0	0	0	22.21	5.E	4.43	0	26.65	62.99
23	Nrth	DcJi-1	Cummins C	B	3	3	2	1	81.14	9.09	21.77	14.8	0	0	0	20.7	5.F	3.75	0	26.1	44.33
24	Nrth	DcJi-1	Sur-83-5	C	3	0	1	4	115.28	8.22	0	19.78	0	0	0	0	5.G	0	0	27.94	0
25	Nrth	DaJn-7	Sur-.180	A	3	3	1	2	94.12	8.9	26.8	28.86	35.11	27	65	24.5	6.A	2.21	0	38.9	0

Case #	Loc	Site	Spec.	Pt. Type	Raw Mat	Base Shp	Lat-E Shp	Flk Ptrn	Flk Ortn	Thck Nss	Ba Wdth	Haft Lth	Shldr W	Bet Shldr	Shldr A	Wdth Bs	Phot #	Bas CC	Bas CV	Wdth	Lngth
26	Nrth	DaJn-7	Sur-.181	A	5	1	1	2	90.33	6	20.4	14.16	20.17	18.85	60	18.63	6.B	0	0	20.22	48.39
27	Nrth	DcJh-9	12N10E-2	C	3	2	1	4	102.5	7.11	17.84	20.4	27.51	22.07	89	18.14	7.A	0	2.65	29.29	0
28	Nrth	DcJh-9	32W45-III	C	3	2	1	1	76.66	7.3	10.28	16.66	21.24	16.85	90	13.16	7.B	0	2.32	23.94	0
29	Nrth	DcJh-9	14N10E-III	A	3	2	2	1	113.71	6.11	14.83	12.73	15.32	12.68	60	13.06	7.F	0	0.9	15.95	39.54
30	Nrth	DcJh-9	36N80W-V	B	15	1	3	1	95.54	6.71	16.56	33.62	0	0	0	17.93	7.G	0	0	25.73	95.82
31	Nrth	DcJh-9	20N21W-C	B	3	1	3	1	91.87	7.02	19.27	22.93	0	0	0	19.49	7.H	0	0	23.82	0
32	Nrth	DbJm-6	Sur-88-1	B	3	3	3	4	42	5.06	21.47	24.92	0	0	0	22.03	8.A	2.5	0	24.32	0
33	Nrth	DfJo-3	972.229.394	B	3	1	3	4	104.5	6.93	21.33	25.01	0	0	0	18.67	9.A	0	0	22.95	0
34	Nrth	DdJt-1	1a-72-10	B	6	1	3	4	120.78	8.45	16.88	48	0	0	0	17.56	9.B	0	0	21.65	98.02
35	Nrth	QP-72	QP-72.5	A	5	1	3	1	92.28	11.41	25.7	32.22	38.69	28.92	28	26.37	9.C	0	0	38.69	114.1
36	Nrth	Pine Point	Lac D'Mille	B	14	3	3	4	121.5	7.67	21.43	28.4	0	0	0	20.75	10.A	3.61	0	29.4	0
37	Nrth	DcJh-11	Loc.1-253	C	3	2	3	4	115.43	6.58	11.58	41.52	0	0	0	13.98	10.B	0	5.69	21.4	0
38	Nrth	DdJe-1	Cummins Pt.	B	14	3	3	1	99.14	5.74	20.3	22.74	0	0	0	19.52	10.E	2.23	0	23.63	62.3
39	Nrth	DdJe-1	VIII-F-27518	B	14	3	3	4	111.66	7	21	34	0	0	0	22.4	0	3	0	24	68
40	Nrth	DdJe-1	VIII-F-27509	B	3	3	3	4	121.8	7	26.24	35	0	0	0	27	0	2.68	0	28.7	0
41	Nrth	DdJe-1	Brohm Ps.lk	B	14	3	2	2	95.86	7	23	30	0	0	0	22.8	0	2	0	23	71
42	Nrth	DdJe-1	VIII-F-27528	B	14	3	3	2	91.14	7	22	32.24	0	0	0	24.66	0	1	0	25	0
43	Nrth	DdJf-4	DdJf-4-1	B	3	1	3	4	127.75	7.37	10.98	31.97	0	0	0	11.71	10.F	0	0	22.05	58.8
44	Nrth	DdJt-3	DdJt-3-81	B	10	1	3	4	112.2	6.9	12.58	34.4	0	0	0	13.35	10.G	0	0	25.02	65
45	Nrth	DdJf-1	DdJf-1-57	B	3	1	3	1	95.17	9.54	37.13	46.81	0	0	0	39.17	10.H	0	0	40.9	99.67
46	Nrth	DeJi-6	DeJi-6-1	B	5	1	3	1	93.11	11.94	20.98	42.44	0	0	0	23.58	11.A	0	0	28.21	112.92
47	Nrth	DeJj-6	DeJj-6-62	A	3	3	3	4	106	6.1	21.58	24.13	22.37	20.8	56.1	18.4	13.A	2.65	0	22.37	0
48	Nrth	DeJj-6	DeJj-6-4	B	3	2	1	2	98	5.55	24.72	31.76	0	0	0	24.88	13.B	0	2.28	26.1	0
49	West	Deer Lake	Deer Lk.-1	A	10	1	1	1	88	9.83	25.3	22.4	32.12	25.28	85	25.29	14.A	0	0	32.31	84.68
50	West	Witch Lake	Witch Lk.-1	B	16	3	3	2	86.5	7.6	15.72	30.04	0	0	0	17.45	15.A	3.27	0	27.26	62.82
51	West	20MQ40	20MQ40-1	A	10	3	2	1	88.86	9.21	26.19	22.36	26.16	22.67	57.1	21.34	16.C	1.43	0	26.19	0
52	West	20MQ69	20MQ69-1	C	10	3	3	1	85.33	6.81	28.85	13.49	31.62	0	0	0	16.B	5.75	0	31.62	0

Case #	Loc	Site	Spec.	Pt. Type	Raw Mat	Base Shp	Lat-E Shp	Flk Ptrn	Flk Ortn	Thck Nss	Ba Wdth	Haft Lth	Shldr W	Bet Shldr	Shldr A	Wdth Bs	Phot #	Bas CC	Bas CV	Wdth	Lngth
53	West	20MQ68	20MQ68-1	A	10	1	3	1	96.67	9.9	16.55	44.2	32.33	31.81	0	19.18	16.A	0	0	33.47	102.47
54	West	20MQ35	20MQ35-1	B	10	2	3	2	85.14	8	14.83	38	0	0	0	15.08	17.A	0	2.36	24.3	87.9
55	West	21372	21372-97.D	B	10	1	3	2	89.2	8.97	22.42	27.89	0	0	0	23.15	18.A	0	0	29.57	0
56	West	21372	21372-95.E	B	10	2	3	2	82.6	7.21	15.01	18.82	0	0	0	16.81	18.B	0	1.23	23.34	0
57	West	21372	21372-72.E	B	5	3	3	1	104	7.95	14.27	49.13	0	0	0	16.79	18.C	2.73	0	33.39	95.6
58	West	20MQ39	20MQ39-1	A	10	1	1	2	86.73	7.48	20.61	14.53	24.75	16.79	99	15.38	19.A	0	0	25.32	120.33
59	West	20MQ39	20MQ39-2	A	10	1	2	2	87.44	10.1	0	21.2	34.8	25.1	86	0	20.A	0	0	36.2	151.2
60	West	20MQ39	20MQ39-3	A	10	1	2	2	98.36	11.78	24.75	21.7	32.65	23.61	88	22.1	20.B	0	0	36.81	111.88
61	West	20MQ39	20MQ39-4	A	10	1	2	2	95.33	8.8	0	21.7	30.5	23.9	90	0	20.C	0	0	31.3	85.9
62	West	20MQ39	20MQ39-5	A	14	1	2	2	88.67	8.3	27.9	20.4	31.8	23.4	89	23.5	20.D	0	0	34.1	89.1
63	West	20MQ39	20MQ39-6	A	10	1	2	2	91.44	10.5	25.4	20	25.7	22.3	84	22.6	21.A	0	0	25.7	63.8
64	West	20MQ39	20MQ39-7	A	10	1	2	2	90.43	9.4	27.7	19	27.9	23.6	85	26.5	21.B	0	0	27.9	68
65	West	20MQ39	20MQ39-8	A	10	1	2	2	87.28	9	29.9	17	34.1	24.8	85	28.3	21.C	0	0	34.1	72.9
66	West	20MQ39	20MQ39-9	A	10	1	2	2	89.83	10.5	25.8	19.8	3.27	23.1	70	24.9	21.D	0	0	32.7	93.7
67	West	20MQ39	20MQ39-10	A	14	1	2	2	89.1	9.9	28.4	21.3	29.3	24.4	77	25.2	22.A	0	0	29.3	0
68	West	20MQ39	20MQ39-11	A	10	3	2	2	89.27	7.9	25.8	17.9	29	23.9	63.5	23.7	22.B	3.9	0	29	77.4
69	West	20MQ39	20MQ39-12	A	16	1	1	4	117.33	8.7	23.5	12.7	29.1	20	85	20	22.C	0	0	29.1	62.4
70	West	20MQ39	20MQ39-13	B	10	2	2	2	88	0	28.8	0	0	0	0	2.64	22.D	0	2.27	0	0
71	West	20MQ39	20MQ39-14	A	10	0	2	2	91.5	11.8	0	16.8	38.3	25.2	109	0	23.A	0	0	38.3	0
72	West	20MQ39	20MQ39-15	A	10	2	2	2	87.8	9.9	29.6	12.6	0	24.7	80	28.5	23.B	0	2.56	34.3	69.6
73	West	20MQ39	20MQ39-16	C	10	1	0	2	93	0	0	19	0	0	0	25.1	24.A	0	0	41.7	0
74	West	20MQ39	20MQ39-17	C	10	3	0	2	89.3	10.9	33	17.9	0	0	0	29.1	24.B	1.14	0	38.56	0
75	West	20MQ39	20MQ39-18	C	10	2	0	2	85.67	8.9	29.7	7.5	0	0	0	19.4	24.C	0	1.78	35	155.1
76	West	20MQ39	20MQ39-19	C	14	1	0	3	0	8.2	0	19	0	0	0	0	24.D	0	0	42.5	73.1
77	West	Renier-2830	R2830/5354	A	10	1	2	1	89.25	8.55	0	20.45	34.61	24.76	110	0	25.A	0	0	35.82	0
78	West	Renier-2830	R2830/5350	A	10	2	2	1	91.17	9.08	25.01	17.01	26.73	20.03	97	24.43	25.B	0	1.51	27.52	0
79	West	Renier-2830	R2830/5351	A	10	3	2	1	94.12	9.62	0	23.9	33.63	23.53	0	0	25.C	1.35	0	35.79	0

Case #	Loc	Site	Spec.	Pt. Typ e	Raw Mat	Base Shp	Lat-E Shp	Flk Ptrn	Flk Ortn	Thck Nss	Ba Wdth	Haft Lth	Shldr W	Bet Shldr	Shldr A	Wdth Bs	Phot #	Bas CC	Bas CV	Wdth	Lngth
80	West	Renier-2830	R2830/5357	C	14	1	0	3	89.33	8.28	34.07	16.78	0	0	0	0	25.D	0	0	42.8	0
81	West	Wisc.3551	W3551/451	B	10	2	3	1	91.95	8.46	19.7	47.29	0	0	0	21.79	26.A	0	2.32	37.57	140.1
82	West	Wisc-GrBa	WGB/267	A	10	2	1	1	91.5	9.59	22.14	22.84	28.24	22.05	53.5	21.93	27.A	0	2.95	30.15	88.53
83	West	Wisc.-1417	W1417/258	B	10	2	3	1	89.31	9.08	22.21	32.28	0	0	0	23.21	27.B	0	2.78	28.35	79.52
84	West	Wisc.-1417	W1417/258B	B	14	2	3	1	88.36	7.83	18.57	31.86	0	0	0	19.29	27.C	0	2.27	27.49	80.73
85	West	Wisc.-1930	W1930/222	B	14	1	3	2	85.33	7.29	11.37	35.7	0	0	0	14.65	27.D	0	0	25.71	65.72
86	Sth	Lake Cnty.	Woods-1	A	12	1	2	1	90.67	9.51	30.9	31.82	40.29	29.84	82	30.5	28.A	0	0	40.29	0
87	Sth	Samel's	Lanc.-1	B	14	3	3	1	95.82	4.92	13.6	21.42	0	0	0	15.92	29.A	2.98	0	16.64	47.26
88	Sth	Samel's	Lanc.-2	B	12	1	3	1	81.18	7.16	19.39	24.81	0	0	0	21.21	29.B	0	0	26.35	72.27
89	Sth	Samel's	Lanc.-3	B	11	1	3	1	89.73	7.58	14.52	34.96	0	0	0	16.86	29.C	0	0	24.83	72.37
90	Sth	Samel's	Lanc.-4	B	12	1	3	1	90.33	7.27	13.83	24.12	0	0	0	16.3	29.D	0	0	21.74	70.55
91	Sth	Samel's	Lanc.-5	B	12	1	3	1	89.62	8.39	11.79	33.05	0	0	0	13.49	29.E	0	0	21.98	91.19
92	Sth	Samel's	Lanc.-6	B	11	1	3	1	91	6.68	11.68	34.35	0	0	0	12.66	30.A	0	0	18.82	84.41
93	Sth	Samel's	Lanc.-7	B	12	1	3	2	108.71	7.26	14.03	21.03	0	0	0	15.91	30.B	0	0	17.98	74.82
94	Sth	Samel's	Lanc.-8	B	12	1	3	2	108.86	6.28	13.88	23.56	0	0	0	14.75	30.C	0	0	16.44	59.08
95	Sth	Samel's	Lanc.-9	B	11	1	3	1	95.37	4.88	13.04	26.77	0	0	0	13.98	30.D	0	0	18.58	58.89
96	Sth	Samel's	Lanc.-10	B	11	1	3	1	92	5.52	10.35	21.62	0	0	0	11.91	30.F	0	0	16.41	0
97	Sth	Samel's	Lanc.-11	B	11	1	3	1	98.25	7.87	14.75	25.34	0	0	0	16.26	31.A	0	0	22.16	51.21
98	Sth	Samel's	Lanc.-12	A	11	1	3	1	81.62	6.72	11.45	21.67	21.4	20.35	32.5	14.47	31.B	0	0	21.4	46.79
99	Sth	Samel's	Lanc.-13	B	12	2	3	2	104.4	5.01	19.08	22.65	0	0	0	20.5	31.C	0	1.03	21.17	44.05
100	Sth	Samel's	Lanc.-14	B	12	2	3	4	85.09	7.15	6.79	44.92	0	0	0	9.23	32.C	0	2.3	18.11	70.22
101	Sth	Samel's	Lanc.-15	B	11	1	3	1	89.86	6.21	12.33	28.96	0	0	0	14.56	33.A	0	0	21.96	0
102	Sth	Samel's	Lanc.-16	B	12	1	3	1	90.86	7.01	13.17	26.6	0	0	0	15.51	33.C	0	0	20.15	0
103	Sth	Samel's	Lanc.-17	B	12	1	3	1	87.5	6.82	15.61	36.71	0	0	0	17.86	33.D	0	0	21.48	0
104	Sth	Samel's	Lanc.-18	B	11	1	3	3	90.2	6.72	12.43	36.57	0	0	0	15.23	33.E	0	0	23.33	0
105	Sth	Samel's	Lanc.-19	B	12	1	3	2	80.71	6.83	17.71	30.93	0	0	0	18.33	33.F	0	0	22.23	0

Appendix A, Table A.2 - Site Data Summaries

Site Name/No.	**Total # of Artifacts***	**Total # Art. In This Study**	**1 = Excavated 2 =Surf/Other**	**Site Type**
George Lake 1	27	3	1	Quarry/Wshop
Sheguiandah	538	5	1	Quarry
HKM-1980	1	1	2	Unknown
HK-1477	1	1	2	Unknown
Rainey River	2	2	2	Unknown
Kenora	1	1	2	Unknown
Rainey R2	2	2	2	Unknown
Rainey 3	1	1	2	Unknown
Rainey 4	1	1	2	Unknown
Rainey 5	1	1	2	Unknown
Devlin Twp.	1	1	2	Unknown
DcJi-1 Cummins	905	5	1 & 2	Quarry/BCamp
DaJn-7 Narrows	2	2	2	Unknown
DcJh-9 Biloski	200	5	1 & 2	Quarry/BCamp
DbJm-6 Tower Rd.	1	1	2	Unknown
DfJo-3	1	1	2	Unknown
DdJt-1 Pines	1	1	1	Unknown
QP-72 Quetico Pk.	1	1	2	Unknown
Pine Point	1	1	2	Unknown
DcJh-11 Catherine	3	1	1	Unknown
DdJe-1 Brohm	82	5	1 & 2	Campsite
DdJf-4	1	1	2	Unknown
DdJt-3	1	1	2	Unknown
DdJf-1 MacKenzie	1	1	2	Unknown
DeJi-6 Boyd	1	1	2	Unknown

Site Name/No.	Total # of Artifacts*	Total # Art. In This Study	1 = Excavated 2 =Surf/Other	Site Type
Deer Lake	1	1	2	Campsite
Witch Lake	1	1	2	Unknown
20MQ40	1	1	2	Unknown
20MQ69	1	1	2	Unknown
20MQ68	1	1	2	Unknown
20MQ35	1	1	2	Unknown
21372 - Flambeau	N/A	3	1	Campsite
20MQ39 - Gorto	106	19	1 & 2	Camp/Burial
Renier - 2830	23	4	1	Burial
Wisc. - 3551	1	1	2	Unknown
Wisc. - GrBa	1	1	2	Unknown
Wisc. - 1417	2	2	2	Unknown
Wisc. - 1930	1	1	2	Unknown
Woods Site	1	1	2	Unknown
Samels	173	19	1 & 2	Base Camp

*Total # of Artifacts - Qty. does not include debitage.

