

SPATIAL ANALYSIS OF ARCHAEOLOGICAL SITES
IN BARKLEY SOUND, VANCOUVER ISLAND

BY

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**Spatial Analysis of Archaeological Sites in Barkley Sound,
Vancouver Island**

BY

Robert Brian Rahn

**A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of
Manitoba in partial fulfillment of the requirement of the degree
of
MASTER OF ARTS**

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ABSTRACT

Initial contact and trade between Europeans and the First Nations of the Northwest Coast created a situation in which precontact ways of life were altered, sometimes radically. Since the ethnographic study of Northwest Coast societies took place some time after the initial contact period, the ethnographic pattern of site use may not be informative regarding settlement patterns prior to European contact. This study attempts to examine the extent and nature of the pre- to post-contact societal changes through the analysis of site patterning. Site pattern is used as a proxy for group environmental and socio-political preferences in selecting habitation sites. In order to accomplish this, archaeological and ethnographic sites in the Toquaht First Nation region of Barkley Sound, Vancouver Island, were input into a GIS and analyzed. The computer database of archaeological site locations was supplemented with topographic, hydrographic and natural resource data derived from published maps and ethnographic sources. Results of analysis seem to indicate a subtle shift in settlement pattern from pre- to post-contact periods, with post-contact settlement being located closer to key food resources. The exact timing of this shift is unclear, but may have begun just prior to European contact.

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TABLE OF CONTENTS	
ABSTRACT	i
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF FIGURES	v
LIST OF TABLES	vii
CHAPTER 1: INTRODUCTION	
1.1 Introduction	1
1.2 Research Plan and Goals	1
1.3 Outline of the Thesis	6
CHAPTER 2: SPATIAL ANALYSIS AND THEORETICAL BACKGROUND	
2.1 Development of Spatial Analysis in Geography	8
2.2 Spatial Analysis in Archaeology	10
2.3 Theoretical Background	12
CHAPTER 3: THE STUDY REGION: NATURAL AND CULTURAL ENVIRONMENTS AND HISTORY OF ARCHAEOLOGICAL RESEARCH	
3.1 Natural Environment	16
3.1.1 Topography	16
3.1.2 Ecological Zones	18
3.1.3 Flora and Fauna	18
3.2 Cultural Setting	21
3.3 Archaeological Background	25
3.3.1 History of Archaeological Research on Western Vancouver Island	25
3.3.2 The Toquaht Archaeological Project	27
3.3.3 Other Research	29
3.3.4 Spatial Analysis Research on Western Vancouver Island	30
3.4 Other Background Information	35
3.4.1 Alternative Views on Nuu-chah-nulth Settlement Patterns	35
3.4.2 The Toquaht	36
3.4.3 Implications for Spatial Analysis	38
3.5 Summary	39
CHAPTER 4: DATA, HYPOTHESES AND TESTS	
4.1 Data	41
4.1.1 Data Definition and Processing	41
4.1.2 Topographic/Hydrographic Data	42
4.1.3 Natural Resource Data	43

4.1.4 Archaeological Data	44
4.1.5 Ethnographic/Local Group Data	45
4.2 Data Categorization	46
4.3 Hypotheses to be Tested	49
4.4 Tests	53
4.4.1 Friction Surface Catchment Areas	53
4.4.2 Viewsheds	58
4.4.3 Nearest-neighbour Analysis	61
4.4.4 Spatial Association	67
4.5 Summary	73
CHAPTER 5: RESULTS	
5.1 Friction Surface Catchment Areas	75
5.2 Viewsheds	89
5.3 Nearest-neighbour Analysis	96
5.4 Spatial Association	109
CHAPTER 6: DISCUSSION & INTERPRETATION	
6.1 Friction Surface Catchment Areas	117
6.2 Spatial Analytical Techniques	118
6.2.1 Viewsheds	118
6.2.2 Nearest-neighbour Analysis	119
6.2.3 Spatial Association	122
6.3 Models of Toquaht Settlement Pattern	126
CHAPTER 7: CONCLUSIONS	
7.1 Conclusions	129
7.2 Suggestions for Improvements	131
7.3 Recommendations for Future Research	133
BIBLIOGRAPHY	135

LIST OF FIGURES

3.1 The Toquaht Archaeological Project study area	17
3.2 The West Coast region of Vancouver Island	22
4.4 Possible point-patterns of two populations occupying the same region	68
5.1.1 Archaeological site catchment areas	76
5.1.2 Ethnographic site catchment areas	77
5.1.3 Local Group site catchment areas	78
5.1.4 Distribution of resources by archaeological site catchment area (2.4km radius)	79
5.1.5 Distribution of resources by local group site catchment area (2.4km radius)	80
5.1.6 Distribution of resources by ethnographic site catchment area (2.4km radius)	80
5.1.7 Distribution of resources by archaeological site catchment area (8km radius)	81
5.1.8 Distribution of resources by local group site catchment area(8km radius)	82
5.1.9 Distribution of resources by ethnographic site catchment area (8km radius)	82
5.1.10 "Outside" site resource cumulative frequencies (8km radius)	84
5.1.11 "Inside" site resource cumulative frequencies (8km radius)	84
5.1.12 "Intermediate" site resource cumulative frequencies (8km radius)	85
5.1.13 Average catchment composition by time period	87
5.5.14 Average catchment composition by site size	87
5.2.1 Combined viewed areas of archaeological sites	90
5.2.2 Combined viewed areas of ethnographic sites	91
5.2.3 Combined viewed areas of local group sites	92
5.3.1 Map of nearest neighbour distances for archaeological sites	98
5.3.2 Map of nearest neighbour distances for ethnographic sites	99

5.3.3 Map of nearest neighbour distances for local group sites	100
5.3.4 Archaeological nearest neighbour statistics compared with random population sample nearest neighbour statistics	101
5.3.5 Detrended archaeological nearest neighbour chart	102
5.3.6 Detrended ethnographic nearest neighbour chart	103
5.3.7 Detrended local group nearest neighbour chart	103
5.3.8 Map showing three clusters of archaeological sites	106
5.3.9 Map showing two clusters of ethnographic sites	107

LIST OF TABLES

4.1 Site types by period	46
4.2 Resource extraction locations by period	47
4.4.1 2x2 table of possible associations between two site types	69
4.4.2 2x2 table of relatively strongly segregated site types	71
4.4.3 2x2 table of relatively weakly segregated site types	71
5.1.4 Chi-square test results comparing site groups	86
5.2.1 Viewed area and viewed angle for archaeological, ethnographic and local group data sets	94
5.2.2 t-test of mean viewed area/angle by site data set	95
5.3.1 Nearest neighbour (NN) distances (in meters) chart highlighting distances to sites DfSi 4 and DfSi 5	96
5.4.1 Pielou's coefficient of segregation (S) results meeting the strength of segregation/association criterion	109
5.4.2 Combined table of Pielou's S and Fisher exact test results	112
6.3 Toquaht archaeological and ethnographic settlement patterns	128

1.1 Introduction

The goal of this thesis is the elucidation and analysis of settlement patterns on the west coast of Vancouver Island, making use of spatial analytical techniques. Spatial analysis in archaeology can be defined as the extraction of information from spatial relationships and the evaluation of activities integrated over very small to very large scales; that is, from within structures to between sites on the landscape (Clarke 1977:8). The relationships determined through the application of spatial analytical techniques can give insight into (among others): seasonality and subsistence efforts, organization of territory, and social relations between and within populations (Parslow 1999:1). In short, the relationships examinable through spatial analysis are all those relationships between humans and other humans, animals, plants, and the inanimate world.

The study region for this thesis is the northwestern section of Barkley Sound, the southernmost large sound on the western coast of Vancouver Island, which is the traditional territory of the Toquaht Band of the Nuu-chah-nulth First Nation. This region was chosen due to the availability of intensive and wide-ranging site survey data suitable for evaluating basic site patterning and changes in site patterning over time.

1.2 Research Plan and Goals

The principal questions to be addressed by this thesis are:

- 1) To what extent does spatial analysis provide a useful description of spatial behaviour in traditional Toquaht territory?
- 2) Do Nuu-chah-nulth settlement patterns in Toquaht territory change over time?

3) If there is change in settlement pattern, what shifts occurred and what is the antiquity of each pattern?

Spatial analysis of archaeological sites has historically taken one of two directions. Analysis of smaller-scale egalitarian hunter-gatherer societies has generally proceeded by comparing site locations to the environmental conditions present at those points. This technique is currently used in efforts to model site locations predictively, whether by inductive or deductive means (see for example Dalla Bona 1993; Ebert 2002; Kvamme 1985, 1988, 1999:172-173; Warren 1990; Wescott & Kuiper 2000). Environmental predictive modelling proceeds from the belief that environmental variables are the prime factor in determining site location; that is, that factors such as shelter, vegetation type, and the presence of water are more likely to condition choices of where to camp, live and work than other, less immediately tangible factors (Warren 1990, Kvamme 1988). Environmental factors are most often the ones applied to hunter-gatherer predictive modelling.

Analyses of larger-scale stratified societies have focused on the location of sites relative to other sites, rather than on environmental variables. This site-patterning approach has been applied mainly to state societies in Europe, but it has also found application in examining the settlement patterning of sites from civilizations of Central and South America, such as the Aztecs of the Basin of Mexico or the past populations of the Virù Valley in Peru (Hodder & Orton 1976, Ruggles and Church 1996, Willey 1953). This technique reverses the assumptions of the environmentally deterministic paradigm, and assumes that less local, less immediate factors affect site locations. These might

include proximity to markets, size of neighbouring settlements, site catchment area, and site intervisibility, to name just a few. Note that here, as above, local and immediate factors are those which coincide directly with a site's location, not merely those that are some arbitrary "close" distance away.

These two approaches to spatial analysis do not provide an adequate methodology for examining societies intermediate between those that are highly complex and those that are very egalitarian. Note that the presence or lack of complexity in these cases does not imply a more- or less evolved or perfected social life. Rather, what is being described is a continuum from more egalitarian societies, where environmental factors have been taken to be the prime cause of site location, to ranked and stratified societies, where socio-political factors have been assumed to dominate over the physical environment. Societies falling somewhere between these two poles have little to indicate whether environmental or socio-political factors were the prime factors that influenced settlement pattern.

As it is usually defined, complexity implies "many interrelated parts" (Price & Brown 1985:7). Increases in complexity, then, can be related to increases in differentiation, specialization and integration of people within a society, all of which serve to multiply the number and variety of parts within a society. Demographic, ecological and social changes have been proposed as causal factors. Many explanations emphasize the role of highly productive environments in "permitting" complexity to arise (Price & Brown 1985:8; Yesner 1980). Others point to economic changes in the development of storage technology (Testart 1982; Woodburn 1982), or changes in mobility (Binford 1980) as factors related to increased complexity. Social pressures in

the form of circumscription and population growth are also invoked (Bender 1978). Most recently, notions of circumscription have been redefined as 'closed' social formations, yielding increased complexity through the need to expand alliance networks to overcome group territoriality (Lourandos 1997:28-29). These causal factors are posited to have permitted and favoured the emergence of elites (Price & Brown 1985:16). While there is likely no single overall causal factor favouring increased complexity in hunter-gatherer societies, a combination of spatially- or temporally-restricted resources in the presence of population growth and/or social circumscription, whether environmentally- or socially-driven, seems to be the most common set of circumstances under which increased social complexity has come about in the past (Lourandos 1997; Price & Brown 1985:8).

On the Northwest Coast, societies took the form of complex chiefdoms, with many features similar to those of state-level societies such as ranked and stratified attributes, surplus production, and control of surpluses to fund elite activities. However, these complex chiefdoms were still based on a hunting and gathering adaptation (Arima 1983; Donald 1985; Drucker 1951; Matson & Coupland 1995:25-30; and see Chapter 3 below). Simply put, both environmental and socio-political factors likely played important roles in the location of sites for all societies, no matter how simple or complex. The archaeologist's goal is ascertaining which factors had the greatest influence at a given location and time (Lourandos 1997:10-11).

General environmental variables such as slope, aspect, distance to water, and vegetation are not the only appropriate data for analysis of site locations on the Northwest Coast. Site locations may have been conditioned by such features as defensibility, viewsheds or concepts of territoriality and site suitability that cannot be expressed in

environmental terms. Additionally, archaeological predictive models based solely on environmental variables have in the past tended to lump together all site types in order to produce sufficiently high site counts for statistical analysis, and to counteract variations in the reliability of classificatory schemes for site types (Parker 1985:186; Kvamme 1985:213-214; Carmichael 1990:218; Warren 1990:203; Warren & Asch 2000; but see also Wescott and Kuiper 2000). While these studies have generally been predictive in nature, this has the unfortunate effect of lumping, for example, fishing stations with lithic procurement sites, solitary kill/butchery locations and habitation sites. In the case of the Toquaht site data, this lumping would require lumping rock-walled fish traps and culturally modified trees with more 'traditional' site types such as village sites to generate an environmental predictive model. This represents a loss of information because it removes an important source of data, site function, from the analysis. Particularities of site function, for example inter-tidal fish traps, within the Toquaht study area make problematic traditional environmental correlates such as distance to water. The same is true of measurements of the slope of the rock on which a pictograph is painted. Such information will only serve to confuse the interpretation of these site types, whose function is other than strictly habitation.

This study therefore proposes to treat these complex chiefdoms as others have treated state-level societies and to make use of techniques of spatial analysis to examine and describe changes in the spatial pattern of sites to ultimately arrive at an interpretation of site location patterns. As will be seen in Chapter 3, other studies employing spatial analytical methodologies on the Northwest Coast have done so as a means of answering questions of polity formation and regionalism. The success of these spatial analytic

studies seems to indicate that similar techniques would be profitable at a simpler level of analysis, that of reconstructing basic site patterning.

1.3 Outline of the thesis

Chapter two will examine the history of research in spatial analysis, from its beginnings in geography through its appropriation by anthropologists and archaeologists. Following this, the discussion will diverge from the field as it is known in geography to focus primarily on developments and applications of spatial analysis in archaeology.

Chapter three returns to the study area, first providing an overview of the natural environment of the area. This is followed by an examination of the culture history of the area, as it is known from historical, ethnohistorical and ethnographic sources. Finally, a brief overview of previous archaeological work on the West Coast of Vancouver Island is presented.

In chapter four, the data collection process for the thesis is presented. The goal is to make collection biases present in the analyzed data set as evident as possible. This chapter also presents the four analytical techniques that will be employed in the thesis. These techniques will explore the interrelationships of habitation sites with their neighbours and the surrounding resource areas. The results of the techniques used are presented in chapter five.

Chapter six presents an interpretation of chapter five's results, as they relate to settlement pattern in the traditional territories of the Toquaht band. Chapter seven contains concluding remarks, including a critique of the methodology employed by the

study, and a consideration of the applicability of the Toquaht pattern to the wider Nuuchah-nulth settlement system.

Chapter 2: Spatial Analysis and Theoretical Background

2.1 Development of Spatial Analysis in Geography

“Spatial analysis” refers to the mathematical and statistical analysis of spatial data (Robinson 1998:254). The origins of spatial analysis within geography can be traced to the “quantitative revolution” in geography in the 1960s and 1970s, where, assisted by the development and elaboration of computers, an examination of the properties of spatial data became feasible (Robinson 1998:254, Boots & Getis 1988:10). A detailed examination of the origins and derivation of each technique within the geographer’s spatial analytic toolkit is beyond the scope of this study. Examination of the development of one body of techniques, point-pattern analysis, is of interest in illuminating the close parallels between the development of geographical and archaeological methods.

The techniques of point pattern analysis were initially developed in the biological sciences to examine and evaluate the presence of spatial patterning caused by interactions between living organisms, especially immobile ones such as seedlings (Boots & Getis 1988:10). The general premise behind these early studies was that competition between organisms of the same or different species for the same resources would result in varying patterns of distribution of these organisms (Boots & Getis 1988:10). For example, a species competing for a scarce resource might very well be expected to demonstrate spatial patterning such that each individual was as far from its competition as possible. In a situation where individuals gain benefit from proximity to one another, one would expect to find their distribution to form clusters. Finally, in cases where no factor

affecting spatial patterning was present, the guiding assumption was that a random or nearly random pattern would result (Diggle 1983:4; Pielou 1969:179).

The result of these studies was a body of formulae that treated these real-world situations mathematically. These were at least potentially applicable to other fields of study dealing with point-based observations without major modifications. However, it was not until the “quantitative revolution” that geographers appropriated, modified and improved upon the various measures developed by the ecologists (Boots & Getis 1988:10-11). As these techniques were being adopted in geography, archaeologists, particularly in North America, were being influenced by Binford’s “processual” archaeology. The objective scientific framework of processual archaeology emphasized, among other things, the testing of explicit hypotheses and an emphasis on the environment as a source for cultural change. The testing of hypotheses in order to arrive at explanatory generalizations and the development of computing tools to carry out analyses on large samples promoted the development of mathematical models to explain cultural stability and change. Within this academic climate, geographical techniques were eagerly adopted by archaeologists as additional tools to test hypotheses concerning past human behaviour.

Over the intervening years, human geographers’ and archaeologists’ interests in spatial analysis have remained quite proximate. This proximity can be seen in the close ties between academic departments in the two disciplines, particularly in Europe. Specifically, both groups are interested in the behaviour of humans over space, with only the cultural foci being different: contemporary humans for the geographers and past human groups for the archaeologists.

2.2 Spatial Analysis in Archaeology

In archaeology, spatial analysis can be defined as:

... the retrieval of information from spatial relationships and the study of the spatial consequence of former hominid activity patterns within and between features and structures and their articulation within sites, site systems and their environments: the study of the flow and integration of activities within and between structures, sites and resource spaces... Spatial archaeology deals with a set of elements and relationships. (Clarke 1977:460).

The spatial programme in archaeology has existed, in some form, since the earliest days of the academic discipline (Clarke 1977:454). In Europe, the early work of the Austrian and German “anthropo-geographers” produced maps of artifact distributions and artifact attribute distributions over space (Clarke 1977:454). The map, in fact, has always been a primary tool of archaeological reporting because, at the smallest of scales, it provides the simplest means of clearly showing where items in an excavation were found. This consideration is the clearest distinction between the archaeologist and the looter of ancient sites, who removes objects without keeping any record of their provenience.

The culture historical paradigm’s main analytical technique was to compare artifact assemblages between sites in order to establish local sequences of cultural succession (Trigger 1989:204). These local sequences could then be compared between sites in a region to develop regional sequences indicating the distribution of cultures, as defined by their artifacts, on the landscape. This type of analysis traces its history back to Montelius’ typological method (Trigger 1989:157). One of the classic results of such analysis was the regional culture-history chart. The goal in establishing such a chart was to indicate what cultures were found in what regions at what times. Once such a chart

was available and accepted, further research involved fitting one's newly discovered site and its assemblages into previously defined cultural "spaces" on the chart. While not maps *per se*, these charts contain an explicit spatial element, because broad regions at the heads of each column are dissected by the presence or absence of traits of a given culture at a given time (e.g. Trigger 1989:171).

The regional data thus presented was still overwhelmingly chronological, fitting the culture historical paradigm. Regions, whether general or detailed, required an agreement as to the borders separating them, and in the majority of cases each region was taken as a monolithic block of land, which either contained culture A, B, and so on, or no people at all. Thus, Switzerland might be divided into eastern and western sections, and charted alongside the Rhine Basin and "Middle Danube North" (Trigger 1989:171). In this example, a political division, a river drainage, and presumably the northern part of a second river drainage are all considered equal region despite the differences in their defining terms.

