IDENTIFYING PAST HUNTER-GATHERER SETTLEMENT PATTERNS IN THE SOUTHERN YUKON: A GEOGRAPHICAL INFORMATION SYSTEMS APPROACH

BY

CARLA A. PARSLOW

A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF ARTS

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Winnipeg, Manitoba

0-612-41755-7

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES
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ABSTRACT

The goal of this thesis is the identification of hunter-gatherer settlement patterns in Kluane National Park Reserve, southwest Yukon. Geographic information systems are used as a tool to conduct this research. This thesis incorporates three types of data: environmental, archaeological and ethnographic. Objectives of this thesis are to add to the current knowledge of human habitation in the study region, to critically evaluate and further contribute to the use of geographic information systems in archaeology, and to assist in the management and protection of cultural resources in Kluane National Park by building a regional model that can be used to predict the location of unknown sites.

From the data available, hypotheses are formulated and tested. Firstly, three types of sites can be identified in the archaeological record - small local band sites, large regional band sites, and special purpose sites. Secondly, the two residential site types are associated with seasonality – local band sites are associated with spring, early summer and winter activities and large regional sites are associated with activities carried out during late summer and fall. Thirdly, the small local band site will be scattered across the region while larger regional band sites will be situated at advantageous locations. Finally, ideal site locations will contain an ample supply of water and wood, are protected from strong winds, and have sufficient flat ground for housing and daily activities.

The outcome of this research is the construction of a regional model for hunter-gatherer land use in the Kluane region. It is concluded that in the fall, the regional band congregated in the Donjek Valley to communally hunt Dall's sheep. In the winter, the regional band broke down into smaller local bands and made use of the resources in the Mush and Bates Lakes areas. These local bands remained in this area throughout the spring. In the summer, the regional band aggregated near Kathleen Lake to communally fish for land-locked salmon. During the summer, special excursions occurred to obtain specific resources. One such trip involves travelling to the Airdrop Lake Plateau area to procure lithic resources.

ACKNOWLEDGEMENTS

I would like to thank the members of my committee for their time, effort and knowledgeable advice – my advisor, Dr. Ariane Burke (Anthropology), Dr Haskel Greenfield (Anthropology), and Dr. David Barber (Geography). Without their instruction, this thesis would not have been completed. Gratitude and thanks go out to the Centre for Earth Observation Sciences (C.E.O.S.), particularly David Mosscrop and Ron Hempel for allowing me to conduct much of my research in their facilities and for always being there when I needed assistance. I would like to thank David Arthurs (Parks Canada) for introducing me to the study region and for supplying me with much of the environmental and archaeological data to conduct this research. The Anthropology laboratory, under the direction of Dr. Stan Freer, is also thanked for allowing me to use the facilities during, and after, business hours.

A great amount of support, encouragement, and comic relief helped to keep me going through the research and writing stage of this thesis. For this I wish to acknowledge some very special people – Valerie McKinley, my lab companion; my most wonderful friends: Dawna Ventura, Tanya Peckmann, and Pam Simpson; and my dearest cousin Carey. I am also grateful to have had the support of my parents, and my brother throughout my journey. For their constant support, I dedicate this thesis to them.

TABLE OF CONTENTS

CHAPTER 5: THE STUDY REGION

CHAPTER 6: VARIABLES AND TOOLS REQUIRED FOR GIS TESTING

CHAPTER 7: RESULTS

CHAPTER 8 DISCUSSION AND INTERPRETATION OF RESULTS

CHAPTER 9 CONCLUSIONS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The goal of this thesis is the identification and analysis of pre-contact hunter-gatherer settlement patterns in the southwest Yukon using geographic information systems. Settlement patterns can be defined as the way in which populations dispose themselves over the landscape (Willey 1953:1). Settlement patterns provide us with more than locational information, however they also include information on the subsistence strategies and seasonal activities of a population, patterns of territorial organization, and the social relations within and between populations.

The study region is the Kluane National Park Reserve, in the southwestern corner of the Yukon Territory (see figure 1.1). Kluane National Park Reserve was chosen because much of the area has been archaeologically surveyed and partially excavated, but no synthetic regional study of settlement patterns and changes in land-use activities through time exists.

Geographic information systems (GIS) are systems of computer hardware, software, and procedures designed to support the capture, management, mathematical manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems (Aldenderfer & Maschner 1996:4; Green 1990:3; Heywood 1990:849; Korte 1997:401; Kvamme 1989:139; Lock & Harris 1992:90; Martin 1996:30; Stine & Lanter 1990:80). GIS are also defined as "spatially referenced databases that allow one to control for the distribution of form over space and through time" (Green 1990:3). Essentially, GIS are the integration of computer-aided mapping, computerized databases, and statistical packages (Fagan 1997:166). As such they have the potential to be very useful for archaeological research studying regional processes.

Central questions that will be addressed in this proposed research include:

(1) What are the determinants of hunter-gatherer settlement patterns in southwest Yukon and do these change over time?
(2) How do settlement patterns relate to environmental factors?
(3) To what extent are settlement patterns related to annual seasonal cycles?
(4) To what extent can the modeling of settlement patterns help us identify annual territory (band territory)?
(5) To what extent are GIS applications beneficial to the identification modeling and analysis of hunter-gatherer settlement patterns?

In addressing these questions, the objectives of this research are threefold. The first objective is to add to the current knowledge about human habitation in the southwest Yukon. The human history of the area is poorly known therefore, research potential is high (Arthurs 1995:10). The second objective is to critically evaluate and further contribute to the use of geographical information systems in archaeology. Geographical information systems have only been applied in the social sciences, particularly in archaeological research, for the past 10 to 15 years. More research must be completed before geographical information systems are recognized as a necessary tool in archaeological research, therefore third, and finally, the objective of this research is to assist in the management and protection of the cultural resources of Kluane National Park Reserve. This final objective will contribute to the fulfillment of the Canadian Heritage Branch - Parks Canada mandate.

The framework for this research (see figure 1.2) was first implemented by Verhagan, McGlade, Risch, and Gili (1995) in their research on socio-economic activities in the Bronze Age of southwest Spain. This framework goes beyond the purely statistical treatment of data and provides a more useful frame of reference within which previously constructed hypotheses might be addressed (Verhagan et al. 1995:196). Figure 1.2 makes it is evident that three levels of knowledge can be used in such an analysis: the archaeological; socio-historical; and environmental. These three levels of knowledge, in turn, form three levels of data transformation: representative; descriptive; and interpretive. As Verhagan et al. (1995:196) point out this framework is not goal directed towards the third level of inquiry. Rather, it exists as a continuum in which different questions and problems can be examined at a particular level or combination of levels. The usefulness of this approach will become evident throughout this thesis.

Before any discussion on hunter-gatherer populations can begin, it is important to define key concepts. One such key concept is the very concept of the hunter-gatherer. This term may appear simple to define but it has had various meanings historically, both to anthropologists and archaeologists. A second key concept, which needs to be clearly defined, is regional studies.

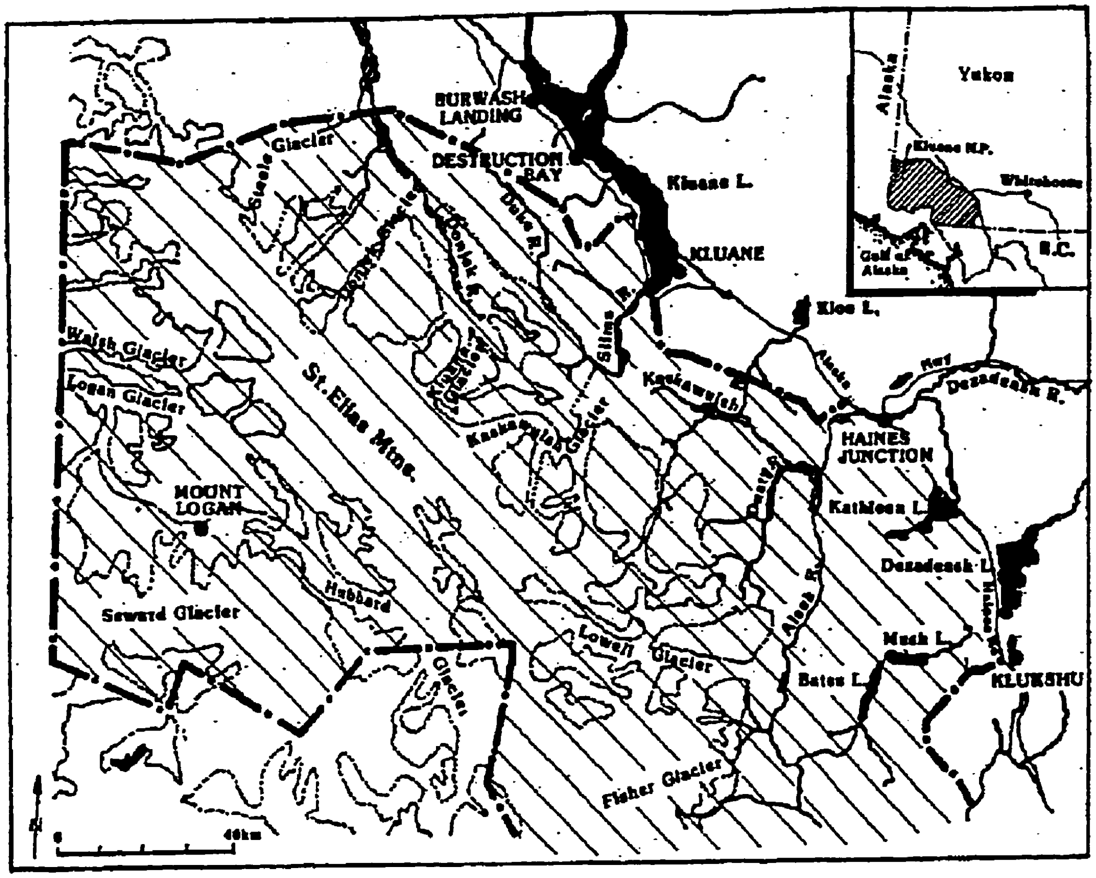


Figure 1.1: Kluane National Park Reserve

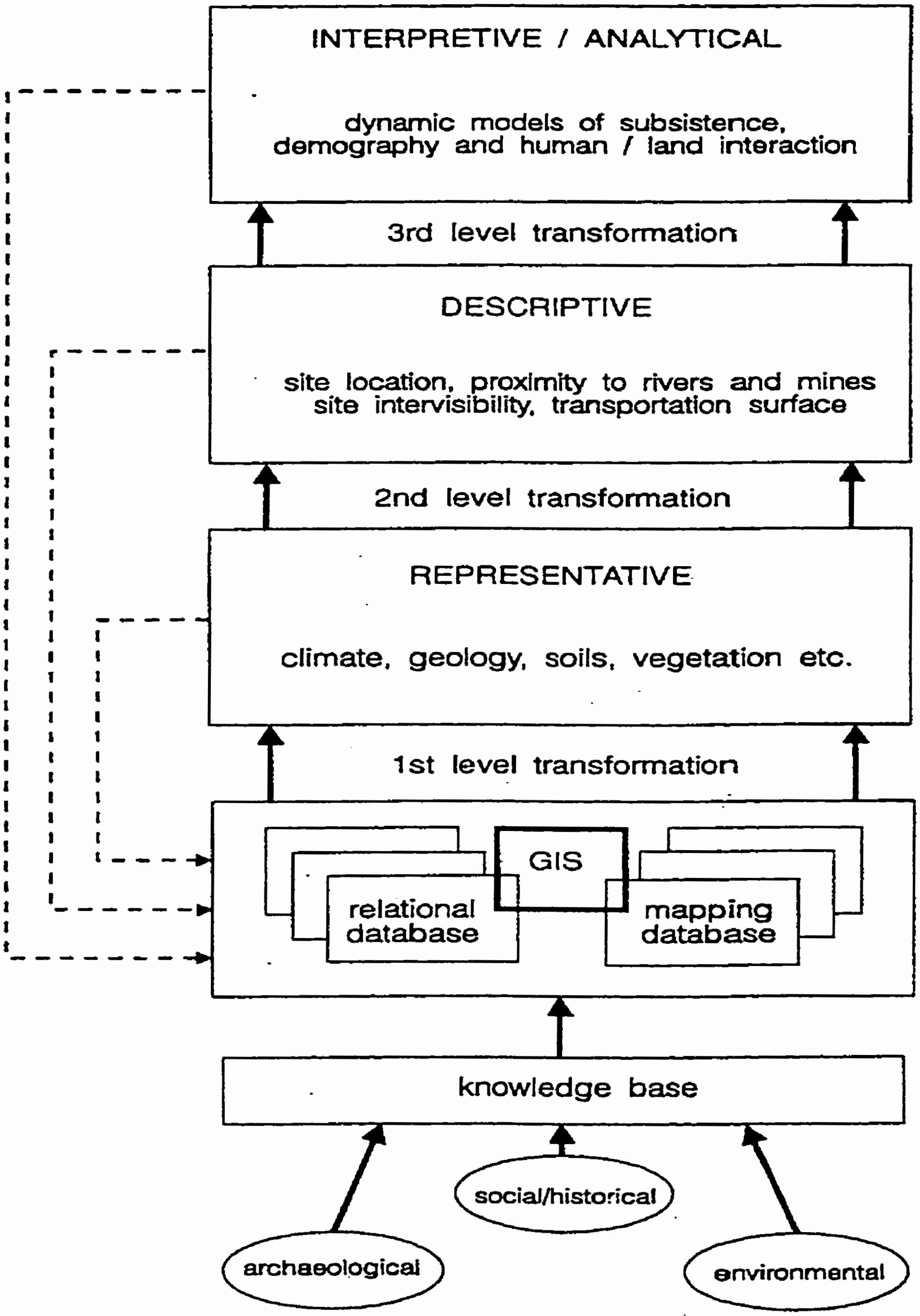


Figure 1.2: Research Framework (Verhagan et al. 1995)

1.2 Defining Hunter-Gatherer Populations

The term hunter-gatherer is superficially self-defining - an individual, or population, that hunts and gathers as the main form of subsistence. Historically however, this term has carried a variety of meanings. Early hunter-gatherer studies emphasized the "primitive" aspects of hunting and gathering as a lifestyle while later researchers such as Sahlins (1972) emphasized the apparent affluence of hunter-gatherer populations. This term is economic in nature because it describes how an individual or population lives, and survives. Ninety-nine percent of the world's hunter-gatherer populations lived in the past (Lee & DeVore 1968:3), and therefore are open to study only through archaeological methods. Hunter-gatherer studies in archaeology have two major characteristics: often they rely heavily on ethnographic research, and therefore hunter-gatherers are often portrayed in ways that serve theories in social sciences (Bettinger 1991:V). In this section, the term "hunter-gatherer" and its relationship with the field of archaeology is examined.

As mentioned earlier hunter-gatherers have been viewed as either destitute primitives or as affluent populations. These opposing assumptions of hunter-gatherer populations are linked to two very different theoretical schools: evolutionists (the former) versus adaptationists (the latter). It is important to understand these two themes because they give an insight into the history of hunter-gatherer studies in archaeology, and explain why archaeologist today view hunter-gatherer societies they way they do.

Although not synonymous with Darwinism, early evolutionist archaeological studies did rely on a general framework supplied by Darwin's *On the Origin of the Species* (1859). Evolutionist research involves the "struggle for existence" and the "survival of the fittest", phrases borrowed from Darwin (and Spencer). For evolutionist anthropologists and archaeologists alike however, the over-arching struggle was "humanity's upward movement toward the perfection of God" (Kelly 1995:8). In other words, a directed evolution was implied although this ran contrary to Darwin's own theory. Key concepts of evolutionist research are the ideas of progress through time, including change and human social order, a belief in the importance of environmental influences, and political economy (Bettinger 1991:10; Sharer & Ashmore 1987:44). The concepts of change, progress and social order can be detected in Lewis Henry Morgan's *Ancient Society* (1877) for example, where Morgan categorizes different societies as fitting into one of three stages: savagery, barbarism, or civilization. Morgan believed, as did many other anthropologists of his day, that cultures move or evolve in a parallel fashion through these formally defined stages.

The bases for constructing evolutionary sequences for human societies were diverse and included technological, social, political, intellectual, and moral factors (Kelly 1995:8). While many of these factors are not evident in the archaeological record, they are implied in the interpretation of the archaeological record. In accordance with the given factors, hunter-gatherer societies, whether observed directly or through the archaeological record, were placed at the bottom of the evolutionary scale. The reason for this low status is because hunter-gatherers have few belongings (material culture), they lead a nomadic lifestyle, they are non-hierarchical and their concept of private property is different from the views of western societies (Kelly 1995:9). Hunter-gatherers, whose daily lives were considered to have been preoccupied with subsistence and related material needs, are portrayed as disadvantaged - as something undesirable that humanity had to leave behind (Bettinger 1991:4; Kelly 1995:10).

There was a change during the 20th in the view of hunter-gatherer populations. Hunter-gatherers were no longer viewed as primitive human populations living on the fringe – constantly faced with harsh living conditions and starvation. Results from fieldwork completed by Lee(1968) on the !Kung populations in Africa and McCarthy and McArthur (1960) on the Australian Aborigines, led Sahlins to conclude that people whose wants and needs were limited could achieve a comfortable life with little time and effort - instead of working all day everyday, these people spent much of their time simply lounging around (Sahlins 1972:1).

In 1966, the first symposium on hunter-gatherer societies, *Man the Hunter,* was held in Chicago. The reason for this symposium was to promote current research on hunter-gatherer societies and to present new data and theoretical interpretations of the hunter-gatherer way of life. It was during this symposium that the concepts of affluent society and the methodological focus on adaptation were brought to the forefront of hunter-gatherer studies. During the subsequent *Man the Hunter* symposia, it was realized that the hunting way of life and its ability to continuously adapt to environmental change had been among the most successful achievements of humankind. Thus, past reconstructions of hunter-gatherer societies where hunter-gatherers were viewed as primitive people living on the fringe, were no longer considered valid (Lee & DeVore 1968:2, 5).

Hunter-gatherers are now viewed as groups of people who were adapted to their natural environment. Adaptation is defined by many archaeologists as any structure, physiological process or behavioral pattern that makes a group more fit to survive and to reproduce (Bailey 1983:1; Clark 1991:428). Behavior is viewed as the dynamics of adaptation - as a strategy for survival and reproduction at the group level (Clark 1991:428). According to Yesner (1994:152), "the full set of adaptations of a group to local resource configurations includes responses to the abundance, diversity, distribution, temporal variability, and sequential pattern of availability of those resources, both individually and collectively." Yesner is linking the behavior of a group to the fluctuation of the natural environment that a group inhabits. Essentially, human adaptation is the possession of a valid set of solutions to a variety of problems. The process of alteration of a cultural system in response to changes in its environmental system is brought about through the medium of behavior (Clark 1991:438).

A model of a more socially and economically complex adaptation was put forward (Mueller-Wille & Dickson 1991:25). This model is known as "the basic model" in the 1960s. This basic model is exactly as its title suggests – it defines some of the characteristics of hunter-gatherer societies generally considered. Not all characteristics in the model apply to all hunter-gatherer populations, in fact some are highly debatable. According to the basic model, hunter-gatherer societies are characterized by (Mueller-Wille & Dickson 1991:26):

1. A simple technology.
2. Subsistence systems capable of producing relatively low levels of food energy.
3. A diet in which plants contributed a greater percentage of the calories than animals.
4. Little emphasis on accumulation of wealth, food or other kinds of surplus.
5. A low density of population per square kilometer.
6. Dependence upon wild food resources which tend to be spatially dispersed and to fluctuate (often either seasonally or over the long run).
7. A population size determined by the amount of wild foodstuffs collectable during the season of minimum availability.

8. A band level of social organization.
9. Reliance on kinship as the most important principle of social organization.
10. Economic distribution and exchange based on reciprocity.
11. Bands as corporate groups holding land resources in common but granting unrestricted access to these resources to all members of the band.
12. An absence of full-time specialization beyond that based on sexual division of labor.
13. An absence of ascribed statuses and roles beyond those of age and sex.
14. Feuding, but no true warfare.

1.3 Defining A Region

A region is defined in Webster's College Dictionary (1996:1134) as "an extensive, continuous part of a surface...a part of the earth's surface of considerable and usually indefinite space...a major faunal area of the earth's surface". According to Willey and Phillips (1958:19,20), a region from an archaeological perspective is "a geographic space in which, at a given time, a high degree of cultural homogeneity may be expected" and which usually coincide with minor physiographic divisions. For Fagan (1997:104,477) a region is "a geographically defined area in which ecological adaptations are basically similar", and archaeological regions are "well defined geographic areas bounded by conspicuous geographic features, such as an ocean, lake, or mountains".

Gamble (1986:70) identifies four methods for defining an archaeological region that have been used in past regional studies:

1. Utilize maps of modern vegetation or of reconstructed vegetation conditions during a glacial period and draw boundaries around the floral zone.
2. Take three contrasted topographical regions and compare the archaeological record that has been recovered from each zone.
3. Take areas of particularly active archaeological research, throw a suitably large spatial net over the areas (120,000 km squared for example) and then compare the contents of one such region with the other.
4. Collect data along preset transects both north south and east west across the continent. These continuous distributions could then be partitioned up into suitable regions depending on where breaks and changes in archeological materials occurred.

Gamble rejects these methods of defining a region. He argues (1986:67-69) that regional units can be defined as arbitrary blocks of land or geographical areas so long as they are larger than the phenomena being studied. Since hunter-gatherers extensively use space, it is required that the regions be large (1986:67-69). According to Gamble (1986:71) "we need a strong inference, or what Binford (1982) aptly termed 'intellectual anchors' which serve as fixed points of reference in the business of model building." There are only three such 'anchors' which pass the test of the principle of uniformitarianism and which can serve in the construction of a regional map: latitude, longitude, and relief". One other aspect must be considered and that is to take the drainage division and drainage basin observation patterns (the direction of the drainage basin) as a guideline (Gamble 1986:71).

For this research, the definition of a region will follow the definition outlined by Gamble. The latitude, longitude, relief, drainage division, and drainage basin observation patterns will be taken into consideration. The target research region is approximately between $60^{0}30'$ to $62^{0}18'$ latitude and $137^{0}10'$ to 140^{0} longitude; this region was then subdivided into regions taking into consideration the main drainage division, the Donjek, River, as well as the Saint Elias and Donjek Mountain Range.

1.4 Organization of this Thesis

The organization of this thesis is as follows. Information on past hunter-gatherer settlement studies will be presented. Chapter two examines the history of hunter-gatherer settlement studies in archaeology. As well, the model used in this thesis, the predictive model is introduced and discussed. The following chapter (chapter three) discusses social organization and how it is approached in archaeology. The approach taken here is through ethnographic analogy. The ethnographic data provides hypotheses as to why hunter-gatherers live where the do.

In chapter four, geographic information systems (GIS) are examined. The history of GIS use in archaeology, as well as its advantages and disadvantages is also presented. The outcome of chapter three is the realization that GIS do have a place in anthropological research.

Chapter five provides a review of the paleo-environmental, archaeological, and the cultural history of the study area. By the end of chapter four, the reader should have a fair understanding of the history of archaeological investigation in the southwest corner of the Yukon Territory.

In chapter six, the methods for this thesis are introduced and discussed. The methodological processed are sectioned into a series of exercises. The results of these exercises coincide with the relationship between known archaeological site locations and the environment in which they reside. The results of the methods used are made evident in chapter seven.

The results from chapter seven are then used as an interpretive device in chapter eight. In chapter eight, the interpretation and analysis of hunter-gatherer settlement patterns in the southwest Yukon is conducted. At the end of this chapter, it will be evident that the ultimate goal of this thesis, the identification and analysis of prehistoric hunter-gatherer settlement patterns in the southwest Yukon, has been achieved.

CHAPTER 2

HUNTER-GATHERER SETTLEMENT PATTERNS AND THE PREDICTIVE MODEL

2.1 Introduction

In this chapter, hunter-gatherer settlement patterns in archaeology are defined as the way past hunter-gatherer populations dispose themselves over an archaeological landscape. The term archaeological landscape is defined as land areas where not only ecological factors, such as topography and hydrology are considered, but also behavioral factors, such as the actions of people working at various spatial and temporal scales with varying degrees of integration and cooperation (Wandsnider 1998:87). The objectives of this chapter are to provide a history of the development of hunter-gatherer settlement pattern studies in archaeology and to outline the model used in this thesis – the predictive model. This definition of hunter-gatherer settlement patterns takes into consideration the symbiotic relationship between the environment, subsistence activities, social organization and settlement.

Based on the objectives of this chapter, the organization for this chapter is such that it is divided into two major sections. Section 2.2, outlines the history of hunter-gatherer settlement pattern studies. In this section, the initial notion of a hunter-gatherer settlement pattern is defined and the pioneers who initially developed this concept are reviewed. Section 2.2 will show two forms of progression in hunter-gatherer settlement pattern studies. The first progression demonstrates how hunter-gatherer settlement pattern studies in archaeology have progressed from one site analysis, to the examination of a number of sites as a part of a system, to eventually an expanded analysis that recognizes a system of sites operating in an environmental context. The second progression demonstrates how hunter-gatherer settlement pattern studies have evolved from studies that are based on little or no theory, to models that draw from more than one school of thought.

Building on the development of models of hunter-gatherer settlement patterns that are based on more than one school of thought, section 2.3 discusses the model that is used in this research. The model used in this research is identified as a predictive model. In this section, the predictive model will be discussed in relation to its development, the schools of thought that contribute to its development, and the advantages to the use of a predictive model.

At the end of this chapter, it will be evident that the history of hunter-gatherer settlement pattern studies in archaeology has grown in complexity and popularity since the concept was first conceived, up until present times. With the increase in complexity and popularity, innovative models have been constructed that can not only identify hunter-gatherer settlement patterns in an archaeological landscape, but can also predict the possibility of hunter-gatherer site locations that have not been previously examined.