Appendix B

APPENDIX B - STATISTICAL FIGURES

Figure B.5.1 Box and Whisker Plot: Flake Orientation, All: Type B

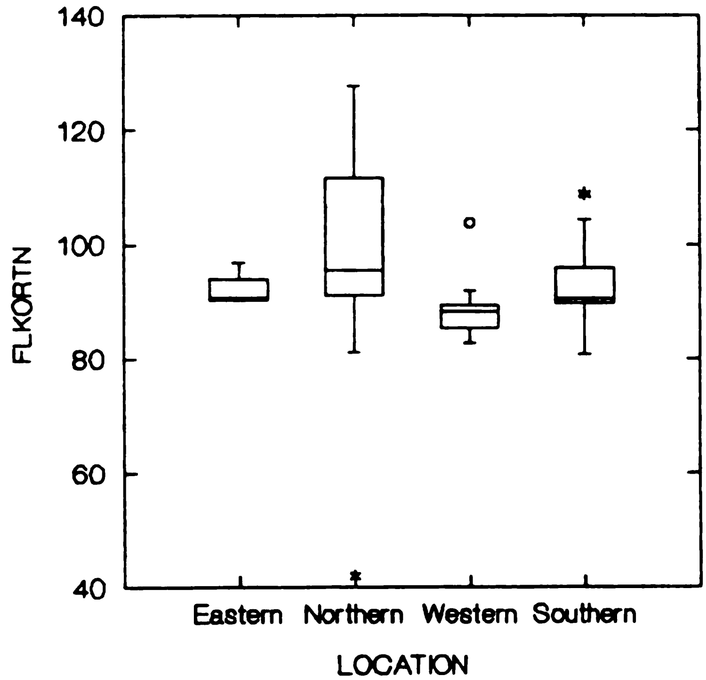


Figure B.5.1A Stem and Leaf Plot of Variable: Flake Orientation. N=26, Northern: Type B

Minimum is:	42.0	4	2	(outside values)
Lower Hinge is:	91.1	8	134	
Median is:	95.6	8	8	
Upper Hinge is:	111.7	9H	111123	
Maximum is	127.8	9M	555589	
		10	14	
		10		
		11H	123	
		11		
		12	011	
		12	7	

Figure B.5.1B Stem and Leaf Plot of Variable: Flake Orientation, N=10, Western: Type B

Minimum is:	82.6	8	2	
Lower Hinge is:	85.3	8H	55	
Median is:	88.2	8	6	
Upper Hinge is:	89.3	8H	8899	
Maximum is	104.0	9	1	(outside values)
		10	4	

Figure B.5.1C Stem and Leaf Plot of Variable: Flake Orientation, N=18, Southern: Type B

Minimum is:	80.7	8	01	
Lower Hinge is:	89.7	8H	57999	
Median is:	90.6	9M	00012	
Upper Hinge is:	95.8	9H	558	
Maximum is	108.9	10	4	(outside values)
		10	88	

Figure B.5.1D Histogram: Flake Orientation, Northern: Type B

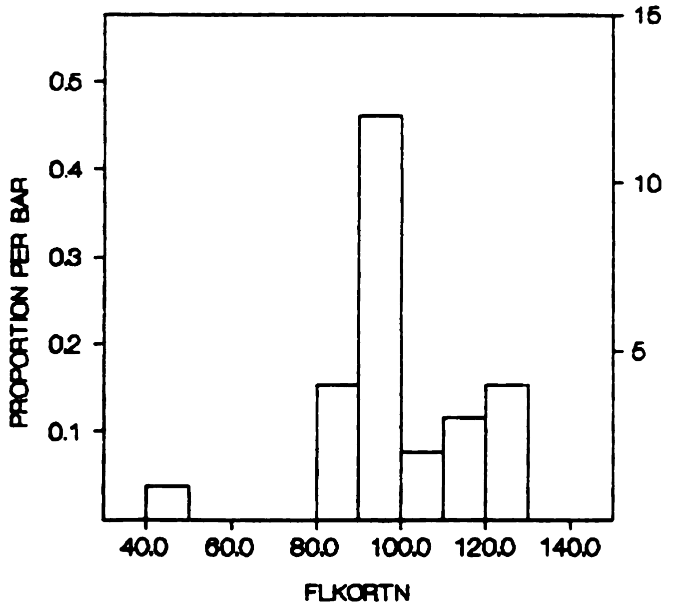


Figure B.5.1E Histogram: Flake Orientation, Western: Type B

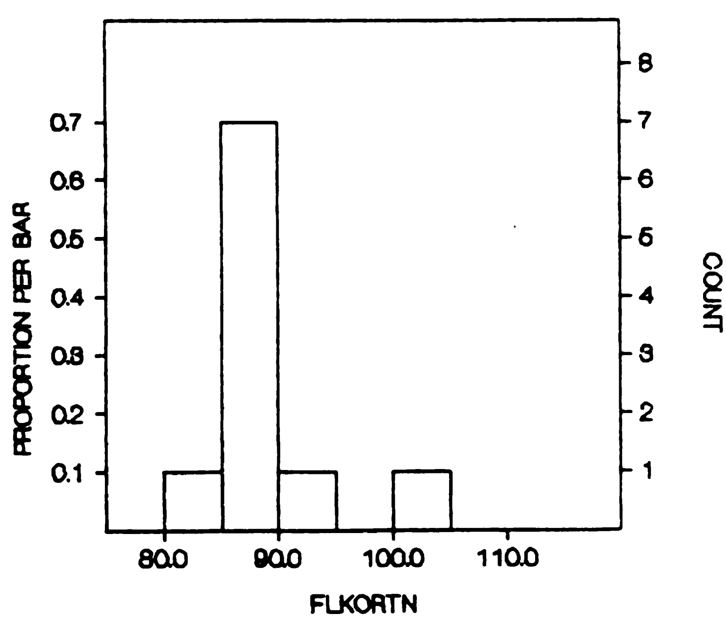


Figure B.5.1F Histogram: Flake Orientation. Southern: Type B

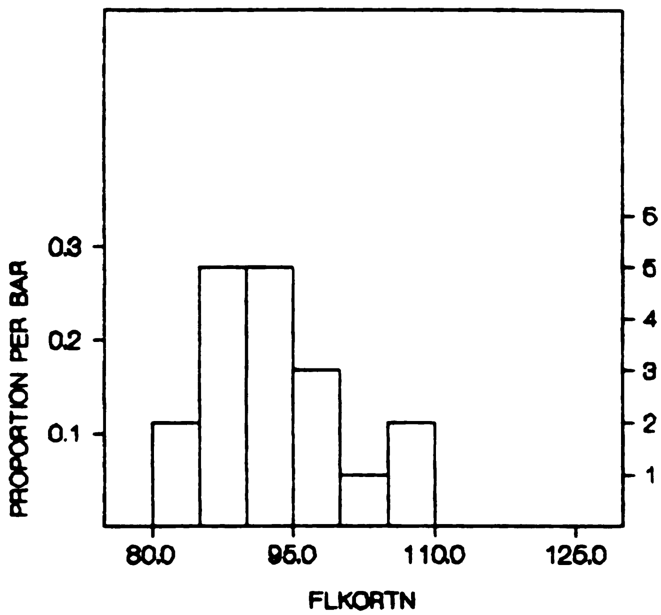


Figure B.5.1G Histogram: Flake Orientation, Eastern: Type B

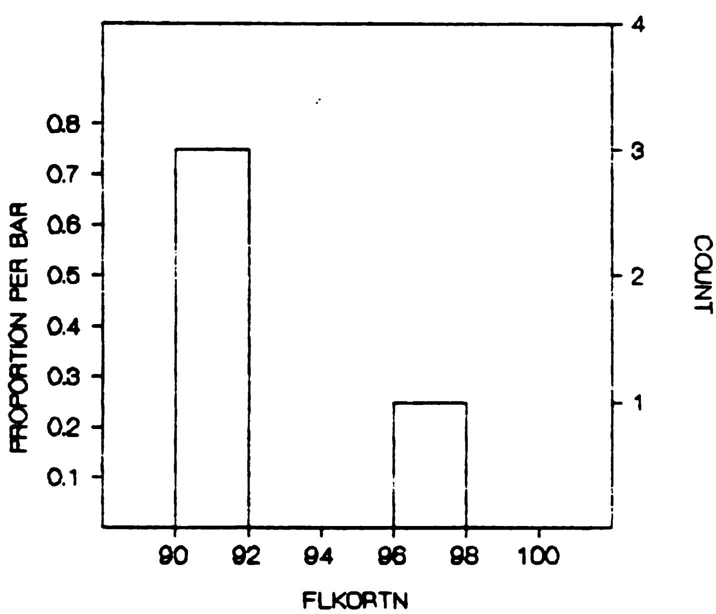


Figure B.5.2 Box and Whisker Plot: Thickness, All: Type B

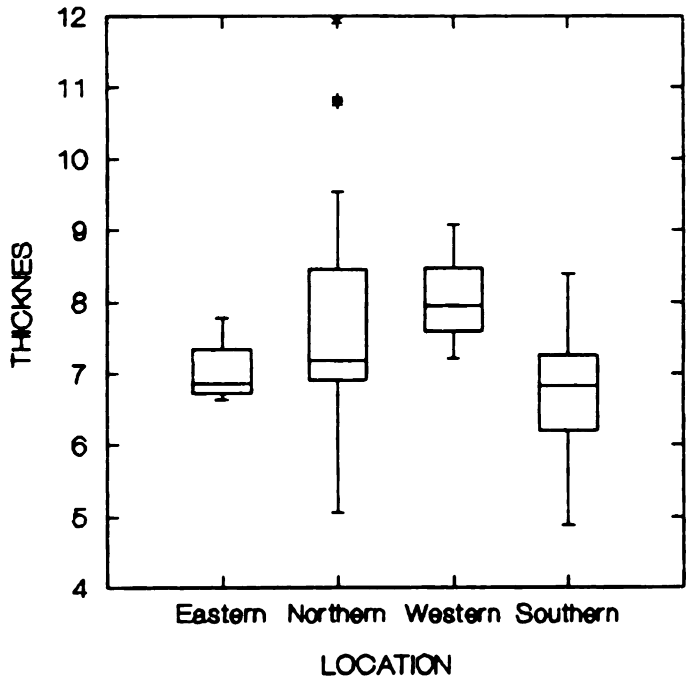


Figure B.5.2A Stem and Leaf Plot of Variable: Thickness, N=26, Northern: Type B

Minimum is:	5.1	5	0	
Lower Hinge is:	6.9	5	578	
Median is:	7.2	6		
Upper Hinge is:	8.5	6H	5799	
Maximum is	11.9	7M	0000033	
		7	699	
		8H	24	
		8		
		9	0	
		9	5	(outside values)
		10	788	
		11	9	

Figure B.5.2B Stem and Leaf Plot of Variable: Thickness, N=9, Western: Type B

Minimum is:	7.2	7	22
Lower Hinge is:	7.6	7M	689
Median is:	8.0	8H	04
Upper Hinge is:	8.5	8	9
Maximum is	9.1	9	0

Figure B.5.2C Stem and Leaf Plot of Variable: Thickness, N=18, Southern: Type B

Minimum is:	4.9	4	89
Lower Hinge is:	6.2	5	0
Median is:	6.8	5	5
Upper Hinge is:	7.3	6H	22
Maximum is	8.4	6M	6788
		7H	01122
		7	58
		8	3

Figure B.5.2D Histogram: Thickness, Northern: Type B

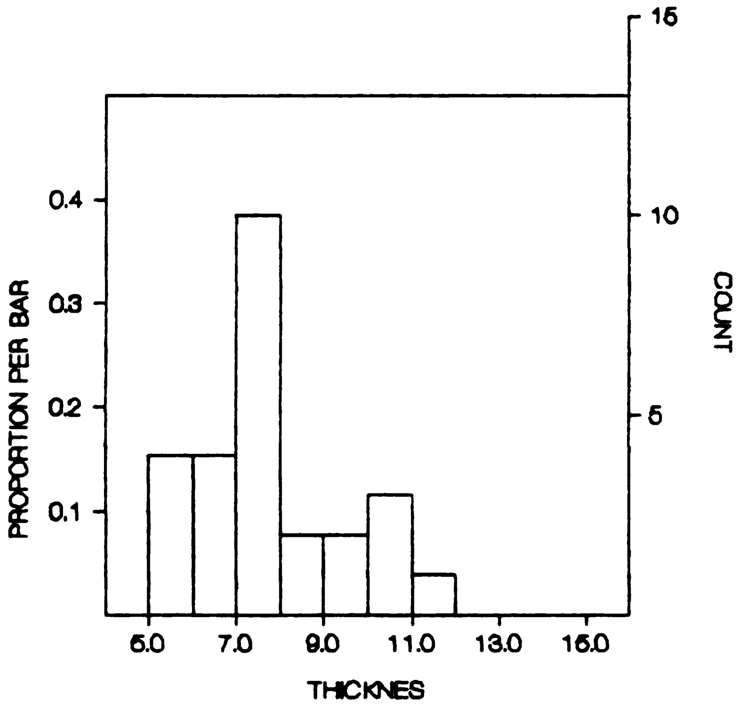


Figure B.5.2E Histogram: Thickness, Western: Type B

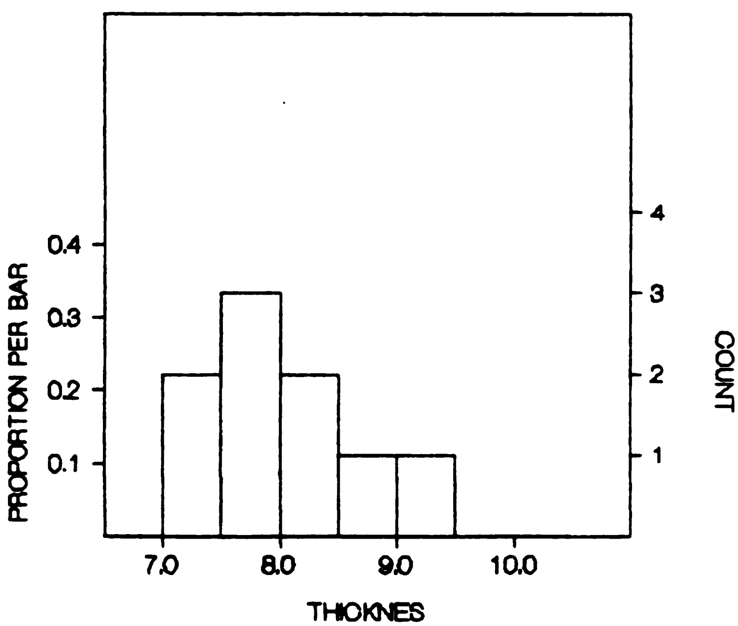


Figure B.5.2F Histogram: Thickness, Southern: Type B

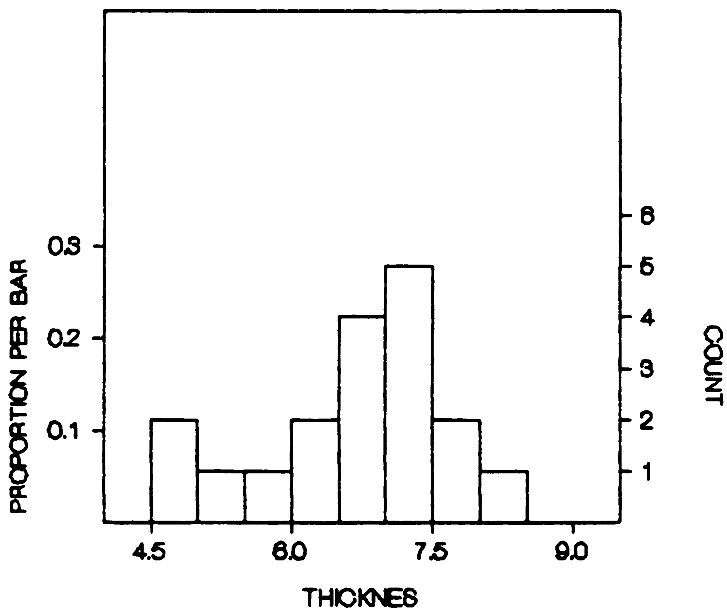


Figure B.5.3 Box and Whisker Plot: Base Width, All: Type B

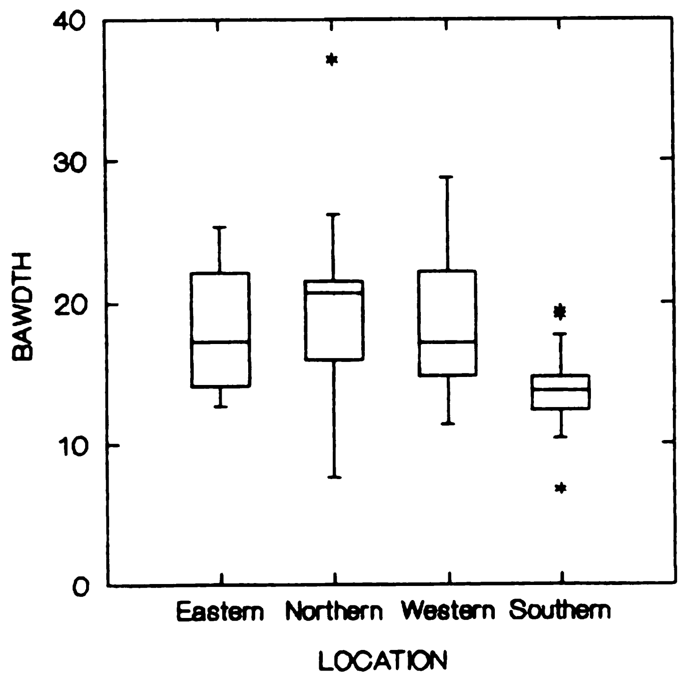


Figure B.5.3A Stem and Leaf Plot of Variable: Base Width. N=26. Northern: Type B

Minimum is:	8.0	0	7	
Lower Hinge is:	16.0	0		
Median is:	21.0	1	0	
Upper Hinge is:	21.0	1	23	
Maximum is	37.0	1H	455	
		1	666	
		1	89	
		2H	001111111	
		2	23	
		2	4	
		2	6	(outside values)
		3	7	

Figure B.5.3B Stem and Leaf Plot of Variable: Base Width, N=10, Western: Type B

Minimum is:	11.0	1	1
Lower Hinge is:	15.0	1	
Median is:	17.0	1H	4455
Upper Hinge is:	22.0	1M	
Maximum is	29.0	1	89
		2	
		2H	22
		2	
		2	
		2	8

Figure B.5.3C Stem and Leaf Plot of Variable: Base Width, N=18, Southern: Type B

Minimum is:	7.0	6	7	(outside values)
Lower Hinge is:	12.0	10	3	
Median is:	14.0	11	67	
Upper Hinge is:	15.0	12H	34	
Maximum is	19.0	13M	01688	
		14H	057	
		15	6	
		16		
		17	7	(outside values)
		19	03	

Figure B.5.3D Box and Whisker Plot: Base Width, All (Agate Basin): Type B

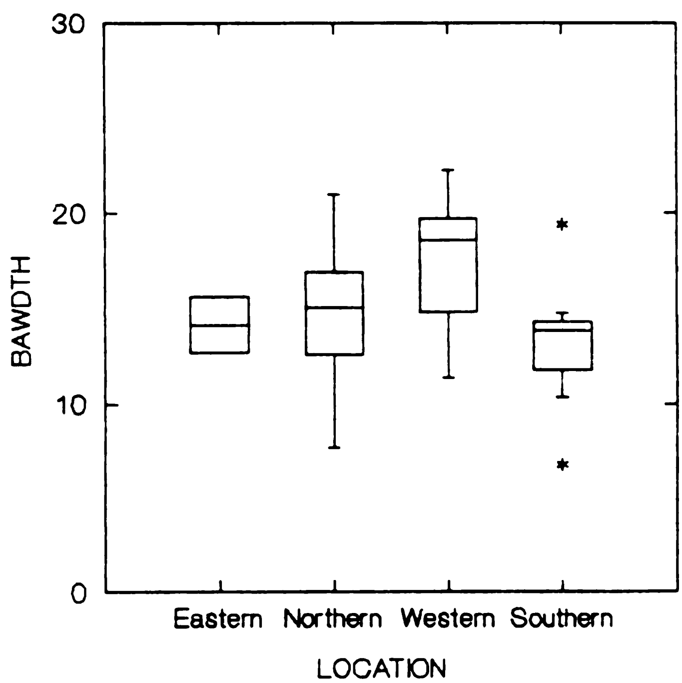


Figure B.5.3E Stem and Leaf Plot of Variable: Base Width, N=2, Eastern (Agate Basin): Type B

Minimum is:	13.0
Lower Hinge is:	13.0
Median is:	14.0
Upper Hinge is:	16.0
Maximum is	16.0

Note: No plot due to small sample.