Both British and American archaeological traditions inherited the "anthropogeographers'" mapping tradition but proceeded in divergent courses. In each case a particular work served to crystallize the form of subsequent interest in spatial archaeological studies. In Britain an existing movement towards reconstructing how settlement patterns were conditioned by landscape and geography was combined with the mapping of artifact distributions ultimately to produce maps tracking regional- to national-scale changes in these distributions, and hence changes in local culture. The crystallizing event was the publication of Fox's *Archaeology of the Cambridge Region* in

1922, which elaborated this technique and spawned similar studies through the pre-war period (Clarke 1977:454-455).

The emphasis on settlement pattern in North America was directed more towards anthropology than geography, with Steward's work on settlement pattern in the American Southwest. This work stimulated Willey's Viru Valley survey and publication (1953), which was the crystallizing event for spatial analysis in American archaeology.

However, subsequent studies building on Steward's and Willey's work tended to focus primarily on economics and ecology, with spatial patterning being a means to these ends, rather than an end in itself (Clarke 1977:455, Trigger 1989:280, 282). In retrospect this ecological focus was unfortunate because Willey himself was fully aware that, while ecological factors influence settlement pattern, the influence of social and cultural factors should not be discounted (Willey 1953:1).

2.3 Theoretical Background of the Research

The main theoretical underpinning of this study is a recognition that social and cultural factors are of great importance in influencing the decision of where to live, even among the most egalitarian of societies.

This study takes the point of view that groups of individuals are constantly involved in negotiating their relations with other, neighbouring groups. This point of view is based on two theoretical perspectives. First, each individual within the group possesses a *habitus*, "...the durably installed generative principle of regulated improvisations..." (Bourdieu 1977:78, 87). The *habitus* conditions the actions of the individual in reacting to situations he or she experiences; they determine what actions are

considered feasible and appropriate in response to a situation (Bourdieu 1977:79). The sum of the *habitués* being reproduced yields a group *habitus* which in turn influences the individual's *habitus*, restructuring it through time (Bourdieu 1977:87). For example, the *habitus* acquired in early childhood conditions the child's experience at school, which modifies the original *habitus*, which then affects how later experiences are met, and so on (Bourdieu 1977:87). Since individual *habitués* will diverge from each other due to unique structuring experiences within that person's life, the group *habitus* is the "generative principle of improvisations" that remain common to the group (Bourdieu 1977:81). The group *habitus* offers collective suggestions as to how to improvise a living both in economic terms and in terms of dealing with humans inside and outside the immediate social group, the application of which produces a group practice. This group practice, then, is what is translated into the archaeological record at the level of the archaeological site, and, to a lesser extent, at the level of resource extraction locations.

Second, it has been suggested that the integration of larger and larger numbers of people within a society requires the elaboration of structures above the level of the individual in order to efficiently process information (Ames 1981; Johnson 1982). Thus, for example, family spokespersons may reach decisions within their families, then negotiate these decisions with the spokespeople of other families to reach a group consensus. In the present study, therefore, it seems reasonable to treat a group as if it were an individual because the available data from the study region does not at present permit us to perceive the actions of individuals in the archaeological past.

In the Northwest Coast case, local group membership may vary and fluctuate as people and families enter and leave. For example, a popular and successful chief may

acquire new followers, or an ineffective one may find his followers abandoning him in favour of leaders that can better provide for their needs. Despite this changing membership, the local group persists, and can be treated as an individual actor negotiating its place among other local group "individuals".

Local group choice of habitation site can be seen as a result of the local group negotiating its place within the social and environmental space. The habitation site then becomes an artifact, the distribution of which on the landscape is amenable to study, just as the distribution of tools within a site is amenable to study. And, just as the distribution of tools in a site can imply certain patterns of social activity, from activity areas to social ranking and beyond, the distribution of sites implies patterned cultural action, or practice, that arises from the collective actions of groups, not the individuals that make them up.

The post-contact Nuu-chah-nulth situation almost everywhere along the coast was one of local groups coalescing to form regional bands. On one level, this represents a further elaboration of Ames' (1981) Johnson's (1982) schemes of successive integrating structures to more effectively process information. The regional bands here can be seen as representing a response to increased economic and social stresses by bringing many people together under an integrating structure. This would take the form of the ethnographically-known Nuu-chah-nulth bands, where lineage heads from one village acted cooperatively to engage in trading and resource extraction activities.

This study, then, will present interpretations of human activity at the level of the local co-residential group, within an interpretive archaeological framework. The focus on society rather than abstract "culture" derives from the British archaeological tradition. This essentially Marxist tradition runs from V. Gordon Childe through to the work of

Colin Renfrew and Ian Hodder (Trigger 1995:373). In doing so it accommodates both processual and post-processual points of view, in contrast to the North American tradition of empirical science where the abstract "culture" is the focus, and a dichotomy is drawn between science and history. This approach permits an overtly scientific and mathematical methodology, in this case spatial analysis, to coexist with a social perspective, in this case the discovery and analysis of group practice and elements of its underlying *habitus*.

Chapter 3: The Study Region: Natural and Cultural Environments, and History of Archaeological Research

3.1 Natural Environment

3.1.1. Topography

The West Coast of Vancouver Island shares common physiographic, climatic, faunal and floral traits with the rest of the coast of British Columbia. The core landform of Vancouver Island is the westernmost range of the Coastal mountains, separated from the mainland by the Straits of Juan de Fuca and Georgia (Fig.3.1). On Vancouver Island, as on the mainland, much of the coastline comprises mountains that run right down to the water's edge. This has the effect of creating a coastline where occasional wave-beaten beaches break the mountains on the outer coast, and deep fjords and inlets dotted with islands provide some shelter from winter storms.

Barkley Sound is the southernmost large sound on Vancouver Island's West Coast (Fig. 3.3). The Sound's topography follows the norm for the island, with the Estevan Coastal Plain extending out from the mountains of the Vancouver Island Range. The interaction of the Estevan Coastal Plain with the adjacent Fjordland produces a coast that alternates between wind- and wave-swept beaches on the outer coastal areas, cut by deep sounds extending into the center of the island, which are themselves headed by thin fjords or inlets that slice even further in between the mountains. In the case of Barkley Sound, Alberni Inlet, the longest fjord by far, extends across the center of the island with only a single range of mountains separating its head from the Strait of Georgia to the east.

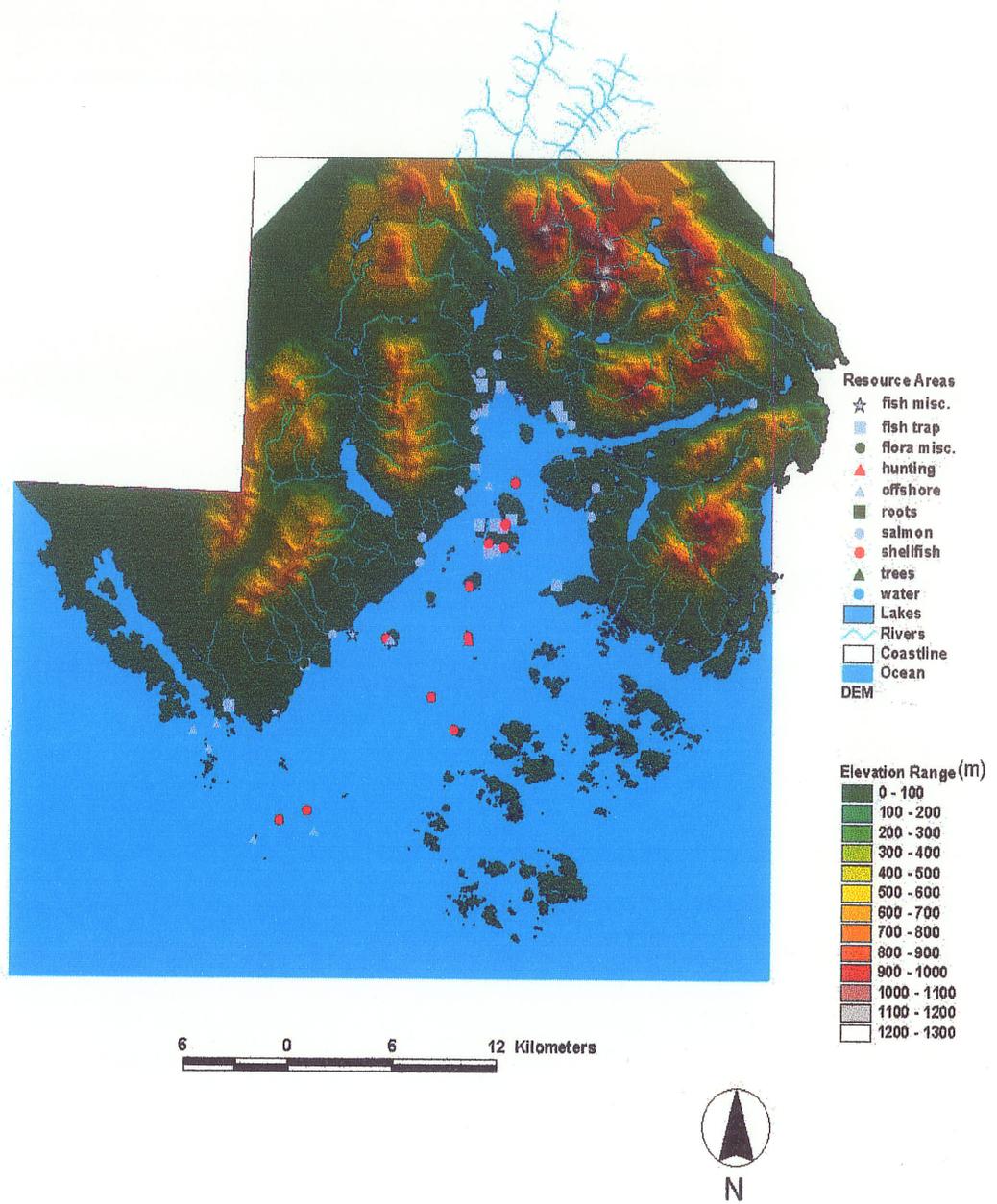


Figure 3.1: The Toquaht Archaeological Project Study Area

3.1.2. Ecological Zones

Various authors present varying numbers of ecological zones for the West Coast region. Turner identifies three biogeoclimatic zones in Barkley Sound. These are the Coastal Western Hemlock Zone, extending from the shore up to almost 1000 m in elevation, the Mountain Hemlock Zone above that to the limit of the tree-line, and the Alpine Tundra Zone extending above the tree-line to the limits of permanent ice and snow (Turner 1995:5). Arima and Dewhirst identify only one, the Coastal Western Hemlock Zone, and divide it into wetter and drier subzones. The drier subzone is present mainly at the head of Alberni inlet and on the leeward side of the adjoining mountains (1990:394). The wetter subzone is present everywhere else on the outer coasts and sounds of Vancouver Island (Arima & Dewhirst 1990:394). Haggarty (1982) identifies five ecological zones, ranging from the deep forest through river-margin habitats, down to sheltered, semi-sheltered and exposed coastal habitats. The habitation sites of the Nuu-chah-nulth as they are presently known, are located firmly within the Coastal Western Hemlock Zone, according to all authors a zone of mild winters (January mean -4 to 5 °C) and cool summers (July mean 13-18 °C). Precipitation in the Coastal Western Hemlock Zone ranges from 165-665 centimeters per year, depending largely on proximity to the mountains.

3.1.3. Flora and Fauna

The flora and fauna of Barkley Sound, as elsewhere in coastal British Columbia, is made rich by both the abundant rainfall and the upwelling of offshore currents. The rain brings the requisite moisture for lush plant growth, and the upwelling brings

nutrients to the surface to sustain an abundant maritime biotic community. The very high yearly rainfalls have produced a deep, dark forest of coniferous trees virtually impassible in parts due to the tangled underbrush and rotting logs that litter its floor (Arima 1983:1; Drucker 1951:9; Sproat 1987:155; Turner 1995:5). This forest contains mainly Douglas fir, western hemlock, western red cedar, Pacific silver fir, Sitka spruce, lodgepole pine, western white pine, and red and yellow cedar (Arima & Dewhirst 1990:394).

A multitude of floral species were utilized to some extent by the Nuu-chah-nulth, as almost every plant had some utility, e.g. building materials, food, medicine, or even clothing (Turner & Efrat 1982). Within the range of plants utilized, however, certain species stand out as particularly important. Among the various trees present, cedar, and especially Western Red Cedar (*Thuja plicata*) was the most important species for all coastal groups. The cedar's soft wood made it easy to work, and its resistance to decay in the wet coastal environment made it ideal for everything from houses to canoes to clothing to rope (Turner & Efrat 1982:36-7). Other important trees included the Red Alder, Western Hemlock, Yellow Cedar, and Sitka Spruce (Turner & Efrat 1982:18). Certain trees were recognized as having the best characteristics for a particular application, e.g. Douglas-fir bark was said to be the best all-purpose fuel (Turner & Efrat 1982:18). Despite this, other trees or plant materials could and would be used if the ideal species was not available, as can be seen in the multiple mentions of similar uses for different species (Turner & Efrat 1982:41-44).

Another major class of plants used by the Nuu-chah-nulth were the various berries and roots that grow in the region. Chief among these were the salal (*Gautheria shallon*) and salmonberry (*Rubus spectabilis*), but a myriad of other berries were harvested and

consumed as they ripened through the summer and fall (Turner 1995:77; 126, Turner & Efrat 1982:17). Roots were harvested, usually in the fall (Turner & Efrat 1982:17), but they seem to have held less importance than berries in the Nuu-chah-nulth diet. The roots harvested did not include the root of the blue Camas (*Camassia quamash*), which was apparently introduced to the area in the nineteenth century (Turner & Efrat 1982:54). Prior to this the Nuu-chah-nulth may have traded with the Salish to obtain the root, as Jewitt reports consuming some during his stay in Nootka Sound (Jewitt 1974).

Considerably more is known about the exploitation of animal species by the Nuu-chah-nulth and other Northwest Coast inhabitants. This is a reflection both of better preservation of bone versus plant remains in the archaeological record and of the focus on hunting of much previous archaeological research. For example, a recent survey of archaeological research on the Northwest Coast devoted three pages to faunal resources, but only one paragraph to floral resources (Matson & Coupland 1995:21-24).

The most important animal species exploited ethnographically by the Nuu-chah-nulth were salmon (*Oncorhynchus sp.*), halibut (*Hippoglossus stenolepis*), cod (*Gadus macrocephalus*), herring (*Clupea harengus*), other flatfish, rockfish, various seals and sea lions, and whales, particularly gray whales (*Eschrichtius robustus*) (Drucker 1951:9; Matson & Coupland 1995:21-24). Salmon were available during the late summer and fall during their spawning runs. Herring were exploited chiefly in the spring during their spawning season, and their spawn was considered a delicacy (Arima 1983:25-26). Whales were taken in the summer, during their annual migration up the coast (Arima 1983:38). Various waterfowl were also hunted, particularly during the spring migration (Arima 1983:26).

In contrast to these seasonal foods, halibut, rockfish, cod, seals and sea lions could be taken throughout the year (Arima 1983). The other year-round foods were a variety of shellfish, including mussels, clams, whelks, barnacles, and cockles (Matson & Coupland 1995:23-24). Land mammals were present, particularly elk, deer, black bear, and wolves; however, they do not seem to have been exploited to the same extent as sea animal resources (Arima 1983:12; Drucker 1951:9).

3.2. Cultural Setting

The present-day inhabitants of the West Coast (Figure 3.2) are the nations of the Nuu-chah-nulth, a term which translates roughly as “all along the mountains”. Closely related both linguistically and culturally are the Ditidaht, who inhabit the West Coast immediately south of the Nuu-chah-nulth area, and the Makah, located around Cape Flattery in Washington State, across the Strait of Juan de Fuca. The Nuu-chah-nulth are those people formerly known as the Nootka, a name given them by Captain James Cook, who seems to have misunderstood words of welcome and navigational instructions for the name of the people and their lands (Arima 1983:v; Mozino 1970:67).

At the time of contact, European traders met and described a people who lived in a structured society made up of three distinct classes: chiefs, commoners and slaves. The presence of chiefs did not confuse the Europeans, who were accustomed to dealing with chiefdoms in many islands of the Pacific. The Nuu-chah-nulth customs of ownership, in which everything contained within the bounds of a local group’s domain was considered to be exclusively owned by one or another chiefly lineage, caused considerable surprise

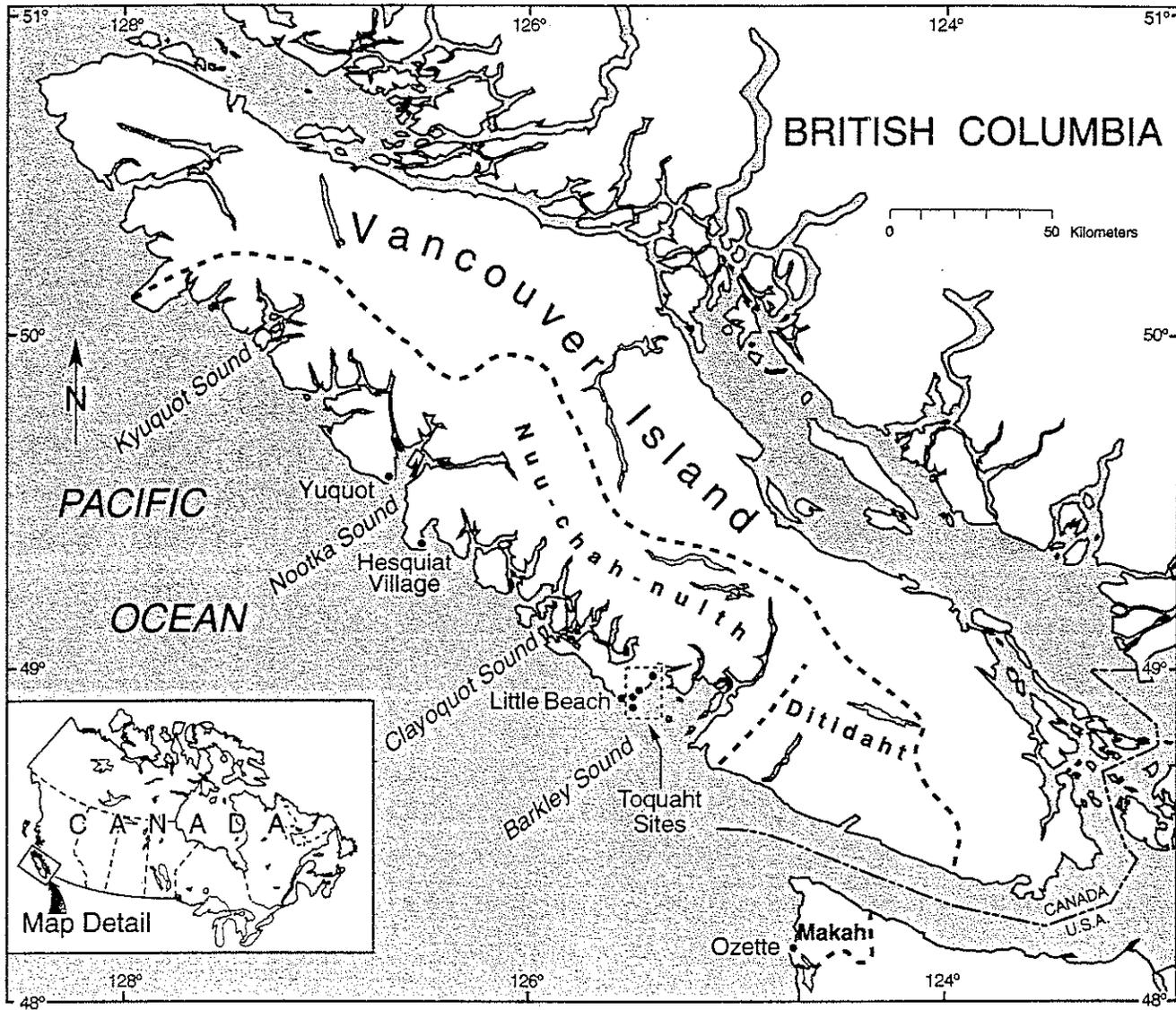


Figure 3.2: The West Coast region of Vancouver Island (Monks *et al.* 2001)

and aggravation to the Europeans, who themselves considered the land to be unoccupied, unused, and therefore unowned by the Nuu-chah-nulth (Inglis & Haggarty 2000:96; Sproat 1987:7-9).