2.2 The History of Theoretical Thought of Hunter-Gatherer Settlement Patterns

Hunter-gatherer settlement patterns have been a topic of interest for archaeologists since the late 19th century. As early as 1881, Lewis H. Morgan researched settlement patterns by examining the distribution of Pueblo ruins. Morgan's research concentrated on site-by site locational analysis rather than regional analysis and is not currently characterized as traditional hunter-gatherer settlement pattern analysis. At the beginning of the 20th century, archaeology was strongly influenced by historical particularism. In describing the environment of settlement studies in the early 20th century, up to the 1930s, Harris observes (1968:676):

> If the hand of historical particularism rested heavily upon the study of cultural regulation among ethnologists, its weight was even more deadening among the archaeologists. If each ethnologist had his tribe, each archaeologist had his "site". If the ethnologist described his tribe in terms particular to and literally borrowed from the lexicon of the people he was studying, the archaeologist concentrated upon the pattern of rim sherd incisions found at his site and possibly at one or two adjacent localities.

The influence of historical particularism constrained the development of hunter-gatherer settlement pattern studies to the examination of a single site. It was not until later in the 20th century that settlement pattern studies, as they are traditionally characterized, actually became the focus of archaeological research. K.C. Chang (1967:39) pointed out this shift in focus by stating that the settlement, rather than the artifact, is the basic unit in archaeology. The settlement is the basic unit of study in archaeology because archaeologists are primarily interested in past peoples living in social groups, and sharing a common culture.

The development of settlement pattern studies has different roots in England and the Americas. In both countries, the developments of settlement pattern studies focused on the way human occupation is distributed across a landscape (Sharer & Ashmore 1987:437). The main difference in settlement pattern studies between the two countries is that while England's archaeologists concentrated on settlement patterns of agricultural societies initially, American archaeologists examined settlement patterns of hunter-gatherer societies. In England, the work of Sir Cyril Fox in the early 1930s provided "the stimulus for relating the distribution of archaeological remains to the distribution of environmental features" (Sharer & Ashmore 1987:437). Fox is recognized for his early ability to link ecological distributional approaches with geographical approaches to examine the relationship between landscapes and culture history (Trigger 1993:249). It is not until 1938, with the work of Julian Steward, that we see a turning point in the analysis of settlement patterns in the Americas. This turning point is of particular importance because the focus of archaeological settlement pattern studies was now on past hunter-gatherer populations and cultural ecology theory was being used.

Steward, foremost recognized as a cultural ecologist, along with F.M. Setzler argued that archaeologists would have to stop concentrating on the stylistic analysis of artifacts and instead, begin to use their data to study changes in hunter-gatherer subsistence economies, population size, and settlement patterns (Trigger 1993:279). Steward not only argued for this change, but also demonstrated its utility in his archaeological research of the *Ancient Caves of the Great Salt Lake Region* (1937). Steward also published a paper in the same year (1937) that used both archaeological and ethnographic settlement pattern data in a study on the relationship between culture and the environment in the American southwest (Trigger 1993:279-80). It was Steward who purposely examined more than one site and understood each, forms part of a system. This settlement system was comprised of human populations and their relation to the natural environment. Steward's approach to the analysis of archaeological data and interest in human settlement patterns had a major impact on subsequent archaeological research.

The next major pioneer of prehistoric settlement pattern studies in the Americas was Gordon Willey. Willey was also influenced by the work of Steward, but carried out his research in a different manner. Willey examined human settlement patterns from a functionalist, rather than ecological perspective. Willey (1953:1), viewed archaeological settlement patterns as a starting point for the functional interpretation of cultures. Willey also stated that hunter-gatherer settlement pattern models must examine the environment, the level of technology on which the past hunter-gatherer population operated, and the institutions of social interaction which the population maintained (Willey 1953:1). Willey viewed settlement patterns as indications of human behavior. He was also the first to offer a systematic methodological framework for a conjunctive approach to research on settlement patterns (Chang 1972:2). What is meant by a conjunctive approach to research is that Willey pioneered regionally orientated research on settlement patterns. In other words, Willey's contribution progresses hunter-gatherer settlement pattern studies from a single culture approach to a multiple culture - regional approach in his search for a general theory of hunter-gatherer settlement patterns. The work of both Jullian Steward and Gordon Willey shaped the future of settlement pattern studies in America. Their work particularly influenced those archaeologists interested in past hunter-gatherer populations. This influence is evident through the 1960s and 1970s.

During the 1960s and 1970s models of hunter-gatherer settlement patterns began to emerge. Two prominent models of hunter-gatherer settlement patterns during the two decades were the site catchment model, originating from the U.K., and the forager–collector model, originating from the Americas.

In the late 1960s and early 1970s, through research conducted by Eric Higgs and Claudio Vita-Finzi, the site catchment model became popular in archaeology as an alternative approach to hunter-gatherer settlement pattern studies. Higgs and Vita-Finzi (1972) attempted to interpret archaeological findings in relation to the total resources available in the vicinity of the settlement, or archaeological site (Trigger 1993:270). This interpretation also took into consideration a presumed seasonal pattern of exploitation. Higgs and Vita-Finzi were not the first to introduce the site catchment model to anthropology, but they were able to present the model in a comprehensible fashion. Originally, the site catchment model had its roots in economic geography. In economic geography, the site catchment model examined locations of settlements relative to the availability of resources (Roper 1979:122).

Vita-Finzi and Higgs (1970:5) define the site catchment model as "the study of the relationships between technology and those natural resources lying within economic range of individual sites." Site catchment analysis examines both the "economic catchment area and the site-exploitation territory" as a means of interpreting the relationship between what resources were potentially available for use by hunter-gatherers and what resources were actually used (Fagan 1997:340). The exploitation territory is the defined as the area surrounding the archaeological site that is habitually exploited by the hunter-gatherer population (Higgs & Vita-Finzi 1970:7). The size of the exploitation territory is dependent on the terrain. Higgs and Vita-Finzi (1970:7) calculate that the exploitation territory is the extent of a two hours walk from the site for hunter-gatherer sites. In relatively flat grounds, the exploitation territory can be quite immense, whereas in a mountainous region, the exploitation territory can be limited. The site catchment model is valuable to this thesis because it can demonstrate how a hunter-gatherer site is adapted to its immediate environment. The site catchment model also allows for interpreting the economy of prehistoric populaitons.

According to Higgs and Vita-Finzi (1972:28), there are three broad classes of prehistoric economies: mobile, sedentary, and mobile-cum-sedentary (Higgs & Vita Finzi 1972:28). Mobile economies " are practiced by groups which move from place to place each year" (Higgs & Vita-Finzi 1972:28). The length of stay at any one place is dependent on available resources. Higgs and Vita-Finzi (1972:28) further state that "in the long run the effort of movement - if successful - will be to coordinate resources into successful economies and to maintain a higher population than could be supported if the resources were being exploited in isolation by specialized groups." Sedentary economies are those practiced by human groups that stay in one place all year long. Sedentary economies are recognizable through the development of lasting wealth in the form of houses, roads and the like (Higgs & Vita-Finzi 1972:29). Finally, mobile-cum-sedentary economies are those distinguished by a mobile element associated with a sedentary occupation. These occupations are often found in lowland areas that lie adjacent to uplands (Higgs & Vita-Finzi 1972:29). Human populations that practice a mobile-cum-sedentary economy can take advantage of the two distinct environments: the uplands for providing animal protein and the lowlands for providing and environment that can produce staple cereal crops (Higgs & Vita-Finzi 1972:29).

Hunter-gatherers are food collectors, not food producers. Because they do not produce food, it is not viable to stay in one location all year long. Resource variability and availability do not allow for it. Therefore, it is reasonable to assume that hunter-gatherer populations can be identified as having a mobile economy. In fact, hunter-gatherers are typically mobile and the site catchment approach allows archaeologists to interpret single hunter-gatherer sites as the constituents of a bigger system where a number of sites may have variable economic specializations.

In the late 1970s and early 1980s, Lewis Binford further explored the concept of mobility and the economic organization of hunter-gatherers and their effect on settlement patterns for hunter-gatherers. Binford, like Willey, examined settlement patterns using a functionalist approach, demonstrating how the function of sites can differ, and how this functional difference shapes and transforms the entire settlement system. Binford proposed "that 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" (1980:4). The more complex the environmental variables (i.e. the greater the fluctuation in seasonal temperatures), the more complex the subsistence or settlement system. Binford proposed that there are two models (systems) of subsistence strategies for hunter-gatherer populations and that these models, in turn, affect settlement patterns. These two models are foraging and collecting (Binford 1980:5-12). Foraging populations are identified by the following characteristics:

1. Seasonal residential moves among a series of resource patches.
2. They typically do not store food.
3. There is considerable variability in the size of the population as well as the number of residential moves made during an annual cycle.
4. There is variability in the duration of stay at different sites.
5. The evidence of "relative redundancy" of land use from year to year.

Examining the archaeological remains from foraging populations, two types of spatial context for the discard and abandonment of artifactual remains exist: residential base and location. Under residential base, residential mobility may vary in duration, spacing between sites, and group size. The pattern of residential mobility may be centered on a series of restricted locations, increasing the year to year redundancy. Under location, it is predicted that the locations are generally low bulk procurement sites, where the site is only occupied for a short period of time. Few tools are expected to remain at the site because of the short occupation period. The archaeological remains may be scattered over the landscape.

Collecting populations exhibit the following characteristics: (1) they supply themselves with specific resources through specially organized task groups; (2) there is storage of food; (3) they have logistically organized food procurement parties; and (4) there are small task groups of skilled and knowledgeable individuals. Upon examination of the archaeological remains of collecting populations, five types of spatial context for the discard and abandonment of archaeological remains exist for collecting populations. These five spatial contexts are residential base, field camps - temporary operation centers, location - where procurement and processing of raw materials takes place, stations - sites where special purpose task groups are localized and engage in information gathering, and caches - temporary storage areas.

Binford's forager and collector model is a modern iteration of the economic zonation model for archaeological settlement pattern analysis with emphasis on the function of a site in relation to the natural environment. The forager-collector model also incorporates middle-range theory in its development. Accordingly, with middle-range theory, not only are economic schools of thought drawn into the model, but ecological schools of thought are also added by stating that the environment is a strong force in the shaping of hunter-gatherer adaptation. The forager collector model also considers ethnography in the construction of the model. Ethnographies of hunter-gatherer populations can be seen, in some instances, as analogous to those hunter-gatherer populations being studied through the archaeological record. One exemplary example of the direct use of the foraging-collecting model and the incorporation of hunter-gatherer ethnography is Thomas' 1983 study on subsistence-settlement systems of hunter-gatherer populations in the Great Basin region.

Binford's forager-collector model is valuable for this thesis because it demonstrates how a hunter-gatherer site is part of the larger system and how this system is adapted to the regional environment. This system shows its adaptive strategies through foraging and collecting. The system is also comprised of a number of functionally different sites that are influenced by subset populations, activities conducted at the sites, the locations of the sites within the regional context and seasonality.

The model of hunter-gatherers where populations are classified as foragers or collectors is still used today in hunter-gatherer studies, both anthropologically and archaeologically. Another model developed in the 1970s that uses ethnographic accounts in its development and currently is still used today in the identification of hunter-gatherer settlement patterns is the predictive model. In the next section, the predictive model will be discussed. The predictive model is of particular importance for this thesis and is used in this thesis to identify hunter-gatherer settlement patterns in the Kluane region.

2.3 The Predictive Model Approach

According to Kohler and Parker (1988:400), a predictive model:

> "Attempts to predict, at a minimum, the location of archaeological sites or materials in a region, based either on a sample of that region or on fundamental notions concerning human behaviour."

Additionally, the prediction of archaeological sites is based on determining a correlation between archaeological sites and the environmental features in a specified region (Green 1973:279). Once a correlation is identified, this information is extended to regions with a similar environment to test for the presence of archaeological sites.

The concept of predictive modeling has its roots in the discipline of geography under the designation of locational modeling (also known as locational analysis). Locational modeling was developed as early as the 1940s, under the direction of August Losch, and further refined in the 1960s by the likes of M. Chisholm and Peter Haggett. Chisholm is known for his research on land-use zones that investigates the distance from a settlement to various services (Haggett 1965:158-9). The services of interest included water, roads, supplies, and electricity. Haggett is known for his application of locational modeling at a regional scale, and his development of nodes and networks – relationship between settlements and location of routes between settlements (Haggett, 1965).

Locational modeling, like site catchment analysis, developed from economic schools of thought and is an extension of central place theory (Redman 1973:15). According to the tenet of central place theory, "in locating settlements, the inhabitants attempt to maximize the available resources" (Redman, 1973:15). It is also stated, through the principles of central place theory that "if one known the critical variables for site location and can assume certain uniformities in the physical situation, it is possible to construct the theoretical optimum distribution of sites in a region" (Redman, 1973:15). In the discipline of geography, a locational model tests hypotheses about non hunter-gatherer settlement patterns. It is not until anthropologists employed the model, that it was applied to hunter-gatherer settlement patterns and referred to as a predictive model. For this thesis, Michael Jochim's perspective on the predictive model for hunter-gatherer settlement patterns is examined. The reason for examining Jochim's perspective rather than other anthropological perspectives is because of its ease of using a geographic information system program as a technique in the methodology.

According to Jochim (1976:xiii), a predictive model is based on "explicit generalizations derived from numerous ethnographic studies." This predictive model of hunter-gatherer economic behaviour is supported by two schools of thought centered on ecology and decision making theory. Based on the two schools of thought, seven general assumptions are to be considered in the predictive model (Jochim 1976:10). These assumptions are as follows:

1. Economic behaviour is the result of conscious choices.
2. These choices are deliberative rather than opportunistic.
3. The deliberation is rational, based on preferences rather than consequences.
4. The probabilities of the outcomes of choices are uncertain and must be estimated.
5. The choices seek to satisfy predetermined aspiration levels, not to maximize any specific measures.
6. The choices will allow or prefer mixed strategy solutions.
7. A desire to limit effort underlies all economic decisions.

Further to these seven general assumptions, the predictive model contains two organizational principles also supported by the ecological and decision making schools of thought (Jochim 1976:10):

1. The problems requiring solutions or choices can be conveniently formulated as a system.

2. The problems can best be approached in the context of human ecology. The problems faced by hunter-gatherers surround issues of resource procurement such as which resource to use, how much of the resource to use, when to use the resource, where the resource should be procured, and how many people can and should procure the resource.

These problems, or issues, can be summarized into three main problem areas: (1) resource use schedule; (2) site placement; and (3) demographic arrangement (Jochim 1976:11). Resource use proceeds site placement and demographic arrangement in magnitude. In fact, resource use determines the magnitude of the remaining two problem areas.

The purpose of the predictive model is to generate a set of predictions about the nature of a hunter-gatherer economy in a particular environment (Jochim 1976:xiii). The predictions about the nature of a hunter-gatherer economy are based on decisions made regarding resource use. These decisions also concern the spatial arrangement of the population in order to meet a number of goals (Jochim 1976:47). The primary goals that affect spatial arrangements are summarized into three main categories (Jochim 1976:50):

1. Proximity of economic resources.
2. Shelter and protection from the elements.
3. View for the observation of game and others.

The decisions concerning the spatial arrangement of the population are also determined by factors other than the three categories outlined. The ecological zones in which also influence the spatial arrangement the hunter-gatherer population lives. According to Jochim (1976:52), "the immediate spatial distribution of soils, elevation, vegetation, temperature, precipitation, and rock forms define the opportunities and constraints."

The predictive model is investigated in this thesis because there are three main advantages to its use. According to Jochim (1976:xiii), the advantages to the use of a predictive model for hunter-gatherer subsistence and settlement are:

1. It operationalizes our expectations about how hunter-gatherers would use a given environment.
2. It allows us to compare these expectations to actual patterns of utilization.
3. It generates predictions about a great variety of activities and their products, thereby allowing its application to the archaeological record containing various classes of remains.

Aside from the three advantages to using the predictive model provided by Jochim, a fourth advantage to its application is its compatibility with geographical information system programs. The use of GIS in a predictive model dispels some of the criticism expressed about the ability to reliably predict site locations in a region. With GIS, a predictive model can be created without the bias of random sampling. The bias of random sampling is eliminated because all site locations can be compared with all non-site locations.

Most recently, Jochim (1998) has modified his concept of a predictive model. In his research on southwest Germany during the Paleolithic and Mesolithic, Jochim maintains that the ecological approach and decision making approach remains valuable in model building. Rather than creating a single complex model to predict aspects of hunter-gatherer spatial behaviour, Jochim develops numerous simple models. This thesis will build a complex regional model for hunter-gatherer land-use (cf Jochim 1976) but this model is based on more than one theoretical model. Binford's (1980) forager-collector model is one of the theoretical models used. A second model is the composite band model (Steward 1955), which will be discussed in the next chapter. Like Jochim, ethnographic data will also play a significant role in the development of the regional model. This ethnographic data comes from studies on western subarctic Athapaskan populations.

2.4 Conclusions

In chapter two, two sections were produced. In the first section, the history of hunter-gatherer settlement pattern studies was discussed. What can be concluded from this first section is that the process of hunter-gatherer settlement pattern analysis moved through several stages. The final stage, which we are presently at for hunter-gatherer settlement pattern analysis, is that a system of archaeological sites must be viewed as operating in an environmental context. This environmental context is the region.

In the second section, approaches to predictive modeling are discussed. The model's beginnings, in the discipline of geography, and adoption, in the discipline of anthropology (particularly the field of archaeology), are traced.

In this thesis, a regional model is constructed. The regional model can then be used to predict archeological site locations within the study region and in regions with a similar environment. The regional model, similar to Jochim's model, uses more than one data set. In this thesis three types of data are integrated to build a regional model for the study area: ethnographic data, environmental data and archaeological data. Based on the ethnographic and environmental data for the study region, hypotheses can be constructed regarding hunter-gatherer site location, settlement patterns and seasonality. In the following chapters, these hypotheses are formulated.

CHAPTER 3

HUNTER-GATHERER SOCIAL ORGANIZATION

3.1 Introduction

Social organization can be defined as the ways in which people organize themselves into groups or alliances. Social organization is influenced by internal factors such as the degree of political integration, religion, gender roles, and trade of a population. Social organization must also be a response to the environment the population is situated in and the economic activities that are employed to extract resources from that environment.

Archaeological research on social organization is limited to the study of material culture and settlement patterns and this limits the amount of information on social organization that can be extracted and interpreted. This dilemma has long been recognized. Clark (1939) stated that research that focuses on the economic factors of an archaeological population or examines the environmental context in which these populations lived "merely constrains rather than determines the nature of social organization and religious beliefs; hence much of the specific content of these higher levels of human behavior is not subject to the same kind of scientific analysis ass are technology, subsistence economies, and trading patterns" (in Trigger 1993:265-266). If, according to Clark, higher levels of human behavior in prehistory are not subject to scientific analysis then other techniques must be used to interpret the social organization of archaeological populations. One such technique is ethnographic analogy.

Analogy is "a process of reasoning that assumes that if objects have some similar attributes, they will share other similarities as well…it implies that a particular relationship exists between two or more phenomena because the same relationship may be observed in a similar situation" (Fagan 1993:301-302). Archaeologists use ethnographies and ehtnohistories of known cultures to assist in the interpretation of archaeological cultures.

The use of ethnographic analogy is prominent in archaeology today, but it is also used with caution. The ethnographically known hunter-gatherer population is not a direct reflection of the archaeological hunter-gatherer population. Ethnographic comparisons are not always an option because the social structure of historical populations may be significantly altered (Lee & DeVore 1968:3). Furthermore, variability in human behavior exists on both the spatial and temporal level.

Binford (1966:269) explains the role of ethnography in archaeological interpretation by stating that:

> "Methodologically, the archaeologist is not dependent on the ethnologist. Archaeologists are dependent for building models upon the knowledge currently available on the range of variability in form, structure, and functioning of cultural systems…. The interpretation of the archaeological record by the citation of analogies between archaeologically observed phenomena and phenomena from a known behavioral context simply allows one to postulate that the behavioral context was the same in both cases".

Binford (1968) maintains that ethnographic data can play two basic roles in archaeological interpretation: (1) they serve as resources for testing hypotheses which seek to relate material and behavioral cultural phenomena; and (2) they may serve as the basis for models of particular social relations which are postulated to have been the behavioral context for an observed archaeological structure. One model that is the result of ethnographic research, and is the focus of this research is the patrilineal and composite band model.

3.2 Band Models

In his publication *Theory of Culture Change* (1955), Julian Steward uses ethnographic research to arrive at two levels of social organization of hunter-gatherer societies: the patrilineal band and the composite band.

3.21 The Patrilineal Band

The essential features of hunter-gatherer populations with a patrilineal band form of social organization are – patrilineality, patrilocality, exogamy, land ownership, and lineage composition (Steward 1955:122). The environment of all patrilineal bands is similar in that (Steward 1955:123-124):

1) They have limited and scattered food sources, which restricts population density and prevents a population from assembling in large permanent aggregates.
2) The principle food source is game which may be profitably hunted collectively.
3) The game occurs in small, non-migratory bands rather than large, migratory herds.

The size of the band territory is variable and must be able to support the entire band population. Steward (1955:125) comments that the population of a patrilineal band is usually sparse, averaging 50 members and rarely exceeding 100 members, and the area in which a band occupies is not extremely large, averaging around 100 square miles and rarely exceeding 500 square miles.

Centralized control in the patrilineal band only exists for hunting, rituals, and a few other affairs that are communal (Steward 1955:126). Examples of patrilineal bands that are known ethnographically include: various bands throughout Australia, Tasmanian bands, the Ona of Tierra del Fuego, the Tehuelche of Patagonia, various southern Californian bands such as the Shoshone, Cahuila, Luiseno, and the Yuman Diegueno, various bands in the central desert of Baja California, the Philippine Negritos, the Semang of the Malay Peninsula, Central African Negritos (pygmies of the Ituri forest), and the Heikum of South Africa (Service 1971:48-50).

3.22 The Composite Band

The term composite band is used to describe the social organization of a population that consists of many unrelated biological families (Steward 1955:143). These families are integrated to form villages or bands of hunter-gatherers, or even small scale farming communities (Steward 1955:143). The composite band is similar to the patrilineal band with the following exceptions (Steward 1955:149-150):

1) It lacks exogamic rules and martial residence customs.
2) The chief game resource is large migratory herds.
3) Because the chief game resource is largely migratory herds, social aggregates of several hundred people are possible.

Examples of ethnographically known hunter-gatherer populations that can be classified as composite bands include the Northern Algonkains, the Andamanese of South Africa and the Canadian Athapaskans.

Although the patrilineal and composite band models may be considered outdated, the composite band model remains the basis for regional models of Northern Athapaskans, in particular the Southern Tutchone of the southwest Yukon Territory.

3.3 The Northern Athapaskan – Southern Tutchone Ethnography

In recent ethnographic research, it has been demonstrated that traditional social organization of the Northern Athapaskans in the Western subarctic has not been altered dramatically by Northwest Coast influences or by European contact. The use of ethnographic models, such as Steward's composite band model, to study settlement patterns of prehistoric hunting-gathering populations is best illustrated by example. In this section, the Northern Athapaskan social organization is of interest to this research because the Northern Athapaskan, particularly the Southern Tutchone, historically, and currently, inhabits the study region.

June Helm (1968) examined the social organization of Athapaskan populations in the Arctic Drainage region and concluded that three main socioterritorial units exist there: the regional (or composite) band, the local band, and task groups. The regional (or composite) band is the sum of all local bands in a territory. The regional band constitutes the marriage universe for the local groups. The regional band is also concerned with the communal economic exploitation of an intensive area (Helm 1968:118). The local band usually consists of a set of adult siblings, for example two brothers, their spouses and children, and very often their parents. Task groups are frequently small groups, usually of the same sex, that congregate to perform a particular task. An example of a task group would be a woman and her children forming a berry gathering party, or a small group of men forming a hunting party.

Catherine McClellan (1981; 1987) has gathered extensive data on the Tutchone of Southern Yukon. McClellan (1981:492) describes the Southern Tutchone as highly mobile people that move about in small local groups, annually exploit hundreds of square miles, and periodically adjust their movements to changes in traditional subsistence resources. The small local groups form a regional (or composite) band that can reach a population count of several hundred.

In more recent ethnographic research, it has been demonstrated that traditional social organization has not been altered drastically in the Western subarctic by the Northwest Coast influence. Catherine McClellan (1981; 1987) has gathered an extensive amount of data on the Tutchone of Southern Yukon. The Tutchone are recognized as a population that is identified as Western Subarctic. McClellan (1981: 492) describes the Tutchone as highly mobile people that move about in small groups, annually exploit hundreds of square miles, and periodically adjust their movements to changes in traditional subsistence resources. McClellan also uses Steward's composite band as a model for social organization of the Southern Tutchone.

Regarding the location of Tutchone living spaces, McClellan (1975:233) had this to say about what constitutes and ideal living space and what living spaces were repeatedly used:

> "The Yukon living sites which were most often used were, of course, those offering the best food resources. A good camp also had ample supplies of wood and water, was protected from strong winds, but had a good breeze in the summer to keep down mosquitoes. It also had sufficient flat ground for housing and for activities such as drying fish or meat, manufacturing snowshoes or other gear and recreation."

From this ethnographic information, it is hypothesized that archaeological hunter-gatherer site locations in the study region, the same region that the Tutchone currently inhabit, with have the same characteristics that were express by McClellan.

Regarding the Southern Tutchone subsistence economy, the Tutchone in the 19th century had an annual cycle of economic activity (McClellan 1981:496). The following information, directly from McClellans ethnographic survey describes the annual round of the Tutchone population inhabiting the region

Spring: The people hunted large mammals, such as moose, and moved from kill to kill. In early spring, fishing parties were set up along a lake shore. Freshwater fish, particularly whitefish, was taken from the ice-covered lakes. This continued until the ice began to melt. Small mammals such as beaver and muskrat, and returning migrant waterfowl were also exploited.