Figure B.5.3F Stem and Leaf Plot of Variable: Base Width, N=10, Northern (Agate Basin): Type B

Minimum is:	8.0	0	7
Lower Hinge is:	13.0	0	
Median is:	15.0	1	0
Upper Hinge is:	17.0	1H	23
Maximum is	21.0	1M	45
		1H	66
		1	8
		2	0

Figure B.5.3G Stem and Leaf Plot of Variable: Base Width, N=5, Western (Agate Basin): Type B

Minimum is:	11.0	1	1
Lower Hinge is:	15.0	1	
Median is:	19.0	1H	4
Upper Hinge is:	20.0	1	
Maximum is	22.0	1H	89
		2	
		2	2

Figure B.5.3HStem and Leaf Plot of Variable: Base Width, N=11, Southern (Agate Basin): Type B

Minimum is:	7.0	6	7	(outside values)
Lower Hinge is:	12.0	10	3	
Median is:	14.0	11H	67	
Upper Hinge is:	14.0	12		
Maximum is	19.0	13M	088	
		14H	057	(outside values)
		19	3	

Figure B.5.3I Histogram: Base Width. Northern, : Type B

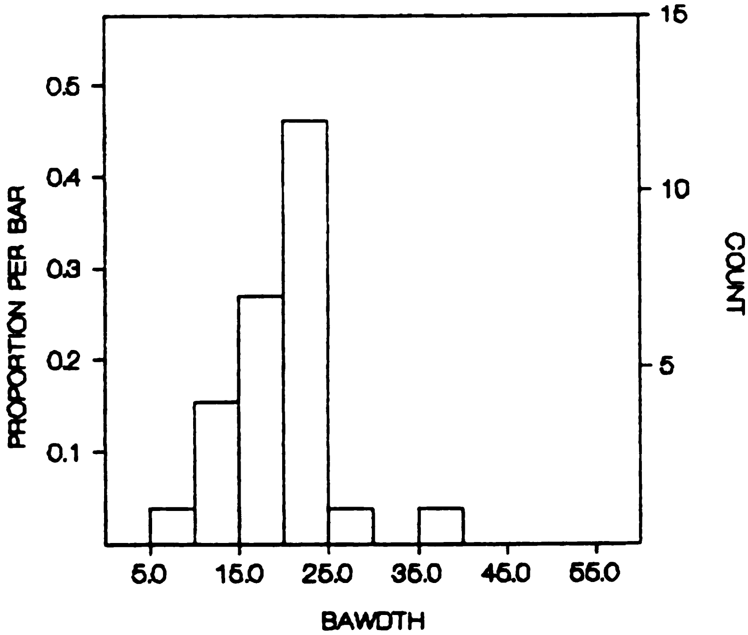


Figure B.5.3J Histogram: Base Width, Western: Type B

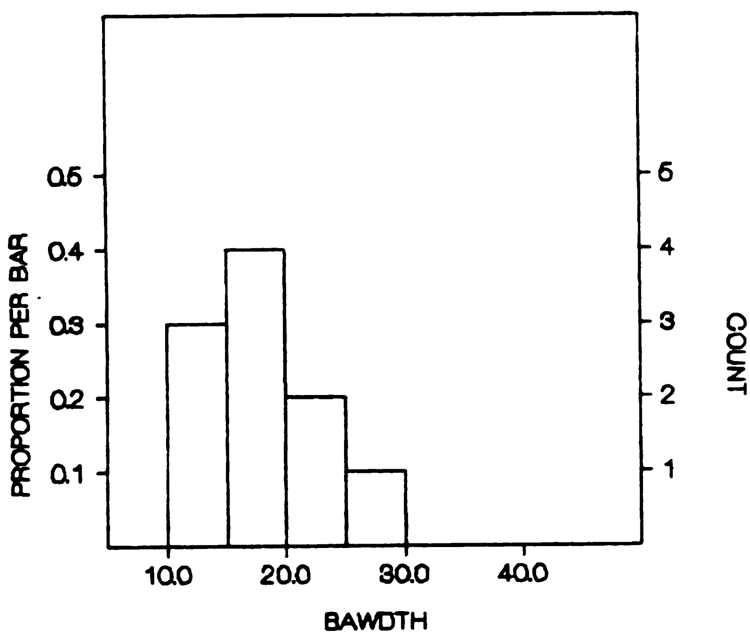


Figure B.5.3K Histogram: Base Width, Southern: Type B

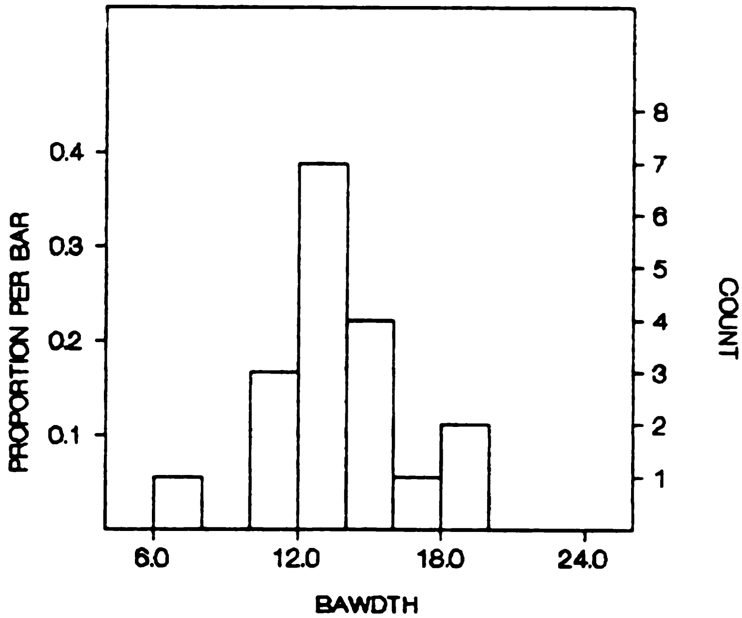


Figure B.5.3L Histogram: Base Width, Eastern, Type B

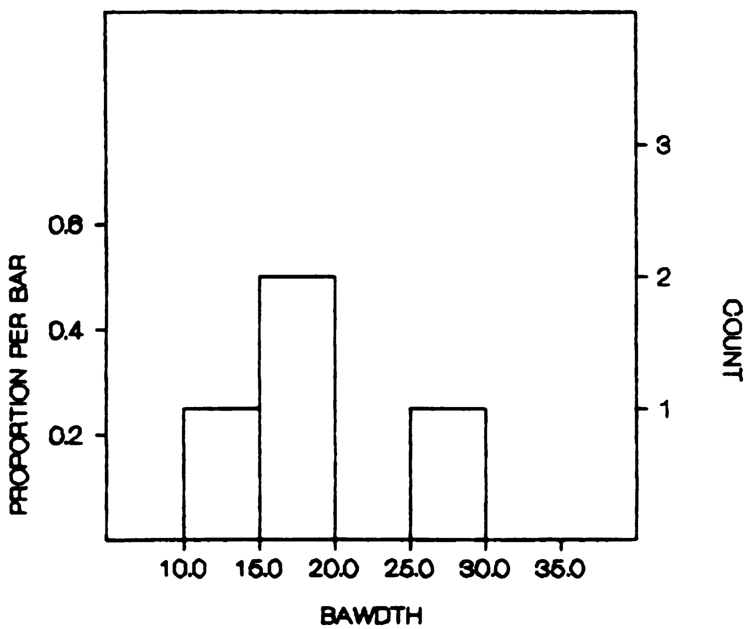


Figure B.5.4 Box and Whisker Plot: Haft Length, All: Type B

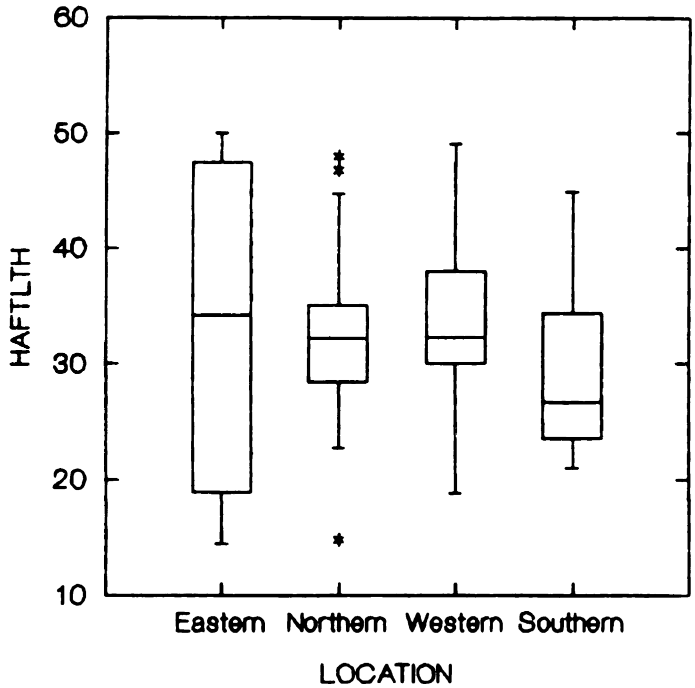


Figure B.5.4A Stem and Leaf Plot of Variable: Haft Length, N=26, Northern: Type B

Minimum is:	15.0	1	4	(outside values)
Lower Hinge is:	28.0	2	223	
Median is:	32.0	2	45	
Upper Hinge is:	35.0	2		
Maximum is	48.0	2H	8	
		3	01111	
		3M	2233	
		3H	4445	
		3	67	
		3		
		4		
		4	2	
		4	4	(outside values)
		4	68	

Figure B.5.4B Stem and Leaf Plot of Variable: Haft Length, N=9, Western: Type B

Minimum is:	19.0	1	8
Lower Hinge is:	30.0	2	
Median is:	32.0	2	7
Upper Hinge is:	38.0	3M	012
Maximum is	49.0	3H	58
		4	
		4	79

Figure B.5.4C Stem and Leaf Plot of Variable: Haft Length, N=18, Southern: Type B

Minimum is:	21.0	2H	1112344
Lower Hinge is:	24.0	2M	5668
Median is:	27.0	3H	0344
Upper Hinge is:	34.0	3	66
Maximum is	45.0	4	4