The Nuu-chah-nulth quickly earned a reputation as shrewd traders, and it was the exchange of some sea otter pelts for objects of metal that would ultimately lead to dramatic and permanent changes for the people of the coast (Gibson 1992:268-278). The sea otter pelts, sold in Canton, brought profits far in excess of the minimal outlay required to purchase them, and European and American traders, quick on the heels of easy money, brought and dumped vast quantities not only of raw metal but also cloth, metal goods and firearms into Nuu-chah-nulth society (Gibson 1992:311, Table 2).

Conflict among the Nuu-chah-nulth took on a more lethal nature after the acquisition of firearms. Evidence of conflict on the Northwest Coast exists since about 3000 BP based on findings from Prince Rupert Harbour (Moss & Erlandson 1992:73). In the West Coast area, there is evidence for an increase in conflict after about 1200 BP, with the occupation of village sites adjoining defensive locations (McMillan 1999:151). Subsequent to European contact, firearms, along with the introduction of venereal and other European diseases, amplified the effects of intergroup conflict along the coast, resulting in accelerated population loss and cultural disruption (Boyd 1990:136, St. Claire 1991:1). Only a few local groups of the Nuu-chah-nulth managed to survive as distinct entities the twin spectres of disease and warfare. It is estimated that more than 25,000 Nuu-chah-nulth inhabited the region prior to European contact, but by the end of the nineteenth century these numbers had declined to around 3,000, roughly an 85 percent decrease (Arima & Dewhirst 1990:408).

Losses due to war and disease did not strike every local group equally. Faced with dwindling populations, a group close to annihilation by disease or enemies could, and usually did, seek refuge with neighbouring groups (Arima 1983:116-117; Sapir & Swadesh 1978b:414, 416, 417, 427). This form of alliance, if it persisted for a long period, typically resulted in the allied groups coalescing into a single larger unit, often preserving the original local group designations in the ranking of the group's chiefly lineages (St.Claire 1991:50-52). In this way, the multitude of small local groups present on the coast around the time of European contact amalgamated over time into the fifteen presently recognized Nuu-chah-nulth groups.

Jose Mariano Moziño, writing in 1792, seems to have observed the operation of seasonal movements of people from one village to another in order to collect seasonally-available resources such as salmon (Moziño 1970: 40). This pattern of seasonal movement, noted in many regions of the Northwest Coast by fur traders, merchants and explorers, was later enshrined in the ethnographic work of Philip Drucker (1951).

Drucker himself was careful to point out the limitations of his 1935-1936 fieldwork, and specifically the perils of extending recollections from the twentieth century back 150 years or more into precontact times (Drucker 1951:15). Nevertheless, his informants' recollections about seasonal shifts in residence entered into the conventional wisdom of Northwest Coast culture history. This conventional wisdom holds that most, if not all, of the First Nations moved seasonally to collect and store resources during periods of localized abundance (Ames & Maschner 1999:120; Arima 1983:11, 24, 47; Matson & Coupland 1995:114-115; Mitchell 1990:355-356), and that this behaviour extended into the archaeological past.

3.3. Archaeological Background

3.3.1. History of Archaeological Research on Western Vancouver Island

1966 marks the beginnings of academic archaeology on the West Coast, with the excavation of the large village site of Yuquot in Nootka Sound. In this same year, excavation at the wet site of Ozette on the Olympic Peninsula of Washington State began a major period of research relating to the Makah, a group closely related both in culture and language to the Nuu-chah-nulth.

The Yuquot excavation revealed a large shell midden over 5.5m deep with radiocarbon dates spanning a period from c.4200 BP through to the present. Yuquot was, in fact, the summer village that Cook's expedition reached and contacted, and it was later the site of a Spanish fortification before being reclaimed by the Nuu-chah-nulth (McMillan 1999:187; Pethick 1980:26, 210). The archaeological sequence from Yuquot suggests a considerable degree of cultural continuity on the West Coast, with all the tool types from the earliest levels being present through the most recent ones (Dewhirst 1980:336). Technological changes are confined to improvements and modifications of existing technology, for example the substitution of toggling harpoon heads for earlier barbed heads. Regarding seasonal use of the site, analysis is incomplete (McMillan 1999:56) but seems to indicate spring to fall occupation from at least 3000 BP until the present, and definite evidence for year-round occupation by 1200BP and into the Historic Period (Dewhirst 1980).

The second large archaeological research project on the West Coast was the Hesquiat Harbour Project, started in 1971 with the eventual intention of locating and recording all archaeological sites within the traditional lands of the Hesquiat First Nation

(Haggarty 1982:17-18). Test excavations were conducted at ten sites, with extensive excavations at four of these, including the site of the major Hesquiat ethnographic village (Haggarty 1982:29). Artifacts uncovered at these sites corresponded with those artifacts of a similar age found at Yuquot and other Nootka Sound Sites (Haggarty 1982). Faunal evidence from Hesquiat indicates that at the earliest dated location (1800BP), all local resources were being exploited. By 1200BP this early pattern of wide-ranging resource exploitation had changed to a pattern of exploitation of resources local to each site, suggesting the presence of autonomous local groups living at each site year-round (Haggarty 1982:181, 191).

The results from these excavation projects formed the basis for Mitchell's (1990) synthesis of a broad West Coast Culture Type spanning the period 4200BP to contact. The basis for this formulation was the evidence for continuity of site use, especially in the case of Yuquot, with little change in artifact distributions or use of resources (Mitchell 1990:357). While this scheme has been criticized as serving to conceal likely real changes in Nuu-chah-nulth culture prior to contact (McMillan 1999:45; Marshall 1993:39), it remains the case that artifact assemblages from the West Coast have generally been lacking in many diagnostic artifact types, such as projectile points, from which changing cultural affiliations may be implied. Work at waterlogged sites such as Ozette and Hoko River may indicate that it was in the realm of perishable artifacts that cultural affiliations on the West Coast found their greatest expression, and so will remain elusive to the excavator of more typical sites (Croes 1989).

The third major excavation project on the West Coast was the Shoemaker Bay dig, conducted in 1973-74, with a subsequent site survey conducted in 1975 (McMillan &

St. Claire 1982:1). This site, located at the very head of Alberni Inlet, is in closer proximity to the Gulf of Georgia than to other West Coast sites, with only a single range of mountains separating it from the Strait of Georgia. The artifact assemblage reveals similarly close links with sites in the Gulf of Georgia, with assemblages that are similar, but not identical to Gulf of Georgia assemblages of the same age (McMillan & St. Claire 1982:147-149). Here again, faunal remains suggest at least spring to fall occupation during the earlier component of the site, and definite year-round occupation during the later component, with the site falling out of use around 1000BP (Calvert & Crockford 1982:195-196; McMillan & St. Claire 1982:128). The overall picture is that of a technology owing much to the cultures of the Strait of Georgia, but with clear economic ties to Barkley Sound and the West Coast of Vancouver Island (McMillan & St. Claire 1982:128).

3.3.2. The Toquaht Archaeological Project

The survey associated with the Shoemaker Bay excavations was the first overall survey of Barkley Sound and Alberni Inlet. Later, more regionally bounded survey work has discovered sites that were missed by this first effort. The Toquaht Archaeological Project (TAP), conducted between 1991 and 1996 by McMillan and St. Claire, focused on the region claimed by the present-day Toquaht Nation. This area includes the northwestern end of Barkley Sound from the rock in Ucluelet Inlet that forms the traditional boundary with the Ucluelet to the southeastern point of Toquaht Bay (McMillan and St. Claire 1993:2, 26). Minor offshore islands were also included in this survey. One hundred percent of this territory was intensively surveyed between 1991 and

1994. This survey was conducted by boat, with small crews being put ashore to do walking survey of accessible areas. Soil probes were used, rocky areas were investigated for burials, rock art and defensive sites, and intertidal features such as fish traps and canoe skids were noted (McMillan & St. Claire 1993:26). This more focused survey with better onshore coverage increased the number of known sites from 9 to 51 (McMillan and St. Claire 1993:29).

The TAP study area (Fig. 3.1) consists of the northwestern segment of Barkley Sound, running from near the mouth of Ucluelet Inlet to Lyall Point across Macoah Passage. It includes Toquart Bay, Pipestem Inlet and Mayne Bay, as well as the Stopper and George Fraser Islands and other small islands contained within a line drawn from Lyall Point through Hankin Island. The George Fraser Islands off the shores of the outer coast are also included (McMillan & St. Claire 1993:1). This represents the area traditionally held by the Toquaht First Nation.

The Toquaht Archaeological Project also excavated three deep midden sites, i.e., the villages of Macoah, T'ukw'aa and Ch'uumat'a (McMillan 1999:63-70). Excavations at Macoah revealed midden deposits with basal radiocarbon dates that suggest initial occupation began roughly 2000 BP (McMillan 1999 65-6, 74). Intensive occupation did not occur until much later, possibly as late as around 600 BP (McMillan 1999:65-6, 74).

T'ukw'aa is the site from which the Toquaht Nation takes its name, "people of T'ukw'aa". While occupation at contact was sparse and sporadic, the extent of the deposits suggests a long and much more extensive occupation in precontact times (McMillan 1999:67-8). This site included both a typical habitation area and also a steep-sided promontory topped with occupation debris, suggesting it was used as a defensive

location (McMillan 1999:68). Radiocarbon dates indicate the site was first used 1200 years ago, although the refuge was only used from 800 BP on (McMillan 1999:69).

Ch'uumat'a is visible on the surface as a large shell midden just east of T'ukw'aa (McMillan 1999:69). Stream cutting and soil probing into the forest behind of the visible midden revealed extended deposits as much as 4m deep (McMillan 1999:71). Extensive excavation returned basal dates of around 2500 BP for the front area (towards the beach), and as early as 4000 BP for the rear area of the midden. This places Ch'uumat'a, along with the Yuquot site far to the north, as one of the only two western Vancouver Island sites to have a continuous record of use over the last four thousand years (McMillan 1999:71). Radiocarbon dates for the upper layers of the site indicate abandonment of the back part of the site around 700BP, the portion towards the beach having been occupied at least into the early Historic Period (McMillan 1999:71).

3.3.3. Other Research

In 1990-1991, a team from Arcas Consulting Archaeologists excavated a buried midden from the site of Little Beach (DfSj 100), near the tip of Ucluth Peninsula. This midden returned several burials, as well as artifacts similar to those from the lowest component at Shoemaker Bay (Arcas Consulting Archaeologists 1991). Radiocarbon dating indicates the site was in use from roughly 4000 to 3000 BP, which is contemporary with Shoemaker Bay (McMillan 1999:78). The assemblages of both Little Beach and Shoemaker Bay, along with the lowest levels of Ch'uumat'aa, show links with the Locarno Beach culture of Georgia Strait rather than with the contemporary West Coast culture type found at Yuquot.

An important body of grey literature exists for the West Coast, and it must be acknowledged. This grey literature of survey and site reports frequently owes its existence to the efforts of forestry companies operating in the region to meet their environmental impact assessment requirements under the Canadian Environmental Assessment Act (CEAA) (Canada 1992). This body of reports is arguably the main reason that culturally-modified trees (CMTs) are a fast-growing class of sites (McMillan 1999:48), being the class of site most likely to be found inland and within a logging block.

Recently, McMillan and St. Claire have begun survey and excavation work in the territory of the Tseshaht, neighbours of the Toquaht located primarily in the Broken Group islands of Barkley Sound. While analysis and publications are still underway, excavation of at least one site on a raised beach terrace has produced a radiocarbon date of c.5000 BP, making this the oldest known site within the Nuu-chah-nulth area (G. Monks 2001:pers. comm.)

3.3.4. Spatial analysis research on Western Vancouver Island

Analysis of site survey data on the West Coast has to date been limited to two instances. This is unfortunate, because site survey both by academic and consulting professionals has been an important component of West Coast archaeology since its beginnings in 1966. The first such study is Yvonne Marshall's (1993) examination of the distribution of sites in and around Nootka Sound in order to evaluate and track polity formation of the Mowachaht and Muchalat local groups. Sites surveyed in Nootka Sound and its associated inlets and outer coast were classified and analyzed to understand the

archaeological antecedents to the political situation observed by European sailors and recorded in oral histories of the Mowachaht and Muchalat peoples (Marshall 1993:23-24).

Marshall finds Mitchell's (1990) synthesis of West Coast culture history to be reductionist in nature. First, its tone gives the impression that Nuu-chah-nulth culture history has been static, whereas there has been change of a gradual nature (Marshall 1993:39). Second, evidence from waterlogged sites such as Ozette and Hoko River shows that the surviving stone artifacts are an extremely minor portion of Nuu-chah-nulth material culture, and that cultural change is better tracked through changes in perishable technology (Marshall 1993:39). Finally, Mitchell's synthesis focuses exclusively on artifacts, and does not make any attempt to evaluate settlement patterning, and potential changes that may have taken place over the past 5000 years and more (Marshall 1993:39).

Marshall evaluates settlement pattern in terms of site size and surface features. Larger site size and number and size of surface features were taken as indicators of increasing levels of social integration and complexity of political arrangements (1993:99, 107). In the absence of more than two dated sites within her survey area, she confines her analysis to the timeframe of 1500BP - 400BP, based on the expansion of settlements in neighbouring Hesquiaht territory during this period (Marshall 1993:39). She finds a preponderance of intermediate size sites within her study area, that are structured; that is, they have at least one feature visible on the surface, such as a house depression or evidence of terracing (Marshall 1993:107-108). Offshore islands tend to have the smallest, simplest sites, inlets tend to be dominated by small and medium sites, and the

outer coasts have a high percentage of large, highly structured sites (Marshall 1993:131-132). The very largest and most structured of sites invariably lie on the outer coasts, at the juncture of coast and sound (Marshall 1993:132).

Marshall suggests, on the basis of these distributions and in conjunction with oral histories, that three settlement patterns existed prior to European contact on the West Coast. First, a dispersed pattern of small, probably politically autonomous settlements existed, particularly in eastern Nootka Sound and also in Barkley Sound within the boundaries of Pacific Rim Park. Second, a clustered pattern of larger, more numerous structured settlements with one single, large site was present in Nootka Sound, which Marshall identifies with the ethnographic Mowachaht/Muchalat confederacy headed by chiefs such as Maquinna and Callicum (Marshall 1993:134). This confederacy involved the negotiation and reinforcement of rank privileges held by the various powerful chiefs of Nootka Sound, and was opposed by other powerful chiefs of the Sound who were not members of the polity. Due to these pressures, no chiefly member of the confederacy had absolute control over the others. Marshall draws on European explorers' observations to argue that in fact the various confederated chiefs acted in concert to support each other and divide up tasks such as diplomacy, trade with European ships, and "holding down the fort" in villages while other chiefs were away (Marshall 1993:212, 215).

The third pattern of settlement is a centralized one associated with the polity of Chief Wickanninish of Clayoquot Sound. Here, Marshall finds a pattern of many small, dispersed and unstructured settlements surrounding three sites in the Very Large category (Marshall 1993:135). She compares the more arm's-length trading behaviour of Wickanninish to that of the Nootka Sound chiefs to suggest that power in Clayoquot

Sound, unlike Nootka Sound, was centralized in the hands of a single chiefly lineage (Marshall 1993:135).

What Marshall's analysis does not do is examine the context of individual sites, either with respect to neighbouring habitation sites, or other neighbouring features, including other classes of archaeological sites such as fish traps or modified trees. Additionally, the patterning of sites on the landscape is not examined, except in the crudest fashion, by comparing the proportions of different site types between different regions of the coast.

Quentin Mackie's work also makes use of habitation site data from Vancouver Island, but Location/Allocation techniques are applied to attempt to find optimum centralized points along the coast as proxies for centers of influence (Mackie 1998:119). While a complete discussion of Location/Allocation analysis is beyond the scope of this thesis, the technique permits Mackie to find which archaeologically-known habitation sites minimize travel distances between neighbouring points and thus could serve as central points on the network of sites (Mackie 1998:125). This technique is frequently used in urban planning situations for similar purposes, such as the siting of fire stations to minimize emergency response times to all points on the street-grid network. The benefit of Mackie's analysis is that he tries to analyze the patterning of sites, going beyond examination of local environmental variables by considering how sites interrelate within their landscape or seascape.

Mackie (1998:130) presents solutions to his Location/Allocation problem for a number N of network centre nodes from 1 to 25. Interestingly, his solutions for $n=5$ to $n=9$ are suggestive of known political relationships on the West Coast known from

ethnohistorical and ethnographic accounts (Mackie 1998:165-169; see also Drucker 1951:222-247; Sapir & Swadesh 1978b).

While they are suggestive of known political relationships, these solutions do not account for centers of influence beyond suggesting that each Sound along the West Coast represented a potential power base. Examining results confined strictly to Barkley Sound reveals at most two nodes in this Sound for any given solution (Mackie 1998:170). These two nodes are located outside of Toquaht territory, with one located in the Broken Group Islands, and the other in Huu-ay-aht territory in the southeast of the Sound (Mackie 1998:170). The presence of only two nodes within Barkley Sound is at odds with the extensive ethnohistorical evidence that there existed five independent groups within the Sound and Inlet during the early nineteenth century, each of which was, at times, capable of dominating its neighbours (Sapir & Swadesh 1978b:413-440).

The finding that each sound is a potential host to a node or nodes may be an artifact of the network analysis procedures, because every site is linked to its neighbours by direct travel routes. Habitation sites represent nodes on the network; hence, any travel past a site necessarily includes that site as a stopping point on the trip. As a result, sounds have more potential interconnections than the outer coasts, because of their less-linear nature, and so tend to be the locations where network centres cluster (Mackie 1998:164). The presence of spurious nodes in regions of high interconnectedness is noted by Mackie in his discussion of the unexpected statistically significant results he obtained for $n=1$, which he attributes to the presence of large sites in the centrally located Clayoquot sound (Mackie 1998:141).

Finally, both Marshall's and Mackie's analyses make use exclusively of habitation sites, that is to say shell midden sites as the basis for their conclusions. Habitation sites are currently the most plentiful site type on the West Coast, although they are rapidly being overtaken by tree resource areas and culturally-modified trees (McMillan 1999:48). There are many other site types present and known on the West Coast, most of which have objectively known functions (Inglis & Haggarty 1986; McMillan & St. Claire 1982:27-32, 1993:29-79). Since information on site function is available, it is worth examining in order to evaluate its effect on settlement location, as well as in evaluating whether and in what manner the different site classes associate themselves on the landscape.

3.4 Other Background Information

3.4.1. Alternative Views on Nuu-chah-nulth Settlement Patterns

The seasonal movement model of Northwest Coast settlement pattern is not without its detractors. In several regional surveys the conventional wisdom has been questioned, especially in light of evidence from faunal analysis. In the case of the Hesquiat Project, the earliest components of site DiSo 9, dating to roughly 1800 BP, indicate that access to all the harbour's resources were accessible and utilized. The use of all the resources present in the harbour implies a lack of settlement mobility at this early stage (McMillan 1999:61). Subsequent phases of occupation seem to indicate a fixed pattern of settlement, with local groups utilizing resources from their immediate areas (Calvert 1980). This change to the use of only nearby resources is in contrast to Dewhirst's (1980:15) contention for Nootka Sound that groups not practising seasonal

movements would have undergone serious hardships. If serious hardships resulted from sedentism, circumscription, and use of localized resources, this settlement pattern would not be expected to arise, as it did, in Hesquiat Harbour.