Summer: Moose were hunted in early summer until they were driven away by flies. Caribou was also another food source but the caribou was not hunted in multiples, but rather individually. Ducks, ptarmigan, and marmots were also utilized. In late summer, those populations with access to salmon began intensive fishing drying and caching of the salmon, those without access to salmon began to intensively hunt, dry, and cache the meat from summer mountain sheep.

Fall: this was a time of movement to the mountains and intensive harvesting of food resources. Moose were hunted in the late summer and early fall until rutting season. The meat was dried and cached. Caribou was also taken in early fall. Throughout September and October gopher (Arctic ground squirrel) were trapped. 200 to 300 snares would be set. The gopher meat would be dried and cached as well. In October and November the hunters concentrated on mountain sheep. This meat was also dried and cached. Ice fishing for whitefish and trout also took place in late October but stopped in mid-November because it became too cold and there were fewer fish by this time.

Winter: The hunter-gatherer populations usually stayed in winter houses and lived off of the cached food resources. These resources almost always ran dry by late winter and the hunter-gatherer groups would have to start hunting moose and caribou thereby, leaving the winter houses and moving from kill to kill. Small mammals, such as rabbit (hare) were also snared.

McClellan (1981:496) acknowledges that special resource locations meant a slightly different emphasis in the general exploitive patterns described here. In other words, if a band had access to rich salmon resources, emphasis on fishing would occur whereas other bands with better access to large game, such as mountain sheep and caribou would concentrate on large game hunting.

With regards to annual settlement patterns, McClellan (1981:497) comments that bands usually returned to good fishing spots annually. These good fishing spots are usually on lakes or tributaries of major rivers. Winter camps were usually located in areas that are sheltered from the wind and summer camps were located in open grassy places (McClellan 1981:497-498).

From the ethnographic record, it is observed that Athapaskan band populations are extremely flexible in size and composition. It is also observe that fission-fusion occurs within both the local and regional bands. Although the ethnographic record cannot be used as a template for the archaeological record, it can be used to form hypotheses about the social organization of archaeological hunter-gatherer populations.

On the basis of this ethnographic data, we can predict that past Athapaskan hunter-gatherers in the Kluane region would have arranged themselves in a similar fashion and three types of sites should therefore be identified in the archaeological record:

1. Small sites are where a local band will camp to trap, hunt and fish; and
2. Larger "aggregation" sites are where the regional local band will gather to communally fish or hunt large game.
3. Special purpose sites are where specific resources are extracted and will not be representative of the local or regional band.

It can further be predicted that the small local band sites will be scattered across the region while larger aggregation sites will be situated at advantageous locations. These advantageous locations include spawning grounds for fish in lakes and tributaries of rivers, and points along the seasonal migration route of large game. It can also be predicted that sites located in sheltered areas can be identified as winter camps and sites located in open areas are possibly summer camps. Large winter camps where there is evidence of caching may be identified as winter aggregation sites, whereas small winter camps with no evidence of caching can be identified as local band camps.

3.4 Conclusions

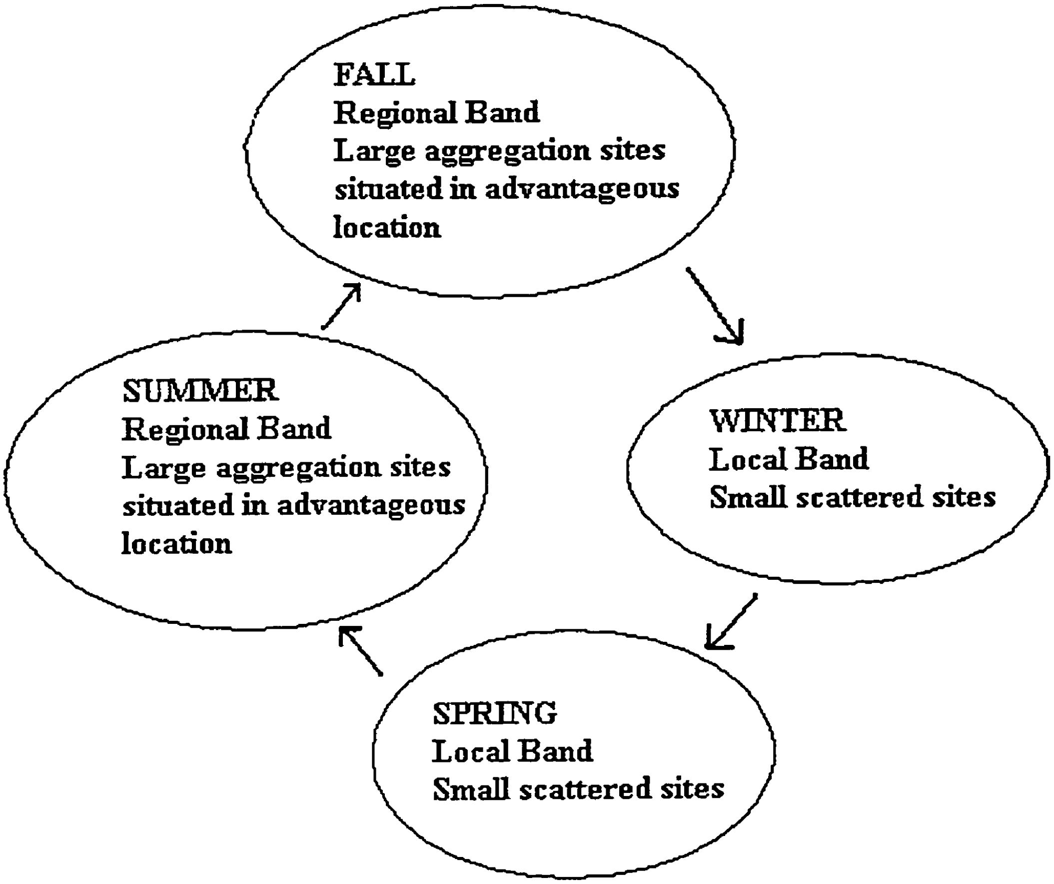
A system of archaeological sites must be viewed as operating in an environmental context. This environmental context is the region, definable as a geographically defined area in which ecological adaptations are basically similar and that, at a given time, a high degree of cultural homogeneity may be expected (see chapter one for detailed definition). Hunter-gatherer settlement patterns studies can be examined from an economic and functional perspective, but in order to understand the social organization of a hunter-gatherer population it is necessary to examine the ethnography.

When using ethnographic analogy, it must be acknowledged that the behavior of ethnographic hunter-gatherer populations is not always reflective of the behavior of archaeological hunter-gatherer populations. However, ethnographic data can be used to formulate hypotheses on human behavior that can then be tested through the archaeological data. Here the Northern Athapaskan ethnographic data, particular to the Southern Tutchone, is used to formulate hypotheses for settlement patterns of northern subarctic hunter-gatherer populations in the study region. These hypotheses are:

1. Three types of archaeological sites should be identified in the archaeological record: small local band sites and larger regional band aggregate sites.
2. Small local band sites should be scattered across the landscape whereas large aggregate sites will be situated in advantageous locations.
3. Small local band sites should be characteristic of spring and winter activities, whereas large aggregate sites are characteristic of summer and fall activities.

A framework for a regional model for the southwest Yukon can be speculated. Figure 3.1 is a visual illustration of these hypotheses. In the following two chapters methods investigating these hypotheses in the archaeological record are discussed using GIS. Through GIS, further hypothesis formulations on important environmental spatial variables and testing of these formulations can be conducted.

Figure 3.1 Hypothesized model for Regional Land-Use by Hunter-Gatherers in The Southwest Yukon



CHAPTER 4

GEOGRAPHICAL INFORMATION SYSTEMS IN ARCHAEOLOGY

4.1 Introduction

To reiterate, the primary goal of this thesis is the identification and analysis of past hunter-gatherer settlement patterns. Chapter two provided the model used in this thesis – the predictive model. Chapter three provided the hypotheses for prehistoric hunter-gatherer settlement patterns in the southwest Yukon Territory. In order to test the hypotheses for settlement patterns, the distribution of known archaeological sites within the study region must be examined in relation to topography, local resources available, and climatic elements. In this chapter, the techniques used to accomplish this task, geographical information systems, are discussed.

In the first section, the concept of geographic information systems will be explained as well as the history of the development of these systems. In the second section of this chapter, the history of the use of geographic information systems in archaeology is examined. In this section, it is acknowledged that although anthropologists have only utilized geographic information systems for a relatively short period of time, they are proving to be of value and are becoming a popular analytical tool for the discipline. Following this, a critical examination of the advantages and disadvantages of geographic information systems as analytical tools will be conducted. Geographic information systems, like all computer programs and applications, are not flawless. It is important to choose the appropriate geographical information system software and to adapt geographic information systems for use as a tool for anthropological analysis.

4.2 Geographical Information Systems

As mentioned in the introduction to this thesis, geographic information systems (GIS) are systems of computer hardware, software, and procedures designed to support the capture, management, mathematical manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems. Computer aided mapping through a GIS are a very powerful tool because it allows the researcher to use more than one map in their analysis. Several thematic maps of a particular area may be layered to illustrate how the various themes can be related. For example, three maps: a topographic map; a map showing the location of known archaeological sites; and a hydrology map may be layered one on top of the other to show how these three "themes" are spatially related.

The integration of statistical function in GIS can provide three types of analysis functions: spatial queries, attribute data queries, and set queries - a comparison or "combination query" that involves two or more query sets (Korte 1997:114). Set queries have the ability to generate new information based on the data (Aldenderfer & Maschner 1996:4; Fagan 1997:166; Stine & Lanter 1990:80). For example, if a researcher wants to identify archaeological sites with two specific attributes, they can specify the attributes of interest and only those sites with the specific attributes will show up in the query. This query can be taken a step further by adding a variable outside of the archaeological database. For example, you may want to explore the spatial location of the archaeological sites you initially queried by differentiating between those sites within a 50-meter range of a water source and those sites outside of this range. In this respect, GIS act as database managers, but still have the ability to visually display the data spatially.

GIS essentially consist of two parts: a standard relational database that allows for cross-tabular searching; and a graphic or mapping database, that allows an examination of space, time, and form (or shape) simultaneously (Green 1990:5). The computerized database component of GIS allow for the storage and retrieval of the information found on the maps and attached to features on the maps. GIS store two forms of data: spatial data and attribute data. Spatial data are "data pertaining to the location of geographic entities together with their spatial dimensions (longitude and latitude)" (Korte 1997:406). Spatial data are typically entered in the form of points, lines and/or areas. Attribute data are the descriptive characteristics of a feature (Korte 1997:596). For example, the location of an archaeological site - the latitude and longitude coordinates - are the spatial data, and the data pertaining to each archaeological site - the Borden number, the site type, and the cultural materials recovered there - are the attribute data.

In a large number of GIS applications, the data encoded into a system relates to both the physical and human aspects of the geographical world (Martin 1996:51). In this case, GIS are sometimes viewed by social scientists as "merely a toolbox for the answering of questions with a spatial dimensions" (Martin 1996:68). While the study and practice of GIS are neither a science, nor an academic discipline, it does permeate the boundaries of many "conventionally defined disciplines" (Martin 1996:68). Others view the application of GIS quite differently. Openshaw (1996:676) states that "the absorption of GIS into geography offers the basis for a long overdue reconciliation between the soft pseudo-science of the social sciences and the hard spatial science of which GIS are a part". One such social science that has been able to effectively use GIS analysis is archaeology.

4.3 The history of GIS in Archaeology

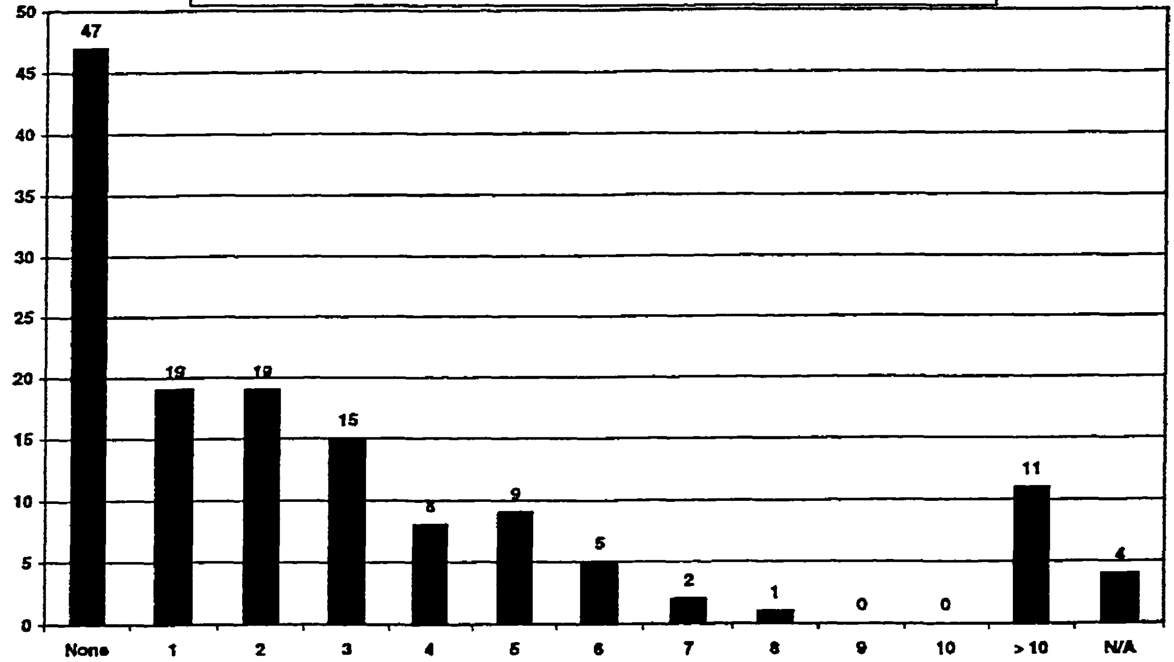
GIS were originally created in the 1960s as a tool to assist government and university researchers to represent the earth's geography through computers (Korte 1997:7; Lock & Harris 1992:89). According to Lock and Harris (1992:89), the potential of GIS for archaeological research was first recognized in North America in the early 1980s. By 1985, both the Commission IV of the Union International des Sciences Pre et Proto-historiques (UISPP) and the Annual meeting of the Society for American Archaeology (SAA) had organized sessions on the uses of GIS in archaeology. Papers presented in these sessions covered methods, principles, and specific regional applications of GIS. By 1986, Kenneth Kvamme had developed an archaeologically focused GIS program called ARGIS, now renamed TERRAINPAC. In 1989, Stanton Green organized a GIS symposium at the Archaeological Congress (Green 1990). In the same year, a NASA sponsored conference was held to encourage anthropologists and archaeologists to engage in some of the new technologies available, particularly GIS, GPS (Global Positioning Systems), and GPR (Ground Penetrating Radar). The result of this conference is "substantive research that could not have been done without these methodological tools" (Maschner 1996:762). With the introduction of GIS in archaeological research, various new types of analysis are possible, such as viewshed analysis – the calculation of a view range from a view point).

In 1998, Kalid Gourad, a graduate student at Hunter College, conducted an Internet based survey of GIS and Archaeology[1]. One hundred and forty archaeologists responded from around the world. Some of the responses of this survey will be illustrated, but it must be cautioned that Gourad solicited responses primarily from archaeologists with a vested interest in geographical information systems. From the survey, it can be concluded that formal GIS education for archaeologists is relatively low, with over fifty percent of the respondents having taken two or less GIS courses. Figures 4.1 shows the level GIS education of the survey participants. In other words, archaeologists using GIS in most cases learn by doing. It is a "hands on" learning process.

Presently, there are three trends in modeling and research that archaeologists can address with GIS: 1) site location models; 2) GIS procedure related studies; and 5) studies that address larger theoretical concerns - for example, the analysis and modeling of settlement patterns, subsistence patterns, and social organization.

[1] Mr. Gourad graciously gave me permission to employ some of his survey results in this research. Further information on the survey can be obtained at URL http://everest.hunter.cuny.edu/~kgourad.

Figure 4.1 GIS Classes Taken by Participants



4.4 Advantages To Using GIS

The utilization of GIS in archaeology, and the social sciences in general, presents several advantages to more traditional landscape analysis. First of all, GIS improves the ability to describe and interpret spatially referenced data (Zvelebil, Green & Macklin 1992:195). Archaeological data can be stored in map format that can be easily retrieved thus making GIS "flexible and comprehensive analytical tool available to archaeologists" (Gaffney, Stancic, & Watson 1995:211). Additionally, GIS not only stores the locational and attribute data, but can also store the topological relationship between each spatial entity (Lock & Harris 1992:90). In other words, not only can the archaeological data be stored and easily retrieved for future research, but the corresponding environmental data, such as hydrological systems and vegetation boundaries, can also be stored for future retrieval.

Second, GIS has the ability to select, integrate, and analyze features from multiple maps and to construct new variables or maps from these sources. Thus, it can generate new information from existing information (Aldenderfer & Maschner 1996:4; Fagan 1997:166; Lock & Harris 1992:90; Stine & Lanter 1990:90). An example of generating new information from existing information is the transformation of spot elevations, points on the landscape where an elevation is recorded, into digital elevation models. Digital elevation models, in turn, can be used to calculate slope for the research area. From an archaeological perspective, slope is of considerable importance. For example, slope can be considered as one of the many environmental variables used to identify site location preferences. Typically, archaeological sites are located on level ground surfaces where steep slopes will not interfere with daily activities (Kvamme 1985:17). Additionally, slope can be associated with the probability of diagenetic alteration through water action and blurring or creation of new patterns of artifact association due to rolling.

Third, GIS are advantageous because it allows for objective testing and exploratory queries that include the entire populations rather than a sample of the population. As a powerful statistical tool, GIS can provide access to objective tests based on statistical principles (Goodchild 1996:242). An example of some of the objective tests based on statistical principles include finding the trend - the average nature of a surface; and determining variability - how much does the observed surface deviate from the average nature of a surface (Barber 1998:96). For example, in this thesis, the observed surface, the location of the archaeological sites, is compared with the average nature of the surface, the region. Statistical principles commonly used include correlation - how one variable relates to another; covariance - the correlation in the variance of more than one distribution; and hypothesis testing - a statement about a population. Statistics are used not only as a means of discovering associations between variables, but are also used as a means of evaluating the strength of associations between variables (Dalla Bona 1994:16). This is particularly important in the development of predictive models.

Fourth, GIS provides a specific methodology for addressing multivariable problems. GIS "provide a means for spatially referencing observations in ways that allow one to describe, analyze, compare, and mathematically manipulate spatial distributions (Green 1990:5). Put in different terms, it allows inexpensive testing of models derived from general theory.

Finally, GIS are advantageous because it allows for reclassification of data. Map data can be reclassified, and continuous variables can be reduced to a categorical form. This type of operation permits contingency tables - forms of error assessment, and associated statistics to be produced to accompany graphical information (Lock & Harris 1992:91).

GIS have several other advantages specific to archaeological research. At the basic level, GIS are an asset to archaeological research because it gives the researcher the ability to map site distributions at the macro, or regional, level, and perform spatial analysis on artifacts at the micro, or site, level. The advantages of utilizing GIS in archaeology really go much further, however. According to Parker (1986:154), the management of an archaeological resource base can be greatly enhanced because GIS assist in: 1) locating the archaeological resources and placing this information into a regional context; 2) maintaining and updating a cumulative database; and 5) predicting potential site locations in areas that are not completely surveyed.

Using GIS to establish site location models can be both descriptive and predictive. Predictive modeling involves either inductive models - models dependent upon a database, or deductive models - models that begin with theories predicting human behavior (Dalla Bona 1994:1). According to Dalla Bona (1994:2), the introduction of GIS into archaeological research has had two profound results: 1) the application of predictive modeling could now be effected over relatively large areas; and 2) the use of GIS allowed for a uniform analysis of these large areas.

Figure 4.2, demonstrates the scope of GIS analyses in archaeology for the respondents in Gourad's survey, supporting the current trends in modeling and research archaeologists address with GIS. However, figure 4.3 demonstrates that even though GIS have the potential to become a powerful tool in archaeologists, GIS are mainly used as a display tool.

Figure 4.2 Scope of GIS Analysis in Archaeology (n=140)

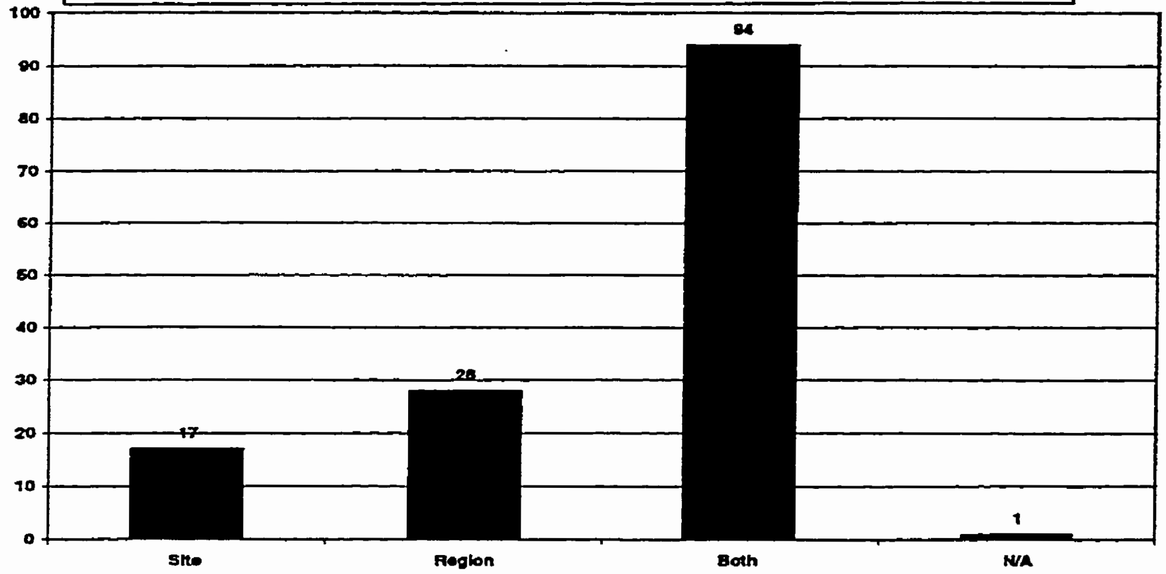
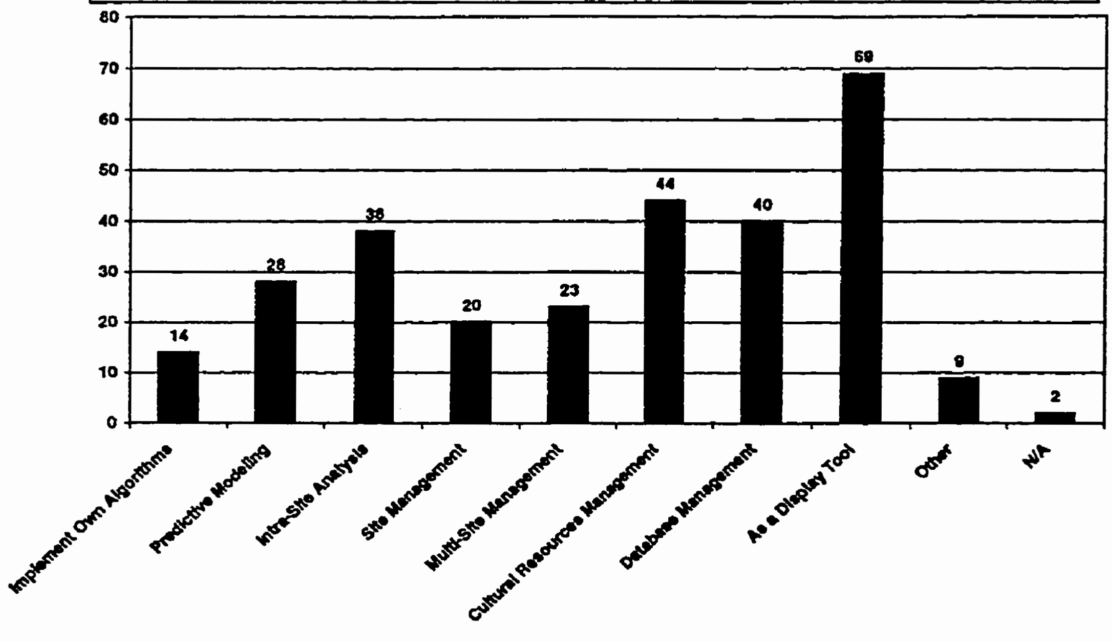


Figure 4.3 Most Successful GIS Application in Archaeology (n=115)



4.5 Disadvantages of Using GIS

Like all computer programs and applications, along with its advantages, GIS also have disadvantages. One disadvantage is linked to the amount of data required to perform analysis using GIS. GIS demand a large amount of spatial data. The cost of acquiring these data and gaining access to them can be restrictive. For example, Geomatics Canada is the major supplier of digitized maps for Canada. Because they control a large portion of the market, prices remain high. Fortunately, some subsidiary companies at the provincial level have reduced pricing arrangements for the purchase of digitized maps for the purpose of research and education. Information sharing between agencies is also becoming more common. In order to handle the large amount of data used in GIS, specific hardware is also required. In some cases, the spatial data alone may require up to or even more than fifty megabytes of space in order to run. A computer with a minimum of 64 megabytes of RAM is required and accessibility to a server is preferred for information storage. The cost of this computer hardware can be restricting.

Another disadvantage, or more accurately a caution, when using GIS for settlement analysis is linked to the types of spatial and temporal data used in archaeological research. Lock and Harris (1996:240) suggest that there is a real limitation to the uses of GIS in archaeological analysis because of the "quality of archaeological data and the current inability of GIS to handle imprecise spatial information and dynamic temporal data." In other words, archaeological information that is sometimes poorly defined spatially, if defined spatially at all. Fortunately in Canada archaeological sites are referenced using the Borden system of map referencing. To take geo-referencing of archaeological sites even further, both the UTM and latitude/longitude coordinates are often recorded.