Figure B.5.4D Histogram: Haft Length, Northern, Type B

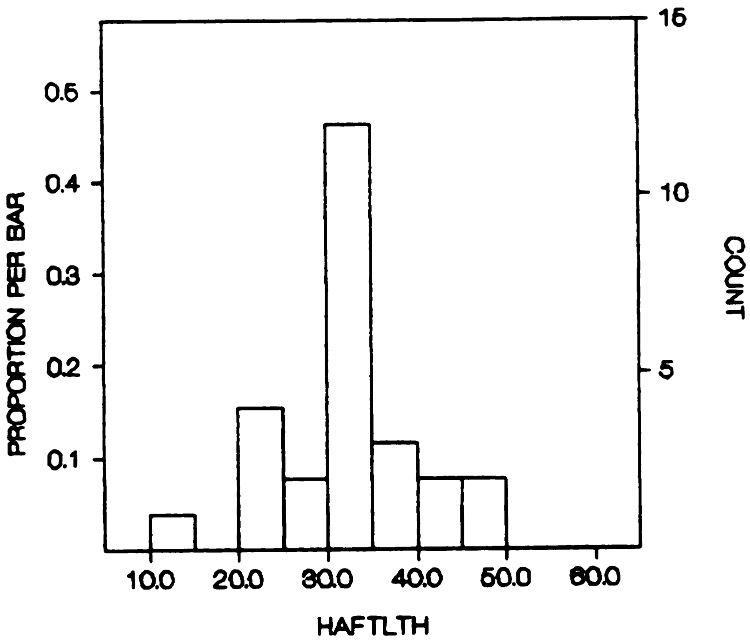


Figure B.5.4E Histogram: Haft Length, Western, Type B

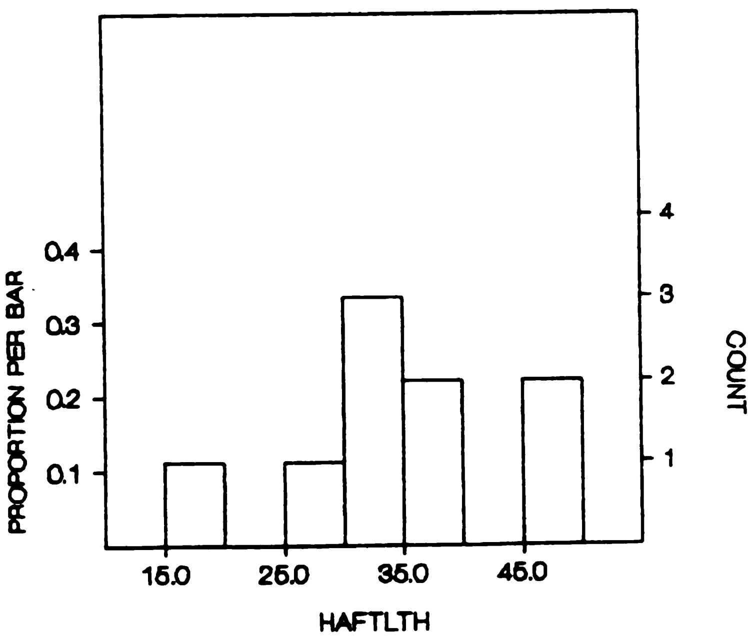


Figure B.5.4F Histogram: Haft Length, Southern, Type B

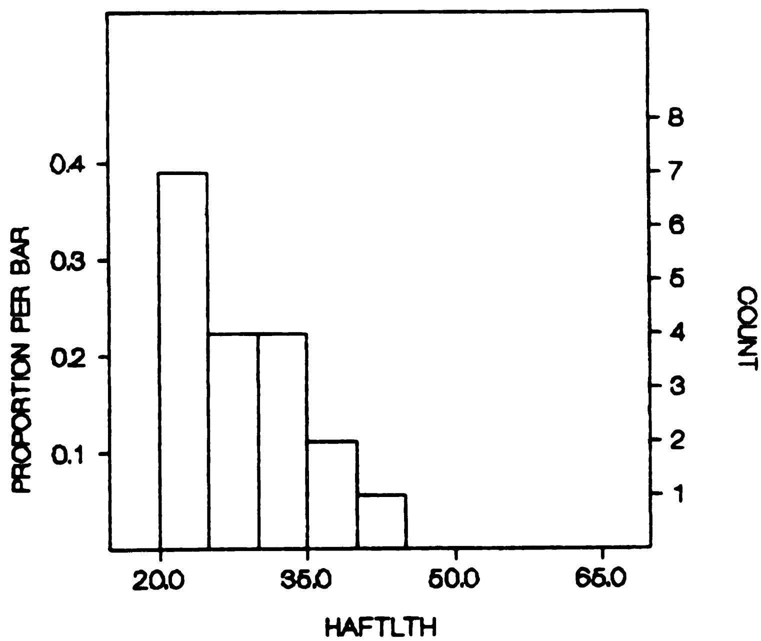


Figure B.5.4G Histogram: Haft Length, Eastern, Type B

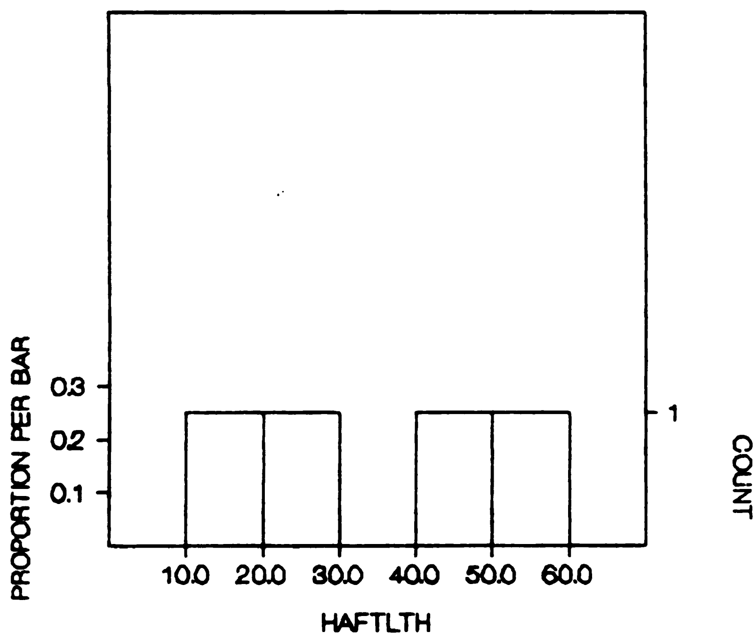


Figure B.5.5A Histogram: Lateral Edge Shape, Eastern, Type B

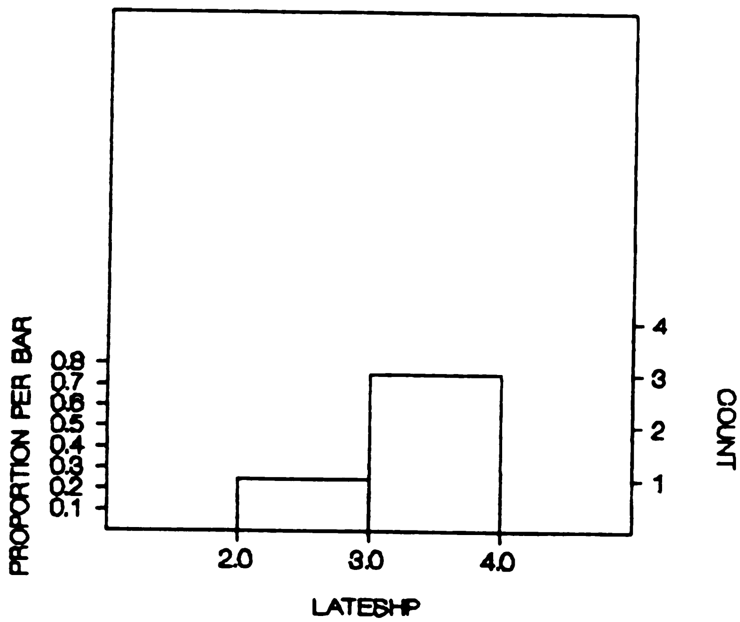


Figure B.5.5B Histogram: Lateral Edge Shape, Northern, Type B

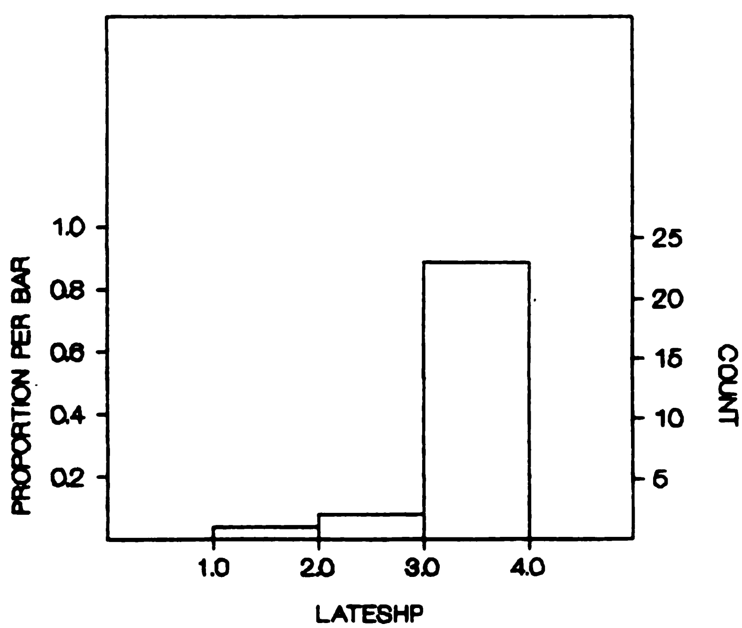


Figure B.5.5C Histogram: Lateral Edge Shape, Western. Type B

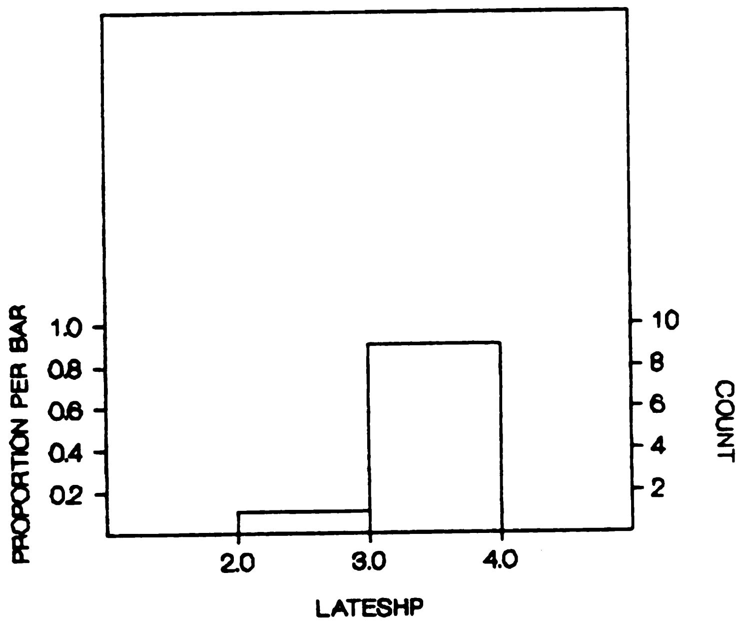


Figure B.5.6A Histogram: Base Shape, Eastern, Type B

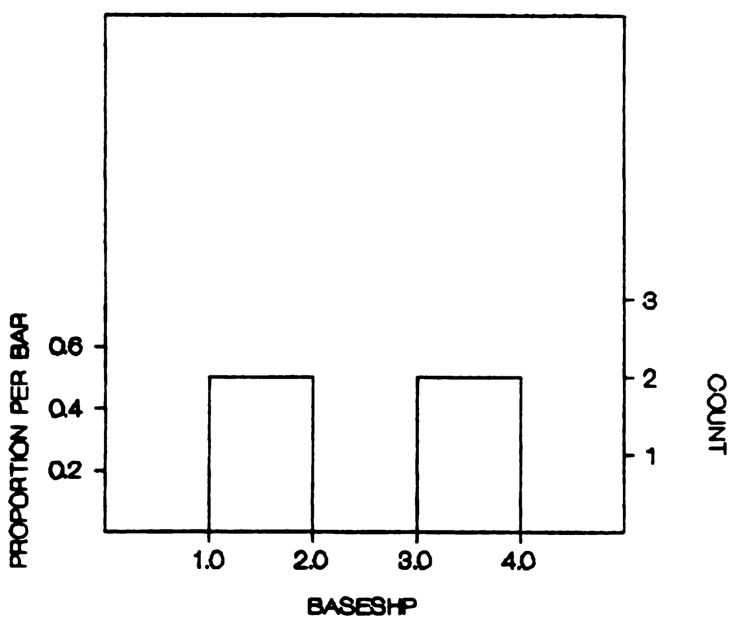


Figure B.5.6B Histogram: Base Shape, Northern, Type B

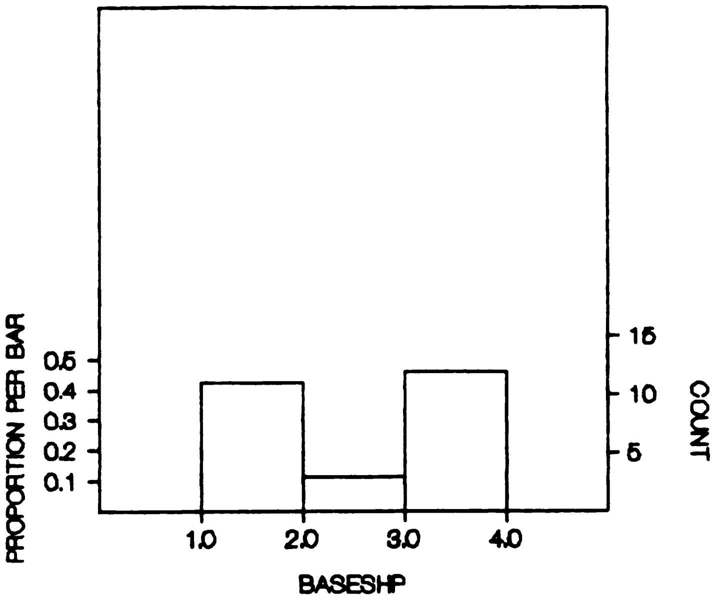


Figure B.5.6C Histogram: Base Shape, Western, Type B

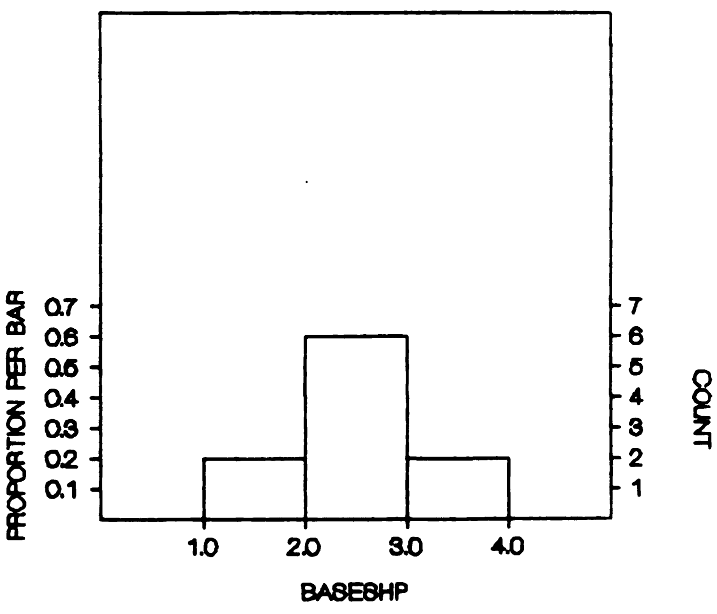


Figure B.5.6D Histogram: Base Shape, Southern, Type B

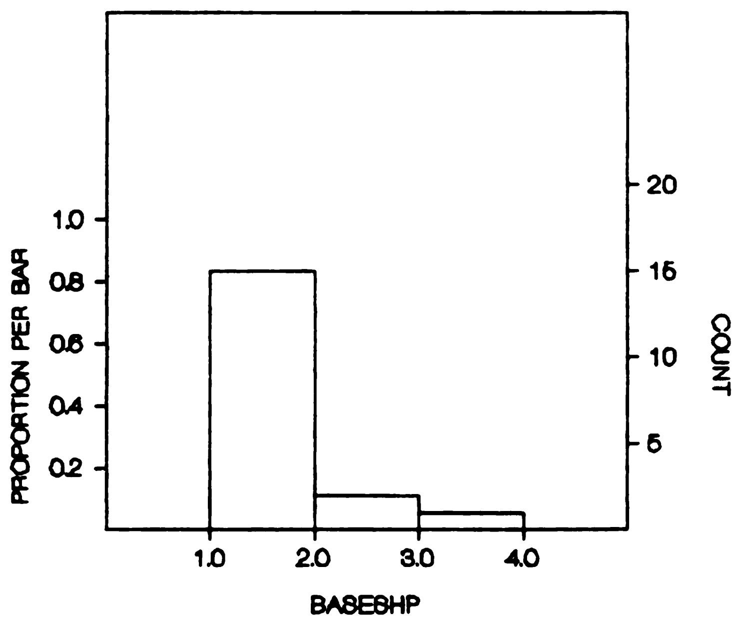


Figure B.5.7A Histogram: Raw Material, Northern, Type B

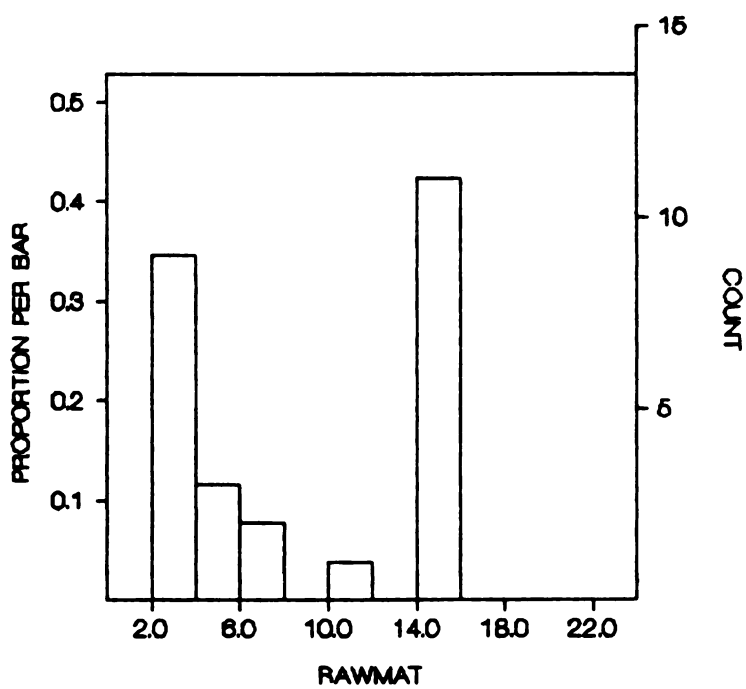


Figure B.5.7B Histogram: Raw Material, Western, Type B

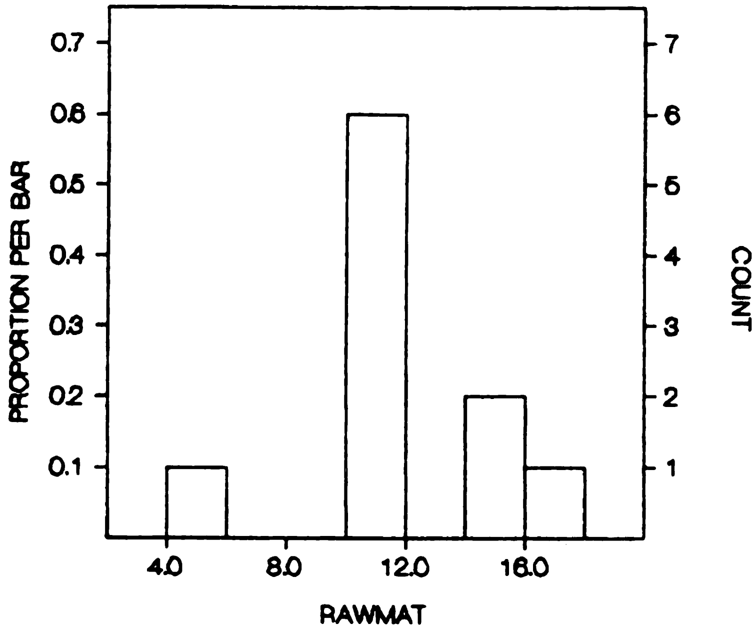


Figure B.5.7C Histogram: Raw Material, Southern, Type B

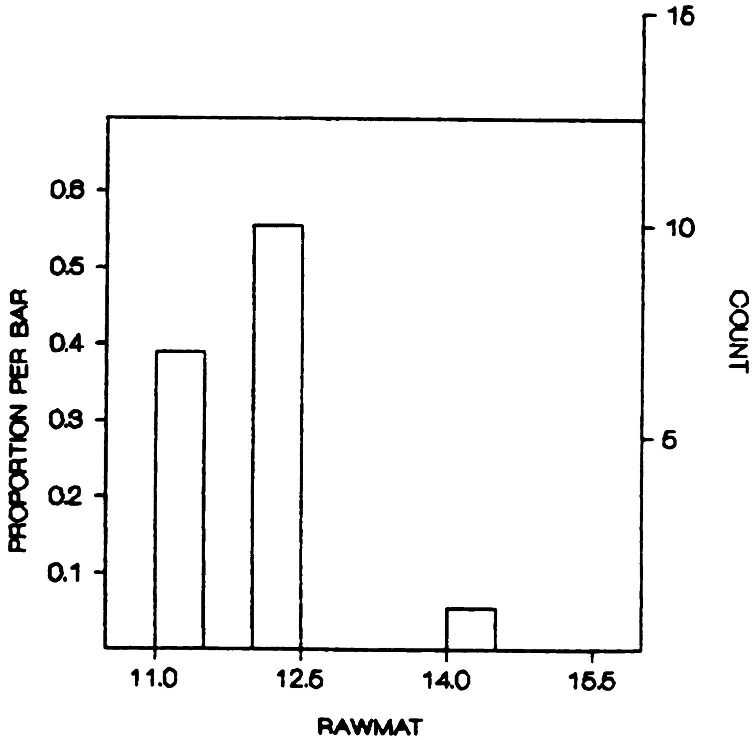


Figure B.5.8 Box and Whisker Plot: Width, All, Type B

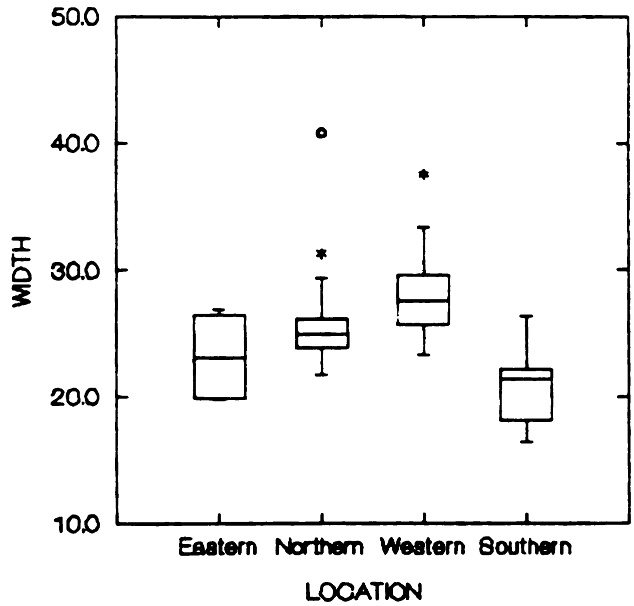


Figure B.5.8A Stem and Leaf Plot of Variable: Width, N=26, Northern: Type B

Minimum is:	21.7	21	6	
Lower Hinge is:	23.8	22	09	
Median is:	25.0	23H	067889	
Upper Hinge is:	26.1	24M	0139	
Maximum is	40.9	25	00587	
		26H	116	
		27		
		28	27	
		29	4	(outside values)
		31	3	
		40	9	

Figure B.5.8B Stem and Leaf Plot of Variable: Width, N=9, Western: Type B

Minimum is:	23.3	2	3	
Lower Hinge is:	25.7	2H	45	
Median is:	27.5	2M	77	
Upper Hinge is:	29.6	2H	89	
Maximum is	37.6	3		
		3	3	(outside values)
		3	7	

Figure B.5.8C Stem and Leaf Plot of Variable: Width, N=18, Southern: Type B

Minimum is:	16.4	16	446
Lower Hinge is:	18.1	17	9
Median is:	21.3	18H	158
Upper Hinge is:	22.2	19	
Maximum is	26.4	20	1
		21M	14799
		22H	12
		23	3
		24	8
		25	
		26	3