The Hesquiat example suggests a settlement pattern lacking seasonal movements starting in the distant past. In discussing more recent times, Inglis and Haggarty (2000:103) draw on historical documents around the period of initial European contact to argue that, at least in Nootka Sound, settlement mobility was initially triggered by European aggression and interference. This forced the temporary abandonment of Yuquot, a prime village site, and the development of an alternate economic pattern. This pattern was one where trading opportunities with the Europeans were monopolized during the summer months, and food was procured during the “off season” (Inglis & Haggarty 2000:103). In Barkley Sound proper, the ethnographically-recorded ancestral territories of some local groups are constrained to the extent that seasonal movements were unnecessary to gain access to alternate resource areas (St. Claire 1991:39, 46). The original local groups are those that later amalgamated to form the five present-day recognized bands, a process that St. Claire suggests triggered the adoption of seasonal movements (St. Claire 1991:82-83).

3.4.2. The Toquaht

This study discusses the Toquaht within an archaeological context. This discussion requires distinguishing the present-day Toquaht from, first, the pre-contact Toquaht polity, and second, from the local group known as the T’ukw’aa7ath which eventually gave its name to the amalgamated polity. The present-day Toquaht are the

end product of more than two centuries of political action, conflict, disease, colonialism, cultural disruption and economic transformation, carried out in interactions with both neighbouring Nuu-chah-nulth groups and with the newly-arrived Europeans. In the interests of clarity, this study will use Randy Bouchard's transliteration (T'ukw'aa7ath) to indicate the local group that inhabited the site of T'ukw'aa (DfSj-23), and the government-registered band name (Toquaht) to refer to the amalgamated polity that was directly ancestral to the present-day Toquaht Nation.

The T'ukw'aa'7ath seem to have held a dominant position in western Barkley Sound prior to European contact. Sproat (1987:18) wrote that the Toquaht were considered to be ancestral to all the other Barkley Sound tribes. At the time of his writing in 1868 the Toquaht were already the amalgamation of several local groups. This position is echoed by St. Claire, who notes the location of some Toquaht sites so as to dominate access to the lands of the neighbouring Ucluelet. Coupled with an apparent tradition of control over drift whale rights, the evidence seems to indicate a former position of dominance by the Toquaht over at least the people living at Ucluelet Arm (St. Claire 1991:53).

The times of amalgamation of the seven to eleven local groups, later divisions identified within the Toquaht polity, are unknown. The major archaeological sites within Toquaht territory have local group names associated with them, but so do sites identified by ethnographic informants that have no known archaeological deposits (McMillan & St. Claire 1993:79-80; St. Claire 1991:55). Jewitt makes mention of the presence, among a group of visitors, of people known as "Schoo-mad-its", which could be a gloss, following Jewitt's style, of "Ch'uumat'a7ath" (the people of Ch'uumat'a), one of the major

archaeological sites in Toquaht territory. Interestingly, there is no mention of the T'ukw'aa7ath. Whether Jewitt's omission indicates the presence or absence of amalgamation of the inhabitants of these two sites is unclear.

There is good evidence that the amalgamation process that brought about the formation of the Tseshaht and Ucluelet, did in fact take place after European contact (St. Claire 1991:45, 58). With no other information available, lack of evidence suggests that Toquaht amalgamation may predate European contact, and this early amalgamation may be the reason for initial Toquaht dominance over the people of Ucluelet Arm.

Little information is currently available regarding the antiquity of seasonal movements of the Toquaht or their immediate ancestors. Initial analysis of faunal materials recovered from the sites of T'ukw'aa (DfSj 23), Ch'uumat'a (DfSi 4), and Macoah (DfSi 5) in Toquaht territory is suggestive of permanent settlement, with similar but not identical representation of faunal taxa (Monks 1993:162-165). Recent research focused on determining season of site use through the external examination of rockfish thoracic vertebral centra seems to confirm that, in precontact times at least, these three major local group sites were occupied year-round (Streeter 2002).

3.4.3. Implications for Spatial Analysis

Two changes in subsistence strategy, and hence settlement pattern, have been posited as taking place among the Nuuchahnulth. The first is a shift from a central place settlement pattern, with few or no constraints to resource acquisition from the presence of neighbours, to a "filled environment", where only resources local to a site were exploitable due to circumscription by neighbouring groups. This shift is

represented by Haggarty's model for Hesquiat Harbour. The second is the shift from this pattern of constrained resource availability to seasonal movements to access multiple niches, with local groups now part of larger polities claiming access to much larger territories. This shift is represented by Inglis and Haggarty's model for postcontact changes in settlement pattern in Nootka Sound.

The extent and degree to which settlement patterns in the TAP study area were disrupted around the time of contact is unknown. This is the purpose of separating sites known archaeologically from sites known ethnographically: if extensive disruptions to Toquaht society took place during or after European contact, they should appear as changes in the patterning of sites or the criteria applied in each data set in selecting a site for use. If, on the other hand, amalgamation of local groups under the name T'ukw'aa7ath took place prior to European contact, and the polity stayed stable (relative to other neighbouring groups) through the contact period, then little or no change in site pattern and site usage should be detected between the data sets.

3.5. Summary

The West Coast of Vancouver Island's environmental setting diverges only slightly from the overall pattern of the Northwest Coast. A great variety of plant and animal resources were available to inhabitants of the region, many of these being only seasonally available. In times covered by ethnographic research, groups moved to be near resource extraction areas and exploited these seasonal resources sequentially. It is, however, by no means clear that this always was the case, nor is it clear that a shift from

permanent settlement to seasonal movement took place at the same time everywhere on the West Coast.

While the history of archaeology on the West Coast of Vancouver Island covers a relatively short time span, a substantial body of literature has accumulated. The basic culture history of the region, at least after relative sea level stabilization c.5000BP, now seems to be fairly solidly grounded, while regional variations and the role and time-depth of outside influences still needs to be fully evaluated. In recent years, analysis has begun to move beyond culture-historical reconstructions into considerations of polity and regional interaction, aided in some instances by techniques of spatial analysis. At present, however, these regional analyses are limited to considerations of one class of site only: structured habitation sites related to the presence of shell middens. Analysis of multiple site classes across class boundaries therefore represents a new avenue of research, which will be addressed by the present study.

Chapter 4: Data, Hypotheses and Tests

4.1 Data

4.1.1. Data Definition and Processing

For the purposes of this study, a “site” is defined as any location known to be even a temporary residence for humans in the past. This included archaeological habitation sites identified by the presence of shell midden deposits, as well as sites indicated as being living places by ethnographic informants.

Habitation sites are kept separate from the set of natural resource extraction locations known to be present in the study area. The term “location” is applied to these in order to keep them separate from habitation sites. Locations are any discrete area to which a known resource extraction function or functions can be assigned. These functions include the harvesting of tree and other plant resources, and faunal resources on both land and sea. It excludes locations whose function was unclear or unknown, such as rock art and petroforms whose immediate purpose is not readily apparent (e.g. McMillan & St. Claire 1993:59).

All data entry and analysis for the study was conducted on a 350-MHz Pentium II computer located in the offices of the Anthropology Laboratory at the University of Manitoba, running Windows NT 4.0. The GIS package used was ArcView GIS 3.2, including the 3D, Network Analyst and Spatial Analyst extensions. Digitizing was carried out on a CalComp DrawingBoard III digitizing table using the built-in digitizing software of the ArcView package. Statistical analysis and comparison of data were run using both Microsoft Excel 2000 and SPSS v.7.5 software packages, in order to make use of the best features of each package in analyzing and displaying data.

4.1.2. Topographic/Hydrographic Data

Topographic and hydrographic data for the study area were derived from 1:50,000 topographic mapsheets prepared by the Geodetic Survey of Canada and distributed through Energy Mines and Resources Canada. These mapsheets are printed in Universal Transverse Mercator (UTM) projection in accordance with NAD 1927. Contour intervals for the mapsheets varied between 20m intervals (for those mapsheets covering low lying coastal areas) and 40m intervals for mapsheets covering mountainous regions, particularly to the north of the study area. Topographic data from these mapsheets was digitized by setting elevation points at known elevations, i.e. along contour intervals, and transforming these points into a Digital Elevation Model (DEM) based on the Triangular Irregular Network (TIN) method of interpolating a three-dimensional surface from irregularly-distributed elevation points. The difference in contour interval between mapsheets did not greatly affect DEM accuracy. In those regions where 40m contours were used, 20m contours would generally have been so closely spaced as to defy separation, which would have potentially added more inaccuracies to the DEM as the digitizer operator attempted to guess which line was to be followed. Digitizing time would also have increased as errors in digitizing lines in close proximity to one another were discovered and corrected. As it stands, the change in vertical resolution is not expected to pose any problems for analysis, because the areas of lower vertical resolution lie outside the region in which sites are located. The effect of lower resolution, therefore, will be confined to, at most, slightly modifying the calculated viewsheds for a given site. Visual inspection of the mapsheets does not show any terrain features that would seriously impact viewsheds, such as small hillocks in close proximity to site locations

that could cut lines of sight. The total effect of this change in resolution is thus expected to be minimal.

Elevation points along contour intervals are not ideal for reconstructing landforms (Burrough and McDonald 1998:127). However, the use of these points to produce the DEM for the study region offered a good compromise between low cost, speed of digitization, and landform accuracy. The DEM was examined visually under magnification after creation to determine whether the model contained slope errors due to the use of contour lines as the basis for TIN vertices. No errors of the type described by Burrough and McDonnell were discovered (Burrough and McDonnell 1998:127, Fig. 5.16). It is believed that the errors guarded against are mainly a product of other (non-TIN) methods for deriving topography from point data (Burrough and McDonnell 1998:127-128).

4.1.3. Natural Resource Data

Natural resource extraction locations were identified from the ethnographic and ethnohistoric literature, including texts and accounts by Arima (1983), Drucker (1951), Jewitt, (1974), St. Claire (1991), Sapir & Swadesh (1978a, 1978b), and Sproat (1987). Taking one of these texts as an example, St. Claire (1991) has mapped resource extraction locations using an ethnohistorical/ethnographic approach, and he provides reasonably precise locations for fishing, hunting, sealing, whaling, gathering, and other food-procurement stations in and around Barkley Sound/Alberni Inlet (St. Claire 1991:85-202). While vegetation cover data was not directly available, locations of CMTs were recorded within the archaeological site database and are located to 1m precision in

UTM coordinates. These were plotted by inputting their locations directly into the GIS software, without requiring correction. Some of these locations represent stands of modified trees that have significant spatial extent, while others represent single trees. In either case these were treated as point objects in the course of analysis. This procedure was followed to avoid difficulties in reconciling data types (point, line, polygon) within the set of CMTs. Specifically, it would have required an additional theme to contain only those tree resource areas that had spatial extent, which would have hampered evaluating the set of CMT resource locations as a united whole. Instead, stands of CMTs were collapsed to the point located in the centre of the stand. This collapsing of stands of trees to point features is not expected to pose a problem of analysis, because the UTM coordinates for a stand of trees should represent the center of the stand and because calculated distances to the center of the stand represent a good average distance to travel to reach the stand.

4.1.4. Archaeological Data

Archaeological data in digital format was obtained from the database of recorded sites maintained by B.C. Heritage and from maps in seasonal project reports prepared by principal investigators of the Toquaht Archaeology Project (McMillan & St. Claire 1993:28). The digital data frequently reported site positions with an accuracy of only +/- 100m, so errors in site position were minimized by comparing the digital UTM coordinates with both published maps of site locations and the TAP authors' descriptions of those locations. The protocol for placing sites on the map was the agreement of at least two of the three sources of information.

It is perhaps impossible to quantify the biases inherent in the various academic, avocational and professional surveys conducted over the years within the study area, that have produced the present-day inventory of known sites. However, in the course of the Toquaht Archaeological Project, an intensive survey of the territory of the Toquaht was conducted. This survey was conducted from a boat, a technique common everywhere on the Northwest Coast (Matson & Coupland 1995:313). Teams of two or three were put ashore to conduct walk-over surveys of "all accessible areas" (McMillan & St. Claire 1993:26), with soil probing to check for deposits covered by overburden. Areas with thin or no soil were still investigated to see if they contained rock art, burials or remnants of defensive locations. Intertidal zones were checked for petroforms, and "Many locations were visited at several different tides" (McMillan & St. Claire 1993:26). While no archaeological survey can hope to detect 100% of sites, the methodology followed by the TAP crews, given the terrain of the study area, seems to have ensured as close to full recovery as possible, given present-day standards and techniques. Walk-over survey in itself is rare in Northwest Coast archaeology. Most site surveys have been conducted by observing the shore from a boat (Matson & Coupland 1995:313), looking for tell-tale depressions or lenses of shell that may indicate the presence of a habitation site.

4.1.5. Ethnographic/Local Group Data

Ethnographic data was obtained from several published sources, notably place-name research conducted by St. Claire in Barkley Sound (1991). These place-names with their recorded ethnographic uses were supplemented with information from ethnohistorical sources where appropriate.

The Local Group set of habitation sites was constructed on the basis of informants' claims about the original living areas of local groups which eventually became part of the Toquaht after amalgamation. This third "local group" set was intended to simulate a late precontact settlement pattern and was composed exclusively of habitation sites used by local groups whose names are now preserved as ceremonial divisions within the Toquaht First Nation.

The archaeologically-known habitation sites, along with the ethnographically-known habitation sites and those sites which possibly were the origin of Toquaht local groups, formed the basis for the Archaeological, Ethnographic and Local group sets of habitation sites for analysis purposes. These datasets, along with their associated natural resource extraction locations, are summarized in Tables 4.1 and 4.2.

Table 4.1: Site types by period

	Archaeological (Precontact)	Ethnographic (Postcontact)	Local Groups (late Precontact)
Habitation	10	11	6
Defensive/Lookout	4	2	1
Total	14	13	7

4.2. Data Categorization

Two types of habitation site are known ethnographically and archaeologically from the Nuuchahnulth region. The first is a "typical" habitation site, comprising some combination of shell midden, house depressions, standing architecture, and other signs of human habitation. The second is the defensive site, a place offering protection from attack to its inhabitants and a commanding view of the surrounding area. These defensive or lookout sites are generally situated on the flat tops of rocky promontories,

Table 4.2: Resource extraction locations by period

	Archaeological (Precontact)	Ethnographic (Postcontact)	Local Groups (late Precontact)
Salmon	18	13	13
Fish Traps ¹	17	17	17
Offshore Fishing	7	7	7
Inshore Fishing ²	4	4	4
Trees	14	14	14
Roots	2	2	2
Flora ³	4	4	4
Hunting (seals)	1	1	1
Shellfish	11	11	11
Water ⁴	26	26	26
Total	94	88	82

¹Includes all rock-walled fish traps where salmon were not likely the desired catch

²Includes all fishing conducted near shore: rockfish, herring, etc.

³Includes all miscellaneous flora resource locations mentioned ethnographically, such as cherry tree bark or oceanspray (*Holodiscus discolor*), but not having a food use and excluding Tree resources

⁴Includes both streams and freshwater springs

sometimes in conjunction with a nearby village site, but they are also sometimes found in isolation (McMillan & St.Claire 1993:34). In practice, the inference of defensive purpose is difficult to justify. First, it is difficult to rationalize strict criteria for differentiating lookout sites from defensive living sites (but see Inglis & Haggarty 1986:227). Second, “regular” village sites such as Macoah (DfSi 5) are recorded in ethnohistorical narratives as being palisaded for defensive purposes (Sapir & Swadesh 1978b:437), further blurring the distinction between habitation sites and sites selected for defensive purposes due to some topographic or geographic peculiarity. Finally, even sites offering clear defensive potential, such as DfSj 29 located on the George Fraser Islands, also have recorded ethnographic functions calling that defensive purpose into question (St.Claire 1991:157). In this particular case, the location is almost certainly the location of a fishing and

whaling site, one where the topography of the George Fraser Islands and the desire to keep a watchful eye out for passing whales may have had a greater influence on site selection than did defense against attack. Faced with these uncertainties over the interpretation of the function of sites located on steep promontories, it was decided to collapse all habitation sites into one category, covering both habitation and defensive sites, for all the analyses conducted.

A further distinction was drawn between habitation sites and resource extraction locations. Resource extraction locations were subdivided according to what resources were extracted at each location. In the case of a site with multiple functions, an ethnographically-known fishing camp being the prime example, two points were entered into the database, one denoting the habitation function, the other the food resource procurement function.

Certain site types were excluded from the study. Burials were excluded on the basis that:

1. Burials are far more culturally sensitive than other site types, and no permission has been sought or given for their locations to be published.
2. All known burial sites in the study area are cave burials, whereas other forms of burial such as exposure in trees and burial in shell middens are known from ethnographic sources, resulting in the cave burials being a biased sample of all burial sites.
3. All known burial sites in the study area are believed to date from the later Historical period, so they cannot be firmly related to sites known archaeologically, making comparison of burials between the periods impossible.

4. Burials are likely conditioned by the presence of nearby habitation, making the spatial distribution of habitation sites a proxy variable for the presence of burials.

Pictographs, of which there is only one known in the study area were excluded on the basis that their specific function and date is not clear. Likewise, several petroform sites were excluded as their functions were undetermined, although they were clearly of human construction. These petroforms were also excluded because it is impossible to determine whether they should be assigned to the Archaeological, Ethnographic, Local Group or all time periods.

4.3 Hypotheses to be tested

Three general models of Nuu-chah-nulth settlement have been proposed, and will be examined in this study. These models are: first, Dewhirst's model wherein seasonal movement to collect resources has a great antiquity. Second, Inglis and Haggarty's model which holds that the seasonal pattern of movement is a result of disruptions caused by European contact. The third model is that proposed by Haggarty for Hesquiat Harbour, where a single habitation site gave way to a number of habitation sites occupied year-round and making use of only local food resources. Evaluating this third model may be difficult for the Toquaht material, in the absence of more extensive chronological information about sequences of site occupation and abandonment.

Dewhirst's (1980) model projects ethnographic findings into the distant past, claiming that seasonal movements to harvest resources have great antiquity, at least in Nootka Sound. He claims that these movements were required to harvest enough resources to last the year without encountering hardship (Dewhirst 1980: 15). Groups that

did not move seasonally would have faced privation for a portion of the year when their locally-available resources were scarce or unavailable. Seasonal movements would have followed the ethnographic pattern of falls and winters spent on the protected inner bays and inlets, and springs and summers spent on the outer coast. This pattern of seasonal movements would have permitted access to salmon runs in the fall, and whales and deep-sea resources such as cod and halibut during the summer.

The implications of Dewhirst's model for settlement pattern are that no great change should be seen between the archaeological and ethnographic settlement pattern, at least as it regards resource extraction. Any changes that are observed should instead be due to depopulation after European contact, because the Nuu-chah-nulth would already have been seasonally mobile prior to contact. In the specific Toquaht case, there should be no major changes in site distribution or usage through time, because the Toquaht held onto their territory even in the face of massive depopulation. The smaller population kept using the same sites as before.