Settlement pattern analysis considers topographic, environmental and palaeoenvironmental data; it is important to realize that these data may not necessarily coincide with the archaeological data. The past environment will not be identical to the present environment. The aptitude of GIS to analyze paleoenvironmental data remains open to speculation (Gaffney, Stancic, and Watson 1996:152). When running tests such as distance to nearest water source, how reliable are the results? Does the present water source mirror the water source of the past? This concern is addressed in this research.

A final disadvantage of applying GIS as an analytical tool can be linked directly with its application in archaeology. It has been suggested that the application of GIS techniques may restrict the general development of archaeological thought (Gaffney, Stancic, and Watson 1996:155). Bradley (1991:77), drawing on the work of Ingold (1986), has suggested that the dominance of cultural remains in archaeology has led to an analysis of "land rather than landscape…of a terrain in which cultural features have substituted those natural elements that map the world of mobile people." Others have argued that GIS have not been an effective tool for archaeological research because it is linked to theories of human behavior that emphasize functional and economic determinism (Aldenderfer and Maschner 1996:15; Gaffney, Stancic, and Watson 1996:152).

To overcome this criticism of the use of GIS in archaeological research three key issues must be addressed:

(1) Archaeological research is not so much interested in the physical properties of the landscape, but rather in identifying the landscape properties which people recognize and respond to either consciously or unconsciously.
(2) That the landscape is not necessarily a determining factor in the behavior of a human population, but rather an influential factor in the decision making process of humans.
(3) Archaeology is interested in changes in human behavior over time, it is a diachronic approach to the study of human behavior.

Behavioral changes over time may be the result of factors other than the environment such the introduction of new human populations in the region (i.e. European settlement in North America) . These factors cannot necessarily be identified through the use of GIS. We must also be aware that there are religious attributes of a landscape that GIS cannot handle. There have been calls for the development of cognized models using GIS (Gaffney, Stancic & Watson 1995:212; Maschner 1996:505), but no real progress has been made to date.

4.6 Conclusions

When using GIS in archaeological analysis, it is important to:

(1) Verify that the data, both archaeological and geographical, are in compatible spatial units - i.e. the map scale and coordinate units of the various maps used are compatible
(2) Verify that the archaeological data are defined spatially; and
(3) To understand that topographic, environmental, and palaeoenvironmental data cannot be assumed to be static components in archaeological analysis - landscape is a dynamic component, subject to change throughout time.

GIS is a viable analytical tool for the study of hunter-gatherer settlement patterns, in particular in archaeology, and has the potential to produce reliable results. To produce such results, it is important to understand the limitations of GIS. It is also important to maintain an anthropological perspective when utilizing GIS in archaeological research. In general, the anthropological approach to examining settlement patterns of hunter-gatherer populations is concerned with how humans choose to distribute themselves on the landscape according to economic and social considerations, rather than how the landscape determines the distribution of hunter-gatherer populations.

CHAPTER 5

THE STUDY REGION

5.1 Introduction

Three topics of considerable importance are investigated in this chapter: the Paleo-environmental history of Kluane, the history of archaeological investigation, and the cultural history of human settlement. The Paleo-environmental history considers characteristics and changes to the environment in the study region over the past 8000 years up to the present date. The archaeological history reviews the history of archaeological investigation in the southern region of the Yukon. This section also describes the archeological data used for this research.. The cultural history, as it is known presently, is the outcome of 50 years of archeological investigations and ethnographic research. At the end of this chapter it will be evident that most archaeological research in the region has concentrated establishing the cultural history of the region. No work has been initiated to understand the behaviour of the humans who occupied this region in the past. For this reason, the need to complete this research becomes clear.

The region of interest is the western half of Kluane National Park Reserve in the southwest corner of the Yukon Territory, Canada (see figure 1.2). Kluane National Park Reserve lies within the North America Cordillera along the northwest edge of the continent (Environment Canada, Parks 1987:5-1). The National Park covers 22,000 square kilometers and can be divided into two broad physiographic areas: the St. Elias mountains and the Shakwak Trench. The St. Elias mountains make up the majority of the park area and are comprised of several ranges including the Kluane, Icefield, Donjek, Bates, and Alsek ranges and the adjacent lowland and plateau areas (Environment Canada, Parks 1987:6-3). The Shakwak Trench is a long straight valley extending northwestward. Glacial, glacial fluvial and aeolian deposits (Environment Canada, Parks 1987:6-7) cover the valley floor. See figure 1.1 for the general range of the study region.

5.2 Paleo-environmental History in Southwest Yukon

Attempts to construct a chronology of the changes in the environment of the southwest Yukon have resulted in a consensus. This will be outlined below.

The Kluane Region has a comparatively young glacial history, in that deglaciation is relatively recent compared to other regions. Table 5.1 presents the known glacial history of the Kluane region. For this research, three chronological periods will be studied: the early Post-glacial period, the Hypsithermal period, and the Neoglacial period. The combination of the early Post-Glacial and the Hypsithermal period is also known as the Slims Nonglacial Interval, but for this research, the two periods within this interval will be differentiated. General landscape features, climatic conditions, vegetation and faunal characteristics are provided for each period.

Table 5.1: Glacial History of Study Region

Shakwak Glaciation	Pre 100,000 BP
Silver Neoglacial Interval	Pre 49,000 BP
Icefield Glaciation	Pre 49,000 - 37,700 BP
Boutellier Nonglacial Interval	37,700 - 30,100 BP
Kluane Glaciation	29,600 - 12,500 BP
Slims Nonglacial Interval	12,500 - 2,800 BP
Early Post-Glacial	12,500 – 8,700 BP
Hypsithermal	8,700 – 3,000 (2,800) BP
Neoglacial Interval	2,800 BP - Present

5.21 The Early Post-Glacial

The early Post-Glacial period begins approximately 12,500 BP and ends at approximately 8,700 BP. This period is characterized by generally warmer and drier conditions compared to the preceding Wisconsinan Glacial period (known in this region as the Kluane Glaciation). Glaciers in the region reduced in size and retreated upvalley during this period. Dust storms deposited fine, silty loess from exposed outwash and valley train deposits over the glacial tills (Arthurs 1995:21). Towards the end of this period, loess deposition greatly decreased signaling the end of the glacial period and rising in humidity levels (Workman 1978:67).

During the early Post-Glacial period, two Phases in vegetation succession most likely occurred (Stuart, Helmer and Hill 1989:349-351). The first Phase is known as the "birch-shrub tundra" Phase, and dates from 12,500 - 9,500 BP. The dominant plant taxon in this Phase, based on core samples from Jenny Lake and from comparative research in Alaska and Northwestern Canada (Stuart et al. 1989:349), is Betula, also known as dwarf birch. Denton and Stuiver (1969:213-214) report a carbon date of 12,500 +/- 200 BP on a wood sample of Betula said to belong to this Phase (Stuart et al. 1989:349). Generally, birch interval signals the reforestation of newly deglaciated landmasses in northern North America.

The second Phase in the early Post-Glacial period is known as the "alder-shrub tundra" Phase, dating from approximately 9,500 to 8,700 BP. During this Phase there is a decrease in dwarf birch and an accompanying increase in alder, a tree that is related to the birch. This change in vegetation communities is indicative of a warmer, drier climate (Stuart et al. 1989:349). This could also be viewed as a transitional Phase from the early Post-Glacial to the Hypsithermal period. Uncorrected radiocarbon dates reported by Stuart et al. (1989:349) on core samples from the Jenny Lake area in Southern Yukon for this Phase are dated at 9020 +/- 320 BP.

The early Post-Glacial period signals a major faunal turnover, the extinction of "megafauna", (i.e. muskox, Yukon short faced bear, and large-horned bison) and the emergence of an animal community dominated by "grazing" fauna, including as moose, caribou, Dall's sheep and bison. The presence of bison in Southwest Yukon has led researchers to conclude that extensive grasslands occupied the region at some point during the early Post-Glacial period, possibly during the later alder-shrub tundra Phase (Arthurs 1995:21; Workman 1978:66). It must be recognized that bison are not always indicative of an extensive grassland area, however.

5.22 The Hypsithermal

The Hypsithermal period begins at the decline of the early Post-Glacial period, about 8,700 BP, and lasts until approximately 3,000 BP. During this period, it is reported that glaciers in the region retreated much higher upvalley than their present day positions

(Arthurs 1995:22). Climatic conditions are represented by an increase in average temperature and a drier trend (Environment Canada, Parks 1987:6-30). A smaller volume of meltwater probably changed the river pattern from a braided to a single channel and large areas of the floodplain and adjacent terrain, previously subjected to loess deposition, stabilized and became vegetated (Environment Canada, Parks 1987:6-30).

Data from floral communities during the Hypsithermal period are conflicting. The appearance of vegetation hindered wind erosion of the soil and the result was the development of a red-brown Brunisolic soil on the loess substrate (Environment Canada, Parks 1987:6-30). This Brunisol is known as Slims Soil. It has been suggested that the presence of Slims Soil indicate the advance of grassland vegetation and the decline of wooded vegetation (Environment Canada, Parks 1987:6-31; Johnson and Raup 1964:111; Workman 1978:69).

Stuart et al. (1989:349-351), on the contrary, predict a different outcome for the floral community during the Hypsithermal period. According to their research, based on core sample testing at Jenny Lake, Southwest Yukon, there are at least two vegetational Phases during the Hypsithermal. The first Phase is the "spruce forest" Phase, lasting from approximately 8,500 to 4,500 BP. In this Phase Picea (spruce) is the dominant species, reaching a level of 80% of the arboreal pollen total. Alder maintains 15% of the tree pollen population, while dwarf birch almost disappears. Based on their observations of the core samples, Stuart et al. (1989:351) propose that during this Phase, the climate stabilized and cooled slightly but likely maintained warmer than present conditions.

The second Phase of the Hypsithermal period, according to Stuart et al., is the "spruce alder woodland" Phase, existing from approximately 4,500 to 2,000 BP. In this

Phase, there is a decrease in spruce and an increase in alder. Alder is a "fire successional" genus that peaks after major fires, then declines as other wooded vegetation, such as spruce, become established (Stuart et al. 1989:351). During this Phase, there is also a general increase in moisture. Additional research conducted by Cwynar and Spear (1995:32-33) in Southwest Yukon mirrors Stuart et al.'s research since it indicates, that at 6,100 BP the tree pollen assemblage was dominated by spruce (40 to 60% of tree pollen population) and juniper (10 to 40% of tree pollen population). Then, the juniper is suddenly replace by black spruce, making up 40% of the arboreal pollen population. Black spruce remains dominant until 4,100 BP.

Recent research by Stuart et al. (1989) and Cwynar and Spear (1995) tends to disprove the previous geobotanical research completed by Johnson and Raup (1964). This has major implications of *all* archaeological interpretations for Southwest Yukon. Prior archaeological investigations have assumed that human populations living during the Hypsithermal period in Southwest Yukon were living in a grassland environment. In actuality, it is quite possible that these people may have lived in a forested region. If this conclusion has merit, interpretations of subsistence and settlement behavior of hunter-gatherers living in the southwest Yukon during the Hypsithermal period must be reconsidered.

The faunal community during the Hypsithermal is not very clear. During this period bison represented a larger proportion of the archaeological faunal assemblage than in the previous, early Post-Glacial period. It is uncertain, however, whether this increase is a result of northward expansion of the bison to newly developed grassland habitats, or if the bison have existed in this region since the time of the Bering Land Bridge.

Youngman (1975) hypothesizes that the mammalian fauna in the Yukon originated from two refugia which existed during the Wisconsinan Glaciation: Beringia and the main non-glaciated part of North America, south of the continental ice margin (Environment Canada, Parks 1987:9-10).

5.23 The Neoglacial

The Neoglacial period begins at the end of the Hypsithermal period, approximately 3,000 to 2,800 BP, and lasts until the present. The Neoglacial period is characterized by the re-advancement of glaciers and a return to cooler, moister climatic conditions. Neoglacial ice front advances occurred at three separate occasions: 2,800 BP; 1,250-1,050 BP; and 450 BP (Environment Canada, Parks 1987:6-32). This glacial re-advancement resulted in another cycle of loess deposition that continues up to present times thereby, burying the Slims Soil. During the Neoglacial period, the re-advancing glaciers, resulting in the reestablishment of "Neoglacial" lakes, dammed the river valleys. These lakes repeatedly filled and emptied during the Neoglacial. More than 150 basins in the White, Donjek, and Slims-Kaskawulsh drainage areas are, or have been, glacier dammed since the beginning of the Neoglacial period (Environment Canada, Parks 1987:6-37). The largest Neoglacial Lake to form was Neoglacial Lake Alsek. The lake formed and drained at least five times in the last 2,900 years (Clague and Rampton 1982:100).

During the Neoglacial period, volcanic eruptions in the nearby St. Elias mountain range spread volcanic ash over the region. This volcanic ash, known as "White River ash", fell on the study region between approximately 1,425 +/- 50 BP and 1,250 BP

(Stuiver, Borns, & Denton 1964:259-260). This environmental catastrophe most likely created a temporarily unsuitable habitat for humans and many animal species, but it is uncertain how long this may have lasted.

The vegetation community of the region during the Neoglacial period is identified as boreal forest. The encroachment of the boreal forest is the direct result of colder, moister climatic conditions and a decrease in the frequency of fires (Workman 1978:70). If there was in fact a dramatic increase in forested areas, this could have led to the decrease in grazing animals. It is perhaps no coincidence, therefore that during the Neoglacial period that bison disappear from the region.

In summary, the study region can be examined chronologically by separating its Paleo-environmental history into three periods. Research, past and present, supports the reconstruction of conditions during the early Post-Glacial period as outlined in this chapter; Paleo-environmental conditions for the Hypsithermal period are currently disputed and need further assessment. If interpretations of earlier research are to be utilized for this research, then the assumption is that the Hypsithermal period was dominated by grassland vegetation. If recent research is to be considered, then the boreal forest has been the dominant vegetative habitat for the study region since 8,500 BP.

Kluane National Park Reserve can also be divided into three bioclimatic environmental zones: montane, subalpine, and alpine. The montane zone is a diverse environment that is characterized as essentially a boreal forest area (Environment Canada, Parks 1987:8-6). Included in this deciduous and coniferous forest community are shrub-dominated communities and bogs and fens (Environment Canada, Parks 1987:8-6). The montane zone generally lies at elevations below 1100 metres above sea level. Tall shrubs, mostly willows, dwarf birch and alder, dominate the subalpine zone (Environment Canada, Parks 1987:8-29). This environmental zone can be found at elevations between 1100 and 1400 metres above sea level. Toward the south end of the park, the subalpine zone covers a larger area because the mountains are lower and less precipitous than in the north (Environment Canada, Parks 1987:8-29). The alpine zone includes all areas above 1400 metres above sea level. It can further be divided into two zones based on elevation. The lower alpine zone (up to 1600 metres above sea level) contains mostly shrub-type vegetation up to one metre in height (Environment Canada, Parks 1987:8-36). Above 1600 metres above sea level is the alpine tundra. The vegetation present in this zone is dependent on the time of snowmelt, available soil moisture, and aspect (Environment Canada, Parks 1987:8-36).

One problem that has been acknowledged by recent researchers is conflicting data concerning the establishment of the "spruce forest" in southwest Yukon. This conflict is important because it has further implications for the reconstruction of past animal communities and therefore of the subsistence activities of humans.

In the next section, the history of archaeological research in southern Yukon and the Kluane region is examined. Understanding the history of archaeological research is significant because it has played an important role in shaping Paleo-environmental reconstruction of the region.

5.3 History of Archaeological Research in the Southwest Yukon

The history of archaeological research in southwest Yukon spans a mere 50 to 55 years. Johnson and Raup, in the 1940's, and MacNeish, in the late 1950's conducted the first two intensive studies. It was these first research projects that built the framework for a cultural history of southwest Yukon.

Johnson and Raup's research was based on two field seasons in 1944 and 1946. The area of interest for their research was the Dezadeash and Shakwak valley. The purpose of this research was to reconstruct the landscape in which the archaeological cultures were developed (Johnson & Raup 1964:3). The geobotanical chronology created by Johnson and Raup was used as a framework for all future archaeological interpretation. Prior to their field research, Johnson and Raup hypothesized that the southwest Yukon had not been inhabited earlier than protohistoric times (Johnson & Raup 1964:4). Johnson and Raup's archaeological field work consisted of reconnaissance and testing of this hypothesis. The cultural resources recovered were limited. They did not find any evidence of human occupation in the research area during the Hypsithermal period (8,700 – 2,800 BP). A total of forty archaeological sites, all dated after 2,800 BP, were recorded during the two seasons of field study.

MacNeish's fieldwork spanned the entire southwest Yukon and was conducted over a period of four years, from 1957 to 1960. MacNeish had definite views on the purpose and aims of archaeology. In a report on the archaeology of southwest Yukon, MacNeish wrote (1964:201):

> "The ultimate goal of archaeological investigations are generalizations about culture change of cultural process. The secondary purpose of archaeology is the

> construction, or the attempt at reconstruction of the culture of peoples in the past, and the arrangement of such reconstruction's in sequences from which historical development may be inferred."

In the course of four years of field research, MacNeish located a total of 129 archaeological sites and collected a total of 5,500 archaeological specimens. From his research, MacNeish devised a cultural sequence that was composed of seven Phases based on the relative chronology of stratigraphy. This sequence included human occupation during the Hypsithermal period.

In 1978, William B. Workman re-examined the prehistory of the Aishihik-Kluane area by examining and analyzing roughly 3,000 artifacts from 23 archaeological sites. The purpose of Workman's research was "to account for recent work in the Aishihik Valley, to provide an areal cultural and chronological framework in which this material can be viewed, and to bring the evidence thus gained to bear on problems of regional prehistory" (Workman 1978:vii). Workman (1978:3) considers his research to be the second "approximation of Southwest Yukon prehistory", after the work of MacNeish. The result of Workman's laborious task is the establishment of a cultural sequence based on MacNeish's original sequence that is still used today. Workman also completed a comparative study of the cultural sequence of Southwest Yukon and adjacent areas, and speculated on the origins of Southwest Yukon lithic technology (Workman 1978).

The 1970's were a quiet decade for archaeological research in Southwest Yukon. Although Workman's publication was published in the late 1970's, it was based on research completed in the late 1960's. In the late 1970's and throughout the 1980's, with the establishment of the Kluane National Park Reserve, there was renewed interest in archaeological investigation within the region. The main focus of archaeological investigations during this time was historic sites, particularly gold rush era sites. Pre-European contact sites were recorded if found, but no major research during this time actively pursued the recording of pre-European contact archeological sites.

In 1991, Michael Zywina conducted a survey and archaeological reconnaissance of site located along the Bighorn Creek. A total of nine pre-European contact sites were recorded. In 1993, Dave Arthurs (Parks Canada) conducted a cultural resource inventory and assessment of the Donjek, Jarvis and Kaskawulsh River Valleys, as well as the Airdrop Lake Plateau. In the 1991 field season, Arthurs documented 45 new archaeological sites, revisited the nine previously recorded sites and incorporated into the survey one previously discovered site. This survey involved sampling a range of environmental zones and concentrated on abandoned shorelines of proglacial lakes. From 1993 to 1998, Arthurs returned to Kluane National Park Reserve to continue his archaeological research. In 1997, Mush Bates and Kathleen Lake were incorporated into Arthurs' survey. As of 1997, 192 archaeological sites have been located within Kluane National Park Reserve; of those sites, Arthurs has identified 83 as pre-European contact, or potentially pre-European contact sites. Appendix A catalogues 69 of the total 83 prehistoric sites that are available for use in this thesis.

5.4 Cultural History of Southwest Yukon Territory

For over thirty-five years, the culture history of the Yukon Territory has been researched, speculated upon, and interpreted. Richard S. MacNeish (1959; 1960; 1962; 1964) was the first to construct a cultural history sequence for the southwest Yukon.

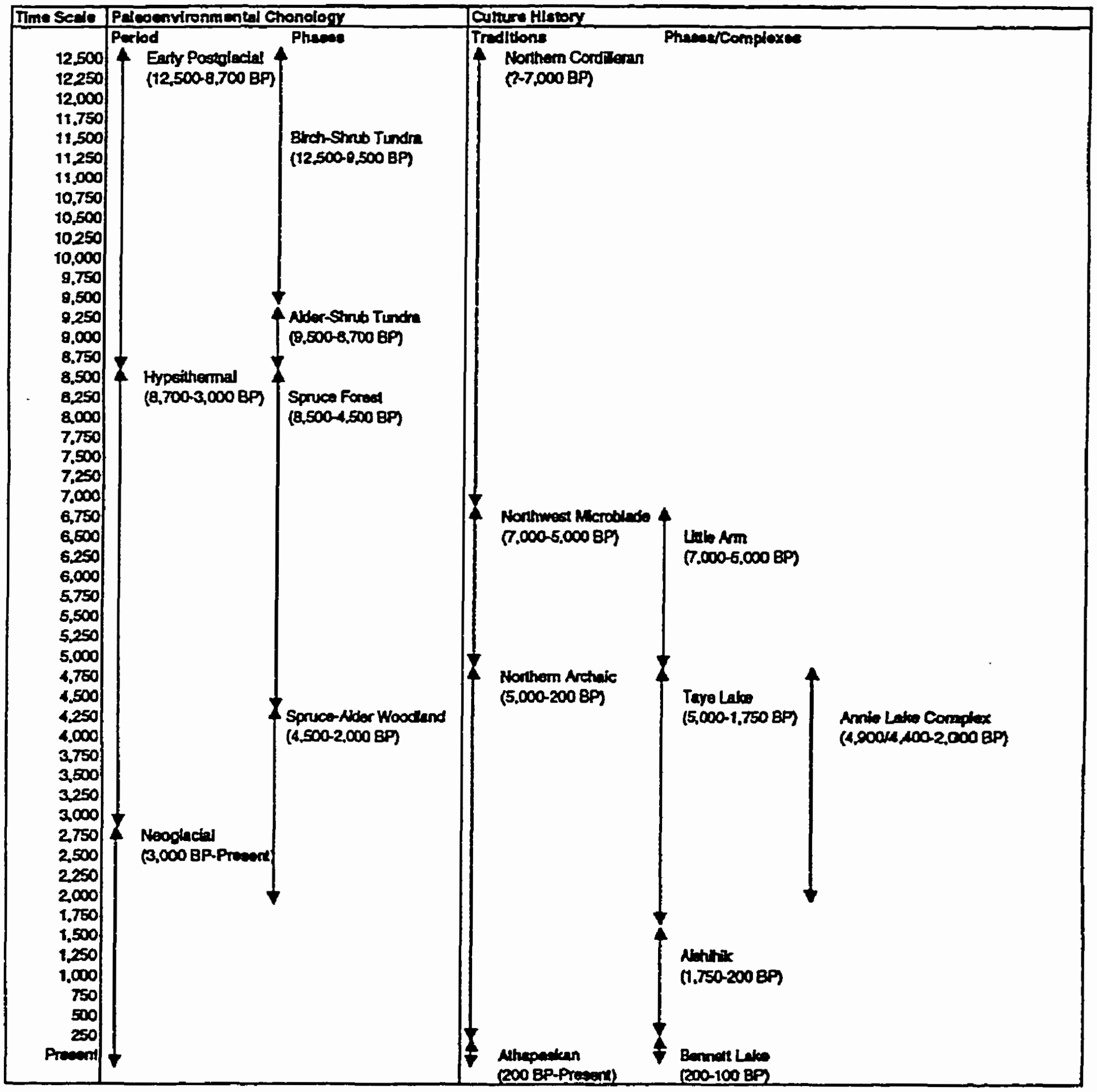
MacNeish's cultural sequence for the southwest Yukon was generally accepted and utilized in interpretations of the prehistory of Northern North America until the early 1970s when William B. Workman undertook the task of reexamining over 3000 artifacts from 23 sites recorded in the region (Workman 1977:46). The outcome of this reanalysis is a modified cultural sequence for this region that nevertheless, maintained the terminology and general outline that MacNeish first presented. For this research, Workman's culture history framework will be adapted with some modifications as explained below. The cultural sequence outlined in this chapter (see figure 5.1) is based on Workman's observations with adaptations based on more recent research by Arthurs (1995; 1996), Greer (1993); and Clark and Morlan (1982).

According to Workman (1974, 1977, 1978, 1980). The culture history of the Southwest Yukon Territory is represented by four cultural traditions: Athapaskan; Northern Archaic; Northwest Microblade; and Northern Cordilleran. The latest cultural tradition, the Athapaskan Tradition, dates from 200 BP to the present. The Athapaskan Tradition is represented archaeologically by the Bennett Lake Phase (200 - 100 BP). The Bennett Lake Phase is characterized by the presence of European trade goods. The Northern Archaic tradition dates from 5,000 - 200 BP and is represented by two archaeological Phases: the Aishihik Phase and the Taye Lake Phase. The Aishihik Phase (1,750 - 200 BP) exhibit the following characteristics: endscrapers with thin working edges, tabular bifaces, and stone wedges. Large bifaces, unifaces with thick working edges, and burins are absent. The Taye Lake Phase (5,000 – 1,750 BP) displays the following characteristics: projectile points that are notched or lanceolate with straight or minimally concave bases, large bifaces, burins and gravers in sporadic proportions, angular or rounded endscrapers that have more than one working edge, and unifaces with thick working edges. The Northwest Microblade tradition dates from 7,000 – 5,000 BP and is represented by the Little Arm Phase (7,000 – 5,000 BP). The Little Arm Phase is characterized by microblades, burins, and round based and stemmed projectile points. The earliest cultural tradition, the Northern Cordilleran Tradition, dates from about 7,000 BP (and earlier). Characteristics of the Northern Cordilleran Tradition are large, leaf-shaped projectile points, knives with round bases, large bifaces, and transverse notched burins (Arthurs 1995:30).