Figure B.5.8D Histogram: Width, Northern, Type B

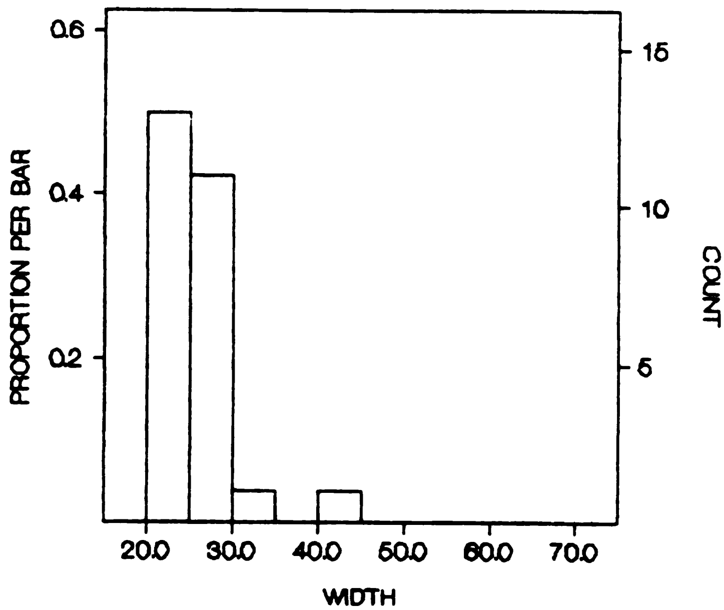


Figure B.5.8E Histogram: Width, Western, Type B

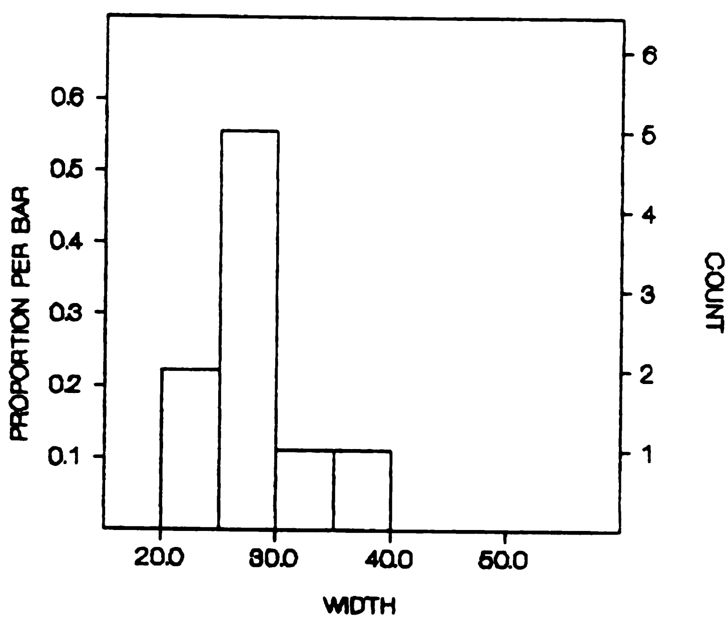


Figure B.5.8F Histogram: Width, Southern, Type B

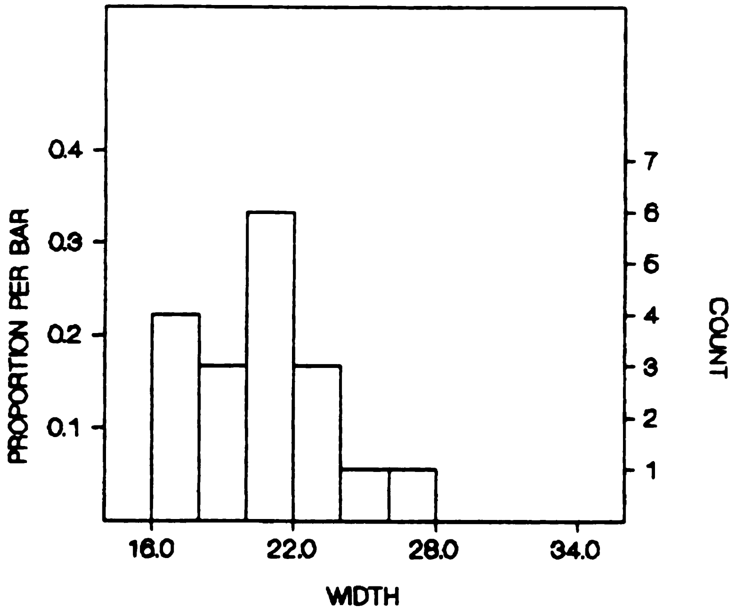


Figure B.5.8G Histogram: Width, Eastern, Type B

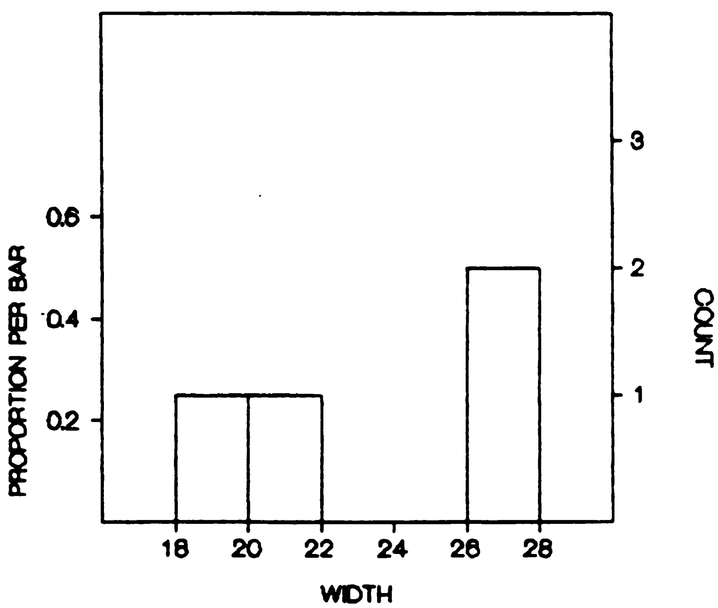


Figure B.5.9 Box and Whisker Plot: Flake Orientation, All: Type A

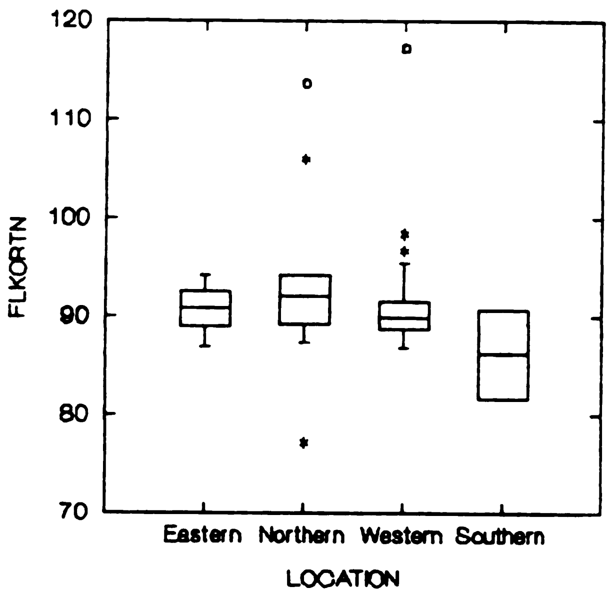


Figure B.5.9A Stem and Leaf Plot of Variable: Flake Orientation, N=10, Northern: Type A

Minimum is:	77.2	77	1	(outside values)
Lower Hinge is:	89.2	87	2	
Median is:	92.0	88		
Upper Hinge is:	94.1	89H	1	
Maximum is	113.7	90	3	
		91M	6	
		92	2	
		93	5	
		94H	1	(outside values)
		106	0	
		113	7	

Figure B.5.9B Stem and Leaf Plot of Variable: Flake Orientation, N=21, Western: Type A

Minimum is:	86.7	86	7	
Lower Hinge is:	88.7	87	248	
Median is:	89.8	88H	068	
Upper Hinge is:	91.5	89M	1228	
Maximum is	117.3	90	4	
		91H	1455	
		92		
		93		
		94	1	
		95	3	(outside values)
		96	6	
		98	3	
		117	3	

Figure B.5.9C Histogram: Flake Orientation, Northern: Type A

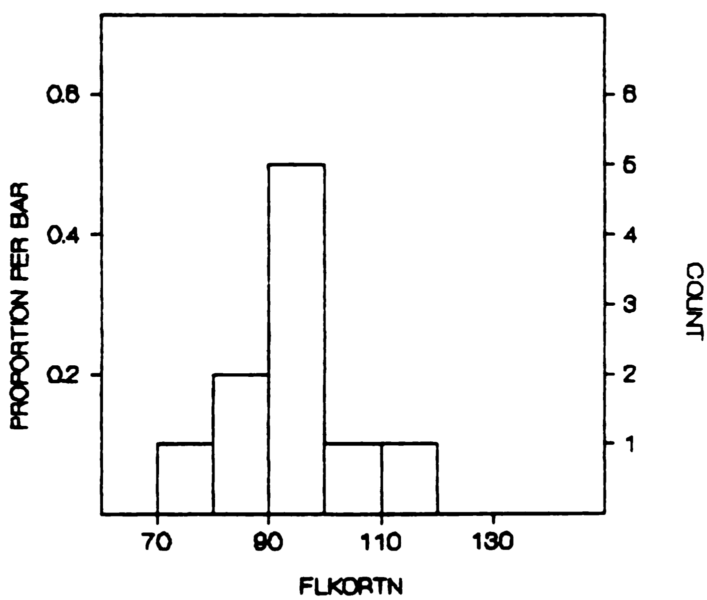


Figure B.5.9D Histogram: Flake Orientation, Western: Type A

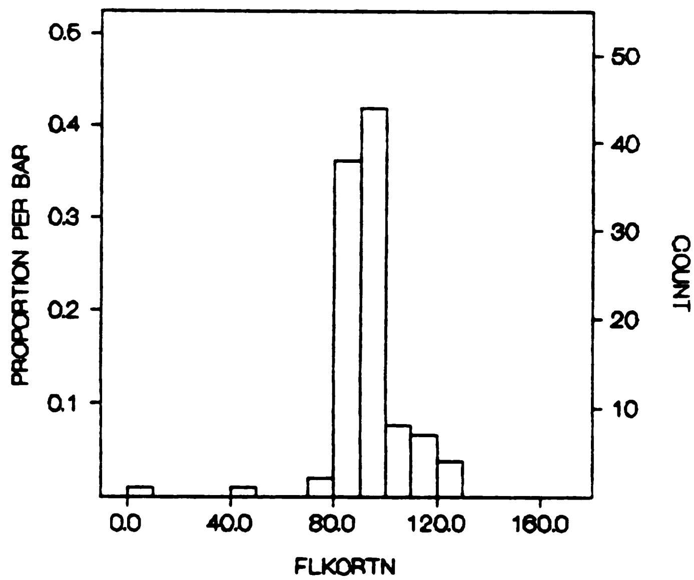


Figure B.5.10 Box and Whisker Plot: Thickness, All: Type A

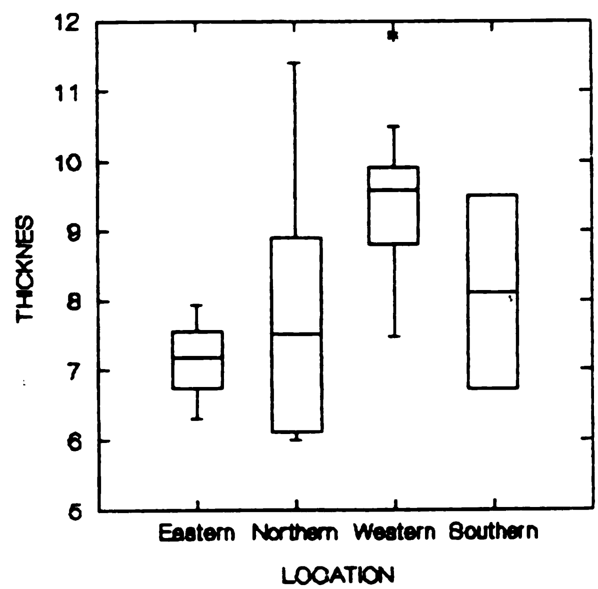


Figure B.5.10A Stem and Leaf Plot of Variable: Thickness, N=10, Northern: Type A

Minimum is:	6.0	6H	0114
Lower Hinge is:	6.1	7M	28
Median is:	7.5	8H	19
Upper Hinge is:	8.9	9	3
Maximum is	11.4	10	
		11	4

Figure B.5.10B Stem and Leaf Plot of Variable: Thickness, N=21, Western: Type A

Minimum is:	7.5	7	4	
Lower Hinge is:	8.8	7	9	
Median is:	9.6	8	3	
Upper Hinge is:	9.9	8H	578	
Maximum is	11.8	9	0024	
		9H	588999	
		10	1	
		10	55	(outside values)
		11	78	

Figure B.5.10C Histogram: Thickness, Northern: Type A

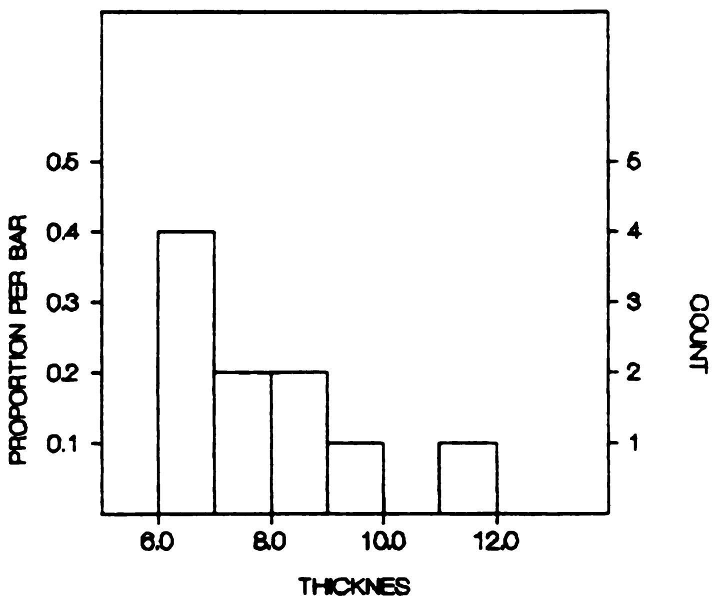


Figure B.5.10D Histogram: Thickness, Western: Type A

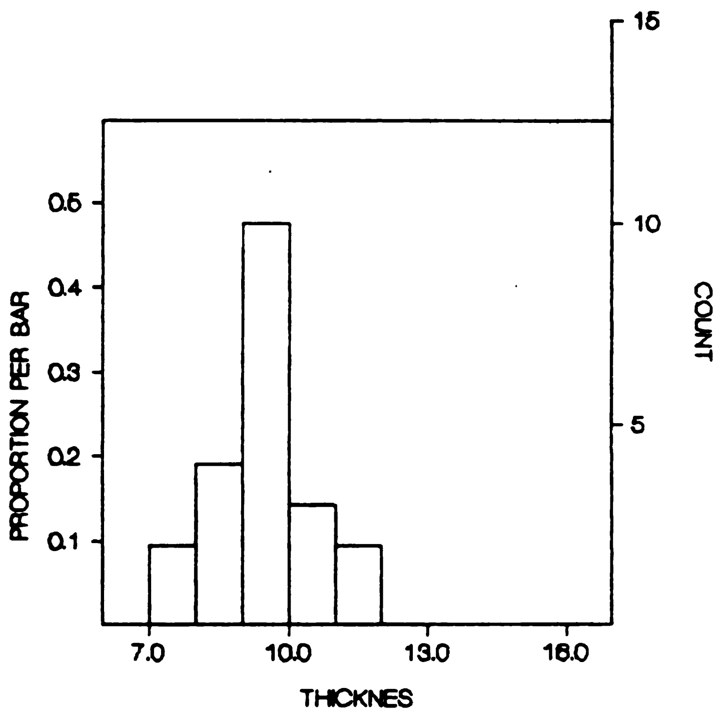


Figure B.5.11 Box and Whisker Plot: Base Width, All: Type A

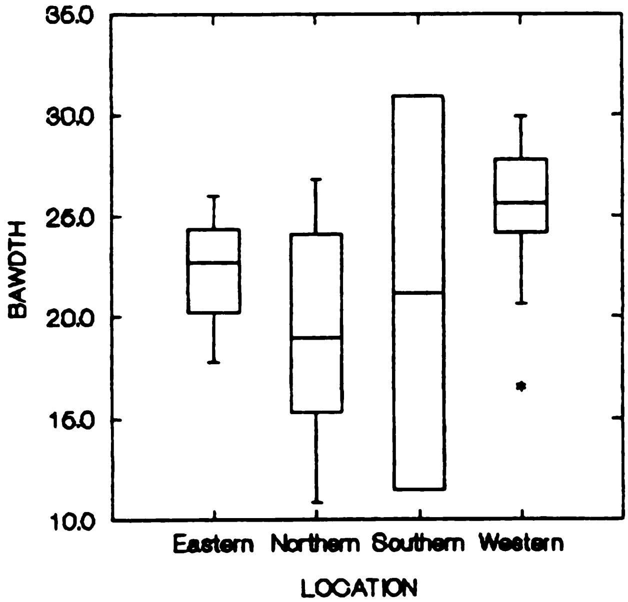


Figure B.5.11A Stem and Leaf Plot of Variable: Base Width, N=10, Northern: Type A

Minimum is:	10.9	1	0
Lower Hinge is:	15.3	1	
Median is:	19.0	1H	45
Upper Hinge is:	24.1	1	67
Maximum is	26.8	1M	
		2	01
		2	
		2H	45
		2	6

Figure B.5.11B Stem and Leaf Plot of Variable: Base Width, N=16, Western: Type A

Minimum is:	16.6	16	5	(outside values)
Lower Hinge is:	24.1	20	6	
Median is:	25.6	21		
Upper Hinge is:	27.8	22	1	
Maximum is	29.9	23	5	
		24H	7	
		25M	03488	
		26	1	
		27H	79	
		28	4	
		29	69	