Inglis and Haggarty (2000) point to European contact and disruptions as the cause of the adoption of seasonal movements in Nootka Sound. They claim the abandonment of Yuquot was forced after the Spaniards killed chief Callicum (Inglis & Haggarty 2000:97). This abandonment caused the former Yuquot residents under Maquinna to modify their subsistence practices in order to specialize as port managers and trade monopolists during the summer. In order to procure enough food to survive and capitalize on the trade wealth available from visiting ships, summers were spent trading at Yuquot, while winters were spent dispersed among upper bay and inlet locations harvesting salmon until the spring and the next trading season (Inglis & Haggarty

2000:103). Trade goods obtained from Europeans could then be exchanged for food during the summer, and the fall move to salmon fishing locations provided food for the winter in a manner that did not conflict with trade activity (Inglis & Haggarty 2000:103). Similar versions of this model have been proposed by Calvert (1980), St. Claire (1991), and McMillan (1999). They argue that for regions beyond Nootka Sound, depopulation from imported weapons and diseases permitted some groups to expand at the expense of others. These expanding groups then adopted a seasonal round in order to establish use rights over resources, or to obtain greater quantities of preferred resources, such as salmon.

The implication of this model for settlement patterns is that a distinct change in pattern between archaeological and ethnographic times should be observed. The archaeological pattern should feature large villages occupied year-round, possibly spaced relatively regularly with respect to one another. Small satellite campsites may also be present from which more distant resources are procured and returned to the main villages. The ethnographic settlement pattern should feature large villages near primary resource locations, particularly salmon streams on the inner coast, again with a few camps to collect and return more distant resources.

In the case of the Toquaht, there is ethnohistorical and ethnographic evidence, on the basis of place-names, that the amalgamated Toquaht polity formed somewhat prior to European contact. While this pre-contact amalgamation is not unique (e.g. Marshall 1993:134-135) and may be part of an overall long-term cycle of the formation and dissolution of larger polities within the Nuuchahnulth area, the net effect is a blurring of

the archaeological pattern into the ethnographic pattern, potentially rendering distinctions between them unclear.

The third model proposed is Haggarty's Hesquiat Harbour model (1982). Here, early occupation seems to have taken the form of a single site from which all the resources of the region were utilized, with no seasonal movement except for collecting trips to bring back food. After 1200 BP, several sites are present, each of which made use of local resources, again with no seasonal movements.

This model is restricted to the period after 1200 BP in this study because prior to this time the site of Ch'uumat'a (DfSi 4) is the only site known to have been used. After 1200 BP, the site of T'ukw'aa (DfSj 23) was inhabited, and the proliferation of defensive sites throughout the study area and the entire Northwest Coast suggests increased conflict, potentially indicating population growth to the point where social factors influenced site selection. A shift from sites located in sheltered inlets to exposed sites with greater visibility should be observed if the transition from precontact to postcontact settlement pattern is reflected in viewsheds. This would imply a change from precontact habitation sites selected for access to resources and shelter from weather, to a postcontact pattern of sites selected for defensive purposes. It might also be expected that the number of intervisible sites would increase, as the inhabitants of the region sought to keep track of their neighbours' activities. If no change in viewsheds is observed, this could indicate either that other factors were more important in site selection than being able to see wide areas surrounding the site, or that the shift to increased viewshed areas took place much earlier in the archaeological period.

4.4 Tests

Four analytical techniques will be applied to the habitation sites. While all four tests fall under the rubric of spatial analysis (Hodder & Orton 1976; Chou 1997), they are divided between two very different kinds of analysis. First, the catchment areas of habitation sites from each dataset will be examined. Second, statistical tests will be applied to the distribution of the habitation sites and resource extraction locations on the landscape, in order to evaluate their patterning and viewsheds.

4.4.1. Friction Surface Catchment Areas:

The concept of a site's catchment area in archaeology is well-known. The inhabitants of a given site are assumed to travel a maximum distance from the site in order to extract and bring back resources. This distance is calculated by the comparison of the energy returns of resources versus the cost of traveling to these resources. Put another way, areas more distant from a site are less likely to have been used by the site's residents than areas closer in (Vita-Finzi & Higgs 1970:7). The distances used for creating these circular catchment areas are typically based on ethnographic or historical analogy, informing as to the rates of travel by different means of transportation available to the people in question. The distance a person can travel outwards on foot in one or two hours, for example, might determine the catchment area of a hunting camp. Thus, drawing bands of these widths around the point at which the site is located should tell us what resource locations were available to which sites. In the case of the Nuu-chah-nulth, the distance one could travel by canoe in a day might be the basis of defining such a catchment area.

In practice, however, terrain features, ground cover and the presence of roads strongly affect rates of travel. Simple circular catchment areas are likely to be unhelpful in regions of high relief and varied modes of travel, such as the Northwest Coast. A solution is to deform the catchment area based on information on the relative difficulty of traveling in different directions from the central site. Initially, this technique was applied by measuring travel times in at least four directions (Higgs & Vita-Finzi 1972:33). More recently, particularly with increases in available computing power and desktop GIS, these distortions can be calculated in a continuous fashion through the generation of a cost surface. Given the topography of a region, the act of moving across a segment of land can be assigned a travel cost dependent on slope, vegetation, and the presence of roads or trackways. The traditional circular catchment area can then be deformed and stretched to reflect corresponding ease or difficulty of travel in different directions, yielding a more realistic depiction of the catchment that could be reached from a site.

Catchment areas for the various habitation sites in the Toquaht region are produced here on the basis of the DEM developed for the region. First, a friction surface is produced. The vector-based DEM is transformed into a raster dataset of cells containing slope information for each cell using the Calculate Slope function of the ArcView Spatial Analyst extension. Cell size was arbitrarily set at 50x50m, representing a compromise between computing efficiency and data precision. The 50m cells offer a level of detail that does not affect assignment of a site or resource area to one site's catchment area over that of another; that is, there are no resources in the dataset whose membership in a catchment area would be affected by decreasing cell size. For

consistency and comparability of results, this cell size was used for all raster data calculations involving the project dataset.

Estimates of travel rates for the Nuu-chah-nulth, whether on foot or in canoe are rare in the ethnographic literature. Gilbert Sproat provides the following two pieces of information:

(The European hunter)... carrying his shooting gear, goods and blankets through intricate woods and over broken ground, *where a mile-and-a-half an hour will be good walking...* (Sproat 1987:155, emphasis mine) and

...but two natives can easily paddle a middle-sized canoe forty miles on a summer day. (Sproat 1987:62)

Drucker has only the following, telling point to make about overland travel:

One must climb over one windfall, duck under the next that lies over a big rock, and go around the third. *The obstacle courses used at training stations in the recent war are the only things I know of that would prepare one for travel through the woods of Nootkan territory.* (Drucker 1951:9, emphasis mine)

While canoe racing and numerous details about the construction and uses of canoes are recorded by Drucker, no mention of rates of travel is made, except to comment that a raft of two freight canoes lashed together to transport household goods traveled "...in good style" in fair weather (1951:88). In the absence of other data on travel rates, Sproat's estimates were used to weight the land portions of the friction surface in order to accurately reflect the different rates of travel. This weighting was accomplished by introducing an additional weighting factor operating on simulated movement up or down slopes. Since the water areas of the DEM are by definition flat, this factor only affected the friction of the land surface. Assuming an eight-hour day, travel by canoe using Sproat's estimate would average $40 \text{ mi} \div 8 \text{ hours} = 5 \text{ mph}$, or 8 km/h . The conversion factor between canoe travel and foot travel is then $5 \text{ mph} \div 1.5 \text{ mph} = 3.3$.

The travel cost was determined by the following formula:

$$\text{Travel Cost} = \text{Horiz. Distance} + (\text{Vert. Distance} \times \text{Slope} \times \text{Horizontal Distance} \times 3.3)$$

Here, slope is expressed as a percentage, such that a slope of 10% over a 50m square yields a change in elevation of 5m. Expressing slope this way instead of in degrees allows change in elevation to be extracted directly from the slope, given constant raster cell size. Multiplying vertical distance by the slope of each cell has the effect of increasing the vertical cost of movement by a factor related to the steepness of the terrain. Multiplying vertical distance by the horizontal distance has the effect of increasing the travel cost of movement to successively more distant cells by a factor proportional to the distance, simulating the effect of traversing the intervening terrain.

Within the ArcView program, the Find Distance function of the Spatial Analyst extension was used to create a raster data theme of distances from the habitation site locations. This function assigns every cell a distance from the origin cell, in this case those cells containing habitation sites. A slope theme was generated using the Find Slope function of the same Spatial Analyst extension. The Map Calculator function of ArcView was then used to multiply the vertical distance theme by the slope, horizontal distance and travel rate comparison factor, and add the horizontal distance theme. The resulting theme represents the travel costs from each habitation site, taking topography into account.

Three catchment zones were plotted at 2.4, 8, and 15.6 km radii around each site, and the resource locations falling within each were enumerated. The 2.4 km radius represents roughly an hour's travel by foot on land (at 1.5 mph = 2.4 km/h), and the 8 km

radii represent roughly an hour's travel by canoe. Finally, the 15.6 km radii represents a quarter day's travel (2 hours) by canoe ($40 \text{ mi.} = 64.4 \text{ km}/4 = 15.6 \text{ km}$). This distance/time was chosen in order to provide half a day's time (4 hours) at the destination. Note that a range of 40 miles in a day renders the entirety of Toquaht traditional lands within at most a half day's (4 hours) travel of any other point in this territory. This effectively brings the entire area into the "catchment" of a group prepared to make an overnight stop to collect and return resources. While catchment radii have previously been discussed in terms of travel times, here distance acts as a proxy for time and effort, because the friction surface calculations serve to convert travelling time into linear distances from a given site.

Initially, all three sets of catchment radii were to be examined for similarities and differences. In practice, the 15.6km radii were so large that their compositions were nearly identical for each site within the study area. This is because the 15.6km catchment areas greatly overlap each other. A chi-square test of independence for the 15.6km catchment compositions returned a P-value of 1, with $X^2=0.191$, $df=10$. Under conditions of competition for resources between sites, or of seasonal mobility, this degree of overlap of catchment areas is unlikely, making the 15.6km catchment radii unlikely to have any explanatory value. The 15.6km radii were therefore abandoned as a target for analysis.

Resources falling within each remaining catchment radius were counted visually, because no ArcView function existed to automate the process. If the resources present in each catchment area are expressed as a proportion of the sum of the resources in all the catchment areas, a $2 \times N$ table will be the result, where N is the number of resource classes

present in the study area. The difference in composition between the various catchment radii of the sites of each dataset can then be evaluated by use of the chi-square statistic, and the proportions themselves can be presented in the form of cumulative frequency graphs.

4.4.2. Viewsheds

A site's viewshed is defined as the swath of land and sea visible from the site's position, taking into account such considerations as landform, vegetation, curvature of the globe and atmospheric extinction. Viewshed analysis is a relatively recent arrival in archaeology, requiring the services of a great amount of computer processing power, both to model the landscape under study and to calculate what points are intervisible on its surface. Recent government initiatives to make digital topographic maps available have also reduced the effort required to evaluate viewsheds by eliminating the time-consuming step of converting paper maps to digital form.

The technical antecedents of viewshed analysis, while not explicit, lie with planners' and engineers' need to place devices such as radio transmitters in positions to maximize the region in direct line-of-sight to the transmitter (Burrough & McDonnell 1998:200). Other uses include the siting of forest-fire watchtowers, scenic overlooks, the calculation of rates of solar energy input, and the creation of simulators for pilot training (Burrough & McDonnell 1998:200). In archaeology, interest in viewed areas and lines-of-sight can be traced back to the work of individuals such as John Aubrey and William Stukeley in the seventeenth and eighteenth centuries who noted the preferential siting of barrows on certain terrain features and explained their patterning with reference to lines

of sight to Stonehenge (Lock & Harris 1996:215). More recently, interest in viewsheds can be traced back to the movement to interpret archaeological sites in their landscape context (Lock & Harris 1996:215).

The advent of desktop-based GIS software and the increasing computing power wielded by even the cheapest personal computers has served to bring viewshed analysis easily within the grasp of virtually all computer-equipped researchers. At present, viewshed analysis tends to be used as a tool for exploratory analysis of spatial data (Aldenderfer 1996:16). The general premise of viewshed analysis is that, given conscious human actors selecting locations in which to live and work, what is visible from a site constitutes a definable portion of the environment of that site and should rightly be considered as a variable influencing site location decisions (Kvamme 1999:177; Lock & Harris 1996:232-233; Maschner 1996:186-187). Going beyond this environmentally deterministic viewpoint, considerations of what is and is not visible also functions within the realm of mental maps and cognitive landscapes (Kvamme 1999:177). The role of visibility in affecting cognitive landscapes can be seen with the simple example of a feudal castle situated on a high point of land to command a view of as much surrounding countryside as possible both for defense and to provide a visual reminder of the overlord's presence in the region (Platt 1996:19). Such a location serves both "environmental", in this case defensive, purposes, as well as arguably providing a visual reminder of power relations within the local community.

Some of the information that can be extracted from a calculated viewshed includes:

1. The number and type of other sites visible from the site in question
2. The total area that can be viewed from the site in question

3. The angle subtended by the viewed surface
4. The composition of the viewed area; how many km² of different land or water types (mountain, plain, lake, ocean, etc.) can be viewed from the site in question.
5. The relative positioning of neighbouring sites within a viewshed; for example, are there sites or a type of site located exclusively along viewshed boundaries?

Not all these variables may be of interest in a given study. Viewshed analysis is perhaps the spatial analytical technique most susceptible to produce the kind of “data-dredging” that characterized multivariate statistics employed in archaeology during the 1970s (Aldenderfer 1996:16). What is required is first to think about the problem at hand and determine what analyses of the calculated viewsheds are particularly appropriate to the problem at hand.

Viewed area (#2 above) for a given site is a variable of interest to the present study. Maschner (1996) notes a significant increase in viewed area for sites during the Late Phase in Tebenkof Bay, Alaska, and interprets the change as part of a move from choosing sheltered site locations to choosing less-sheltered, locations with greater visibility in order to defend against attackers (Maschner 1996:187). Maschner identifies this change with the transition from multiple single-lineage villages occupied simultaneously to single, multiple-lineage villages occupied sequentially (1996:187). This transition from simpler sedentary groups to more complex mobile ones is analogous to the suggested transition among the Nuu-chah-nulth from solitary local-group habitation sites prior to European contact to the aggregation of these local groups into larger polities during and after the fur-trade years as outlined in Chapter 3, above. It might therefore reasonably be expected that a similar change in viewed area would be observed in Barkley Sound. Viewed angle (#3 above) may also be a proxy variable for this transition from sheltered to more-defensible site locations.

The other sites that are visible from a given point (#1 above) may also be important. Intervisible sites are more closely linked than sites invisible to each other because of the residents of each site being able to track their neighbours' movements more easily. Within the Toquaht study area it might be expected that large sites have one or more smaller sites within viewing distance, either as a result of control of a subordinate group or as a protective measure against attacks on resource collectors, a frequent feature of ethnohistorical warfare (Arima 1983:106; Sapir and Swadesh 1978b:341, 353, 363, 418; Sproat 1987:105).

Composition of viewed area (#4) and the presence of 'border' sites (#5) do not seem to be profitable subjects of analysis. Because virtually all habitation sites are located on the sea coast of Barkley Sound and are flanked by heavily forested land rising steadily to the mountains that form the backbone of the island, almost all visibility will be exclusively towards the water. As a general rule, this seaward-orientation of viewsheds means that sites further along the coast cannot be viewed directly, so they do not meet the viewshed boundary conditions in #5 above. Viewshed analysis of the Toquaht Archaeology Project sites will therefore consider points #1-3 above, using exploratory data analysis to measure distribution and composition of viewsheds between Archaeological, Ethnographic and Local Group datasets.

4.4.3. Nearest-neighbour Analysis

Three general descriptions serve to describe all possible distributions of points on a plane surface. These are:

1. Regular spacing of points
2. Clustered spacing of points

3. Random spacing of points

Evaluating the distribution of a set of points can shed light on the factors affecting the patterning of the points. Regularly spaced points may be the result of competition between the organisms represented by the points, whether these are bacteria, plant seedlings, or communities of humans, while a clustered pattern may indicate factors such as trade or access to scarce resources that favour a more compacted distribution of points. A random spacing of points is generally taken to indicate that there are no factors strongly influencing the distribution of the points. Evaluating the degree of randomness in a point pattern is the goal of the measures covered by point pattern analysis.

Various techniques have been proposed and used for evaluating the randomness or lack thereof of spatial point patterns. The simplest and earliest method was that of quadrat analysis, where squares, or indeed any other sampling shape, are placed over the study area, and the number of points falling within each quadrat are counted (Diggle 1983:23-24; Hodder & Orton 1976:33; Pielou 1969:99). The distribution of numbers of points falling within the sampled quadrats can then be compared to a Poisson distribution having the same density of points through use of a goodness of fit test, such as the chi-square statistic (Hodder & Orton 1976:34).

Quadrat methods are computationally simple to implement, but they suffer from a number of problems that have been identified and discussed at length (Pielou 1969:100-110). Quadrat size has a direct effect on whether a pattern appears to be clustered, random or regular. Larger quadrats frequently suggest regularity in clustered patterns through lumping one or more clusters together within the same quadrat (e.g. Hodder & Orton 1976:37). Also, as Pielou demonstrates, a clustered pattern and its reverse produce

very similar graphs of quadrat counts versus quadrat sizes, even if several quadrat sizes are used to reduce the chance of erroneous results (Pielou 1969:106, Fig.12). Finally, by summarizing spatial relationships as quadrat counts, the spatial dimension is lost, resulting in very different point patterns having identical measures of dispersion (Boots & Getis 1988:25).

The alternatives to quadrat methods are those measures that deal directly with inter-point distances (Boots & Getis 1988:35). These are known collectively as nearest-neighbour analysis, and they are the techniques and measures used in the present study. At its simplest, analysis of nearest-neighbour distances involves taking the set of distances to the nearest neighbour of each point in the dataset, summing them and dividing by the number of points in the dataset (n) to obtain the mean observed nearest neighbour distance:

$$r_{\text{mean}} = \sum r_i / n, \text{ for } i= 1 \text{ to } n.$$

The r_i are the set of distances from each point to its nearest neighbouring point (Hodder & Orton 1976:38). The expected nearest neighbour distance for n points in a region of area A is given by:

$$r_{\text{expected}} = 1 / (2\sqrt{\rho})$$

In this formula, $\rho = (n-1) / A$, making ρ the density of n points in an areas of size A (Robinson 1998:268). The mean observed and expected values can then be compared by dividing the mean value by the expected value to produce the *nearest-neighbour statistic* (Boots & Getis 1988:36-37; Robinson 1998:269).

$$R = r_{\text{mean}} / r_{\text{expected}}$$

The nearest-neighbour statistic has a range of 0 to 2.149, where a value of 0 indicates complete clustering, and 2.1491 indicates complete regularity. Values of the nearest-neighbour statistic that fall around 1, approach a random distribution of sites (Pinder & Wethrick 1975:17-18, Robinson 1998:268).

Higher-order nearest neighbours can be calculated and compared in a similar manner, by extracting the set of nth-order nearest neighbours (second nearest, third nearest), and comparing their mean with the generalized expected nth-order mean nearest neighbour distance.

$$r_k = 1 / (2\sqrt{\rho}) \cdot (2k)! \cdot k / (2^k \cdot k!)^2$$

Here ρ is again the density of points, k is the order of nearest neighbour; 1 = first, 2 = second, and so on (Robinson 1998 :269).

While nearest-neighbour analysis was originally developed to deal with situations in two dimensions (Clark & Evans 1954), the mathematical formulae are adaptable to situations in one dimension, such as the distribution of stores along a street, or indeed third or higher order dimensions, such as the distribution of galaxies in space.