Since Workman's research, numerous archeologists have expanded our understanding of cultural sequences in the study region (Clark 1983, 1984, 1991; Clark & Morlan 1980, 1982, Greer 1993, Greer & LeBlanc 1983, Morlan 1974, Morlan & Workman 1980). Their research has resulted in the further modification of the cultural sequence in southwest Yukon. One of the more important modifications is the introduction of the Annie Lake complex. The Annie Lake complex dates from 4,900/4,400 – 2,000 BP (Greer 1993:34) and falls between the Little Arm Phase and the Taye Lake Phase. It is believed that the Annie Lake complex is an early form of the Northern Archaic tradition (Arthurs 1995:32). The characteristic tool type associated with this complex is a lanceolate projectile point with a concave base (Greer 1993:33).

Figure 5.1 provides a summary of the cultural sequence of the Yukon Territory as it is currently understood. Although this research does not focus directly on the reconstruction of the culture history provides preliminary information needed to carry out research that incorporates GIS in settlement pattern studies. This culture history also serves as a relative dating technique, albeit a speculative one, for archaeological sites in the study where no radiocarbon date are available.

Figure 5.1 Cultural Sequence in the Southwest Yukon Territory



5.5 Area of Interest

For reasons of time, the study region for this thesis is limited to five areas that represent the majority of the river valley regions of Kluane National Park Reserve. The five areas are: Bighorn Creek, Airdrop Lake , Kathleen Lake, Bates Lake and Mush Lake. Figure 5.2 shows the locations of these five areas. The names of these areas are based on the National Topographical System (NTS). The corresponding NTS locations in order are 115G/03, 115B/09, 115A/06, 115A/11, and 115A/05. Because the methodological tool for this research is Geographic Information Systems, it is advantageous to use NTS coordinates as boundaries for the study area. A brief description of each of the NTS locations that make up the study region are outlined as follows:

5.51 Bighorn Creek (Donjek Valley)

The Bighorn Creek area (NTS 115G/03) is the most extensively archaeologically surveyed area in the study region (see figure 5.2). Within the Bighorn creek area are the Donjek, Alsek, and Kaskawulsh Rivers. A total of 41 archaeological sites have been located in this area. Of the 41 sites, 29 archaeological sites are identified as prehistoric. Because the majority of the prehistoric sites are located within the Donjek Valley, this area of interest will further be henceforth to as the Donjek Valley area in this research. The size of these prehistoric sites range from multi-component sites to isolated finds. Appendix A catalogues all prehistoric sites for the Donjek Valley. As well as other areas of interest for this study, Appendix A includes the following information for each site: NTS identification number, Borden site designation, the locational coordinates of the archaeological site, any features recorded at the site, cultural affiliation, and a radiocarbon date (where available).

5.52 Airdrop Lake

Most archaeological surveying in the Airdrop Lake area (115B/09) has occurred at the Airdrop Lake Plateau. The Plateau is described by Arthurs (1995:183) as:

> an imposing steep-faced massif that rises more than 1100 meters above the Kaskawulsh River. The topography of the summit, which lies at an average elevation of 1800 meters above sea level, is generally gently rolling with a few prominent mountain peaks, like Hoodoo and Chalcedony mountains, rising above this level.

A total of 16 prehistoric sites have been recorded for this area. Many of these prehistoric sites are lithic scatters. The sites are in the vicinity of both Hoodoo and Chalcedony Mountain, two known sources for lithic tool manufacturing materials such as obsidian and chalcedony. Figure 5.2 shows the Airdrop Lake area and the positioning of the two mountains in the area.

5.53 Mush, Bates, and Kathleen Lakes

The Mush, Bates, and Kathleen Lakes (NTS reference numbers 115A/06, 115A/04, and 115A/11 respectively) are grouped together as one area because the most recent archeological resource inventory survey, conducted in 1997, focused on these three areas and information on these areas is found together. The Mush, Bates, and Kathleen Lakes are the largest bodies of water in Kluane National Park and support an abundant supply of fish resources (Arthurs 1997:1). During the course of the 1997, a total of 11 previously recorded sites were revisited and 35 new archaeological sites were recorded.

Of the total 46 archaeological sites found within this area, 29 are classified as prehistoric. Those 29 prehistoric sites are used for this research. Figure 5.2 illustrates the location of this area in the study region.

5.6 Conclusions

As mentioned in section 5.2, possible interpretations of the vegetation community during the Hypsithermal period ranges from a vast grassland environment to a wooded environment. However, for this research the more recent interpretation is supported. Figure 5.1 illustrates the changes in the palaeoenvironment throughout time, in association with the corresponding cultural sequences.

Examining the history of archaeological research in Southwest Yukon, it is evident that although archaeological research has been conducted for the last fifty years, this research has merely "scratched the surface". The cultural history that is the result of this ongoing archaeological research is subject to questioning because it is based on a relatively small sample of archaeological sites. This is not the fault of "bad" research, but rather a lack of information available to construct an encompassing cultural sequence.

Recent archaeological surveys in the Donjek Valley, Airdrop Lake Plateau, and the Kathleen, Bates and Mush Lakes area have yielded an ever-increasing collection of archaeological sites and data. Besides the need for management and protection of archaeological sites, research on the archeological data needs to be conducted in order to have a greater understanding of how human populations lived and interacted in their natural environment.

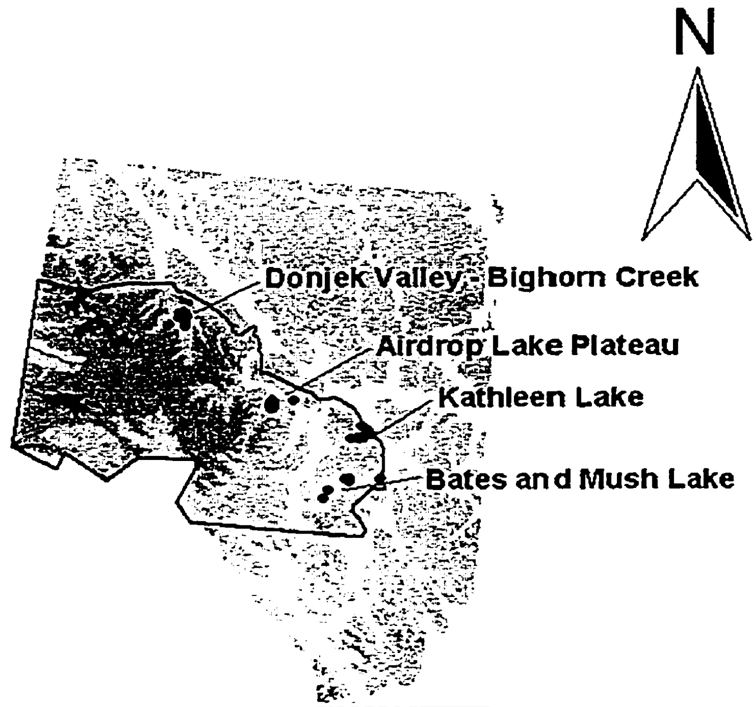


Figure 5.2

1:250,000 Scale Map - Southwest Yukon Territory
Kluane National Park Reserve with Previously
Located Archaeological Sites

70 0 70 140 Kilometers

CHAPTER 6

VARIABLES AND TOOLS REQUIRED FOR GIS TESTING

6.1 Introduction

Up to this point, this thesis has discussed:

1. Theoretical models of hunter-gatherer settlement patterns.
2. The applicability of the composite band model and ethnography used to formulate hypotheses for the development of a regional model for hunter-gatherer land use.
3. The application of GIS in archaeology as a tool to perform spatial analysis.
4. And, the study region

In this chapter, the variables required to test the hypothesis regarding ideal site location (ample supply of water and wood, protection from strong winds and suitable flat ground) are discussed. The testing is executed through geographical information systems

The variables used in this research were developed from a research model that was first published in 1976 by Jochim. These variables were also adopted and further expanded to use in a GIS environment by Kvamme (1985, 1986, 1989). These variables concentrate on the environmental data the author deemed important in predicting hunter-gatherer site location. The environmental variables are water, landform, shelter and vegetation.

Primary data are required to conduct the techniques used in this research. This is the topic of the first section of the chapter. Once the data is assembled, the variables measured can be addressed. The second section of this chapter is focused on the variables measured in this thesis.

6.2 Primary Data Required For Research

For this research, three types of data are required: digital elevation models for the study region, digitized hydrological and vegetation maps of the study region, and archaeological data. Each type of data will now be defined and the data that is available for this research will be described.

Digital elevation models (DEMs) are continuous raster data layers where a grid of cells is superimposed over a map region. Each cell contains an elevation value. Other information can also be stored for each cell such as location in space (x and y coordinates), and attribute data – whether an archaeological site is present in the cell or not. DEMs have been used in the study of regional archaeological surfaces for some time in North America but in most studies, the DEMs were employed as a way to better visualize patterns of archaeological distributions within regions (Kvamme 1995:2).

For this research, a DEM at a scale of 1:250,000 is used. The reason for using a 1:250,000 scale DEM is because it covers the entire southwest portion of the Yukon Territory. To isolate the study region, a vector file containing the boundary of Kluane National Park Reserve is overlaid on the DEM. The portion of the DEM outside of the boundary is "clipped" or removed, leaving only the information within the Park boundary visible. Each cell in the DEM represents an area of $100m^2$ and a mean elevation value is provided for each cell. Although minute relief features, such as small cliffs and crags, may not be visible, by and large the DEM is reasonably accurate and can be used with confidence in this research.

The second set of data used in this research is vector-based information on the hydrology and vegetation of the region. The hydrological information includes the spatial location of known water sources. These water sources include rivers and streams, lakes and ponds, moraines, bogs and dry riverbeds. This vector data can be displayed in three ways: as points; lines; or polygons. For this research, hydrological data are displayed as either lines – as in the case of rivers or streams, or polygons – as in the case of lakes, ponds, moraines, bogs, and dry river beds. The hydrological data are available at the 1:50,000 scale, and corresponds with the specified areas of interest for the study region discussed in chapter four: Bighorn Creek; Airdrop Lake; Kathleen Lake, Mush Lake and Bates Lake.

Vegetation data includes all information on vegetation in the region. This data is in displayed in polygon format for wooded areas and in line form for shrub-grassland areas. To transform the line data to polygon format, a process known as "heads up digitizing" was conducted. In this process, digitizing from an image, rather than digitizing from a paper map, is conducted to create a new polygon theme. The vegetation data was available at the 1:50,000 scale and also correspond with the specified areas of interest for the region.

The final set of data used in this research was archaeological in nature. These data are tabular rather than digital, but are easily transformed through the use of GIS software. The data used in this research was obtained from Dave Arthurs, Parks Canada and from the Canadian Heritage Information Network Website. The data was entered into a spreadsheet and the following information was recorded:

1. Borden Number
2. Map: 115A/04; 115A/06; 115A/11; 115G/03
3. Location Coordinates: Latitude, Longitude; Easting; Northing
4. Elevation
5. Site Type: Campsite; Isolated Find; Unknown
6. Features: Hearth; Scatter (Lithic, Bone, Fire Cracked Rock); Blind; Stone Feature; Cut Wood (Stump; Adze); Unknown
7. Culture: Unknown; Little Arm Phase; Aishihik; Taye Lake; Bennett
8. Radiocarbon Dates

Appendix A contains the set of archaeological data. Once primary data has been gathered from all three sources, the research can begin. The next step is to discuss the research methodology.