Figure B.5.11C Histogram: Base Width, Northern: Type A

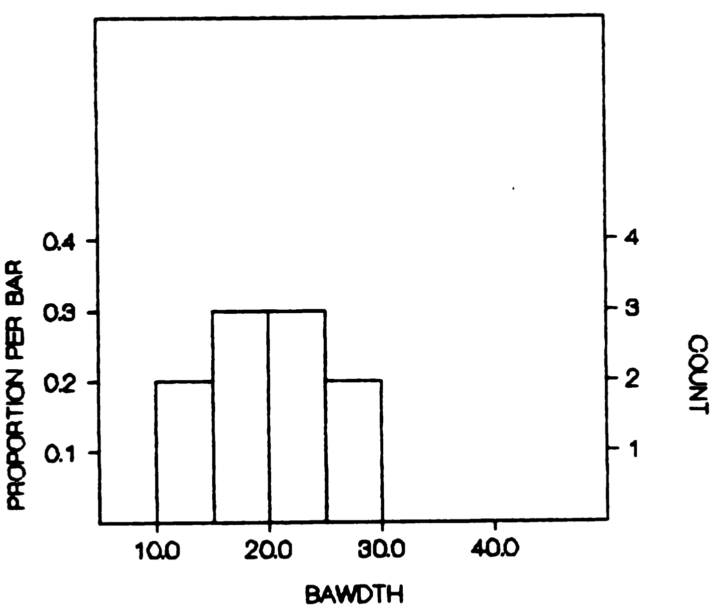


Figure B.5.11D Histogram: Base Width, Western: Type A

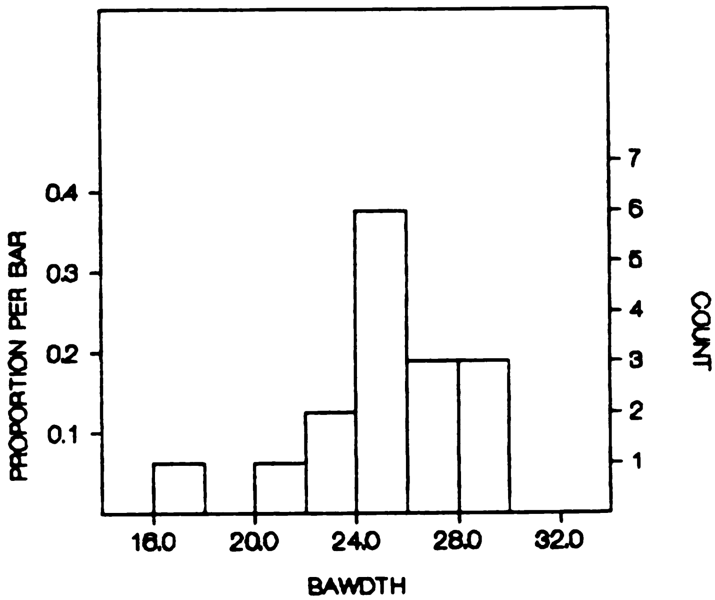


Figure B.5.12 Box and Whisker Plot: Haft Length, All: Type A

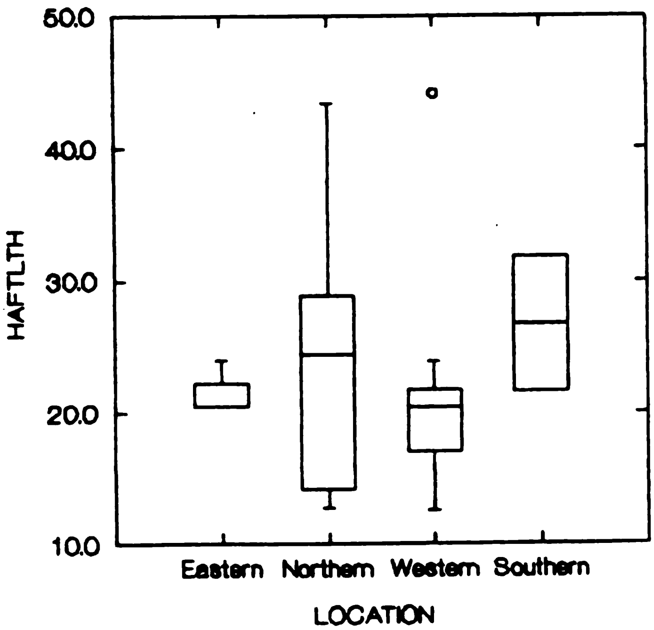


Figure B.5.12A Stem and Leaf Plot of Variable: Haft Length, N=10, Northern: Type A

Minimum is:	12.7	1H	2344
Lower Hinge is:	14.2	1	
Median is:	24.3	2M	44
Upper Hinge is:	28.9	2H	68
Maximum is	43.4	3	2
		3	
		4	3

Figure B.5.12B Stem and Leaf Plot of Variable: Haft Length, N=21, Western: Type A

Minimum is:	12.6	12	67	
Lower Hinge is:	17.0	13		
Median is:	20.4	14	5	
Upper Hinge is:	21.7	15		
Maximum is	44.2	16	8	
		17H	009	
		18		
		19	08	
		20M	044	
		21H	2377	
		22	348	
		23	9	(outside values)
		44	2	

Figure B.5.12C Histogram: Haft Length, Northern: Type A

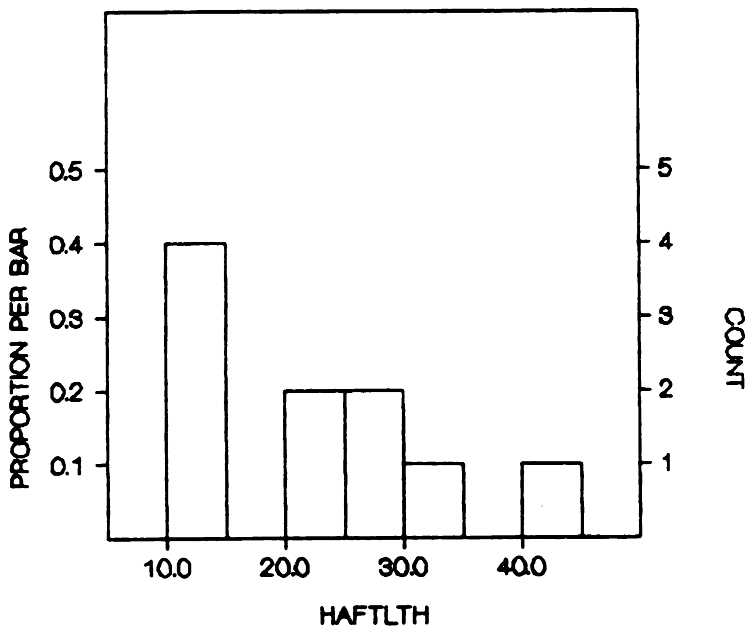


Figure B.5.12D Histogram: Haft Length, Western: Type A

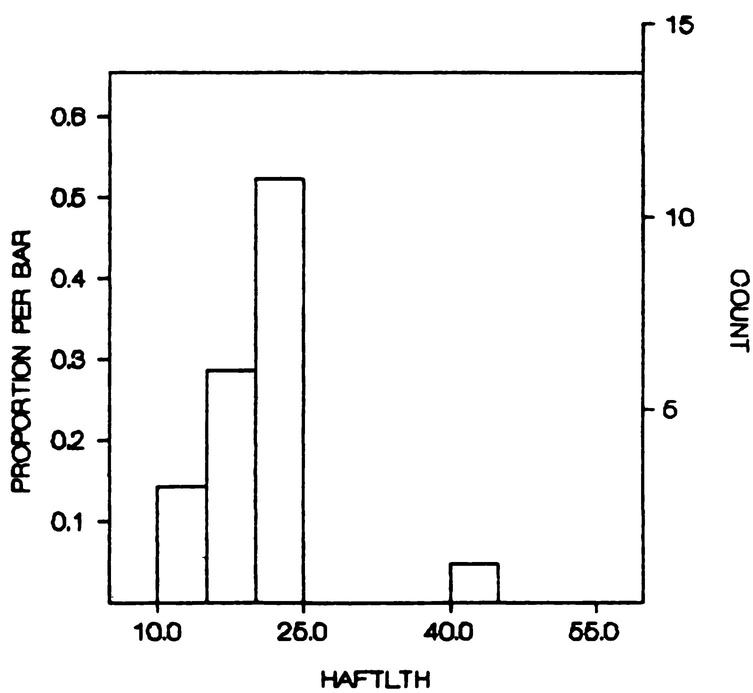


Figure B.5.13 Box and Whisker Plot: Shoulder Width, All: Type A

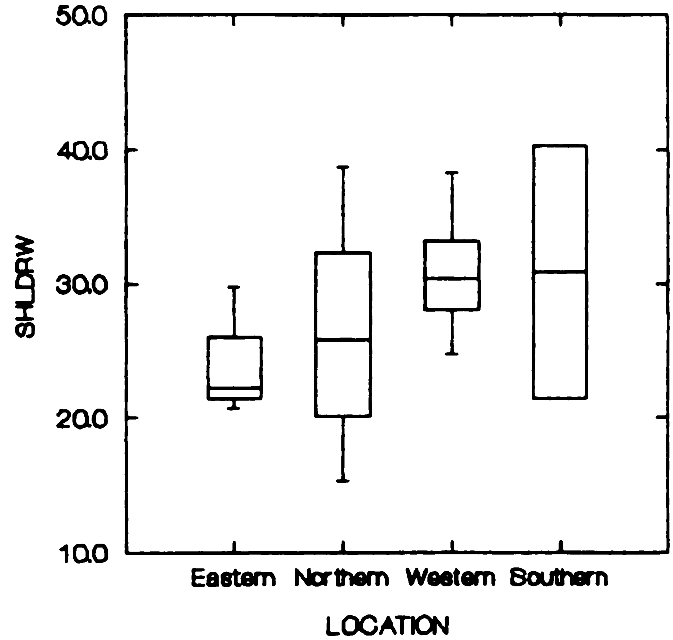


Figure B.5.13A Stem and Leaf Plot of Variable: Shoulder Width, N=10, Northern: Type A

Minimum is:	15.3	1	58
Lower Hinge is:	20.2	2H	024
Median is:	25.9	2M	79
Upper Hinge is:	32.3	3H	2
Maximum is	38.7	3	58

Figure B.5.13B Stem and Leaf Plot of Variable: Shoulder Width, N=20, Western: Type A

Minimum is:	24.8	2	45
Lower Hinge is:	28.1	2	667
Median is:	30.4	2H	8999
Upper Hinge is:	33.1	3M	001
Maximum is:	38.3	3H	2223
		3	444
		3	
		3	8

Figure B.5.13C Histogram: Shoulder Width, Northern: Type A

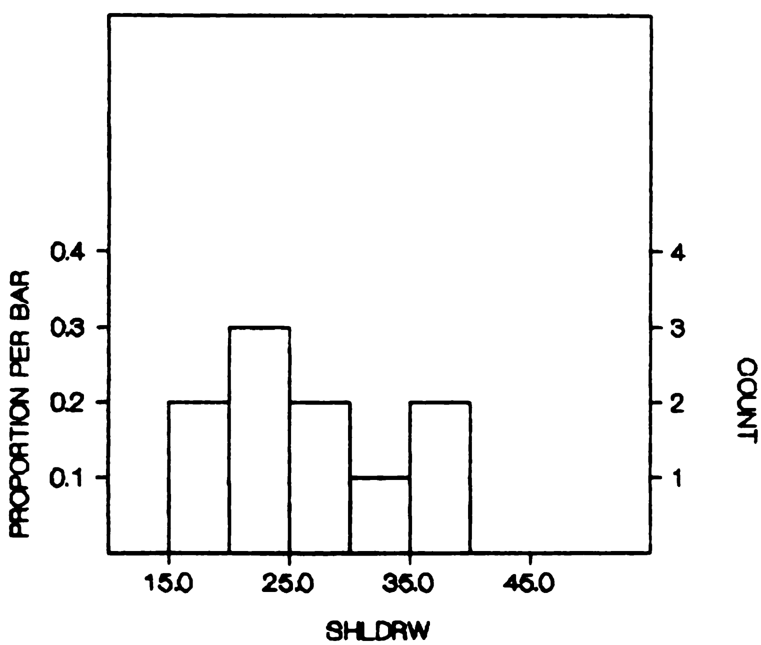


Figure B.5.13D Histogram: Shoulder Width, Western: Type A

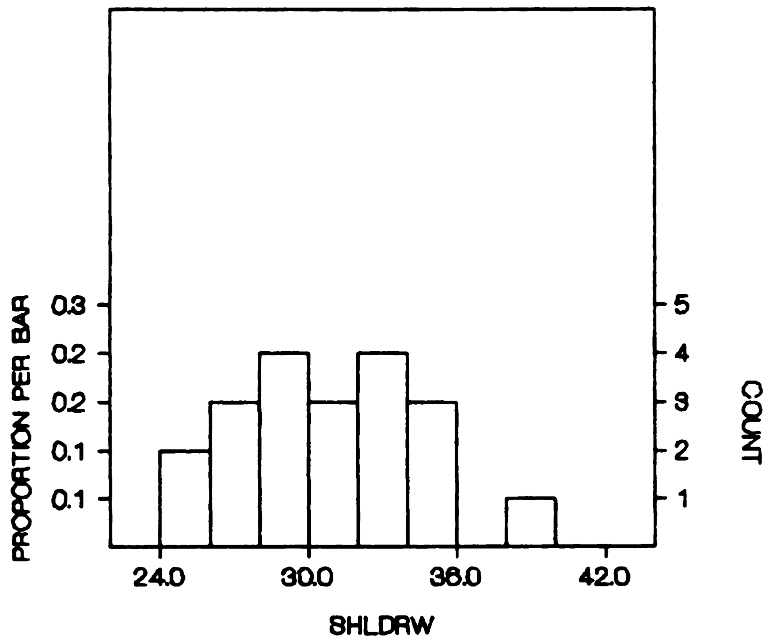


Figure B.5.14 Box and Whisker Plot: Between Shoulder, All: Type A

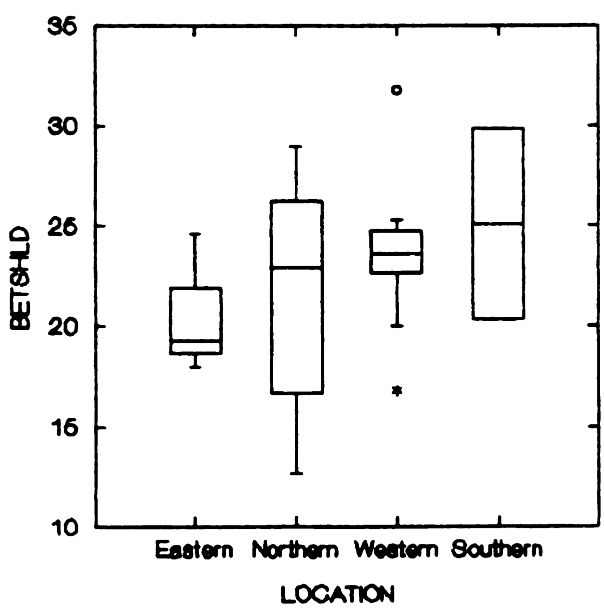


Figure B.5.14A Stem and Leaf Plot of Variable: Between Shoulder, N=10, Northern: Type A

Minimum is:	12.7	1	2
Lower Hinge is:	16.7	1	5
Median is:	22.9	1H	6
Upper Hinge is:	26.3	1	8
Maximum is	28.9	2	0
		2M	
		2	55
		2H	67
		2	8

Figure B.5.14B Stem and Leaf Plot of Variable: Between Shoulder, N=21, Western: Type A

Minimum is:	16.8	16	7	(outside values)
Lower Hinge is:	22.7	20	00	
Median is:	23.6	20		
Upper Hinge is:	24.8	21		
Maximum is	31.8	21		
		22	03	
		22H	6	
		23	14	
		23M	56699	
		24	4	
		24H	778	
		25	122	(outside values)
		31	8	

Figure B.5.14C Histogram: Between Shoulder, Northern: Type A

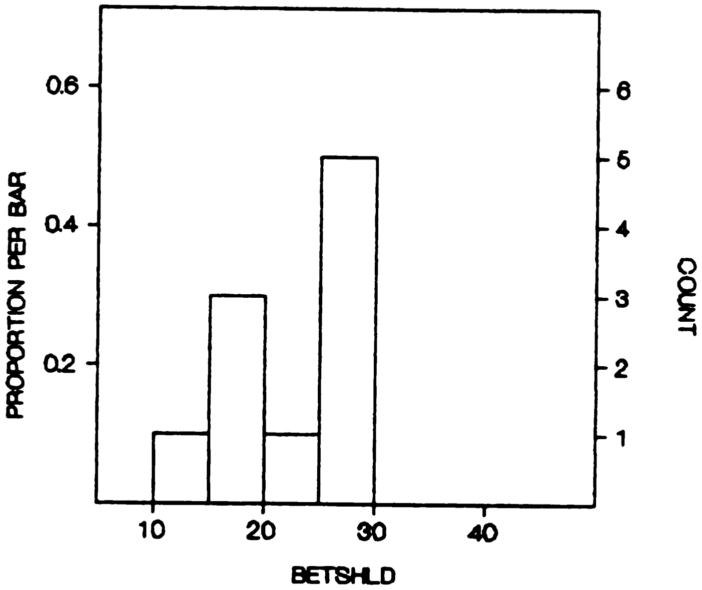


Figure B.5.14D Histogram: Between Shoulder, Western: Type A

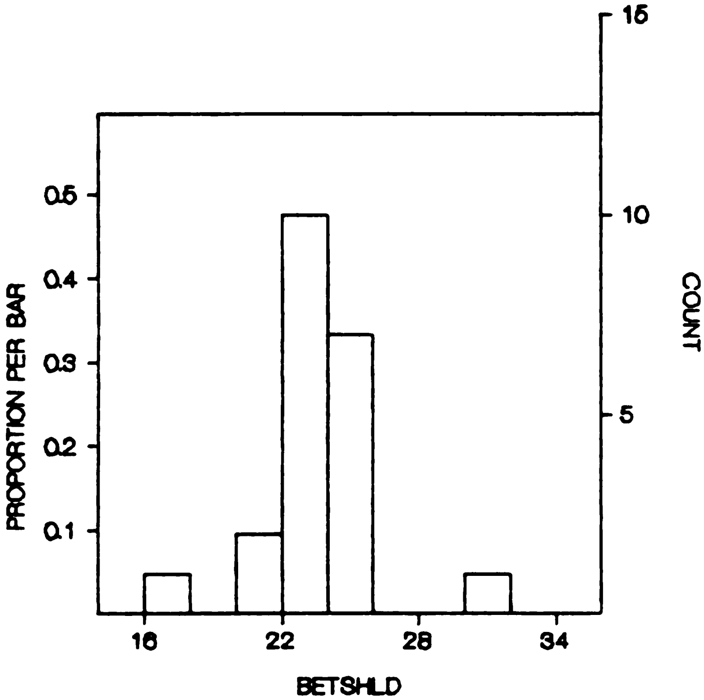


Figure B.15.5 Box and Whisker Plot: Shoulder Angle, All: Type A

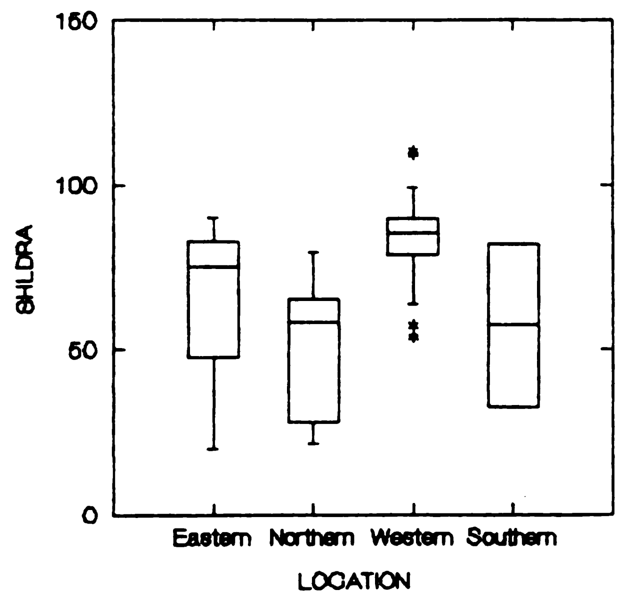


Figure B.5.15A Stem and Leaf Plot of Variable: Shoulder Angle, N=10, Northern: Type A