The one-dimensional nearest-neighbour formulae are as follows:

$$r_{\text{mean}} = \sum r_i / n, \text{ for } i=1 \text{ to } n.$$

Again, the r_i are the set of nearest neighbour distances, this time along the line being examined. The expected value of r is given by:

$$r_{\text{expected}} = 0.5 (L / n-1)$$

where L = total line length. Then:

$$R = r_{\text{mean}} / r_{\text{expected}}$$

The dimensionality of the Toquaht Archaeological Project study area actually serves to complicate matters, because it is not entirely clear which order of nearest-neighbour formula is the most appropriate. With certain exceptions, notably sites located at the mouth of the Toquaht River, habitation sites in the Toquaht Archaeological Project study area are located on or near the coastline (see Fig.3.1). This coastal effect on habitation site location is due largely to the aquatic focus of Nuu-chah-nulth life, given the difficulties in penetrating the dense forests growing almost down to the water's edge. Due to this coastal constraint to habitation site location, the sites within the study area are in large measure located along a line, this line being the coast. There are, however, notable and important exceptions, such as the habitation sites located offshore in the George Fraser, Stopper, and other islands of Barkley Sound.

The situation in Barkley Sound appears to be intermediate between canonical one- and two-dimensional nearest neighbour datasets. In the absence of a clear means of deciding which formula to use, the areal and both linear formulae were eventually applied and the results compared. With the presence of habitation sites located on islands off the main coastline, the one-dimensional nearest-neighbour statistics consistently overestimated the regularity of habitation site location to such an extent that occasionally the calculated nearest-neighbour statistic exceeded the possible range of the statistic.

One-dimensional nearest-neighbour analysis was therefore abandoned in favour of areal (two-dimensional) nearest-neighbour analysis.

Use of two-dimensional nearest-neighbour formulae also poses a problem, however. The coastal location of most of the sites within the study area virtually guarantees that the pattern of sites will appear clustered when two-dimensional analysis is attempted. In order to evaluate trends in the data derived from the constrained nature of the dataset, a series of 100 test cases was generated and compared to the distribution of n -th order two-dimensional nearest-neighbour statistics calculated from the datasets. These test cases were created by randomly selecting X- and Y- coordinates from the pool of X- and Y- coordinates obtained from the habitation sites in a given dataset. Each test case contained the same number of random site locations as were in the (Archaeological/Ethnographic/Local Group) dataset being evaluated. Nearest-neighbour statistics (NNS) were calculated for each of the 100 test cases, and their average NNS was eliminated from the observed set of nearest-neighbour statistics in order to normalize the observed set around a value of 1.0, or a random distribution. Removing the average test case NNS eliminated coastal effects constraining the observed set of nearest-neighbour statistics. Any remaining departures from randomness could then be assumed to derive from real departures from spatial randomness on the part of the habitation sites and, therefore, to provide information on the process of site selection by groups present in the study area.

4.4.4. Spatial Association

Point pattern analyses by means of nearest neighbour techniques can only evaluate the distribution of a single class of sites. While sites of several types could be lumped together and analyzed by these techniques, the results would only give information about the distribution of the sites analyzed. This procedure effectively eliminates any information that might exist regarding the different roles and functions these sites had during their use. The solution to this loss of information is to examine the degree and kind of association *between distributions* of sites. Factors affecting the distribution of one site type may also affect the distribution of other site types in the same region.

Two point distributions occurring in the same region may have a number of different degrees and kinds of spatial association or lack thereof. Fig 4.4 shows six such possibilities of interaction between clustered and random patterns. A similar set could be produced for interactions between clustered and regular, or random and regular patterns.

Pielou (1969:117) makes a distinction between measures of association and measures of segregation. In biology, association measures the distribution of two species relative to the ground, while segregation measures these distributions relative to each other (Pielou 1969:179). More precisely, Pielou's measures of association are quadrat measures comparing rates of presence-absence of species per quadrat, while his measures of segregation are grounded in nearest-neighbour distances (Pielou 1969:160, 181).

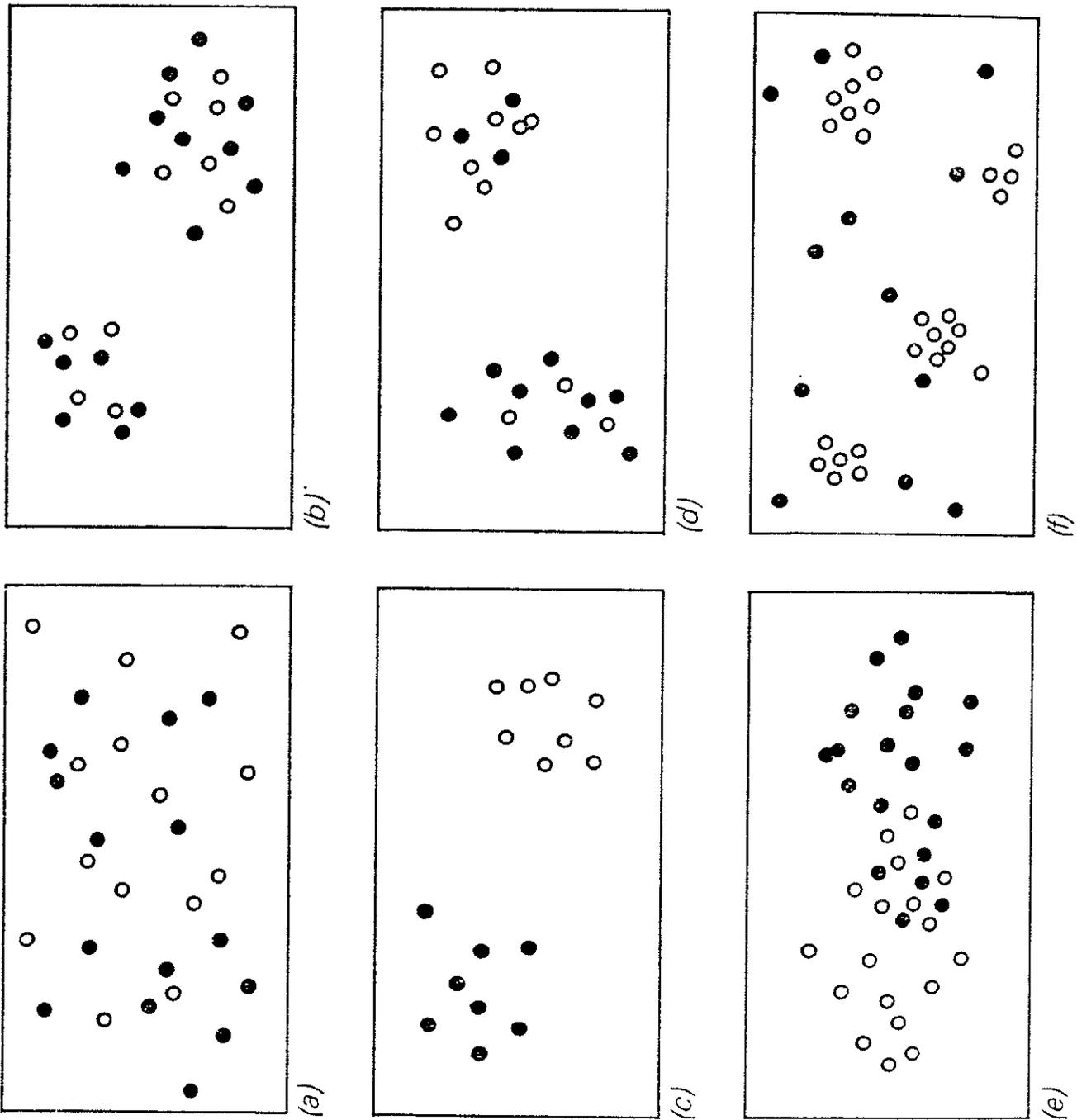


Figure 4.4: Possible point-patterns of two populations occupying the same region

(Hodder & Orton 1976:199)

Hodder and Orton (1976:201-204), in contrast, gloss the difference between association and segregation in considering measures of spatial association for archaeological data. They reason that quadrat measures have serious problems of bias dependent on quadrat size, where different sizes of arbitrary quadrats can make identical distributions appear clustered, random or regular (Hodder & Orton 1976:37 Fig. 3.5).

The problem with the effect of quadrat size makes selecting the “correct” quadrat size for this study virtually impossible, because the size of quadrat is directly tied to whether a given pattern will appear clustered, random or regular. Also, the data in this study are being approached with no particular preconceptions about site spacing and location choice, which could determine an appropriate quadrat size. Additionally, the imposition of a quadrat grid and analysis of that grid within GIS software is non-trivial. As a consequence, this study will make use of the previously-calculated nearest-neighbour distances to evaluate degree of spatial association between habitation sites and resource locations.

To display the association between two mutually-exclusive groups of sites or locations, a table of the following form can be constructed:

Table 4.4.1: 2x2 table of possible associations between two site types.

		Base Point		Row total
		Type A	Type B	
Nearest neighbour	Type A	a	b	e
	Type B	c	d	f
	Column total	g	h	n

The value of “a” is the number of sites of Type A which have Type A sites as their nearest neighbour, “b” is the number of sites of Type B which have Type A sites as their nearest neighbour. These tables can also be constructed for higher-order nearest

neighbours, so that “a” is the number of sites of Type A that have Type A sites as their second (third, fourth, nth) nearest neighbour. Naturally, the composition of “Type A” and “Type B” are variable, and they can even contain sites of multiple classes, so that habitation sites, for example, can be tested against the locations of the set of fishing, shellfishing and tree harvesting resource locations.

To compare the degree of segregation or association between two populations, Pielou suggests the use of a coefficient of segregation, S , which he defines as:

$$S = 1 - (c+b) \cdot n / (e \cdot h + f \cdot g)$$

Here b , c , e , f , g , h , and n are defined in Table 4.4.1 above (Pielou 1969:182).

The value of S ranges from +1 for perfectly segregated, that is, non-intersecting distributions, to -1 for a spatial arrangement of pairs of site types A and B. A value of zero represents random intermingling of the two site types (Pielou 1969:183). The interpretation of S then becomes similar to the interpretation of nearest-neighbour statistics.

Significance of result is difficult to assess for Pielou’s S , because S is a population parameter and has no variance due to sampling (Pielou 1969:183), which makes selecting a particular cut-off value of S difficult to justify. A value of $S = \pm 0.25$ was chosen as the minimum value for significance of result. This value was chosen as being intermediate between the following two cases, the first of which shows relatively strong segregation (Figure 4.4.2), and the second of which shows a less clear case of segregation (Figure 4.4.3).

Table 4.4.2

	A	B	
A	2	1	3
B	1	2	3
Total	3	3	6

$$S = 0.333$$

Table 4.4.3

	A	B	
A	3	2	5
B	2	3	5
Total	5	5	10

$$S = 0.2$$

Despite this lack of objective statistical significance in Pielou's S coefficient, the measure still has utility. The S coefficient provides information on the presence of either segregation, association or random intermingling of the two populations in question. Armed with a statistical test to measure the strength of the detected relationship, a statistically defensible significance level can be arrived at as a cutoff to measure which segregations or associations detected by Pielou's S should be used to draw inferences about settlement patterns.

Statistical testing for variation in the relationships between A sites and B sites in a 2x2 table requires the use of the chi-square (χ^2) statistic. This distribution approximates the exact sampling distribution for a 2x2 contingency table but is inappropriate for use when $n < 20$ or when any given expected cell value is < 5 (Shaeskin 1997:221). Given the low number of sites present in the study area, there is a strong possibility of these situations arising, therefore the Fisher exact test will be used. The Fisher exact test calculates the exact hypergeometric probability of the association of the two point distributions in question. The Fisher exact test makes use of the same assumptions as the chi-square test, with the exception of that regarding small expected frequencies as described above. The Fisher exact test equation is as follows:

$$P = \frac{g!h!e!f!}{n!a!b!c!d!}$$

This formula yields the probability of obtaining a specific set of observed frequencies (Shaeskin 1997:222). It should be noted that this formula is identical to the one given by Pielou (1969:160) for analyzing 2x2 tables of observed quadrat counts, but he does not give the source of this formula.

The Fisher exact test evaluates the null hypothesis of

$$H_0: P_1 = P_2$$

against the alternative hypothesis

$$H_a: P_1 \neq P_2$$

where P_1 is the proportion of observations in the first row of the table, and P_2 is the proportion of observations in the second row of the table.

The Fisher exact test works by calculating the probability of obtaining a distribution of observations equal to, or more extreme than, that recorded, given a particular 2x2 matrix (Shaeskin 1997:223). The two-tailed alternative hypothesis will be used in evaluating site distributions because there are no particular preconceptions about the positioning of site and location types relative to one another.

Because the number of possible combinations of sites and locations grows exponentially, and because there are 11 discrete site and location types present in the TAP study area, it was impossible to evaluate each potential combination of site and location types. In order to reduce the number of combinations to evaluate, only combinations such as the sum of all types of fishing locations, or combinations of major resource locations such as salmon, trees, fish traps and shellfish were considered. Major classes of resource locations were focused on in part because they represent resources known ethnographically to have been highly important, such as salmon, cedar trees, and

shellfish. These resources and combinations thereof were selected because they might be expected to have a strong influence on where people chose to live. Also, classes represented by a small number of locations are much more likely to show negative correlation simply because there are not enough of them to be proximate to each habitation site.

The standard of significance for Fisher's exact test in this study is set at $\alpha = 0.05$. Because the Fisher exact test can also be used to measure strength of association and independence, this situation will be capitalized upon through a comparison of the results of the Fisher exact test and Pielou's S. Pielou's S provides a measure of segregation or association. Pielou's S coefficient will therefore be used to determine whether segregation or association of habitation sites and resource locations is present. The Fisher exact test will then be used to evaluate whether the segregation or association detected by Pielou's S is statistically significant or not.

4.5 Summary

Known archaeological and ethnographic site locations were input into a GIS package preparatory to analysis. Habitation sites and defensive locations were collapsed into a single category for the purposes of analysis due to difficulties in reliably identifying sites with exclusively defensive functions and to the ethnohistorical presence of defensive structures at locations with no overt topographic defensive characteristics. Other site types such as burials, petroglyphs and some petroforms, were excluded from analysis due to their sensitive nature, their unclear temporal affiliations, and their lack of known function(s).

The major difficulty in preparing the various databases for use in the analysis of Toquaht site locations was reconciling the divergent site locations presented in the site survey reports and recorded in the provincial site database. Reconciliation of these data sources was accomplished by placing sites on the GIS map where at least two of the three data sources were in agreement. Total site numbers by dataset were: n=94 for the archaeological set, n=88 for the ethnographic set, and n=82 for the local groups set.

Four spatial-statistical tests have been proposed for application to the Toquaht Archaeology Project dataset. These tests range from those that make heavy use of the ArcView GIS software's capabilities to those that are more statistical in nature and for which the GIS database merely provides a means of storing and verifying location coordinates for analysis. These four tests fall into two general sets of techniques: first, the technique of catchment area analysis, and second, the techniques of statistical spatial analysis. Each class of tests will be applied to the archaeological, ethnographic and local group sets of habitation sites separately, then the results will be compared.

Chapter 5: Results

5.1 Friction Surface Catchment Areas

Figures 5.1.1 through 5.1.3 show the calculated catchment areas for the archaeological, ethnographic and local group sets of habitation sites.

The set of archaeological catchment areas include a trio of habitation sites on the Stopper Islands (DfSi 60, -65 and -69). Archaeological survey of these islands has uncovered a series of stone fish trap complexes all around the islands, suggesting that these islands were important locations for taking herring or other schooling fish. Ethnographic informants also mention large quantities of shellfish present on these islands (St.Claire 1991:163). Beyond the Stopper Islands, all other habitation sites in the archaeological set are located on the north and west coasts of the TAP study area, with no sites in and around Pipestem Inlet. This distribution places the group of fish trap, tree and salmon resources located around the mouth of Pipestem Inlet out of the set of site catchment areas.

In the ethnographic set of sites, Pipestem Inlet and the southeastern quadrant of the study area are now utilized, but the Stopper Islands have been abandoned. Their location close to the mainland, however, means that the fish trap complexes located there are still within the 8km catchment radius of sites on the mainland, particularly Site 73, DfSi 5 (Macoah), and the grouping of sites around the mouth of the Toquart River.

The Local Group set of sites is the smallest in numerical terms, but qualitatively they seem to be the most evenly distributed. The presence of Sites 71 and 73 at the mouth of Pipestem Inlet bring a number of fish trap, salmon and tree resource areas within the 2.4km catchment radii of the set of sites, and the head of the Inlet with its

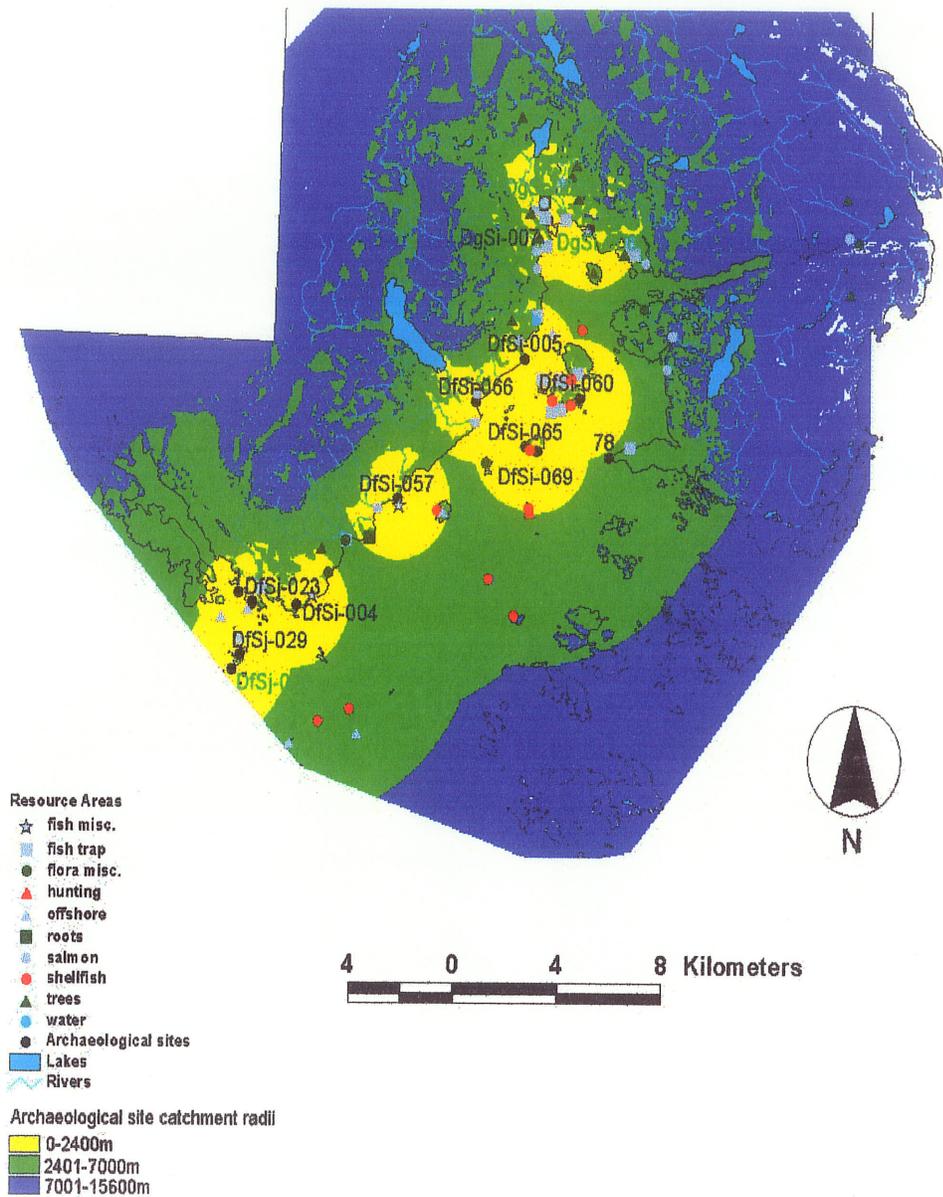


Figure 5.1.1: Archaeological Site Catchment Areas

Note that sites #1 and #78 do not represent archaeological sites but are marker points indicating the extent of the TAP study area. These "sites" are necessary to perform nearest-neighbour analysis of the sets of habitation sites.