Figure 6.1: DEM with Archaeological Sites

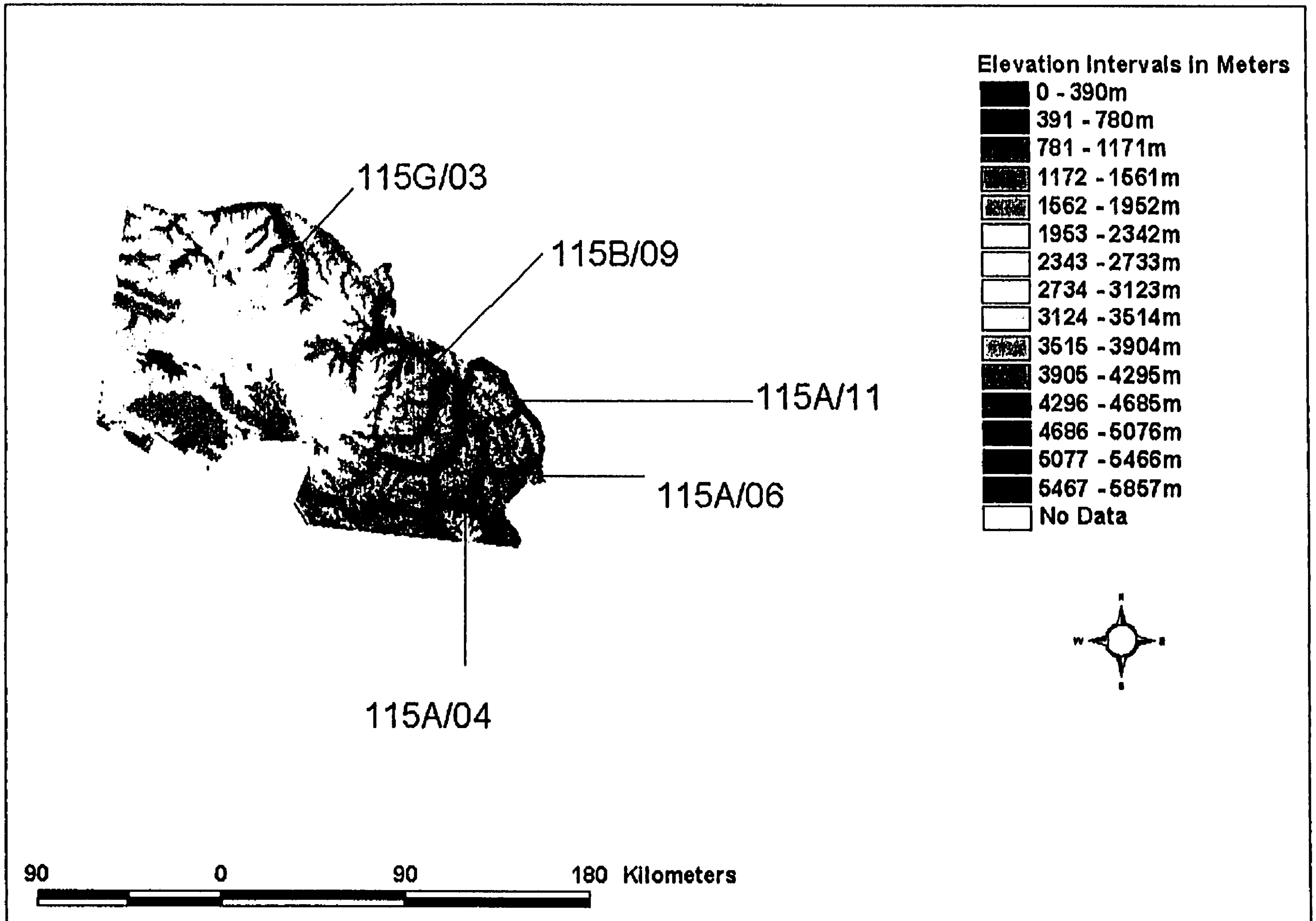


Figure 6.2: Donjek Valley 1:50,000 Scale

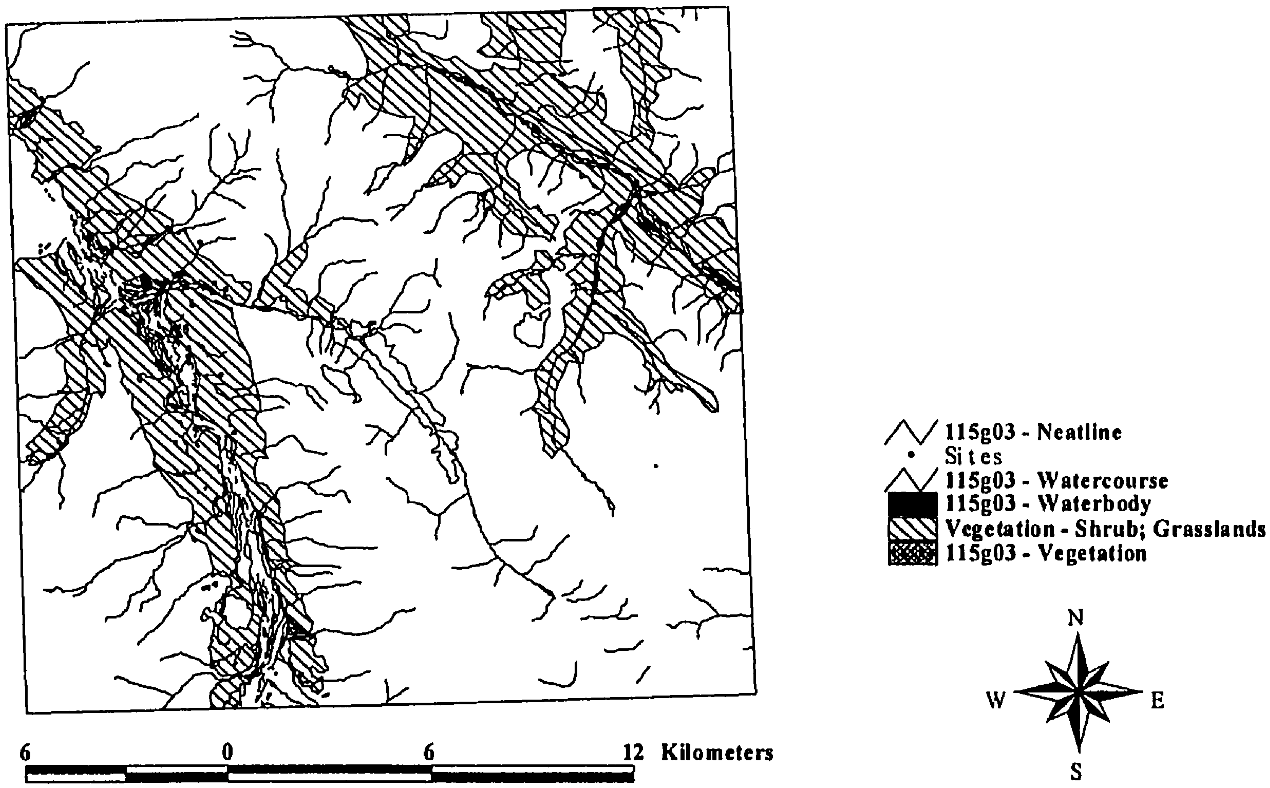


Figure 6.3: Airdrop Lake Plateau 1:50,000 Scale

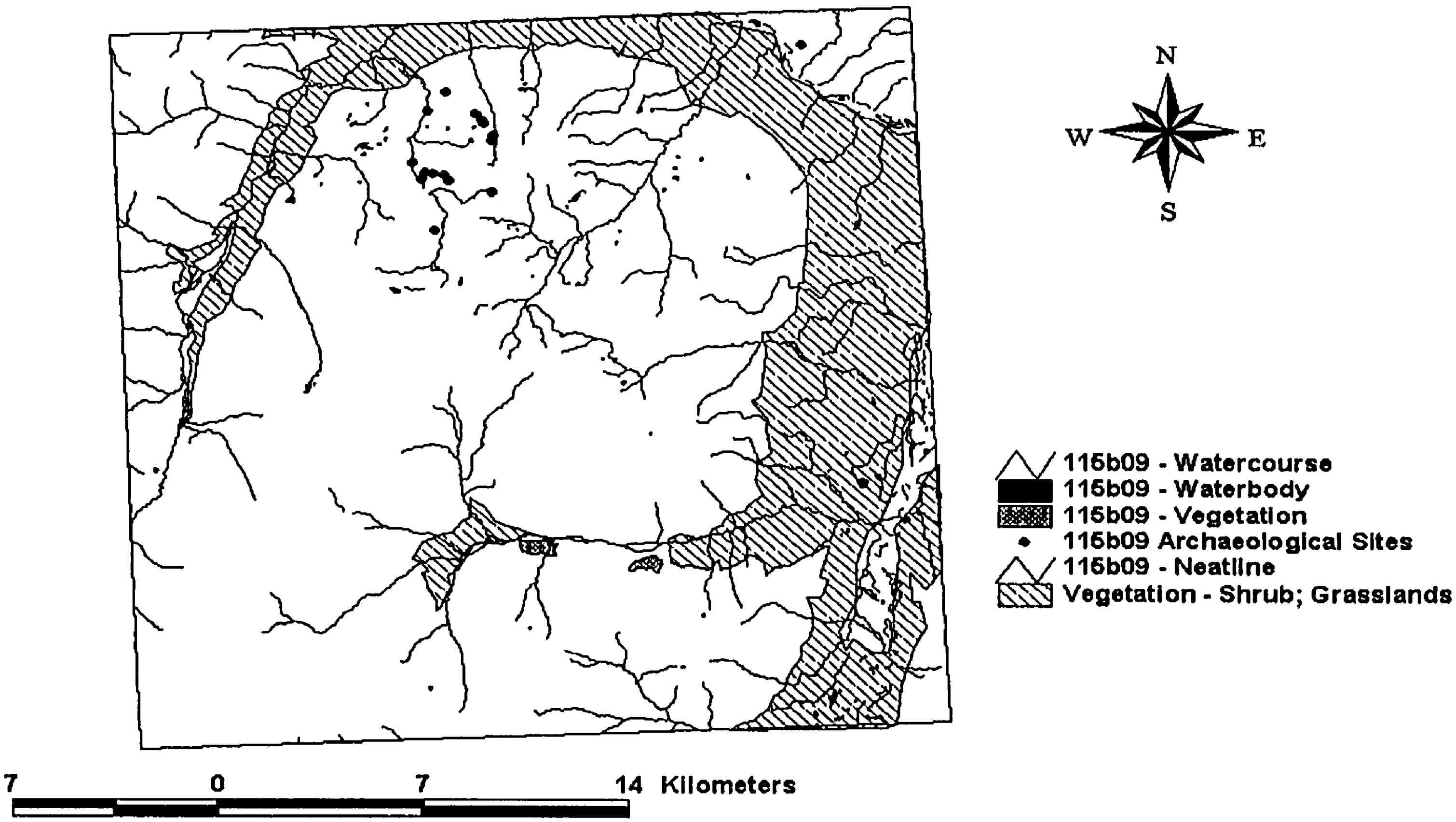


Figure 6.4: Bates Lake 1:50,000 Scale

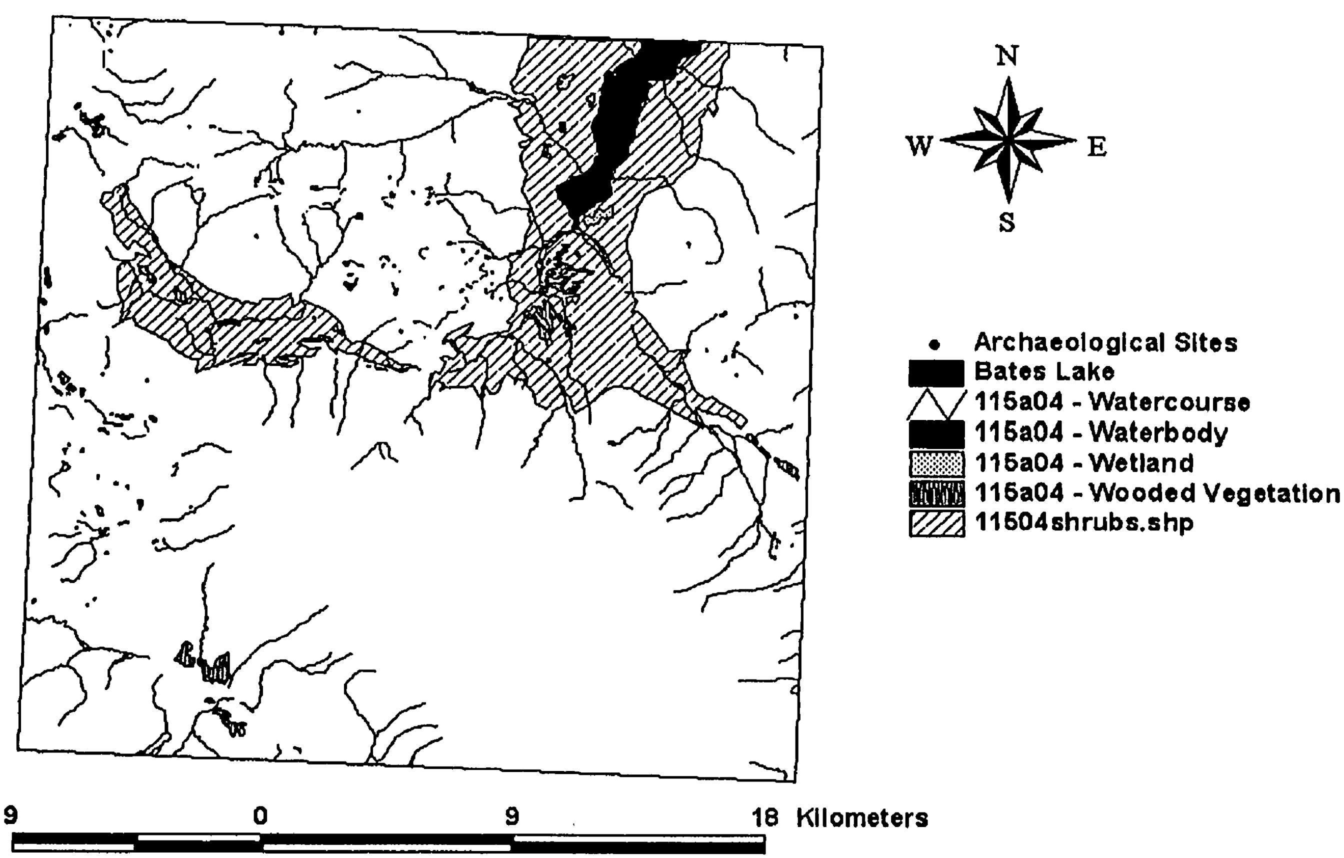


Figure 6.5: Mush Lake 1:50,000 Scale

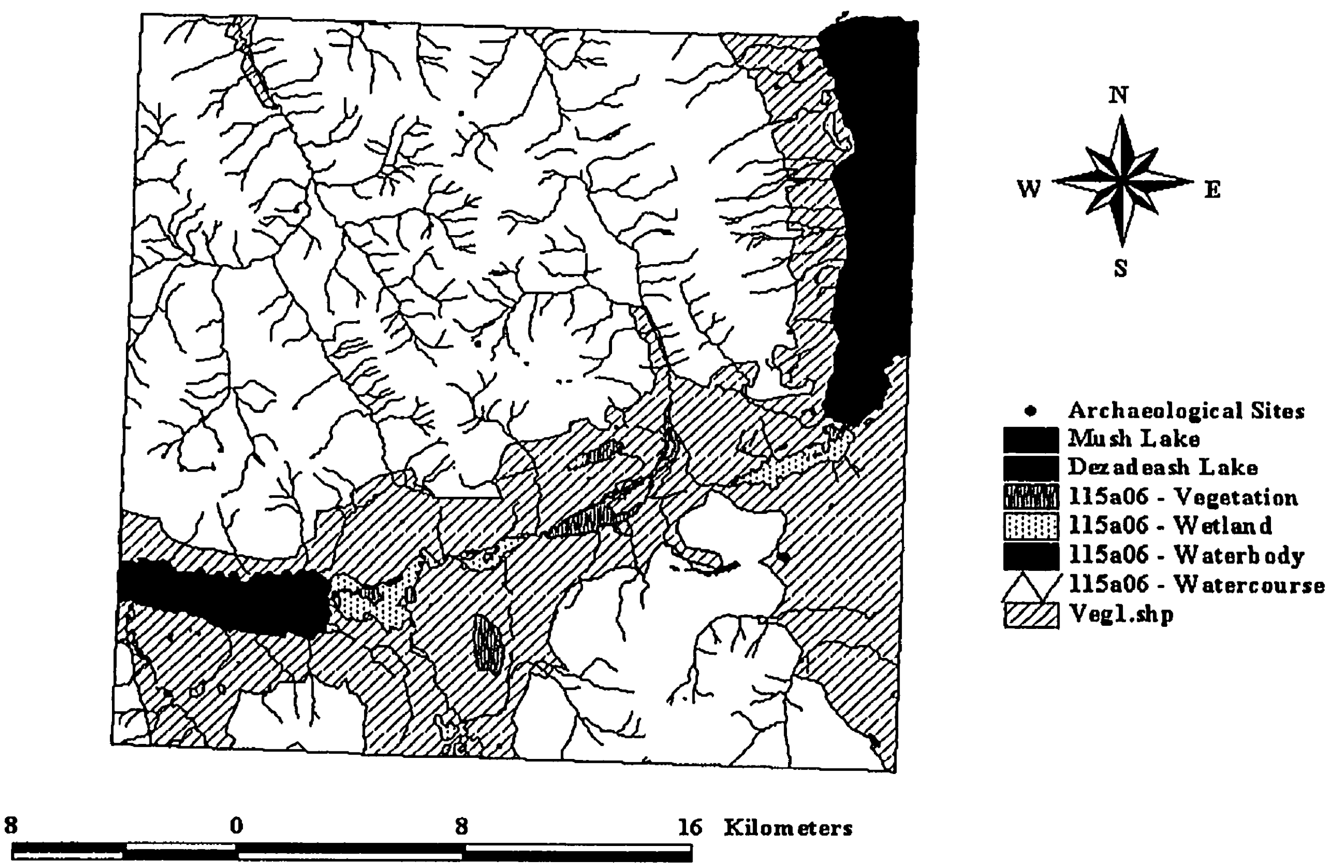
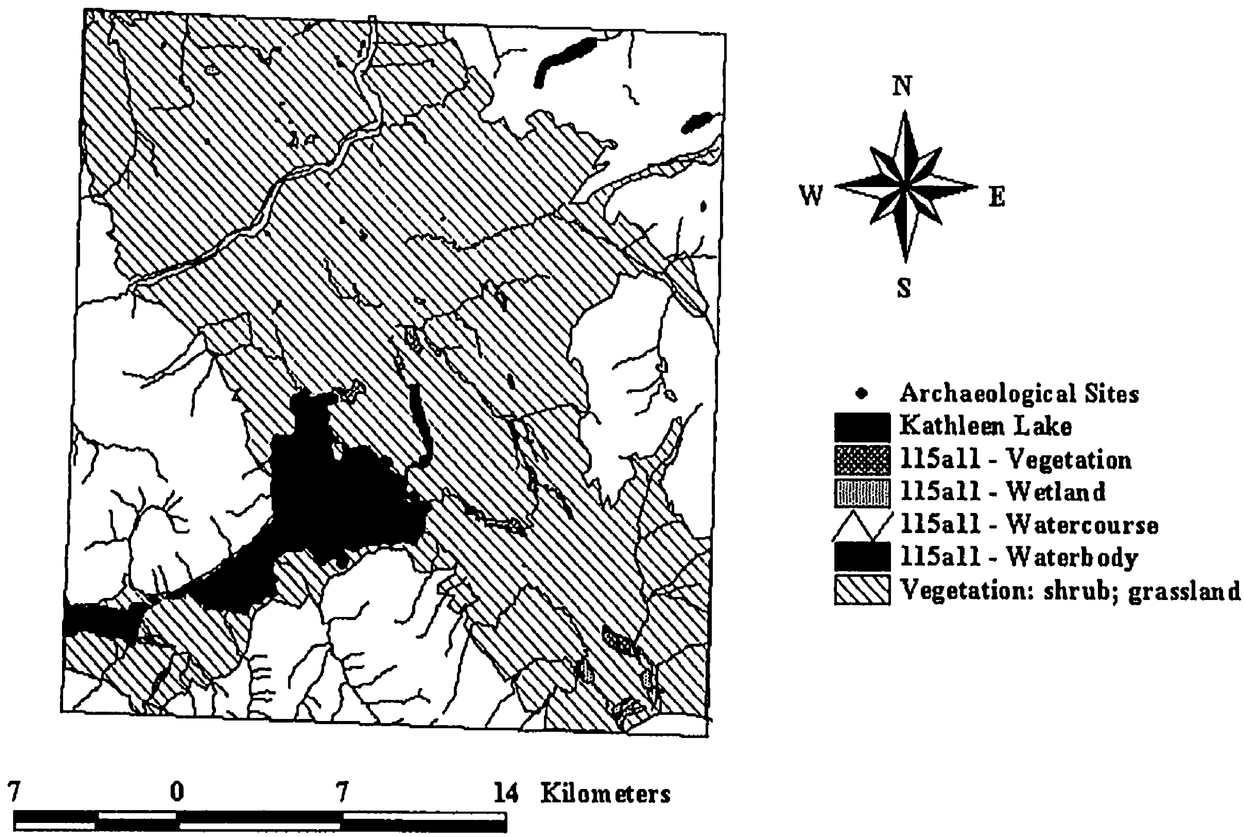


Figure 6.6 : Kathleen Lake 1:50,000 Scale



6.3 Variables Measured

As mentioned in the introduction to this chapter, the model used for this thesis was developed by Jochim (1976) in his construction of a model to predict hunter-gatherer settlement patterns. Four variables - water, shelter, landform, and vegetation - are examined in this research. These variables correlate with the ethnographic data describing the ideal site location. These variables have been used extensively, and proven effective, in previous archaeological research e.g. (Kvamme 1987 and Kellogg 1987). In the following sections, the criteria examined to justify using these environmental variables are addressed. The techniques used to measure the variables are found in Appendix B.

6.31 Water

Water resources are widely accepted as an important variable in the choice of site location by hunter-gatherers and are a key factor in determining site location (Jochim 1976:55; Kvamme 1985:215). For this thesis, the distance between archaeological sites and water sources is examined. The Euclidean distance measurement, the shortest distance between two points, is used in this research. This measurement is used because it can give information about preference. The main criticism of using Euclidean distance measurements is that it does not take into consideration the topography of the landscape. For example, the distance between two points may be a short distance but the actual distance, when the terrain is taken into consideration, may be relatively longer. Other forms of distance measurement, such as friction surfaces, would more accurately calculate distance but because this research is interested in preference and because of its ease in use, Euclidean distance measurement is used.

Two types of water sources can be identified: permanent water sources and seasonal water sources. Permanent year round water sources include watercourses - rivers, and water bodies - lakes and large ponds. Seasonal water sources are those water sources classified as permanent plus other drainage areas such as dry riverbeds and wetlands. There is a wealth of information on the relationship between archaeological site locations and water sources. It has been documented in previous studies (Williams et al. 1973) that a large percentage of archeological sites are located within one kilometer of a permanent or seasonal water source. Others, for example Higgs and Vita-Finzi (1972), state that the ease of access to water, rather than the actual distance to a water source is of greater importance.

6.32 Landform

A single variable is utilized to measure the importance of landform in settlement pattern location in this research: slope. Slope is measured in this thesis because it describes the ground surface, and it is easily calculated and analyzed through GIS. Slope is usually computed as a percent grade unit or in degrees. For this exercise, slope is presented in degrees ranging from 0 to 90 degrees.

To examine difference in slope between the background environment and the location of archaeological sites the Kolmogorov-Smirnov one-sample goodness of fit test is applied. This test has been used in previous archaeological research, but most recently, has been used in conjunction with a GIS environment by Kvamme (1990). According to

Kvamme (1990:367), "one-sample tests that compare a site sample against a background standard are conceptually and statistically superior, but have been difficult to implement for continuous data types." However, with the advancement of computer technology, particularly GIS, a complete description of the nature of the background environment for categorical and continuous data can be completed (Kvamme 1990:367). According to Kvamme (1990:373), in a GIS context the entire database serves as the background population distribution and the distribution of the sample archaeological locations can then be compared statistically against this background distribution to ascertain whether is differs significantly. One-sample tests in regional archaeological research, where the entire background is treated as the population, have been promoted for the last twenty years e.g. (Cowgill 1977), but have not been feasible until recently, with the development of GIS.

6.33 Shelter

For this research, exposure is the primary variable used to measure the importance of shelter. Exposure is measured at each site by noting the prominent direction of sloping terrain indicated by a line drawn perpendicular to the elevation contours. This is also known as calculating aspect. The calculation of aspect may seem complicated and time consuming, particularly if the study region is large, but in actuality, it is quite simple if a DEM is available.

To examine difference in aspect between the background environment and the location of archaeological sites the Kolmogorov-Smirnov one-sample goodness of fit test is applied once again. The Kolmogorov-Smirnov goodness of fit test is carried out in the same way as it was for examining slope in the previous section, with the exception that in this exercise, aspect is of interest (see Appendix B for full instruction).

6.34 Vegetation

For this research, two vegetation variables are measured: the distance from archaeological sites to the nearest vegetation source and the relationship between archaeological sites and environmental ecotones. The distance to the nearest wooded areas for each archaeological site can be correlated with the distance to the nearest firewood and building material source, required by hunter-gatherer populations (Kvamme 1985:218). As with the water variable, the Euclidean distance measurement is used.

Besides wooded areas, other vegetation areas containing shrub-like vegetation can provide the necessary wood needed for fuel. Therefore, shrub-grassland areas are also considered for the vegetation variable.

The ecotone is the contact or transition between two biotic communities and according to Kvamme (1985:218), sites located in an ecotone would allow easy access to both biotic communities and the resources they contain. Information on ecotones in the study region was not available in digital format, but from reports on the ecology of the region, it is known that there are four main biotic communities: montane, subalpine, lower alpine, and upper alpine (see discussion in chapter 4). Each of these communities is distinguished by elevation boundaries. The following table summaries the distinctions between the four biotic communities.

Table 6.1 Ecotones Identified in Study Region

Biotic Community	**Elevation Boundaries**	**Associated Vegetation**
Montane	< 1100 metres asl	deciduous and coniferous forests; shrub dominant; fens and bogs
Subalpine	1100 - 1400 metres asl	tall shrubs – mostly willows, dwarf birch, and alder
Lower Alpine	1400 - 1600 metres asl	shrub type vegetation up to one metre in height
Upper Alpine	> 1600 metres asl	dependent on the time of snowmelt, available soil moisture, and aspect

In previous research on site location in relation to ecotones, no set formula is given to calculate the size of the ecotone (Jochim 1976; Kvamme 1985). For this research, ecotones are arbitrarily set based on elevation. The elevations are set at fifty metres below and above the biotic community boundaries. Therefore, ecotones would exist between the following elevation zones: 1050 - 1150 metres; 1350 - 1450 metres; and 1550 - 1650 metres. The use of ecotones in archaeology has been met with some scepticism (Roades 1978). It has been argued that archaeologists "superficially and selectively" apply the concept of ecotone because the ecotone has been used to offer simple solutions to difficult problems-such as site location in relation to resources (Rhoades 1978:608-611). Regardless of this criticism, ecotone will remain a criteria for this thesis. The outcome of this thesis may support or reject this criticism.

6.4 Conclusions

The primary data required for this type of research is divided into three categories: digital elevation models; vector based digital map data; and archaeological data. The outcome of this section is an understanding of the "ingredients" needed to conduct GIS driven research of settlement patterns. It is also noted that although it is not difficult to obtain this primary data, the configuration of the data can be a difficult task.

The second section examines each environmental variable based on their criteria. The outcome of this section is the development of the criteria required to test the variables in a GIS environment. The next chapter illustrates the results of this testing.

CHAPTER 7

RESULTS

7.1 Introduction

The last chapter discussed the methods and techniques used in this thesis. This chapter shows the results of these methods and techniques. Referring back to the research framework (see figure 1.1), this chapter will explore the descriptive level of transformation. The results about to be presented are a direct result of GIS. These results are organized in this chapter according to the environmental categories distinguished in the previous chapter.

7.2 Water

Table 7.1 shows the result of the exercise on the distance to water sources. From this table, it is evident that the closest water source for all areas of interest in the region is a watercourse – a river. The average distance from an archaeological site to a river is 424.78m. This value is consistent with past research that maintains that water sources are typically within two kilometers from an archaeological site. The second closest water source is identified as a waterbody. In fact, sites located in the Kathleen, Mush and Bates areas record waterbodies (lakes) as the closest water source. The results of this exercise demonstrates that permanent water sources are closer to archaeological sites than seasonal water sources.

Table 7.1 Summary of Distance (in metres) From Archaeological Site to Water sources

Map Number	Data	Total
115a04 Bates Lake	Average of Watercourse	644.27
	Average of Waterbody	126.34
	Average of Wetlands	1686.31
	Average of Dry River Bed	N/A
115a06 Mush Lake	Average of Watercourse	872.11
	Average of Waterbody	83.55
	Average of Wetlands	2411.50
	Average of Dry River Bed	N/A
115a11 Kathleen Lake	Average of Watercourse	893.75
	Average of Waterbody	388.45
	Average of Wetlands	6218.33
	Average of Dry River Bed	N/A
115b09 Airdrop Lake	Average of Watercourse	289.43
	Average of Waterbody	694.09
	Average of Wetlands	N/A
	Average of Dry River Bed	5826.37
115g03 Bighorn Creek	Average of Watercourse	106.64
	Average of Waterbody	1186.42
	Average of Wetlands	N/A
	Average of Dry River Bed	1596.86
Total Average of Watercourse		424.78
Total Average of Waterbody		759.64
Total Average of Wetlands		4789.85
Total Average of Dry River Bed		3134.87

7.3 Landform

Table 7.2 is a summary of the slope values for area of interest. The higher the value, the greater the slope angles, the greater the vertical incline or decline. From examining this table, it can be stated that the general tendency for archaeological site locations is flat ground. This statement is based on the fact that the mean slope for all sites is less that 10 degrees.

Table 7.2 Slope values in degrees for each area of interest in the region

NTS	MIN	MAX	MEAN	STD
115A/04	0.0000	2.9503	1.4752	1.4752
115A/06	0.0000	11.3687	6.8517	3.5752
115A/11	0.0000	38.7740	7.4841	13.0912
115B/09	0.9554	18.2925	7.4932	4.5273
115G/03	0.8165	17.6428	3.9197	3.2461

To test whether there is a difference in slope between the background environment and the location of archaeological sites the Kolmogorov-Smirnov one-sample goodness of fit test was applied. To begin, I started by stating the following:

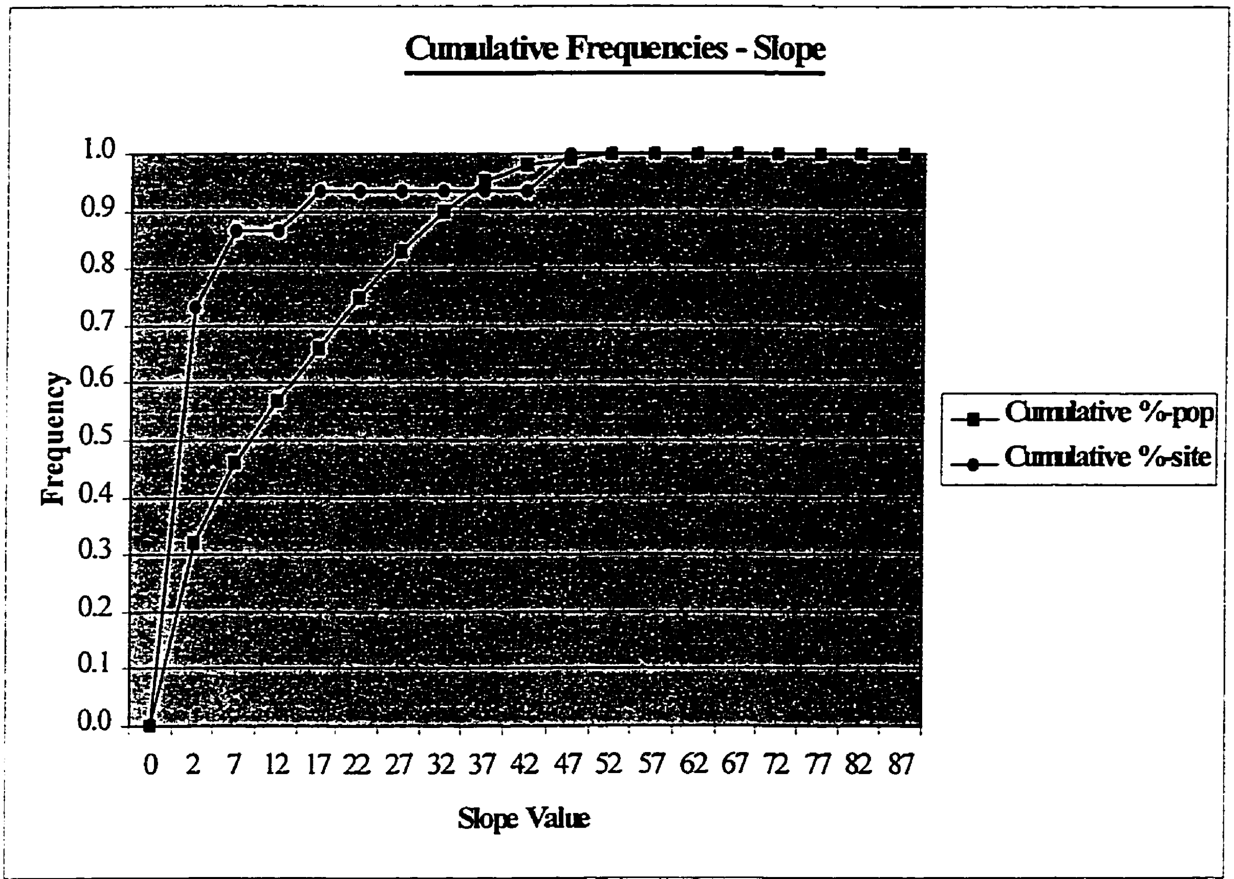
H_0= there is no difference in slope value between the background environment and the archaeological site locations

H_a= there is a difference in slope value between the background environment and the archaeological site locations

Figure 7.1 illustrates the cumulative frequencies of slope values for both the archaeological site locations and the background environment.

The maximum distance (D_{max}) between the slope value cumulative frequencies for archaeological sites and the background environment is 0.41. Because the maximum distance between cumulative frequencies is greater than the critical value (0.164), the null hypothesis is rejected in favor of the alternate hypothesis. From this result, it can be concluded that there is a difference between the slope at archaeological site locations when compared to the slope of the region.

Figure 7.1 Cumulative Frequency Distribution of Slope between Background Environment and Archaeological Site Location



7.4 Shelter

Table 7.3 is a summary of the aspect values for each site. To read table 7.3 the values must be defined. Preceding the table is a guide that shows how the value number, in degrees, is correlated to the exposure at the archaeological site locations. From the summary results, it can be stated that the majority of archaeological sites have a southern exposure. With the exception of the Bates River area, 115A04, all other areas have either a southeast or southwest exposure.

North Exposure	$0^0 - 22.5^0$; and $337.5^0 - 360^0$
Northeast Exposure	$22.5^0 - 67.5^0$
East Exposure	$67.5^0 - 112.5^0$
Southeast Exposure	$112.5^0 - 157.5^0$
South Exposure	$157.5^0 - 202.5^0$
Southwest Exposure	$202.5^0 - 247.5^0$
West Exposure	$247.5^0 - 292.5^0$
Northwest Exposure	$292.5^0 - 337.5^0$

Table 7.3: Summary of Aspect values (in degrees) for archaeological Sites

NTS	MIN	MAX	MEAN	STD
115A/04	0.0000	77.9638	37.4819	38.4819
115A/06	0.0000	199.3119	146.7519	77.0214
115A/11	0.0000	334.0087	228.9472	89.1494
115B/09	2.2026	347.4712	227.2481	120.6401
115G/03	8.4270	303.6901	242.8610	56.7920

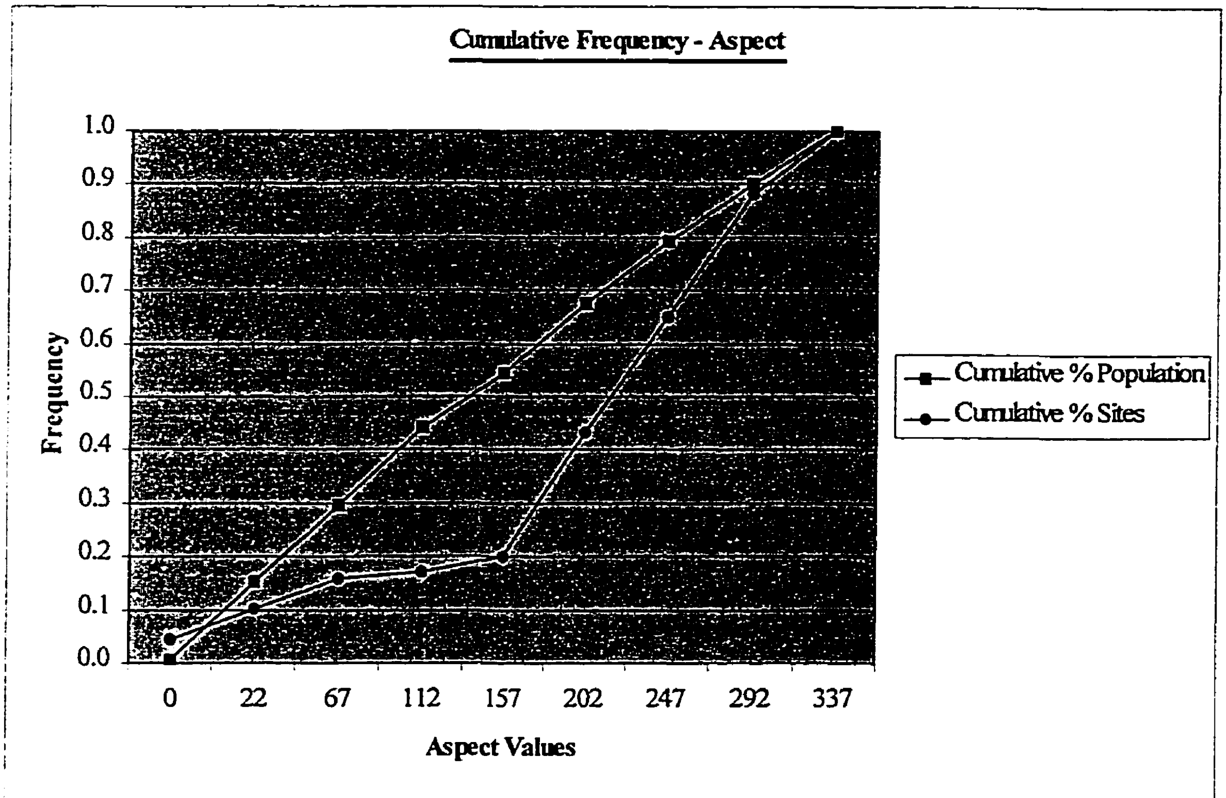
One-sample testing strategies for regional archaeological analysis was also performed. Two hypotheses were first formed:

H_o= there is no difference in aspect value between the background environment and the archaeological site locations

H_a= there is a difference in aspect value between the background environment and the archaeological site locations

The Kolmogorov-Smirnov goodness of fit one sample statistical test was once again performed. Figure 7.8 illustrates the cumulative frequencies of the aspect values for both the archaeological sites and the background environment. In this exercise, the critical value (d) is 0.164 and the D_{max} is 0.341 therefore, the null hypothesis can be rejected in favor of the alternate hypothesis. There is a significant difference between aspect values recorded in at archaeological site locations and the background environment. This result supports the earlier statement that protection from climatic elements may be an influential factor in deciding site location.

Figure 7.2 Cumulative frequency distribution between background environment and archaeological site locations.



7.5 Vegetation

The first exercise investigated the distance from each site to the nearest vegetation area. Two vegetation areas were identified: wooded and shrub. The result of this exercise is a table with the distance recorded between each archaeological site and the nearest wood and shrub area. Appendix C illustrates the results of this exercise for each site. Tables 7.4 and 7.5 summarizes these results for each area of interest. Through examination of both tables, it is evident that archaeological sites are located closer to shrub vegetation areas compared to wooded vegetation areas.