Minimum is:	22	2H	128
Lower Hinge is:	28	3	
Median is:	58	4	
Upper Hinge is:	65	5M	16
Maximum is	80	6H	005
		7	09

Figure B.5.15B Stem and Leaf Plot of Variable: Shoulder Angle. N=19. Western: Type A

Minimum is:	54	5	37	(outside values)
Lower Hinge is:	79	6	3	
Median is:	85	6		
Upper Hinge is:	90	7	0	
Maximum is	110	7H	7	
		8	04	
		8H	5555689	
		9	0	
		9	79	(outside values)
		10	9	
		11	0	

Figure B.5.15C Histogram: Shoulder Angle, Northern: Type A

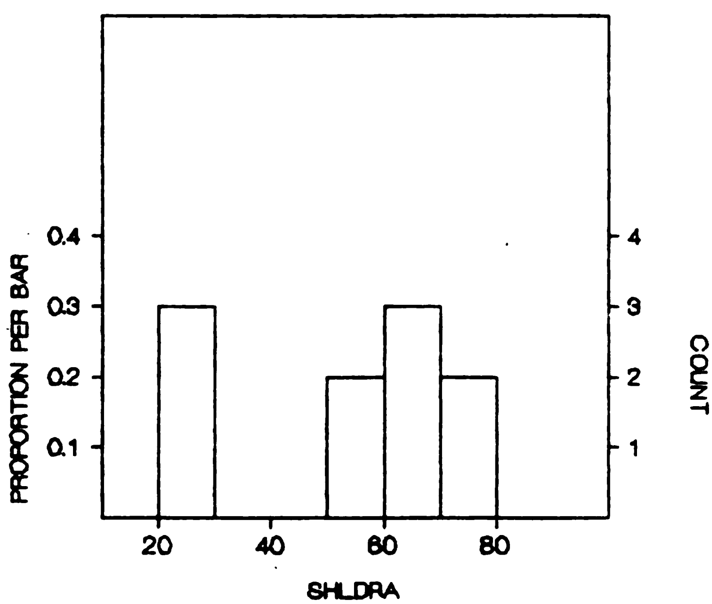


Figure B.5.15D Histogram: Shoulder Angle, Western: Type A

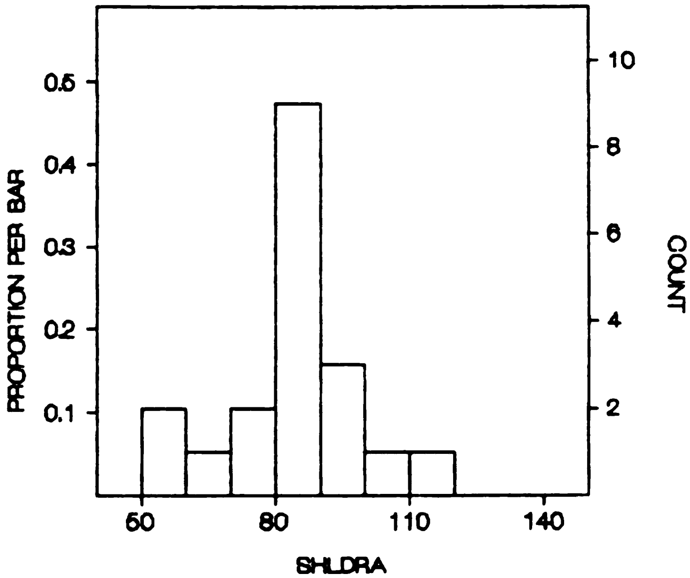


Figure B.5.16 Box and Whisker Plot: Width, All: Type A

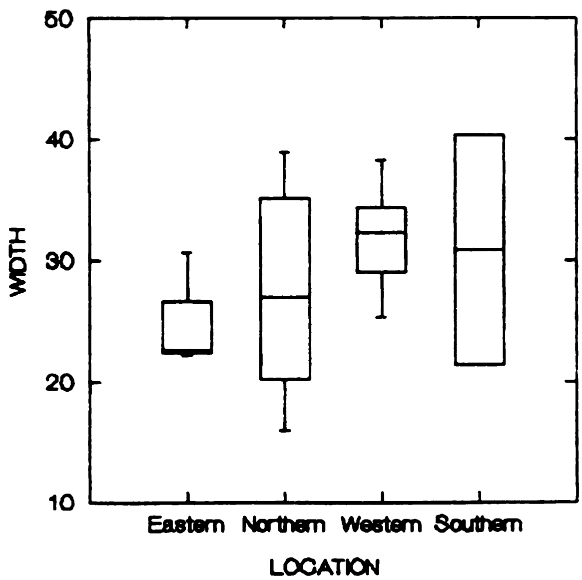


Figure B.5.16A Stem and Leaf Plot of Variable: Width, N=10, Northern: Type A

Minimum is:	16.0	1	58
Lower Hinge is:	20.2	2H	02
Median is:	26.9	2M	67
Upper Hinge is:	35.1	3	1
Maximum is	38.9	3H	588

Figure B.5.16B Stem and Leaf Plot of Variable: Width, N=21, Western: Type A

Minimum is:	25.3	25	37
Lower Hinge is:	29.0	26	1
Median is:	32.3	27	59
Upper Hinge is:	34.3	28	
Maximum is	38.3	29H	013
		30	1
		31	3
		32M	37
		33	4
		34H	113
		35	78
		36	28
		37	
		38	3

Figure B.5.16C Box and Whisker Plot: Width, Western Main Mode: Type A

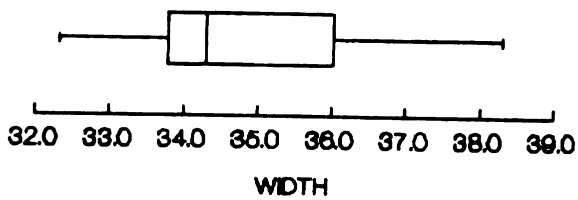


Figure B.5.16D Box and Whisker Plot: Width, Western Sub Mode: Type A

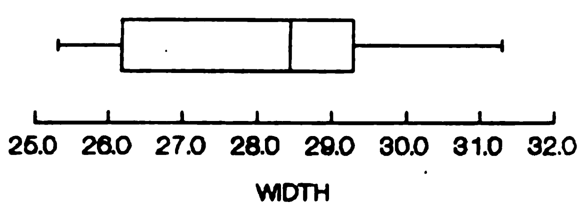


Figure B.5.16E Stem and Leaf Plot of Variable: Width, N=11, Western Main Mode: Type A

Minimum is:	32.3	32	37
Lower Hinge is:	33.8	33H	4
Median is:	34.3	34M	113
Upper Hinge is:	36.0	35	78
Maximum is	38.3	36H	28
		37	
		38	3

Figure B.5.16F Stem and Leaf Plot of Variable: Width, N=10, Western Sub Mode: Type A

Minimum is:	25.3	25	37
Lower Hinge is:	26.2	26H	1
Median is:	28.5	27	59
Upper Hinge is:	29.3	28M	
Maximum is	31.3	29H	013
		30	1
		31	3

Figure B.5.16G Histogram: Width, Northern: Type A

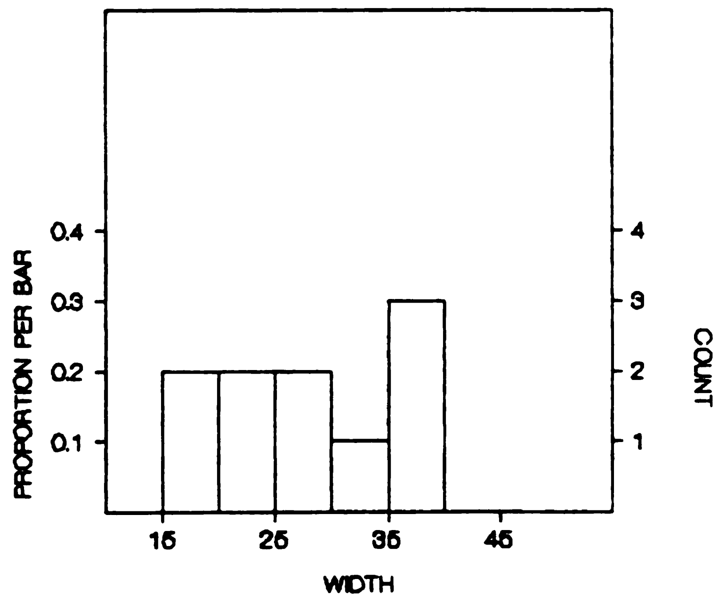


Figure B.5.16H Histogram: Width, Western: Type A

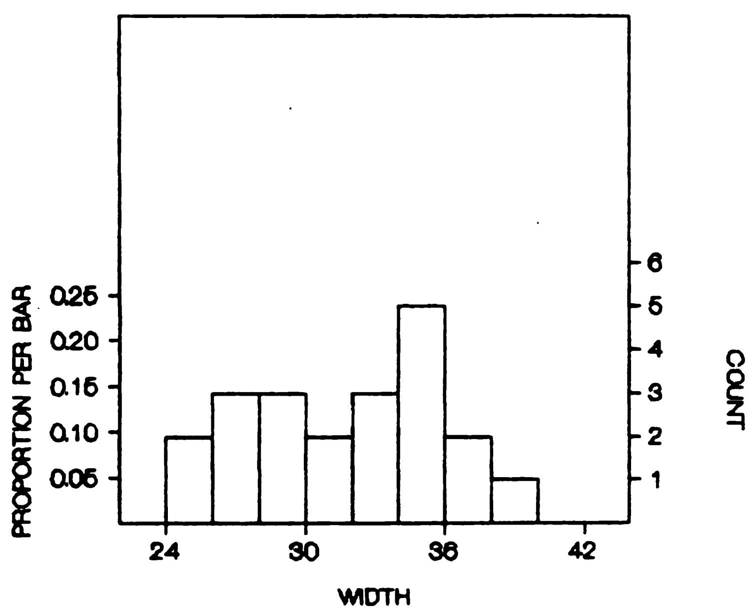


Figure B.5.16I Histogram: Width, Western Main Mode: Type A

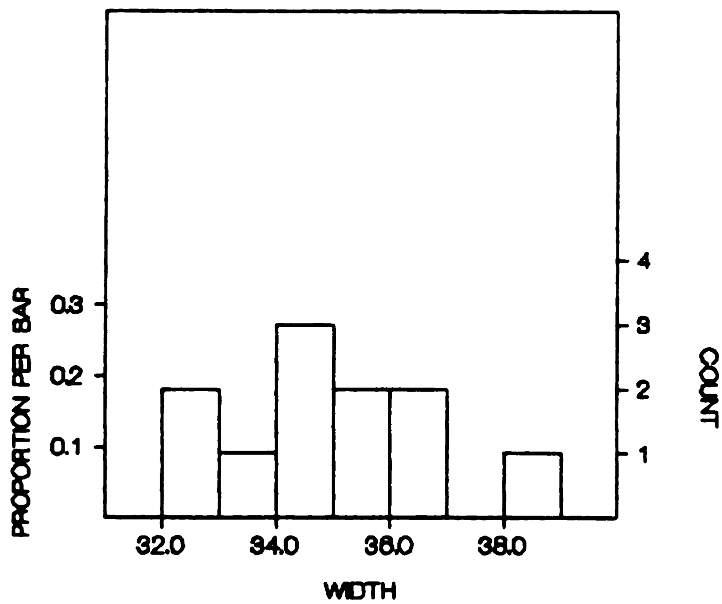
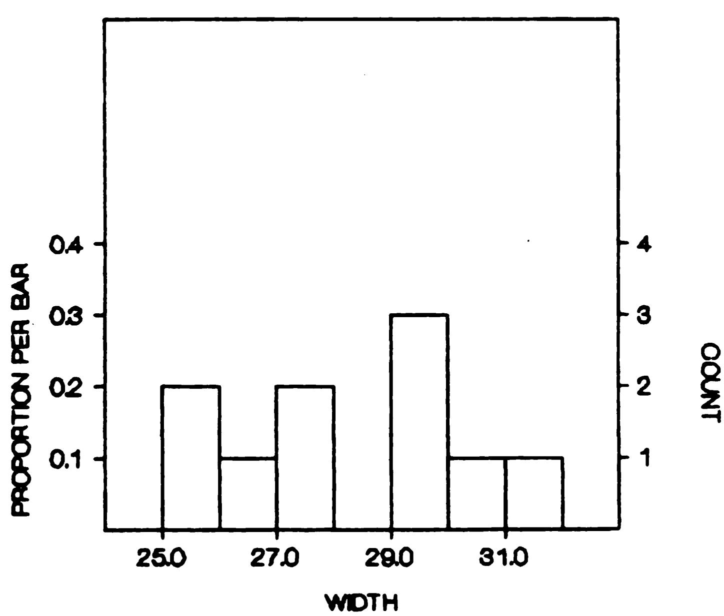


Figure B.5.16J Histogram: Width, Western Sub Mode: Type A



Appendix C

Appendix C - INAA - Raw Material Tests

REPORT ON INAA OF ARCHAEOLOGICAL AND GEOLOGICAL QUARTZITE FOR SOURCE DETERMINATION OF RENIER SITE ARTIFACTS

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At the request of Mr. David Ruggles, an archaeological quartzite flake from the Renier site, Wisconsin, was subjected to instrumental neutron activation analysis (INAA). This flake had been recovered in direct association with the Scottsbluff/Eden projectile points from Renier site cremation. The purpose of this analysis is to chemically compare the archaeological specimen with geological sources of quartzite commonly used by prehistoric Native populations in the Upper Great Lakes region, and to attempt to determine the source. The archaeological specimens from the Renier site had previously been identified as being of a pseudoquartzite known as Hixton silicified sandstone (Mason 1981:118).

A total of 37 samples (5 archaeological, 32 geological) were analyzed by INAA, as listed below (Table 1). In addition, data was used from 10 samples of Mt. Mesnard (upper Michigan) geological quartzite that had been previously analyzed are included here for comparative purposes. The samples were analyzed for the following short half-life producing elements (Al, Ba, Ca, Cl, Dy, K, Mg, Mn, Na, Si, Sr, Ti, U, V, Sr, Sm, La), and the data from the 37 samples is attached. Of the above elements, three (Ti, K, and Mg) proved to be useful in chemically separating the Hixton geological from the other sources, and these data are presented in Table 1, and presented on ternary diagram Figure 1. These are not the only chemical differences that could be used, Al also differs by about a factor of two between the Hixton and other geological samples tested.

The method used in INAA provenance studies of lithics is explained in several attached publications (Julig etal 1991; Julig etal 1992)

TABLE 1 Archaeological and Geological Quartzite Samples tested by INAA and select elemental data used in Ternary Diagram (Fig.1)

Archaeological (Renier Site)

Sample#	Ti (ppm)	K (ppm)	Mg % (corrected)
1.	53	<69	.013
2.	57	<86	.015
3.	69	<73	.015
4.	<24	<118	.016
5.	53	<90	.014
(Hixton Geological, yellow)			
6.	33	<74	.012
7.	<17	<71	.013

Sample#	Ti (ppm)	K (ppm)	Mg (%) (corrected)
8.	<15	<73	.012
9.	<19	<83	.014
10.	<16	<70	.011
11.	<21	<82	.014
12.	<17	<66	.012
13.	<28	<174	.013
	(Hixton Geological, tan)		
14.	44	<55	.010
15.	70	<54	.010
16.	76	<52	.009
17.	68	<49	.012
18.	49	<43	.010
19.	67	<51	.011
20.	71	<42	.012
21.	<27	<74	.012
	(Agibik Geological, Marquette Mi.)		
22.	59	949	.043
23.	64	1131	.047
24.	38	934	.038
25.	56	1078	.041
26.	330	812	.038
27.	93	941	.040
28.	97	966	.043
29.	87	1140	.043
	(Sheguiandah Geological, Manitoulin Isl. (Bar Island F.)		
30.	286	1022	.039
31.	266	1079	.044
32.	234	961	.038
33.	263	871	.037
	(Willisville Geological, Ontario, (Lorraine Fmt.)		
34.	55	1219	.048
35.	69	1422	.051
36.	84	1348	.048
37.	65	1156	.047
	(Mt. Mesnard Geological, Marquette, Mi)		
39.	54	<950	<.02
40.	119	1713	.10
41.	59	<715	<.016
42.	87	<565	.04
43.	114	<787	.06
44.	177	2409	.11
45.	139	2085	.10
46.	180	2163	.08
47.	138	2251	.10
48.	132	2341	.09

*For samples with detection limits (shown as <), concentrations have been doubled to attain 95% confidence levels, when plotted on Figure 1.

RESULTS

The elemental data in Table 1 are plotted on Figure 1. Based on the standardized and normalized data on Ti, K, and Mg as plotted on the ternary diagram, The Hixton geological groups separately from the other geological samples tested (Mt.Mesnard, Agibik, Sheguiandah, Willisville). There is one chemically exceptional Hixton sample (#13), which has a K concentration of 348 pm, and falls outside the Hixton cluster (Fig.1).
It should be noted that these are relatively few geological samples, and they may not be a representative of the chemical variability within the materials quarried and used prehistorically. Normally about 30 samples, representing the range of materials from prehistoric quarries, snould indicate the chemical variability.

Some additional Sheguiandah (Bar Island) geological samples have been analyzed previously but have not been included in this report. However, the chemical mean concentrations of those samples are generally similar to those reported here.

The Renier archaeological samples are shown to group chemically with the Hixton geological materials (Figure 1), and are chemically quite different from other quartzites in Upper Michigan (Mt.Mesnard, Agibik), as well as in Ontario (Sheguiandah Bar Island; Willisville, Lorraine) used prehistorically. These chemical data supports the previous identification of Hixton quartzite as the material source of the Renier quartzite artifact assemblage.