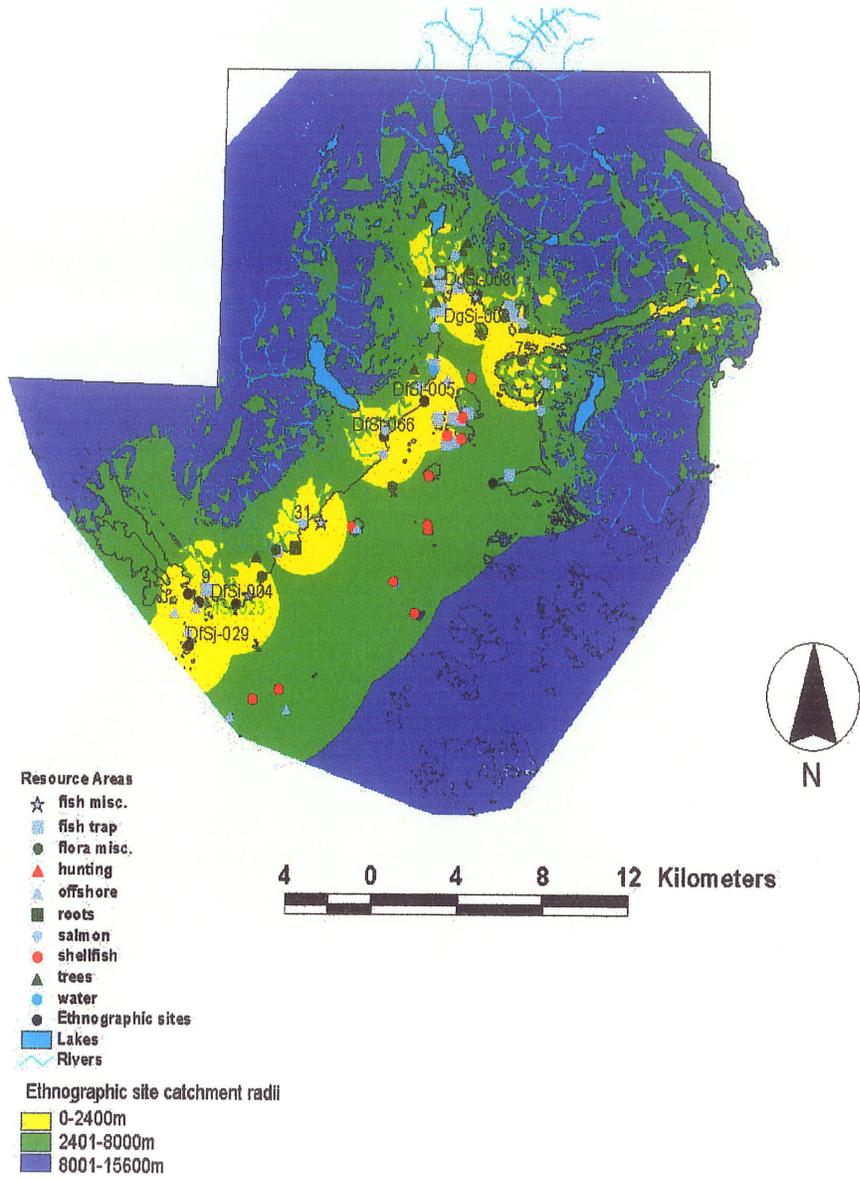


Figure 5.1.2: Ethnographic Site Catchment Areas

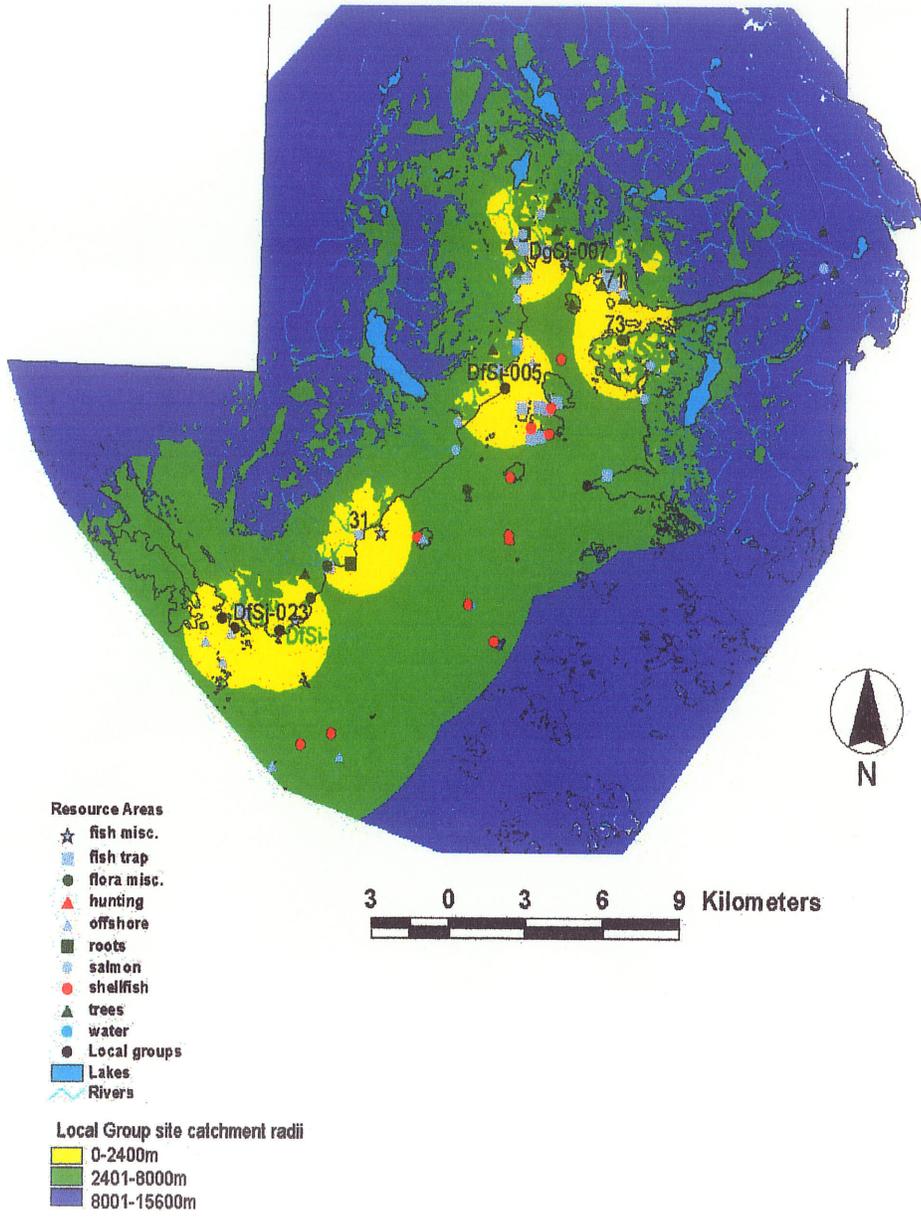


Figure 5.1.3: Local Group Catchment Areas

salmon fishing station and a number of tree resource areas is only just outside their 8km catchment radii.

In order to visually represent and compare the compositions of each site's catchment area, resource areas falling within the 2.4 and 8km catchment radii were counted and represented as cumulative frequencies. Figures 5.1.4 to 5.1.6 present the counts of resources within 2.4km of habitation sites graphically so that each site's local resources sum to 100%.

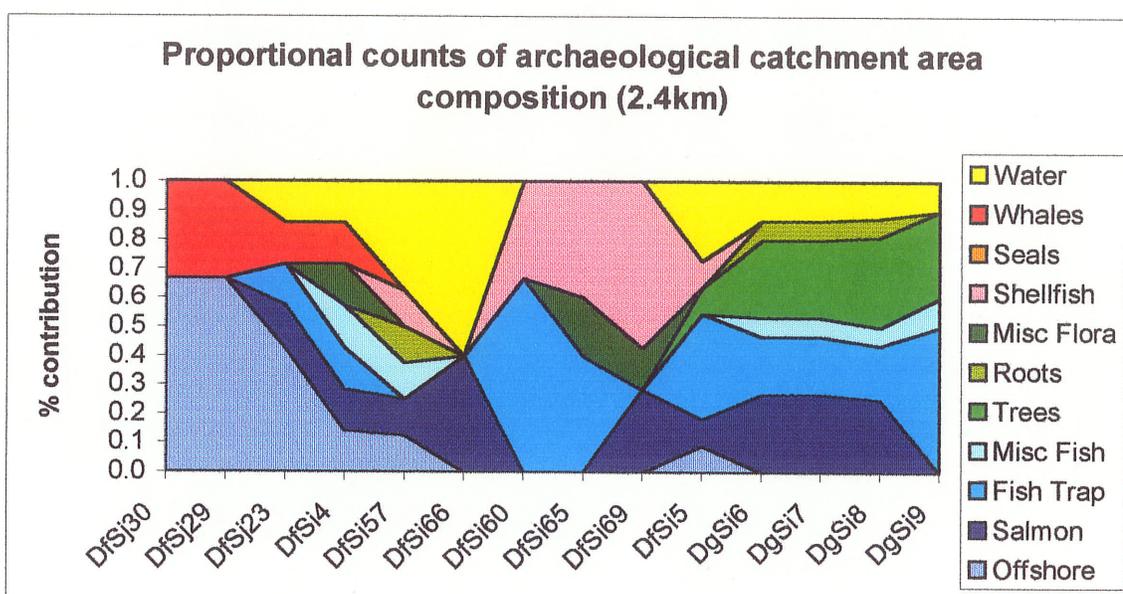


Figure 5.1.4: Distribution of resources by archaeological site catchment area (2.4km radius)

Figure 5.1.4 indicates a gradual change in catchment composition. Sites on the extreme left, located on the outer coast, have catchment areas dominated by whaling and offshore fishing resources. Sites in the center, primarily those located offshore on the Stopper Islands, are dominated by shellfish and fish trapping resource areas. Those on the right, representing sites located on the inner coast, have a mix of tree, fish trapping and salmon resources.

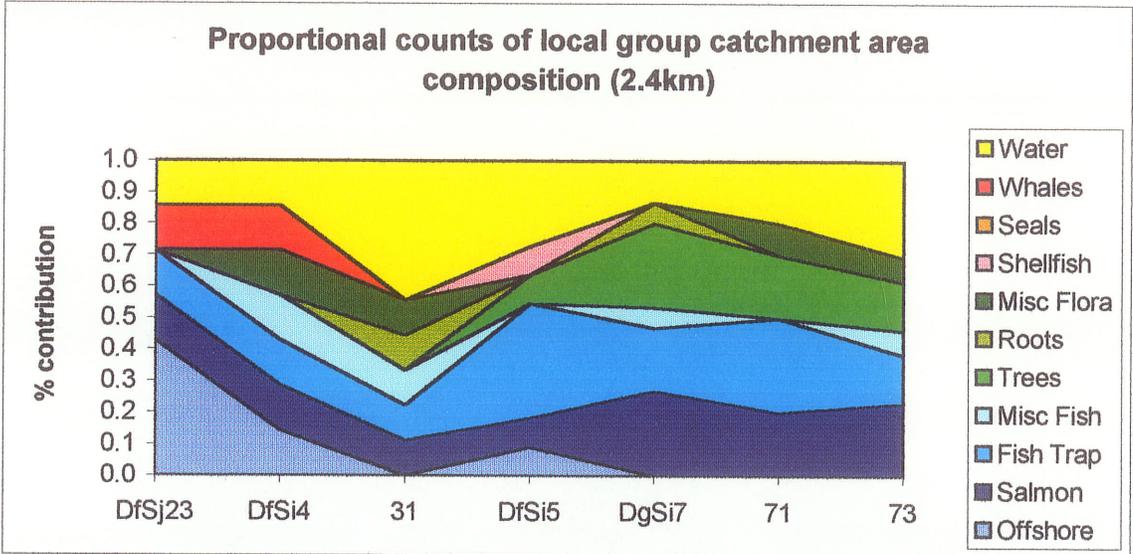


Figure 5.1.5: Distribution of resources by local group site catchment area (2.4km radius)

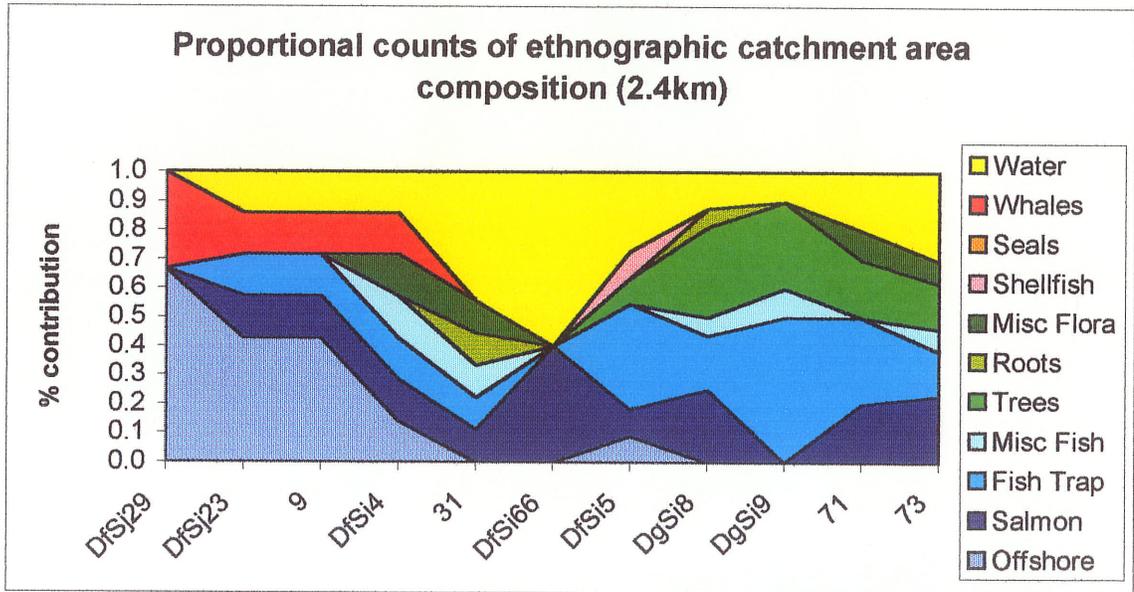


Figure 5.1.6: Distribution of resources by ethnographic site catchment area (2.4km radius)

Both Figure 5.1.5 and Figure 5.1.6 show a similar pattern of resource composition to that in Figure 5.1.4, with an emphasis on offshore fishing and whaling on the outer coast, and fish trapping, tree harvesting and salmon fishing on the inner coast. Note however that the central region, which in the archaeological case was heavily dominated by shellfish harvesting, is essentially absent in these two data sets.

Figure 5.1.7 to 5.1.9 present counts of resources falling within 8km of archaeological habitation sites, again with each site's resources summing to 100%.

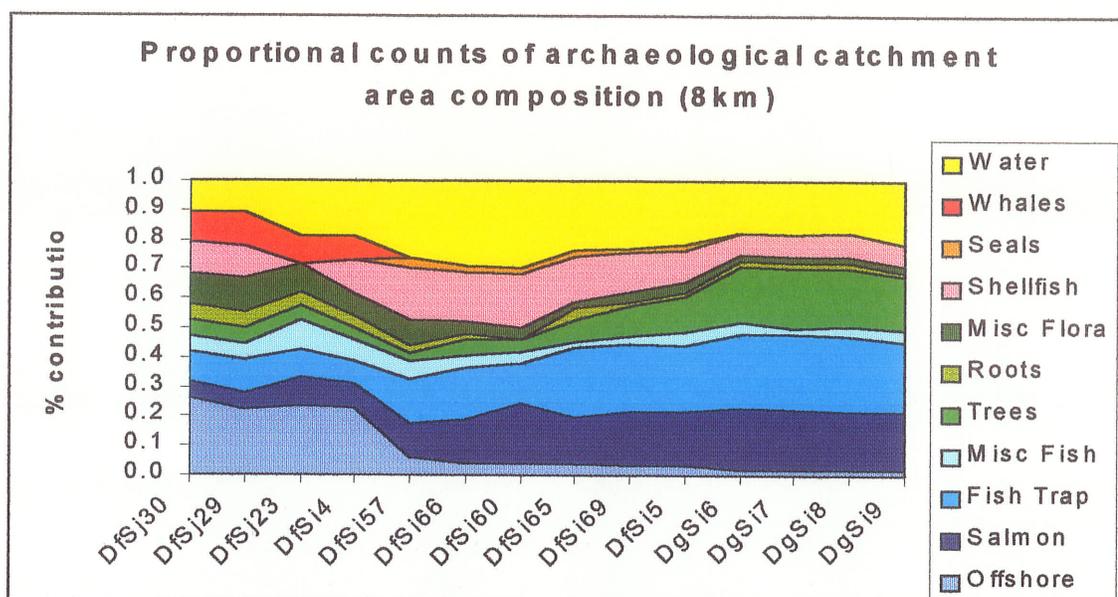


Figure 5.1.7: Distribution of resources by archaeological site catchment area (8km radius)

As with Figure 5.1.4, three groups of habitation sites can be identified from the archaeological data set. The outer coast group is composed of sites DfSj 30, DfSj 29, DfSj 23, and DfSi 4, who are the only sites to include whaling resources, and have a much higher proportion of offshore fishing resource locations. Miscellaneous floral resources are also more prevalent in these sites' catchment areas.

From the left, or inner coast, Sites DgSi 09, -08, -07, -06, and DfSi 05 seem to be dominated by salmon, fish traps and tree resource areas. Sites lying between these groups appear to emphasize shellfish resources and are the only sites to make use of recorded seal hunting locations.