Table 7.4 Distance to Nearest Wooded Vegetation

NTS Map Area	Distance To Wooded Area
115a04 – Bates Lake	1244.84 meters
115a06 – Mush Lake	3217.57 meters
115a11 – Kathleen Lake	4627.42 meters
115b09 – Airdrop Lake	5972.77 meters
115g03 – Donjek Valley/Bighorn Creek	1117.16 meters
Total Average for Archaeological Sites	3273.05 meters

Table 7.5 Distance to Nearest Shrub Vegetation

NTS Map Area	Distance To Shrub - Grassland Area
115a04 – Bates Lake	0 meters
115a06 – Mush Lake	0 meters
115a11 – Kathleen Lake	0 meters
115b09 – Airdrop Lake	3237.09 meters
115g03 – Donjek Valley/Bighorn Creek	21.28 meters
Total Average for Archaeological Sites	758.80 meters

In the next exercise, the location of archaeological sites in relation to ecotones was examined. The resulting view, figure 7.3 a through e, depicts where the archaeological sites are located in relation to the biotic communities. Appendix A displays the elevation recorded for each archaeological site. Table 7.6 and 7.7 shows a breakdown of archaeological sites into both biotic communities and ecotones. These results show that archaeological sites are found in all biotic communities but relatively few sites are represented in the ecotone zones.

Table 7.6 Location of Archaeological Sites in Relation to Biotic Communities

Zone/Maps	Montane	Subalpine	Lower	Upper Alpine	Unknown
Zone 7					
115b09	-	2	6	7	1
115g03	-	28	1	-	-
Zone 8					
115a04	2	-	-	-	-
115a06	7	-	-	-	-
115a11	14	-	-	-	2

Table 7.7 Location of Archaeological Sites in Relation to Ecotones

Zone/Maps	Montane/Subalpine	Subalpine/Lower Alpine	Lower/Upper Alpine
Zone 7			
115b09	-	4	3
15g03	5	-	-
Zone 8			
115a04	-	-	-
115a06	-	-	-
115a11	-	-	-

7.8 Conclusion

The results achieved coincide with the relationship between known archaeological site locations and the environment in which they reside. From these results, the following statements can be made:

1 The average distance from an archaeological site to a nearest water source is within 500m.
2 On average, archaeological site locations face a southerly exposure to maximize warmth from the sun.
3 Exposure, measured through aspect, differs significantly between known archaeological sites and that of the background environment.
4 On average, archaeological sites are located on level ground surfaces thereby, making travel from the site to nearby areas less difficult or time consuming.
5 The ground slope differs significantly between the recorded ground slope of known archaeological sites and that of the general background environment.
6 There is no correlation between archaeological site location and distance to nearest wooded area.
7 Archaeological sites do not have the tendency to be located in ecotones.

The results of the methodological processes are the foundation of the environmental knowledge for the research framework. In the next chapter, the archaeological, socio/historical, and as well as the results from the GIS exercises will be united to provide a model of hunter-gatherer regional land-use which can be used predictively.

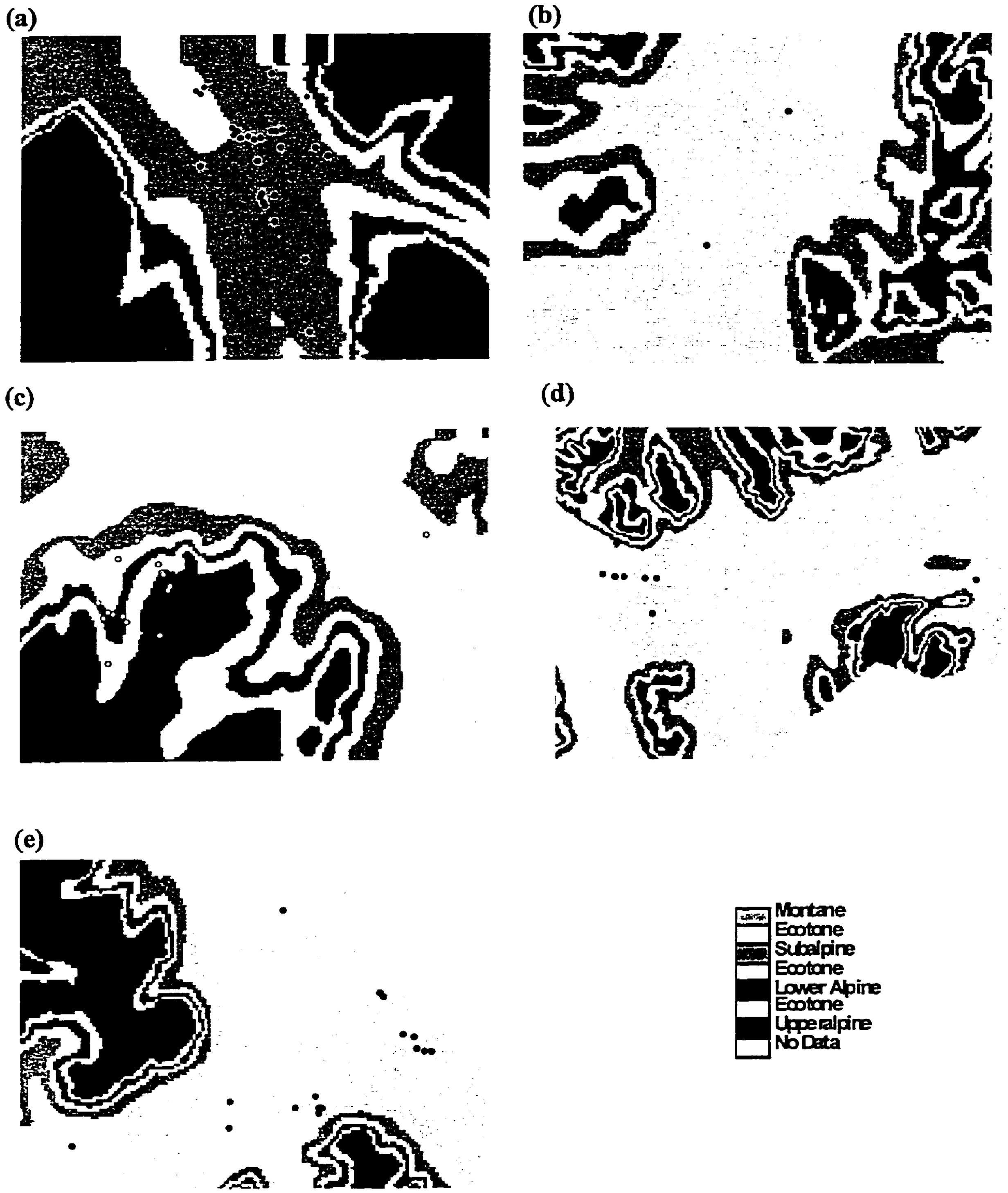


Figure 7.3 Archaeological Sites in Relation to Nearest Ecotone (enlarged). (a)Bighorn Creek; (b)Airdrop Lake; (c)Bates Lake; (d)Mush Lake; (e)Kathleen Lake

CHAPTER 8

DISCUSSION AND INTERPRETATION OF RESULTS

8.1 Introduction

In the introduction of this thesis, it was stated that the ultimate goal of this research is the identification and analysis of prehistoric hunter-gatherer settlement patterns in the southwest Yukon Territory. In chapter six, the variables used to carry out the methodology were discussed. Chapter seven illustrated the results of the methods and techniques. The outcome of the last two chapters, in relation to the research framework discussed, was a descriptive transformation of the archaeological and environmental data through the application of GIS techniques. In this chapter, the results illustrated in chapter seven, along with ethnographic and archaeological data are used to answer the central questions asked at the beginning of the thesis. The focus of this chapter is on the third level of inquiry – the interpretive and analytical level (see figure 1.2).

To focus on the interpretive and analytical level of inquiry, the theoretical model must be applied. To review, the theoretical model used for this thesis is the composite band model. This model supported by ethnographic data available for the Northern Athapaskan populations, states that composite bands of collectors in a western subarctic habitat follow a seasonal cycle of fission and fusion. The seasonal cycle of fission and fusion is mapped on to the landscape in the form of sites of varying function and size.

The composite band model, along with ethnographic data on the Northern Athapaskans, make it possible to form hypotheses on hunter-gatherer settlement patterns for the study region. To review from chapter three, the hypotheses formed for this thesis are:

1. The ideal site location should contain an ample supply of water and wood; is protected from strong winds and has sufficient flat ground for housing and daily activities.
2. Three types of sites should be identified in the archaeological record: smaller local band sites, larger regional band (composite) sites and special purpose sites.
3. The two residential site types should be linked to seasonality: small sites are associated with spring, early summer and winter and large sites are associated with late summer and fall.
4. Small local bands should be scattered across the region while larger aggregation sites will be situated at advantageous locations.

The framework for this chapter is such that each area in the study region – the Donjek Valley, Airdrop Lake Plateau, Kathleen Lake and Mush and Bates Lake – is examined in relation to the hypotheses formed. At the end of this chapter, a model for hunter-gatherer regional land use in the Kluane region will be evident.

8.2 Donjek Valley

Based on the results from chapter seven, the archaeological sites are situated in ideal locations. There is a permanent water source less than 500 meters from each site and all sites are located in a shrub-grassland area therefore, there is an ample supply of water and wood. Additionally, these sites have a predominantly southwest exposure and are located on flat ground.

Upon examination of figure 6.2, it is evident that in the Donjek Valley region, the majority of the sites are located in close proximity to one another. This may be the result of a stratified archaeological survey, but the fact remains that there is a concentration of sites at the confluence of the Donjek River and Bighorn Creek. This concentration of sites ranges in cultural affiliation from the Bennett Phase (200 BP to present) to the comparatively early Taye Lake Phase (5,000 – 1,750 BP). Based on the ethnographic data presented in chapter three, it is interpreted that the Donjek Valley is home to aggregation sites where the regional band will gather to communally hunt for large game.

These aggregation sites are located in an advantageous location. In the Donjek Valley there are an abundance of food resources. Besides being one of the finest all-season ranges for Dall's sheep, the Valley is also an excellent habitat for grizzly bears, the most northerly range for mountain goats on the continent, and is frequented by many upland bird species (Arthurs 1995:53). The Donjek River, at the heart of the Donjek Valley, is one of the largest glacially fed rivers in Kluane. Presently there is evidence of arctic grayling in the river (Environment Canada, parks 1987:10-25). The arctic grayling population is currently severely undersized (the size of fish bait) and their population are low, possibly a result of the glacial advance at approximately 3,000 – 2,800 BP. Therefore, arctic grayling are not considered an acceptable food source today (Arthurs pers. com. 1999).

From the zooarchaeological reports for two of the excavated sites in the Donjek Valley – JgVu-2 and JgVu-3 (Rick 1995, 1996), it has been ascertained that the assemblage consists primarily of mammals. Many of the faunal specimens were not identifiable past class and the majority of identifiable bone are Artiodactyla. Species identified included Dall's sheep, mountain goats, caribou, and bison. The most common species identified was Dall's sheep and mountain goat. Only one sample was positively identified as caribou, and three faunal samples were identified as bison. Of the remaining faunal specimens collected at the two archaeological sites, the majority are identified as Arctic ground squirrel and the remainder of the identifiable faunal remains where made up of snowshoe hare, vole, ermine, and small rodent. No fish bone and only one birs spacimen was recovered from the archaeological sites

Based on the assumption that the sites in the Donjek Valley are aggregation sites where the regional band will gather to communally hunt, and based on the identified fauna from the archaeological sites, it can be determined that the Donjek Valley was occupied in the fall. From the results in chapter seven, it is determined that the vast majority of sites recorded in the Donjek Valley are located in the subalpine biotic community. In the fall, the temperature would be cool but habitable. Hunter-gatherers probably stayed in the Donjek Valley until the fall season of sheep hunting was complete, then moved to lower elevation areas, such as the montane biotic community, for the winter.

8.3 Airdrop Lake Plateau

The results from chapter seven indicate that while the Airdrop Lake Plateau area meets the criteria for an habitable site location there are observations that suggest that the Airdrop Lake Plateau is not an ideal site location when compared to other locations. For example, almost every site in the study region is located in a shrub-grassland vegetation zone. This is not the case for the Airdrop Lake Plateau. None of the sites are located in a shrub zone. Also, from the results on the landform, it would indicate that the sites are located on relatively flat ground. However, from recent literature on the environment of Airdrop Lake Plateau, it has been documented that parts of this area are very rocky making it difficult for travel on foot and certainly not suitable for carrying out daily activities (Arthurs 1995a:184). It is determined that while the sites in the Airdrop Lake Plateau may meet most of the criteria required to characterize them as being situated in an ideal location, they are not suitable for residential habitation.

If the sites in the Airdrop Lake Plateau are not residential sites then, according to the hypothesis on site type, they must be special purpose sites. Near the plateau are two prominent peaks – Hoodoo Mountain and Chalcedony Mountain. Hoodoo Mountain, the nearest mountain to the plateau area, provides a high quality obsidian source located one kilometer from the mountain peak. The source of the lithic material from the archaeological sites is undisputedly traced back to Hoodoo Mountain (Ebell 1988; Arthurs 1995). From the archaeological material recovered from the recorded sites and the environmental data calculated through GIS, it can be concluded that this area was not a living area but rather, a location where procurement and processing of raw material takes place. The function of the sites on the plateau is not detectable through the ethnographic record therefore; no verification of site function is available historically. However, considering the archaeological and environmental knowledge available through GIS, the need for ethnographic information is not as great.

Determining the season of site occupation on the plateau is somewhat speculative. Ethnographic accounts do not mention people traveling to specific areas to obtain raw material for producing stone tools. Therefore, a hypothesis on seasonality cannot be established based on existing ethnographic data. From the environmental data it can be suggested that travel to, and occupation of the sites on the Plateau would be difficult, if not impossible during the winter because of the climate. Spring and fall would also be unfavorable seasons to obtain lithic resources because they are typically periods of intensive hunting according to the ethnographic record. This would leave summer as the only logical season to make a trip to the quarry to obtain lithic resources. Procurement of the lithic resource in summer would also ensure that there would be available lithic resources for the projectile points needed in the intensive fall hunting.

Although there is no evidence of hearths in any of the plateau and there are no faunal remains, it cannot be assumed that past hunter-gatherers did not stay at the sites for a short period of time. All archaeological sites located in the plateau area have either lithic scatters or isolated lithic finds identified at the site locations. The lithic scatters are the result of primary lithic reduction activities. Furthermore, it is evident that a number of the sites, seven in total, are located in an ecotone. Four are located in a subalpine/lower alpine ecotone and three are located in a lower/upper alpine ecotone. Sites located in an ecotone have access to resources from both biotic communities. Therefore, it is plausible that small lithic procurement parties may have been able to stay at the sites, for short periods of time, because of probable access to the resources of more than one ecotone.

8.4 Kathleen Lake

From the results illustrated in chapter seven, archaeological sites located in the Kathleen Lake area are situated in ideal locations. There is a permanent water source less than 500 meters from each site - Kathleen Lake. As well, all sites are located in a shrub-grassland area therefore, there is an ample supply of water and wood. In addition, the

Kathleen Lake sites have a southwest exposure, on average, and are located on flat ground.

Archaeological sites are abundant in the Kathleen Lake area and are closely spaced together, similar to spacing of archaeological sites in the Donjek Valley (see figure 6.2 and 6.6 for comparison). This evidence indicates that these sites are residential sites and furthermore, they can be identified as large aggregate sites where the regional band gathered to hunt or fish.

An abundant supply of land-locked salmon, known as kokanee, is available in Kathleen Lake. It is suspected, but not confirmed, that before the Neoglacial period the Alsek River supplied salmon in Kathleen Lake (Workman 1978:25). The salmon in Kathleen Lake became land locked through the ice damming of the Alsek River by Lowell Glacier during the Neoglacial ice advance. No fish bones were discovered at any of the archaeological sites. Considering that preservation of fish remains at the archaeological sites is not likely due to the composition of the soil in the mixed forest fishing activities at these sites cannot be ruled out. Based on ethnographic accounts, fishing played a part in the annual round of recent hunter-gatherers. This suggests that there may have been several groups of past hunter-gatherers congregating to harvest the salmon resources found in abundance in the summer. From what is known through the archaeological and ethnographic data, it can be stated that the regional band gathered along Kathleen Lake and communally fished for kokanee.

According to ethnographic data, the height of salmon season, when they are most abundant and at their largest is in the late summer. Therefore, the regional band resided along Kathleen Lake in the summer. The land surrounding Kathleen Lake is home to small mammals such as beaver, muskrat and rabbit and caribou are thought to have existed in the valley areas in prehistoric times (Adams 1991:2). The site located in the Kathleen Lake area are also located in a lower elevation montane biotic community. Based on this knowledge, it can also be suggested that the Kathleen Lake area would also be suitable for residence in the spring or winter. Because no small, scattered local band sites identified in this area, habitation in the spring and winter is not ruled out. But for this research, it is asserted that Kathleen Lake was primarily exploited for its salmon in the summer.

8.5 Mush and Bates Lakes

Mush and Bates Lakes are combined in this analysis because they are in close proximity to one another (see figure 1.1 and 6.1). Archaeological sites in both areas are located near a permanent water source – the Mush and Bates Lakes. The sites are also located either within, or right next to the boundaries of a shrub-grassland vegetation zone therefore, all sites have access to wood. All sites are located on flat ground and with the exception of one site in the Bates Lake area, all sites have a southern exposure. Based on the results, elaborated in chapter seven, the hypothesis suggesting the criteria for an ideal site location is accepted for these areas.

Archaeological sites in the Mush and Bates area are small and scattered throughout the areas. This indicates that smaller local bands probably resided in the Mush and Bates Lake area extracting food and non-food resources as required.

Moose are frequently found in the lowlands where the lakes are located (Adams 1991:2). There are various summer and winter moose ranges surrounding the lakes

(Environment Canada, Parks 1987:Map 9.1a and b). In the summer, Dall's sheep and goats can be found in the near Goatherd and Alsek Mountain to the east of Mush Lake (Environment Canada, Parks 1987:Map 9.1a and b). Similar to Kathleen Lake, small mammals such as beaver, muskrat and rabbit are also found in the valley and caribou are thought to have existed in the valley areas in prehistoric times (Adams 1991:2). Unlike Kathleen Lake, Mush and Bates Lake do not contain kokanee. Instead, both the Mush and Bates Lakes carry a supply of various fresh water fish such as pygmy and round whitefish, arctic grayling, Dolly Varden, lake trout, and slimy sculpin (Environment Canada, Parks 1987:10-25). In reviewing the food resources available for these areas, it can further be concluded that although there is an abundant supply of food resources, there is not enough to support a regional band. This further supports the statement that these areas were siutable for inhabitation by small local bands.

All sites in this area are located in a montane biotic community. All sites are located at the base of the mountain valley with elevations ranging from 680 to 884 meters a.s.l.. The vegetation in the area is characterized as a mixed forest. The combination of a low recorded elevation for the sites, the fact that all the sites are located near the base of the mountain valley, and the mixed forest vegetation suggest that these site locations are currently protected from cold weather and wind. Indicating that they would be suitable for winter occupation. However, the fact that all three lakes in the area have abundant fish resources would suggest that the location of the sites might have been ideal in the spring and summer, too. Based on the environmental evidence it is determined that the Mush and Bates Lakes areas were occupied by small local band in both the winter and spring.

8.6 Model of Hunter-Gatherer Regional Land-Use for Kluane

Up to this point, discussion and interpretation of the data has been focused the areas located in the region. To build a regional model, the interpretations must be linked to show the connection between all areas. The link between the areas is based primarily on seasonality.

Through the application of GIS techniques, and the incorporation of ethnographic and archaeological data, it is possible to construct a regional model for hunter-gatherer land use in the Kluane region. This model takes into consideration the types of sites occupied, the activities conducted at the sites, the season in which they were occupied, and the level of social organization at the sites.

Using the interpretations from the previous sections in this chapter, it can be determined that a regional band occupied the Kluane region. In the fall, the regional band would gatherer in the Donjek Valley to communally hunt Dall's sheep and mountain goat. This meat was dried and cached for the winter. In the early winter, the regional band would live off of the cached resources.

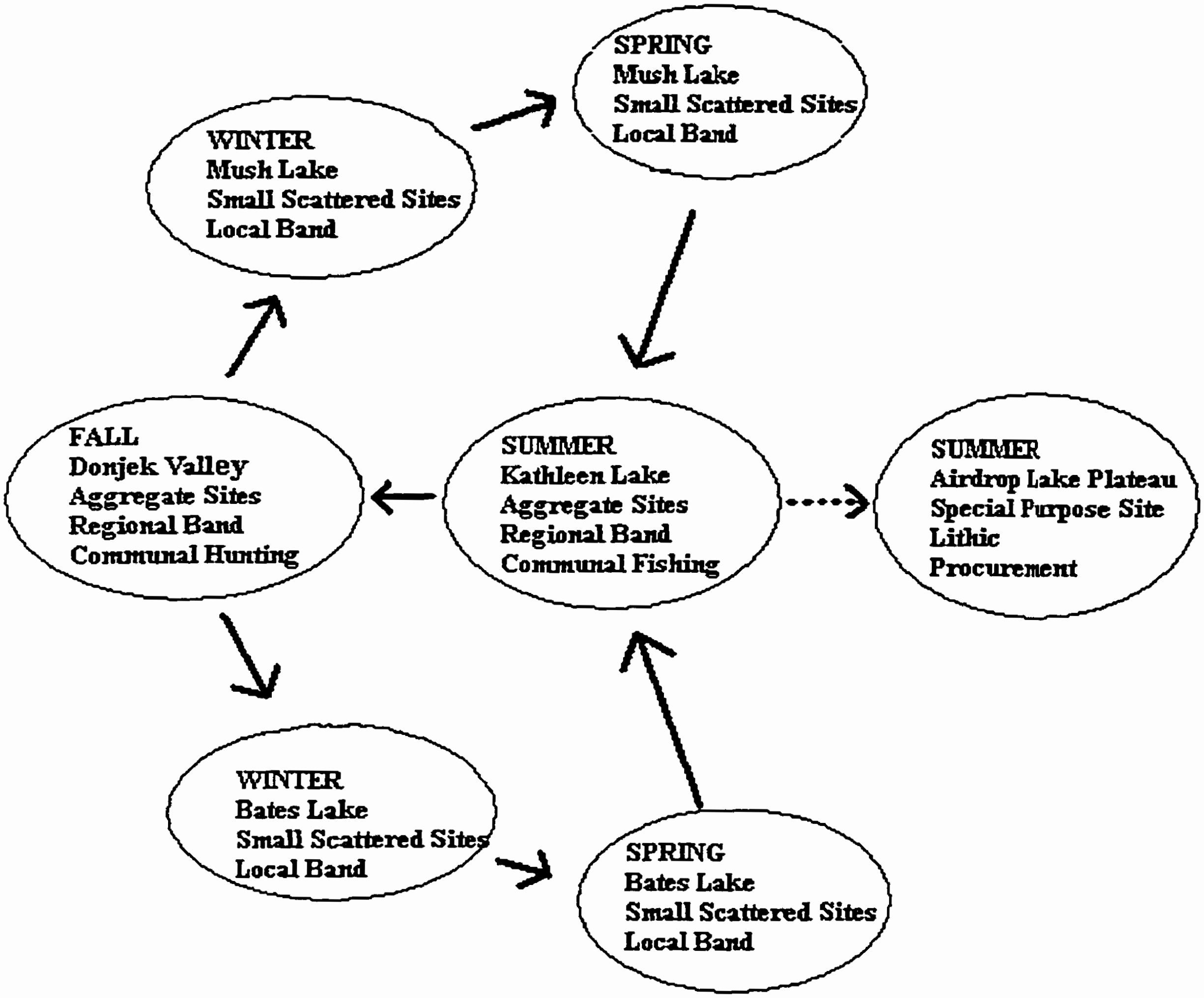
Once these resources were depleted, the regional band would then break into smaller local bands, consisting of approximately two nuclear families, and move throughout the regions hunting individual large game resources and trapping small mammals. These small local bands would locate themselves in the southern part of the Kluane region, near the Mush and Bates Lakes.

In the spring, the local bands would continue to live off the resources in the Mush and Bates Lakes area forming small, scattered sites throughout the area. By late spring to early summer, the local bands would gradually proceed to Kathleen Lake.

By the middle to late summer all local bands in the Kluane region would unite to form a regional band at Kathleen Lake hence, forming a larger aggregation site. The regional band would communally fish for salmon. Although much of the salmon was used at the aggregation site, some of the salmon was dried and cached for later use. During the summer, special activities also took place at locations that were not normally occupied by hunter-gatherers. Airdrop Lake Plateau is one of those special purpose sites. Small groups of hunter-gatherers would travel to the Airdrop Lake Plateau area to procure obsidian used in the production of lithic tool. These small groups of hunter-gatherers would reduce the obsidian nodules so that they could be transported back to the regional band site.

In the fall, the regional band would converge back to the Donjek Valley to again communally hunt for Dall's Sheep and mountain goat. Figure 8.1 illustrates the annual round for hunter-gatherers in the Kluane region.

Figure 8.1 : Descriptive Model of Hunter-Gatherer Regional Land Use:



CHAPTER 9

CONCLUSIONS OF THIS RESEARCH

9.1 Introduction

It has been determined that there are characteristics that can be measured to determine an ideal settlement location – water, landform, shelter and vegetation. To test these measurable characteristics, GIS are necessary. Based on the outcome of the testing and the analysis of the results, it is determined that sites located in the southwest Yukon can be identified based on their function and the annual season of occupation. At this point, a model for regional land use was constructed for prehistoric hunter-gatherers in the southwest Yukon.

9.2 GIS in Archaeology

One of the goals of this thesis is to prove that GIS are valuable tools in archaeology. Earlier, it was stated that there are three trends in modeling and research that archaeologists can address with GIS: site locational models, GIS procedure related studies, and studies that address larger theoretical concerns. It was proven through the methods of this research that GIS can be applied to compare archaeological sites against each other and to also comparison archaeological sites against the region. The results of this analysis revealed that variables measured for prehistoric archaeological sites, in particular slope and aspect, do not apply to the region as a whole.