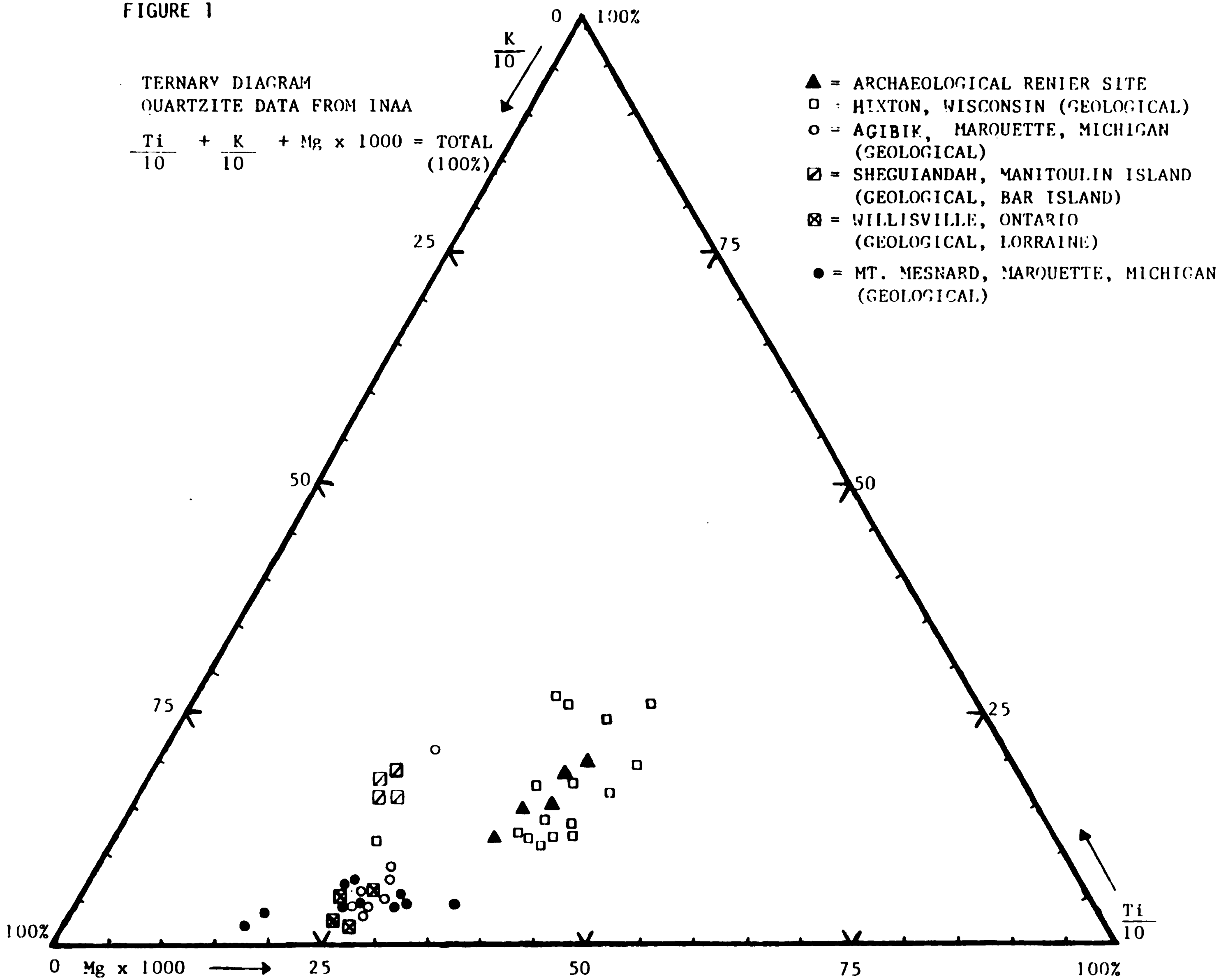


FIGURE 1

TERNARY DIAGRAM
QUARTZITE DATA FROM INAA

$\frac{Ti}{10} + \frac{K}{10} + Mg \times 1000 = \text{TOTAL (100\%)}$

Appendix D

Appendix D - List of Photographs

Figure D.1 Eastern

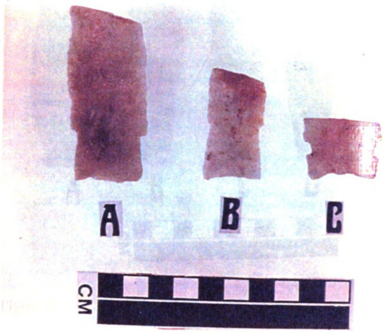


Figure D.2 Eastern

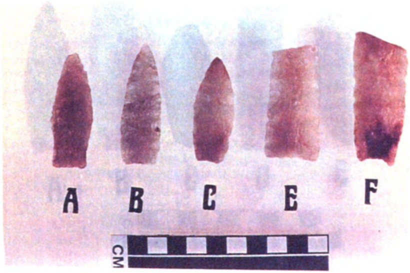


Figure D.3 Northern

Figure D.4 Northern

Figure D.5 Northern

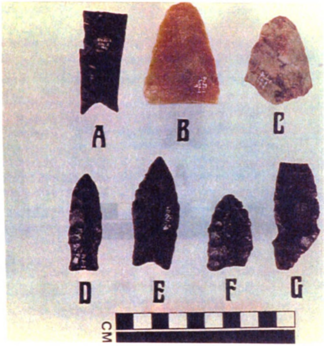


Figure D.6 Northern

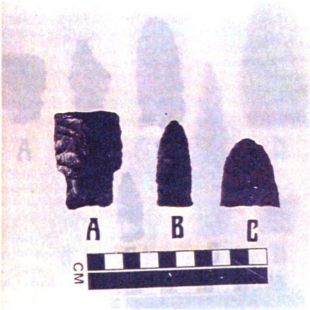
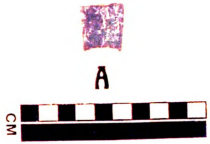


Figure D.7 Northern



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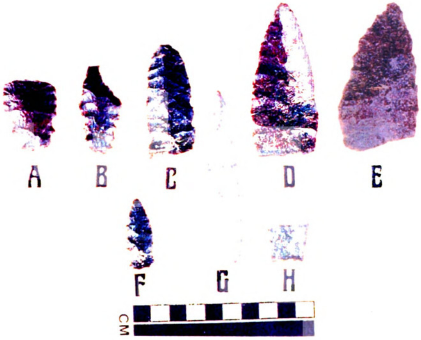


Figure D.9 Northern

Figure D.10 Northern

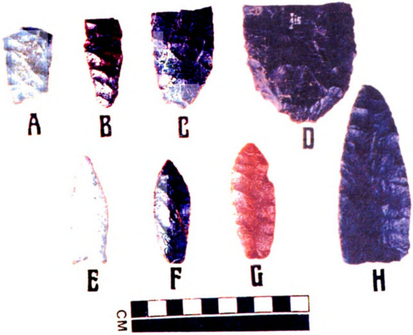


Figure D.11 Northern

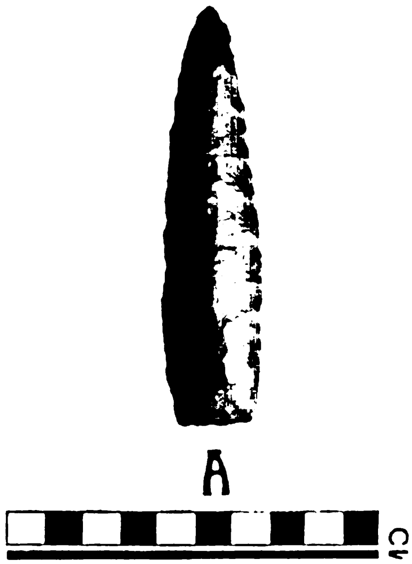


Figure D.12 Photograph unavailable

Figure D.13 Northern

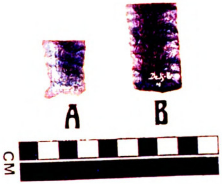


Figure D.14 Western

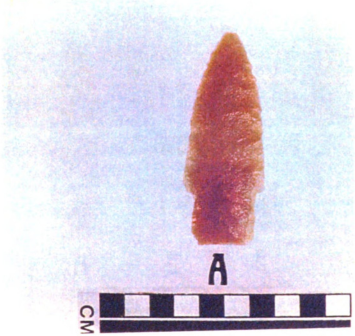
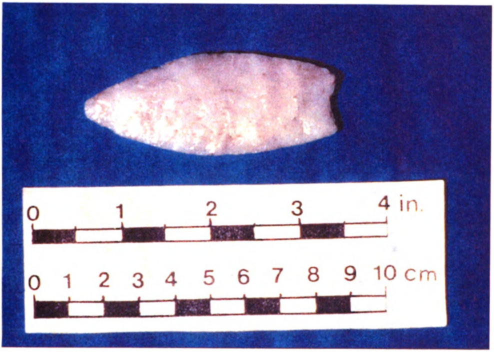


Figure D.15 Western



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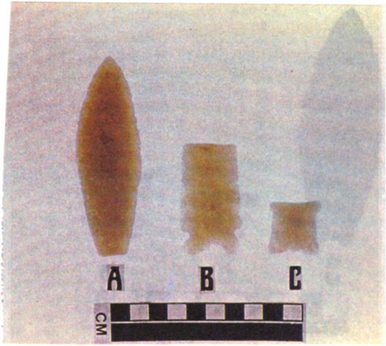


Figure D.17 Western

Figure D.18 Western

Figure D.19 Western

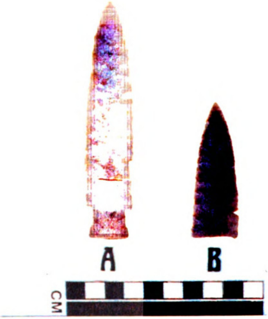


Figure D.20 Western

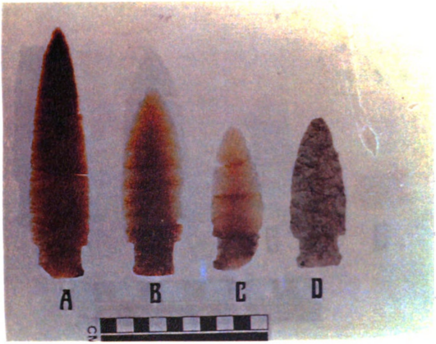


Figure D.21 Western

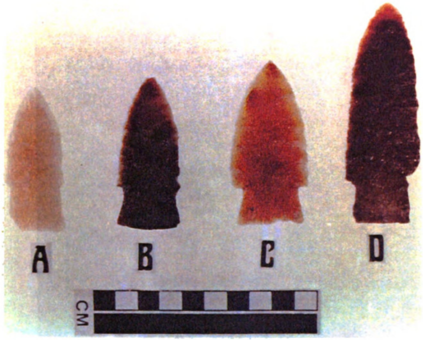
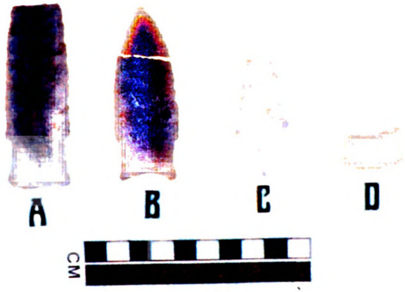


Figure D.22 Western



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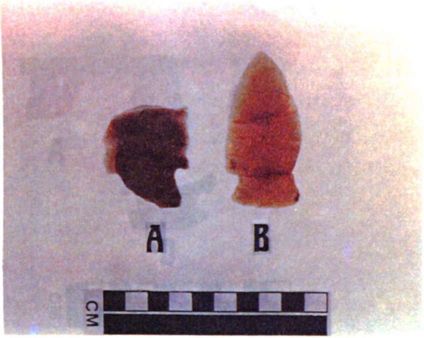


Figure D.24 Western

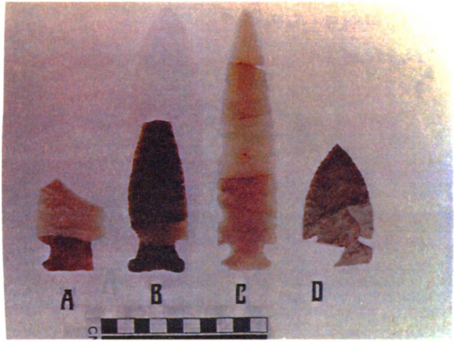


Figure D.25 Western

Figure D.26 Western

Figure D.27 Western

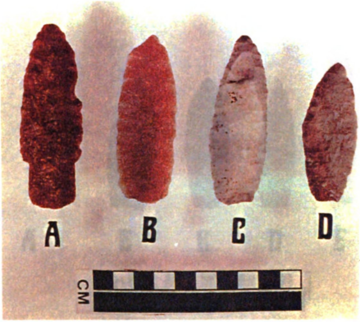


Figure D.28 Southern

Figure D.29 Southern

Figure D.30 Southern

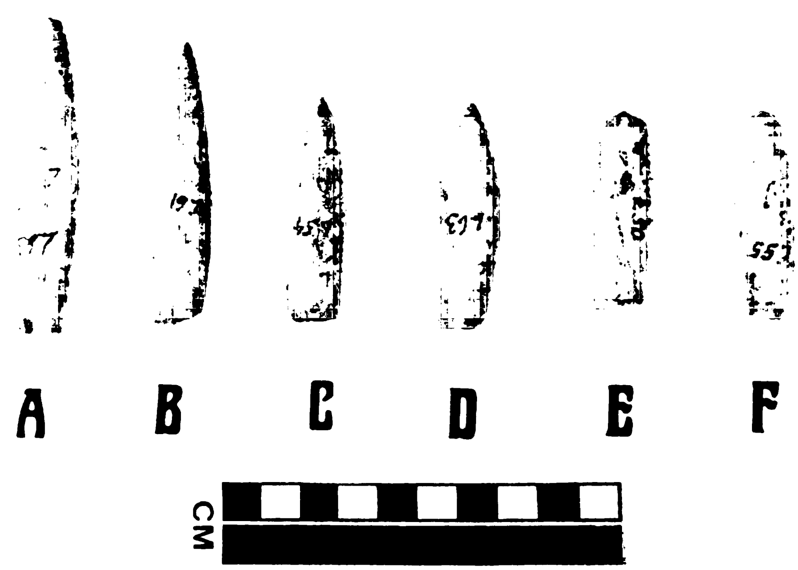


Figure D.31 Southern

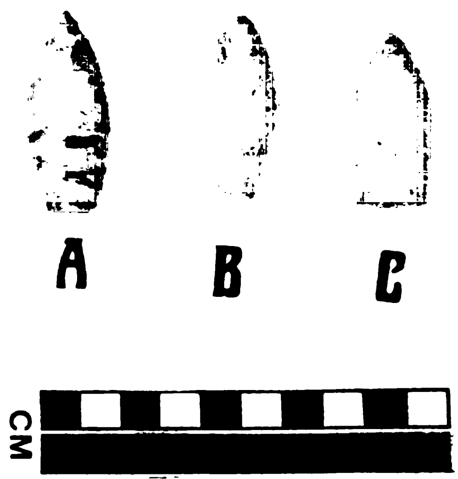


Figure D.32 Southern

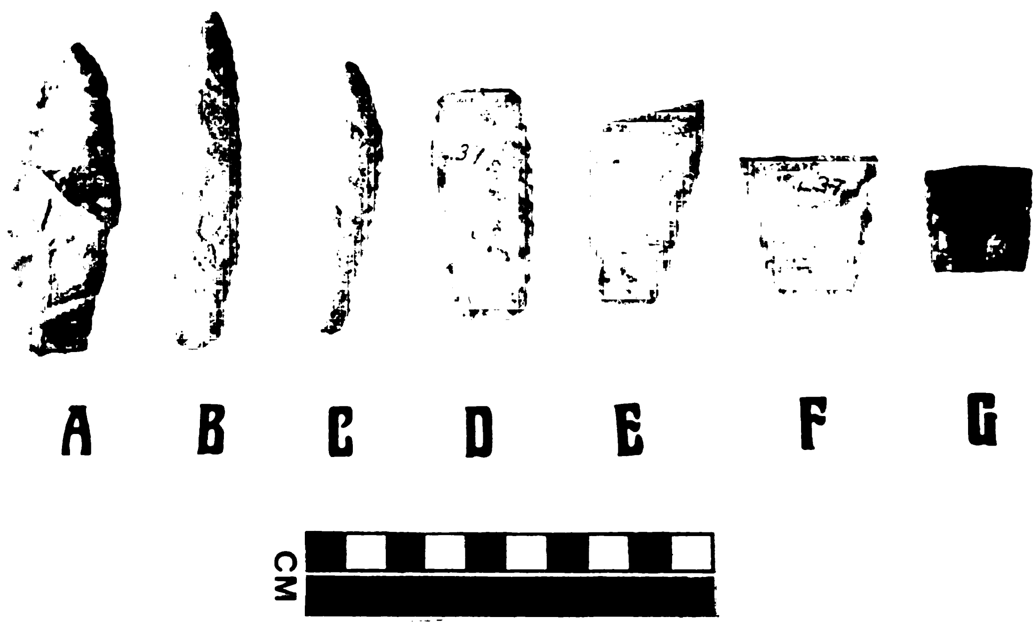
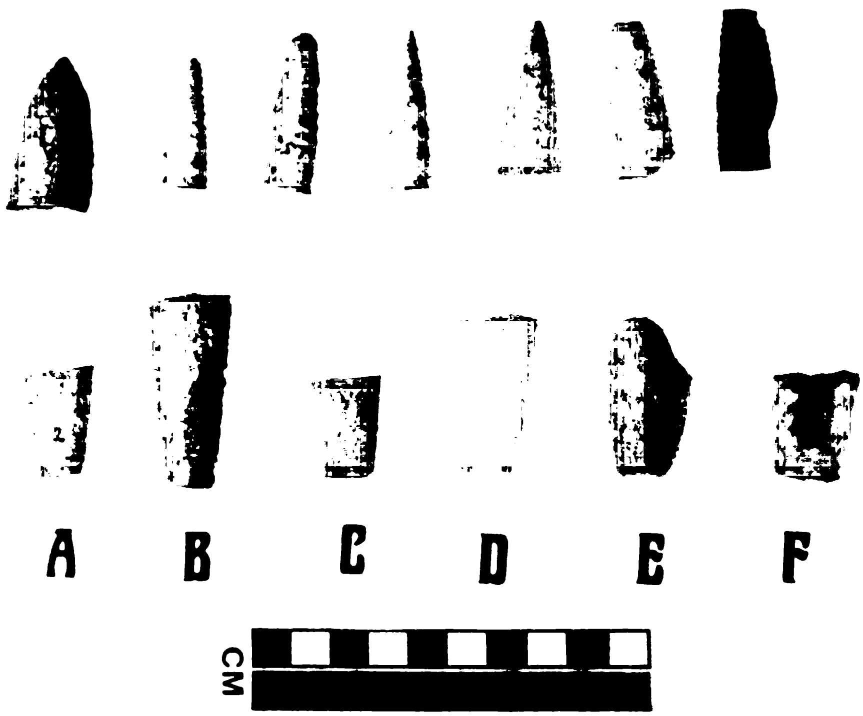


Figure D.33 Southern



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