In this study, a region the size of 22,000 square kilometers was tested against known prehistorical archaeological sites recorded in the study region. In past regional archaeological studies, a sample of the region would be used rather than the entire study region. Through GIS it is now possible to measure the entire study region. GIS not only allowed this study to measure and calculate variables such as slope and aspect for the entire study region, but also performed these calculations in less time than it would to take to perform these calculations on even a sample of the region without the assistance of GIS. This made for very expedient research. Not only has the implementation of GIS allowed for efficient testing of the study region, it has also made the results of the testing more reliable. Because the entire region is examined rather than just a sample of the region, bias in sampling is not an issue.

The use of GIS in this research has also proven useful in creating a database of the prehistoric archaeological sites in the region. Records of the archeological sites have been documented previously, but it is not until the sites were integrated into a GIS that they became spatially referenced. Because the sites are spatially referenced, they could now be implemented into any future inter-site spatial studies. GIS has created a powerful display tool to the Kluane region. This has made it easier to visualize site locations in relation to environmental factors. It can be argued that this can be conducted without the use of GIS. This argument is true, archaeological sites can be plotted on paper maps that show various environmental variables. But, only through GIS can we integrate the archaeological site database with the geographical variables, and in tern ask questions of the relationships between the site locations and the geographical variables. Essentially, it is easier to conduct any form of spatial analysis with the archaeological site database integrated with a digital map.

As mentioned above, the use of GIS in this research permits future inter-site spatial research. All digital data required for any future research is already gathered and geo-referenced therefore, any future research can be conducted without the tedious process of gathering and transforming the data so that it can be integrated. One type of research that can be conducted regionally using the variables measured in this research is the prediction of unknown site locations within the study region. In other words, a predictive model of regional land-use can be constructed. The outcome of the methods employed in this research is, in fact, the foundation of a predictive model for the southern Yukon region.

9.3 Testing Regional Models of Hunter-Gatherer Land-Use

Using this regional model for hunter-gatherer land-use it is predicted that archaeological sites within the study region or within a similar regional setting may be located in areas where:

1. An available water source is within 500 meters
2. The area is relatively flat (slope < 7.5 degrees)
3. The aspect or exposure faces southeast to southwest (aspect value > 90 degrees but less than 270 degrees)
4. An available vegetation source, including shrub type vegetation, surround the predicted site location.

By isolating areas that meet these above conditions, it is possible to predict where archaeological sites may be located in a region, before a survey is conducted. This is done through the process of querying in a GIS. Through a query, areas of a digital map that contain the above conditions (water source, vegetation source, and desirable slope and aspect value), can be isolated and identified as potential areas where prehistoric sites may be located.

At this point, it is necessary to state that this first step in the prediction of prehistoric site locations cannot be used exclusively. As it was demonstrated in this research, the three knowledge bases - archaeological, environmental, and ethnohistorical information - must be used concurrently to understand not only where archaeological sites are located, buy why they are located at specific place. In knowing this, it can be further stated that this research limited the use of GIS to the environmental knowledge base.

9.4 Contributions to the Discipline

The resulting data and analysis supports the idea that human occupation, throughout the holocene in the southwest Yukon, did not substantially differ from the ethnographic descriptions of populations recently, or currently, living in the region. It can also be stated that the ethnographic data can be a suitable analogy for predicting hunter-gatherer behavior in the archeological record. This statement is significant for only this region and is in sharp contrast to other regional studies that have been conducted (e.g. Bettinger's and Baumhoff's 1982 research on the rapid spread of Numic populations in the Great Basin region).

In light of the recognition that the behavior of hunter-gatherer populations in the southern Yukon did not change dramatically from the archaeological to the ethnographic record, the theoretical contribution becomes evident. The ethnographic data does have a place in hunter-gatherer settlement studies. In some cases, such as the southern Yukon, the ethnographic data can be used as an analogy for past hunter-gatherer behavior.

A further contribution stemming from this thesis is methodological - the bridging of more than one discipline. A mehtodology that combined geographic techniques - GIS, archaeological data, and ethnographic data helped to create a holistic study. This contribution is significant because it shows how various forms of data may not be strong on their own, but when incorporated into an overarching methodology helps build a strong model for hunter-gatherer regional land-use and provides the means for testing hypotheses.

9.5 Future Potential of This Study

GIS has proven valuable for this research because a framework for the implementation of a predictive model has been created for the Kluane region – the regional model. This can assist in identifying areas in the region yet to be investigated for the presence of archaeological sites. This framework needs to be tested for it to be proven valid for the Kluane region. This is the future potential of this thesis.

Through GIS in this thesis, the Kolmogorov-Smirnov cumulative frequency distribution was applied to examine differences in slope and aspect values between archaeological sites and the study region. This test can be taken one step further to develop probabilistic models with an interest in uncertainty. These probabilitic models include the regression model (contains physical constants, little variability) as well as an uncertainty value. It essence, a model is created that contains the regression model plus a margin of error. This would produce a more realistic *predictive* model.

A predictive model can aid in heritage preservation in this region. For example, a percentage of archeological sites that were addressed in this thesis were in a deteriorated condition. It is important to identify other locations in the Kluane region that could be considered hazardous to the preservation of cultural remains. Through a predictive model, these locations could be identified and the cultural remains preserved for future research.

Further information on the paleo-environment also needs to be addressed. Not enough information on the paleo-environment is known to accurately depict the relationship between prehistoric hunter-gatherers and the environment that they once occupied. Of particular interest would be the effects of the ice-dammed glacial lakes on the mobility of the past hunter-gatherers and the specific of past vegetation in the region

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Appendix A Prehistoric Archaeological Site Recorded for Region

NTS	Borden No.	Lat.	Long.	Site Type	Features	Culture	C14 Date	Elev. (m)
115G/03	JgVu-02	610915	1392415	Campsite	scatter (lithic,bone, fire cr. rock); hearth	Aishihik Phase	1860 +/- 80 B.P	1158
115G/03	JgVu-03	610915	1392348	Campsite	scatter (lithic, bone); hearth	Late Taye Lake	1820 +/- 70 B.P.	1158
115G/03	JgVu-6	610925	1392434	Find: isolated	scatter (lithic)	unknown	n/a	1127
115G/03	JgVu-11	610926	1392305	Unknown	scatter (lithic, bone); cut wood (adze)	Aishihik Phase; Bennett Phase	n/a	1158
115G/03	JgVu-21	610817	1392250	Find: isolated	Unknown	unknown	n/a	1155
115G/03	JgVu-20	610749	1392244	Unknown	scatter (artifacts)	unknown	n/a	1158
115G/03	JgVu-13	610921	1392423	Unknown	scatter (lithic, bone)	Aishihik; Bennett	n/a	1158
115G/03	JgVu-09	610918	1392428	Station: chipping	scatter (lithic, bone, fire cr. rock)	Late Taye Lake Phase	n/a	1158
115G/03	JgVu-27	610815	1392317	Campsite	hearth; scatter (bone, fire cr. rock)	Aishihik	790 +/- 60 B.P.	1158
115G/03	JgVu-28	610810	1392310	Unknown	scatter (lithic)	Aishihik	n/a	1158
115G/03	JgVu-29	610807	1392306	Unknown	scatter (bone, fire cr. rock); hearth	unknown	n/a	1158
115G/03	JgVu-07	610852	1392334	Find: isolated	scatter (lithic)	unknown	n/a	1158
115G/03	JgVu-30	610928	1392251	Find: isolated	scatter (bone)	unknown	n/a	1189
115G/03	JgVu-04	610918	1392335	Campsite	scatter (lithic, bone, fire cr. rock); hearth	Taye Lake; Aishihik	n/a	1158
115G/03	JgVu-05	610925	1392311	Campsite: hunting	scatter (lithic)	unknown	n/a	1188
115G/03	JgVu-08	610817	1392317	Campsite	hearth; scatter (bone)	unknown	n/a	1158
115G/03	JgVu-10	610714	1392128	Find: isolated	Unknown	unknown	n/a	1128
115G/03	JgVu-17	610840	1392529	Unknown	scatter (lithic)	Late Aishihik; Bennett Phase	n/a	1158
115G/03	JgVu-22	610909	1392247	Campsite	tent pole; cut wood (stump, adze)	unknown	n/a	1158
115G/03	JgVu-25	610913	1392134	Find: isolated	Unknown	unknown	n/a	1250
115G/03	JgVu-26	610905	1392108	Unknown	scatter (lithic)	unknown	n/a	1280
115G/03	JgVu-19	610957	1392548	Find: isolated	Unknown	unknown	n/a	1128
115G/03	JgVu-31	610917	1392359	Find: isolated	Unknown	unknown	n/a	1158
115G/03	JgVu-32	610557	1392101	Campsite	scatter (lithic)	unknown	n/a	1173
115G/03	JhVu-08	611005	1392544	Campsite	hearth; scatter (bone)	Taye Lake	n/a	1158
115G/03	JhVu-02	611001	1392601	Campsite	hearth; scatter (lithic, bone, fire cr. rock)	Archaic; Tate Lake Phase	3660 +/- 80 B.P.	1127
115G/03	JhVu-03	611026	1392326	Campsite	hearth; scatter (lithic, bone)	Aishihik	n/a	1310
115G/03	JhVu-06	611006	1392208	Find: isolated	scatter (lithic)	unknown	n/a	1402
115G/03	JgVu-06	610925	1392434	Campsite	hearth; scatter (lithic, bone, fire cr. rock)	Taye Lake; Aishihik	n/a	1127
115B/09	JeVn-01	604040	1381800	Lookout	scatter (lithic)	Little Arm; Taye Lake	n/a	1640
115B/09	JeVn-10	604333	1381719	Unknown	stone feature (circular); pit	unknown	n/a	1360

NTS	Borden No.	Lat.	Long.	Site Type	Features	Culture	C14 Date	Elev. (m)
115B/09	JeVm02	604418	1380401	Find: isolated	Unknown	unknown	n/a	N/A
115B/09	JeVn-11	604229	1381540	Unknown	scatter (lithic)	Little Arm Phase	n/a	1740
115B/09	JeVn-12	604235	1383536	Station: lithic	scatter (lithic)	unknown	unknown	1740
115B/09	JeVn-13	604255	1381602	Station: lithic	scatter (lithic)	Little Arm Phase	n/a	1680
115B/09	JeVn-14	604251	1381558	Station: chipping	scatter (lithic)	unknown	n/a	1760
115B/09	JeVn-15	604304	1381613	Unknown	scatter (lithic)	unknown	n/a	1680
115B/09	JeVn-02	604125	1381548	Unknown	Unknown	unknown	n/a	1780
115B/09	JeVn-06	604141	1381720	Find: isolated	Unknown	unknown	n/a	1600
115B/09	JeVn-07	604148	1381732	Find: isolated	Unknown	unknown	n/a	1600
115B/09	JeVn-05	604150	1381758	Station: lithic	blind (hunting)	unknown	n/a	1524
115B/09	JeVn-08	604204	1381841	Find: isolated	Unknown	unknown	n/a	1448
115B/09	JeVn-09	604309	1381800	Find: isolated	Unknown	unknown	n/a	1360
115B/09	JeVn-03	604144	1381823	Find: isolated	Unknown	unknown	n/a	1424
115B/09	JeVn-04	604151	1381814	Find: isolated	Unknown	unknown	n/a	1520
115A/06	JbVi-10	601834	1372403	Find: isolated	scatter (lithic)	unknown	n/a	680
115A/06	JbVg-01	601918	1370416	Find: isolated	Unknown	unknown	n/a	823
115A/06	JbVi-15	601729	1372322	Unknown	scatter (lithic)	unknown	n/a	686
115A/06	JbVi-16	601835	1372640	Unknown	scatter (lithic)	unknown	n/a	707
115A/06	JbVi-17	601832	1372555	Unknown	scatter (lithic)	unknown	n/a	701
115A/06	JbVi-18	601832	1372523	Unknown	scatter (lithic)	unknown	n/a	701
115A/06	JbVi-19	601836	1372321	Unknown	scatter (lithic)	unknown	n/a	707
115A/04	JbVj-09	601120	1373910	Unknown	scatter (lithic)	unknown	n/a	680
115A/04	JbVj-10	601403	1373636	Campsite	scatter (lithic)	unknown	n/a	680
115A/11	JdVh-02	603438	1371333	Unknown	Unknown	unknown	n/a	736
115A/11	JdVh-04	603436	1371317	Unknown	Hearth	unknown	n/a	733
115A/11	JdVh-05	603436	1371303	Campsite: fishing	scatter (lithic)	unknown	n/a	734
115A/11	JdVh-06	603350	1371342	Find: isolated	scatter (lithic)	unknown	n/a	762
115A/11	JdVh-07	603322	1371751	Campsite: fishing	scatter (lithic)	unknown	n/a	N/A
115A/11	JdVh-11	603326	1371707	Campsite	scatter (bone, lithic)	unknown	n/a	822
115A/11	JdVh-12	603325	1371657	Unknown	scatter (bone)	unknown	n/a	884
115A/11	JdVh-13	603324	1371650	Campsite	scatter (bone, lithic)	unknown	n/a	853
115A/11	JdVh-14	603319	1371656	Campsite: hunting	scatter (bone, lithic)	unknown	n/a	822
115A/11	JdVh-15	603452	1371407	Campsite	scatter (bone, lithic)	unknown	n/a	731

NTS	Borden No.	Lat.	Long.	Site Type	Features	Culture	C14 Date	Elev. (m)
115A/11	JdVh-18	603532	1371455	Unknown	scatter (lithic)	unknown	n/a	737
115A/11	JdVh-19	603536	1371505	Find: isolated	scatter (lithic)	unknown	n/a	746
115A/11	JdVh-20	603658	1371854	Campsite	scatter (bone, lithic)	unknown	n/a	732
115A/11	JdVi-06	603255	1372010	Unknown	scatter (lithic)	unknown	n/a	731
115A/11	JdVi-01	603323	1372013	Find: isolated	scatter (lithic)	unknown	n/a	N/A
115A/11	JdVi-02	603222	1372539	Find: Isolated	scatter (lithic)	unknown	n/a	732

APPENDIX B: GIS Techniques for Measuring Environmental Variables

WATER:

To examine the distance between each archaeological site and its nearest water source, two types of data are used: archaeological data – site locations and hydrological data (watercourses, water bodies, wetlands, and dry riverbeds). In Arc View, a new view is created for this exercise. The two data themes are then added to the view. Figure 6.2 through6.6 illustrate the five NTS maps with the data themes added to the corresponding views. The next step is to measure the distance. To accomplish this step, the water source theme of interest is made active. From the Analysis menu in Arc View, "find distance" is selected. The following step is to select the archaeological sites data theme to make it active, then from the Analysis menu, select the "summarize zone" function. The result of this process is a table with the distance recorded between each archaeological site and the water source theme of interest. These steps are repeated for each water source theme available in each NTS map.

LANDFORM:

To conduct this exercise, the slope of the study region is first calculated. The DEM at the 1:250,000 scale is used to calculate the slope. In a new view in Arc View, the DEM is first added as a theme in the view. While the DEM is active in the view, the function "derive slope" is performed. This function is a built in map algebra function available when the spatial analyst extension is added to Arc View. The result of this second step is a second theme in the view that contains a slope value for each raster cell. These data, as well as the archaeological data, are added as themes into a new view in Arc View. The third step involves using the spatial analysis tools in Arc View. The query “summarize zones” is first selected for the active archaeological data theme. This query asks for a theme containing the variable to summarize – the slope theme – for each archaeological site.

For Kolmogorov-Smirnov test: The first step is to plot the cumulative distributions of the archaeological sites and background population respectively and obtain the difference between the two curves (D). Second, the maximum value of D (D_{max}) is compared with a critical value (d) obtained from the sample size at the confidence interval of α=0.06. The formula for the critical value is $d=1.36/\sqrt{n}$, where n = number of archaeological sites. If D_{max} exceeds d, then the distribution of slope values at archaeological site locations can be said to be significantly different from the population distribution, or background environment (reject H_o).

SHELTER:

To produce a map depicting the aspect of the land, the 1:250,000 scale DEM is used once again for this exercise. First, a new view in Arc View is opened and the DEM is added to the view as a theme. While the DEM is active in the new view, the function “derive aspect” is carried out in Arc View. This is the second step in the exercise. This function, like the "derive slope" function, is a built in map algebra function that is also available through the spatial analyst extension. The result of this second step is a second theme where an aspect value is contained in each cell. The third step is to add the archaeological data as a theme to the view. Using the spatial analysis tools in Arc View, the query summarize zones is selected for the archaeological data theme that is active. This query asks for a theme containing the variable to summarize. The theme used in this exercise is the newly created aspect theme.

VEGETATION:

The first step in this section is to examine the distance to the nearest vegetation source. To complete this exercise, a new view in Arc View is created and two data themes, archaeological site points and vegetation - wooded area polygons, are added to the view. The distance from each archaeological site to the nearest wooded area is then measured using the same process that was implemented in calculating the distance to the nearest water source. First the vegetation - wooded area theme for each NTS map is made active. Second, from the Analysis menu in Arc View, "find distance" is selected. Third, the archeological site theme is made active and finally, from the Analysis menu, the function "summarize zone" is selected. The result of this process is a table with the distance recorded between each archaeological site and the nearest vegetation - wooded area polygon. The vegetation polygon is considered and the centre of each polygon, based on the calculated area, is used in calculating the distance between each archaeological site and the nearest wooded area.

ECOTONE:

To view the four biotic communities through a GIS, digital elevation models (DEM) are used. DEM's are first added as a theme to a new view in Arc View. Using the "reclassify" command, all cells in the DEM with a recorded elevation of less than 1100 metres are reclassified as montane. Cells with an elevation between 1100 and 1400 metres are reclassified as subalpine. Cells with an elevation between 1400 and 1600 metres are reclassified as lower alpine, and cells with an elevation over 1600 metres are reclassified as upper alpine. Once the reclassification of the DEM's is completed, the next step is to add the archaeological data points as a theme to the view.

Appendix C Distance to Water Sources (distance in meters)

Site Number	Map Number	Watercourse	Waterbody	Wetlands	Dry River Bed
JeVm-02	115b09	427.20	721.11		721.11
JeVn-01	115b09	250.00	1990.60		6021.00
JeVn-02	115b09	180.28	1118.03		7510.33
JeVn-03	115b09	70.71	320.16		5124.45
JeVn-04	115b09	282.84	100.00		5206.01
JeVn-05	115b09	492.44	150.00		5455.73
JeVn-06	115b09	350.00	807.77		6074.95
JeVn-07	115b09	550.00	552.27		5857.69
JeVn-08	115b09	100.00	640.31		4729.69
JeVn-09	115b09	100.00	502.49		5178.80
JeVn-10	115b09	600.00	1400.89		5948.11
JeVn-11	115b09	50.00	801.56		7304.28
JeVn-12	115b09	0.00	806.23		7350.17
JeVn-13	115b09	403.11	320.16		6921.89
JeVn-14	115b09	300.00	364.01		7014.45
JeVn-15	115b09	474.34	509.90		6803.31
JgVu-02	115g03	0.00	1052.28		1133.34
JgVu-03	115g03	148.81	941.19		1488.15
JgVu-04	115g03	0.00	905.20		1581.92
JgVu-05	115g03	0.00	1133.34		2104.56
JgVu-06	115g03	0.00	2695.15		2695.15
JgVu-07	115g03	148.81	210.46		1133.34
JgVu-08	115g03	148.81	613.58		613.58
JgVu-09	115g03	148.81	1227.16		1227.16
JgVu-10	115g03	148.81	2115.05		1609.68
JgVu-11	115g03	0.00	1133.34		2104.56
JgVu-13	115g03	0.00	1372.00		1372.00
JgVu-17	115g03	0.00	595.26		595.26
JgVu-19	115g03	0.00	1663.80		1663.80
JgVu-20	115g03	332.76	536.56		536.56
JgVu-21	115g03	148.81	665.52		665.52
JgVu-22	115g03	148.81	470.59		1996.56
JgVu-25	115g03	148.81	1073.12		2603.19
JgVu-26	115g03	148.81	1411.78		2744.00
JgVu-27	115g03	148.81	470.59		470.59
JgVu-28	115g03	210.46	297.63		297.63
JgVu-29	115g03	148.81	148.81		148.81
JgVu-30	115g03	148.81	1052.28		2324.56
JgVu-31	115g03	210.46	998.28		1403.91
JgVu-32	115g03	148.81	2251.97		2146.23
JhVu-02	115g03	148.81	1347.57		1347.57

Site Number	Map Number	Watercourse	Waterbody	Wetlands	Dry River Bed
JhVu-03	115g03	0.00	2923.74		3483.66
JhVu-06	115g03	0.00	2276.43		3583.93
JhVu-08	115g03	148.81	1636.96		1636.96
JbVj-09	115a04	644.27	4645.92	455.57	
JbVj-10	115a04	644.27	1161.48	2917.04	
JbVg-01	115a06	1932.82	1959.48	322.14	
JbVi-10	115a06	644.27	4200.15	2254.96	
JbVi-15	115a06	720.32	4200.15	1610.68	
JbVi-16	115a06	911.14	2752.34	3672.92	
JbVi-17	115a06	720.32	2969.95	3865.64	
JbVi-18	115a06	455.57	3188.99	3543.50	
JbVi-19	115a06	720.32	4756.29	1610.68	
JdVh-02	115a11	0.00	5361.42	3601.60	
JdVh-04	115a11	0.00	5542.25	3285.16	
JdVh-05	115a11	0.00	5542.25	3285.16	
JdVh-06	115a11	455.57	4917.20	3984.61	
JdVh-07	115a11	720.32	6833.55	7897.27	
JdVh-11	115a11	1610.68	6129.06	7152.59	
JdVh-12	115a11	1734.76	6442.73	6886.49	
JdVh-13	115a11	1734.76	6442.73	6886.49	
JdVh-14	115a11	1610.68	6764.87	6953.97	
JdVh-15	115a11	911.14	4475.26	4381.53	
JdVh-18	115a11	2277.85	3039.03	3879.04	
JdVh-19	115a11	2277.85	3039.03	3879.04	
JdVh-20	115a11	322.14	1610.68	4074.74	
JdVi-01	115a11	0.00	7065.00	9291.84	
JdVi-02	115a11	0.00	11619.26	14130.01	
JdVi-06	115a11	644.27	7956.18	9923.68	

Appendix D Distance to Vegetation (distance in meters)

Site Number	NTS	Shrub/grassland vegetation (meters)	Wooded vegetation
JbVj-09	115a04	0.00	1328.20
JbVj-10	115a04	0.00	1161.48
JbVg-01	115a06	0.00	4788.90
JbVi-10	115a06	0.00	3285.16
JbVi-15	115a06	0.00	2881.28
JbVi-16	115a06	0.00	2752.34
JbVi-17	115a06	0.00	2969.95
JbVi-18	115a06	0.00	3188.99
JbVi-19	115a06	0.00	2656.41
JdVh-02	115a11	0.00	3601.60
JdVh-04	115a11	0.00	3285.16
JdVh-05	115a11	0.00	3285.16
JdVh-06	115a11	0.00	3984.61
JdVh-07	115a11	0.00	6833.55
JdVh-11	115a11	0.00	6129.06
JdVh-12	115a11	0.00	6442.73
JdVh-13	115a11	0.00	6442.73
JdVh-14	115a11	0.00	6764.87
JdVh-15	115a11	0.00	4381.53
JdVh-18	115a11	0.00	3039.03
JdVh-19	115a11	0.00	3039.03
JdVh-20	115a11	0.00	1610.68
JdVi-01	115a11	0.00	6609.69
JdVi-02	115a11	0.00	2597.15
JdVi-06	115a11	0.00	5992.09
JeVm0002	115b09	801.49	3063.49
JeVn0001	115b09	5250.36	6021.00
JeVn0002	115b09	5198.10	7510.33
JeVn0003	115b09	3717.43	5124.45
JeVn0004	115b09	3570.89	5206.01
JeVn0005	115b09	3656.45	5455.73
JeVn0006	115b09	4130.78	6074.95
JeVn0007	115b09	3860.48	5857.69
JeVn0008	115b09	3129.91	4729.69
JeVn0009	115b09	1458.73	5178.80
JeVn0010	115b09	1283.01	5948.11
JeVn0011	115b09	3742.19	7304.28
JeVn0012	115b09	3570.89	7350.17
JeVn0013	115b09	2868.89	6921.89
JeVn0014	115b09	2955.74	7014.45

Site Number	NTS	Shrub/grassland vegetation (meters)	Wooded vegetation (meters)
JeVn0015	115b09	2566.02	6803.31
JgVu-02	115g03	0.00	1052.28
JgVu-03	115g03	0.00	941.19
JgVu-04	115g03	0.00	905.20
JgVu-05	115g03	0.00	1133.35
JgVu-06	115g03	126.73	1996.56
JgVu-07	115g03	0.00	210.46
JgVu-08	115g03	0.00	905.20
JgVu-09	115g03	0.00	1199.78
JgVu-10	115g03	0.00	210.46
JgVu-11	115g03	0.00	1133.34
JgVu-13	115g03	0.00	1133.34
JgVu-17	115g03	89.61	1791.97
JgVu-19	115g03	0.00	446.44
JgVu-20	115g03	0.00	595.26
JgVu-21	115g03	0.00	905.20
JgVu-22	115g03	89.61	470.59
JgVu-25	115g03	0.00	1073.12
JgVu-26	115g03	0.00	1411.78
JgVu-27	115g03	0.00	1052.28
JgVu-28	115g03	0.00	1199.79
JgVu-29	115g03	0.00	1133.34
JgVu-30	115g03	0.00	1052.28
JgVu-31	115g03	0.00	998.28
JgVu-32	115g03	0.00	2146.23
JhVu-02	115g03	89.61	665.52
JhVu-03	115g03	0.00	2440.74
JhVu-06	115g03	200.37	2276.43
JhVu-08	115g03	0.00	744.07