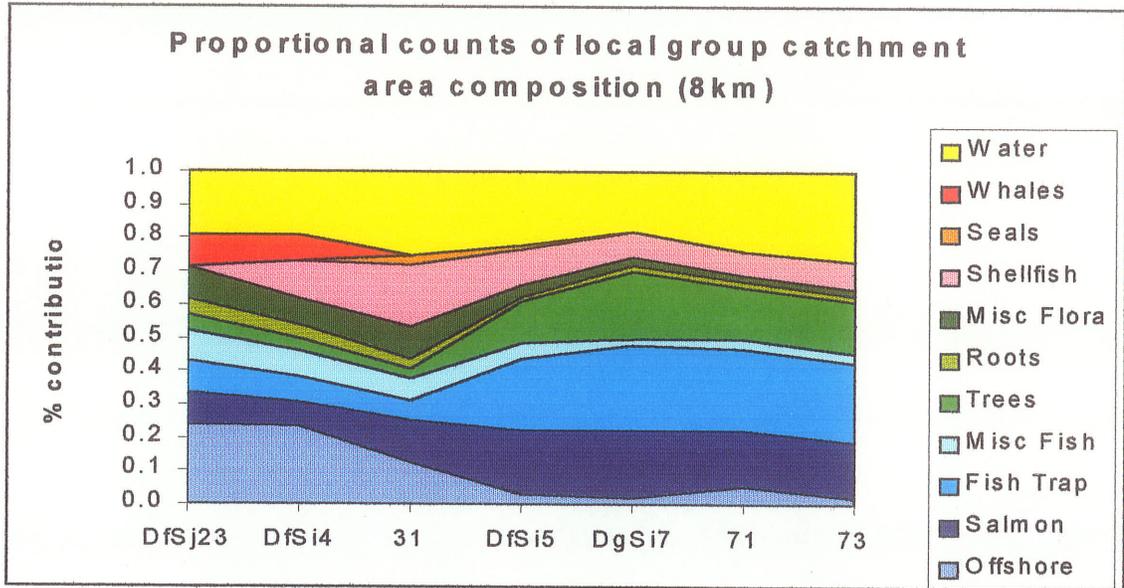


Figure 5.1.8: Distribution of resources by local group catchment area (8km radius)

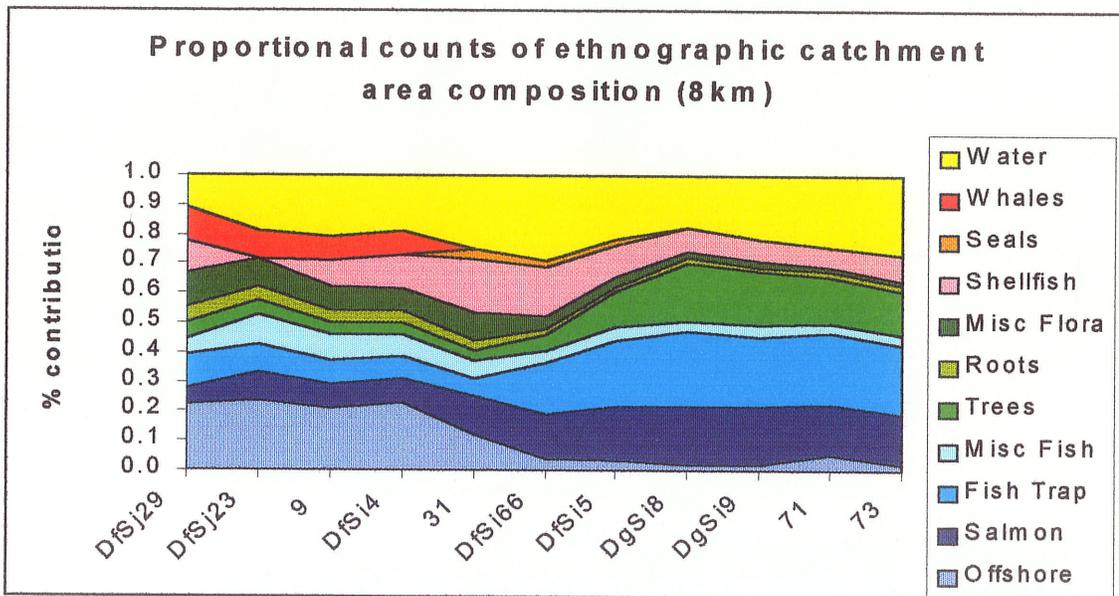


Figure 5.1.9: Distribution of resources by ethnographic site catchment (8km radius)

The wider eight kilometer catchment areas serve to smooth out small-scale variations in catchment composition, but again the central group of shellfish harvesting sites is absent in the local group data set, and is reduced from four to only one site, DfSi 66, in the ethnographic set.

Site 72 is clearly anomalous with respect to the other sites. This is due to its location far removed from most resource areas within Toquaht traditional lands. As mentioned above, Site 72 is located at the head of Pipestem Inlet, a location which is actually closer to neighbouring Effingham Inlet than to the rest of Toquaht territory. Because of its anomalous nature, it is excluded from subsequent analysis. Note however that its catchment areas contain salmon and tree resource locations, both of which are an important feature of the catchments of other inner coast sites.

Three distinct groups of sites can be characterized. The “outside” group of sites are DfSj 30, -29, -23, and Site 9, all characterized by relatively high proportions of whaling and offshore fishing resources. The “inside” group of sites are Sites 71 and 73, DgSi 09, -08, -07, -06, DfSi 05, -60, and -66, all characterized by high proportions of salmon, fish traps and trees. Finally, there is an “intermediate” group of sites, covering Site 31, DfSi 57, -65, and -69. These sites, while maintaining a higher proportion of salmon and fish trap resource locations than the “outside” group, also possess a higher proportion of shellfish collecting areas than the sites falling into the “inside” category.

Trends in the data become more apparent when the catchment compositions are presented in an order mirroring their geographic location. Figures 5.1.10 to 5.1.12 present the catchment area compositions of the three geographic groups of sites as cumulative frequency graphs.

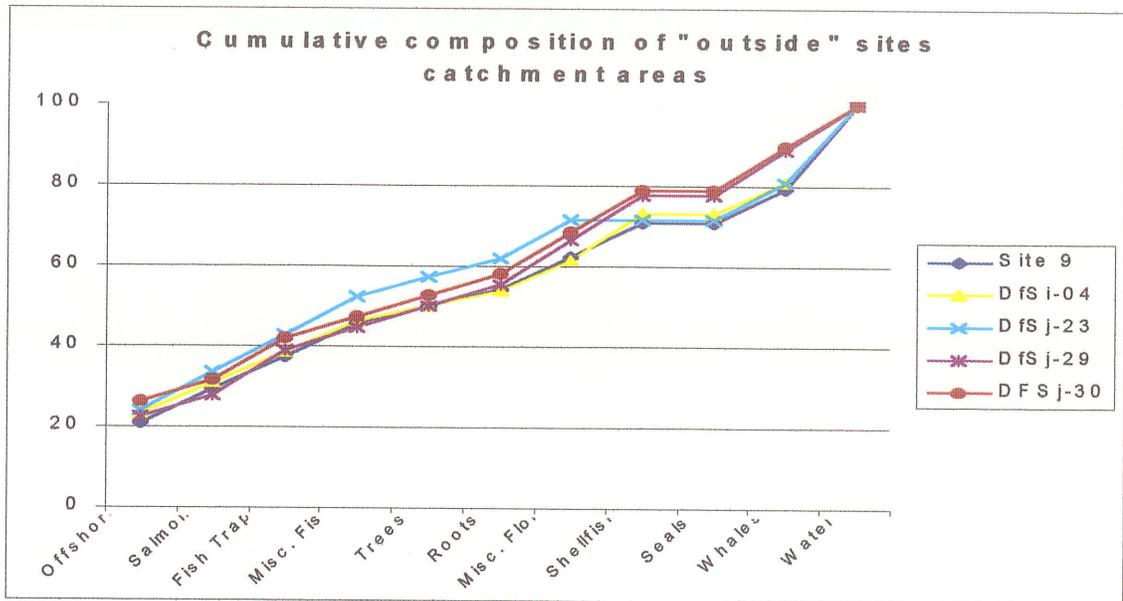


Figure 5.1.10: "Outside" site resource cumulative frequencies (8km radius)

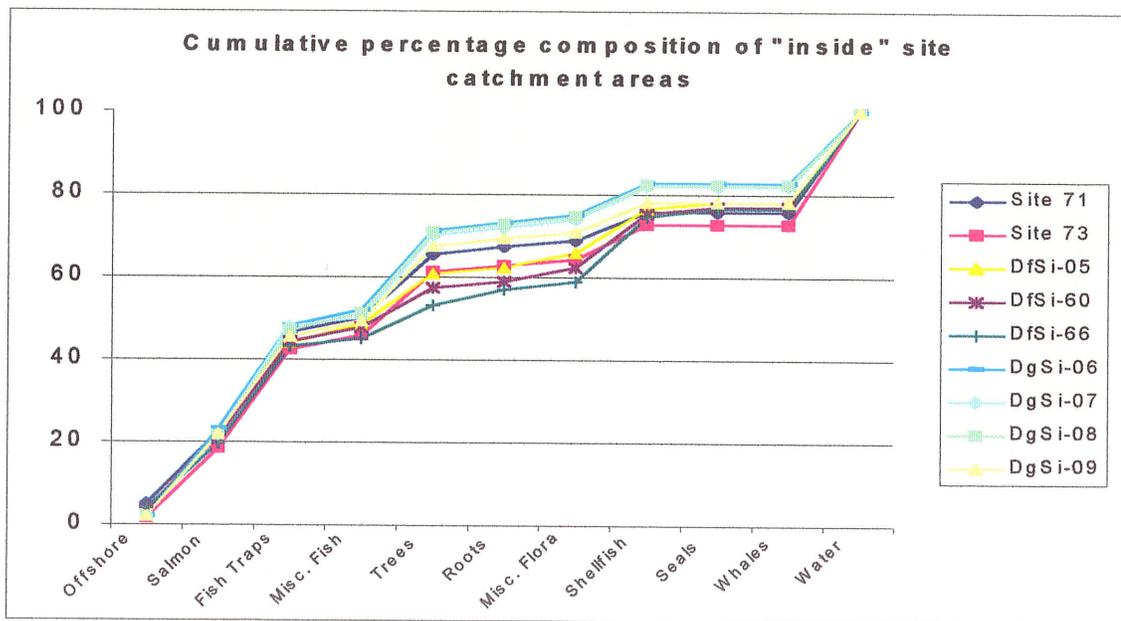


Figure 5.1.11: "Inside" site resource cumulative frequencies (8km radius)

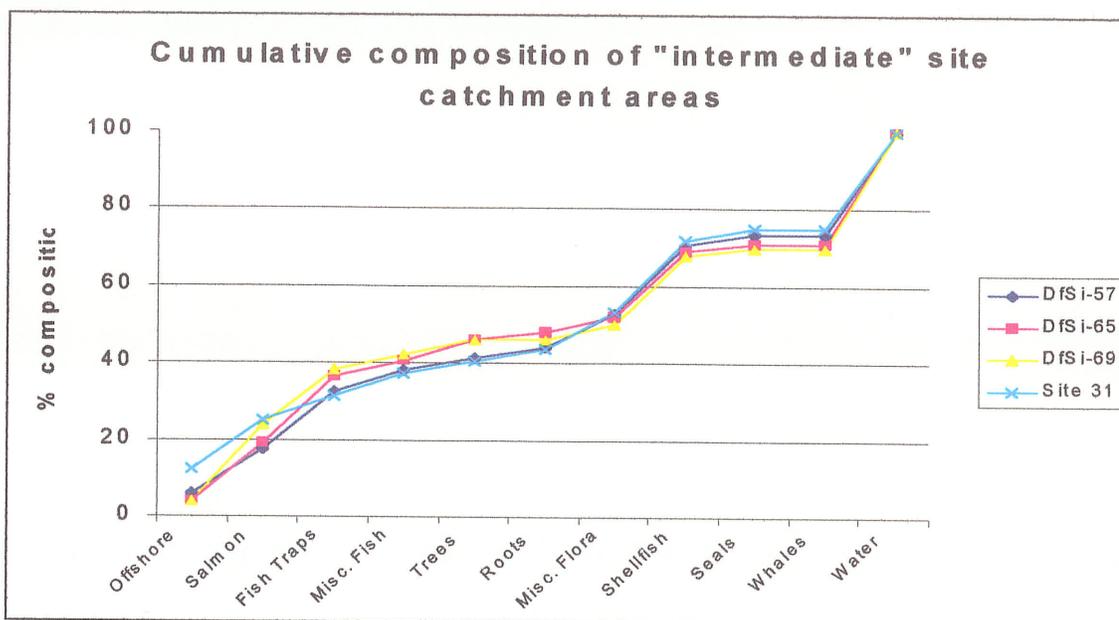


Figure 5.1.12: "Intermediate" site resource cumulative frequencies (8km radius)

In Figure 5.1.10, offshore fishing and whaling make the largest proportional contributions to the food resource bases of outer coast sites. Also, these outside sites are the only ones to have any resource contribution from whaling activity. Water resources are important, as can be seen in their high proportion (roughly 10-20%).

In Figure 5.1.11, salmon and trees make the largest contributions to the food resource base, followed by fish traps. Water is more important here, with water resources making up roughly 20% of the resource locations within a given site's 8km catchment area.

In Figure 5.1.12, sources of water have proportionally the highest representation, averaging 25%, while shellfish and fish traps make the greatest food contribution, closely followed by salmon fishing.

A chi-square test for independence was performed on the average catchment compositions of each of the three groups in order to compare them to each other statistically. The results of these comparisons are presented in Table 5.1.4:

Table 5.1.4: Chi-square test results comparing locational site groups

Catchment	Sites compared	df	χ^2	P
2.4 km	Outside vs. Inside	9	>50	<0.0001
2.4 km	Intermed. vs. Inside	8	>50	<0.0001
2.4 km	Intermed. vs. Outside	8	>50	<0.0001
8 km	Outside vs. Inside	10	39.85	<0.0001
8 km	Intermed. vs. Inside	9	15.34	0.08
8 km	Intermed. vs. Outside	10	34.41	0.00015

There is very strong evidence for a difference in resource distributions between the Outside/Inside and Intermediate/Outside groups. The distinction between Intermediate and Inside groups is strong in the 2.4km analysis. For any individual site, the proportions of resources found within the 2.4km and 8km catchment area of that site had more in common with the rest of its own locational group than with that of the other two locational groups.

Figure 5.1.13 presents the average cumulative catchment composition for the sets of archaeological, local group and ethnographic sites. Figure 5.1.14 presents the average cumulative catchment composition for the sets of Small (<300m²), Medium (300-1000m²) and Large(>1000m²) sites.

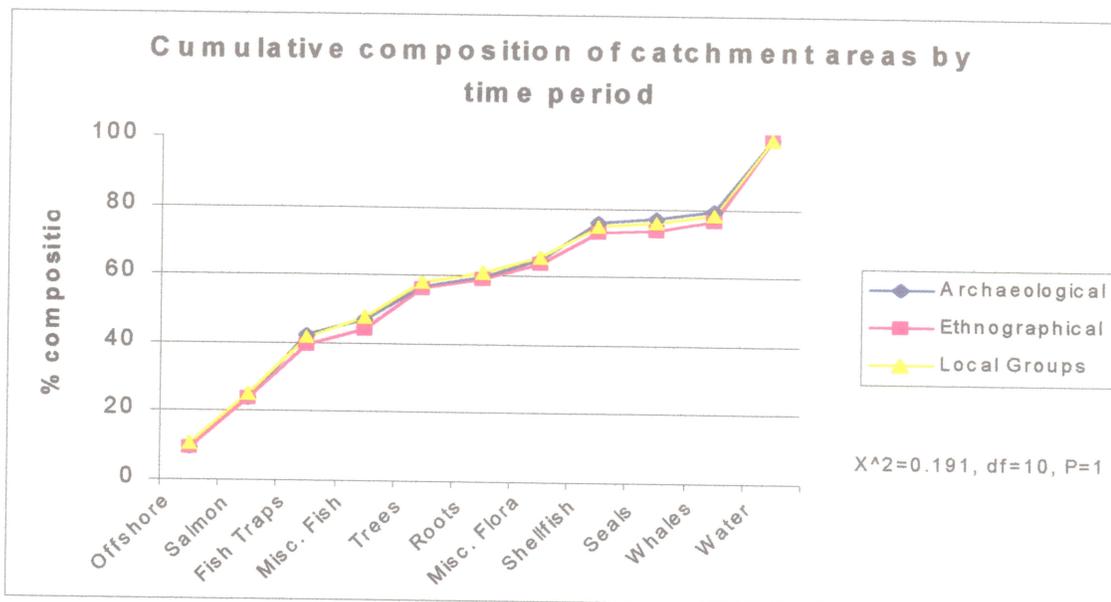


Figure 5.1.13: Average catchment composition by time period

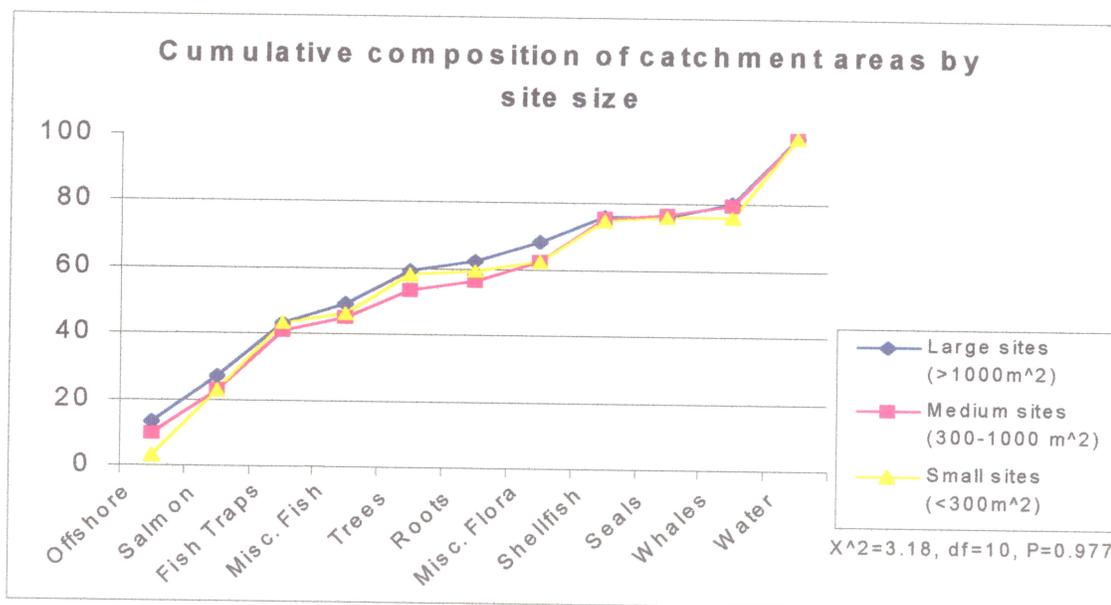


Figure 5.1.14: Average catchment composition by site size

As can be seen in the figures above, there is no real difference between the distributions of the Archaeological, Ethnographic and Local Group sets of sites, nor is there a difference between the distributions of Small, Medium and Large sites. This is in contrast to the clear differences between the geographically-determined groups of sites analyzed above. The Archaeological/Ethnographical/Local Group sets returned a P-value

of 1 ($X^2=0.191$, $df = 10$), and the Small/Medium/Large sets had a P-value of 0.977 ($X^2=3.18$, $df = 10$), both of which suggest strong similarity of catchment distributions.

The implication of the lack of variability between the three sets of habitation sites (Archaeological/Ethnographic/Local Group) is that there is no change in the range of resources that are collectively covered by site catchments over time, at least between the recent archaeological past exemplified by the Archaeological and Local Group data sets.

5.2 Viewsheds

Viewshed analysis will examine three things:

1. The number and type of other sites visible from the site in question
2. The total area that can be viewed from the site in question
3. The angle subtended by the viewed surface

Examination of the combined viewshed maps from each of the three time periods reveals the presence of three regions that are more likely to be visible from any locations in the sets of sites examined (Figures 5.2.1-5.2.3). These regions are:

1. The entrance to Barkley Sound, away from land, and roughly intermediate between the mainland and the islands of the Broken Group.
2. The mouth of Pipestem Inlet, in particular the Black Peaks located immediately north of the inlet, just east of its mouth.
3. The Broughton Peaks, located south of Pipestem Inlet.

The first of these three is the major body of open water adjoining many of the sites in question, and the last two are some of the highest mountain peaks near Toquaht territory. Because of the prominence of these locations within the region, their high level of visibility is perhaps not surprising. The mouth of Pipestem Inlet is the location of the sole pictograph located in the study area, but the pictograph panel itself is not in the intensively-viewed area. The panel is in line of sight to only one or two sites, and it is the mountains inland from it to the north-east that are the focus of 5-8 viewsheds in any given site set (archaeological, ethnographic, local group).

5.2.1 Site Intervisibility:

Two groups of intervisible sites were identified. These are:

- 1) DfSj-23/DfSj-29 (facing each other between the mainland and George Fraser Islands)
- 2) Site 71/Site 73 (facing each other across the mouth of Pipestem Inlet)

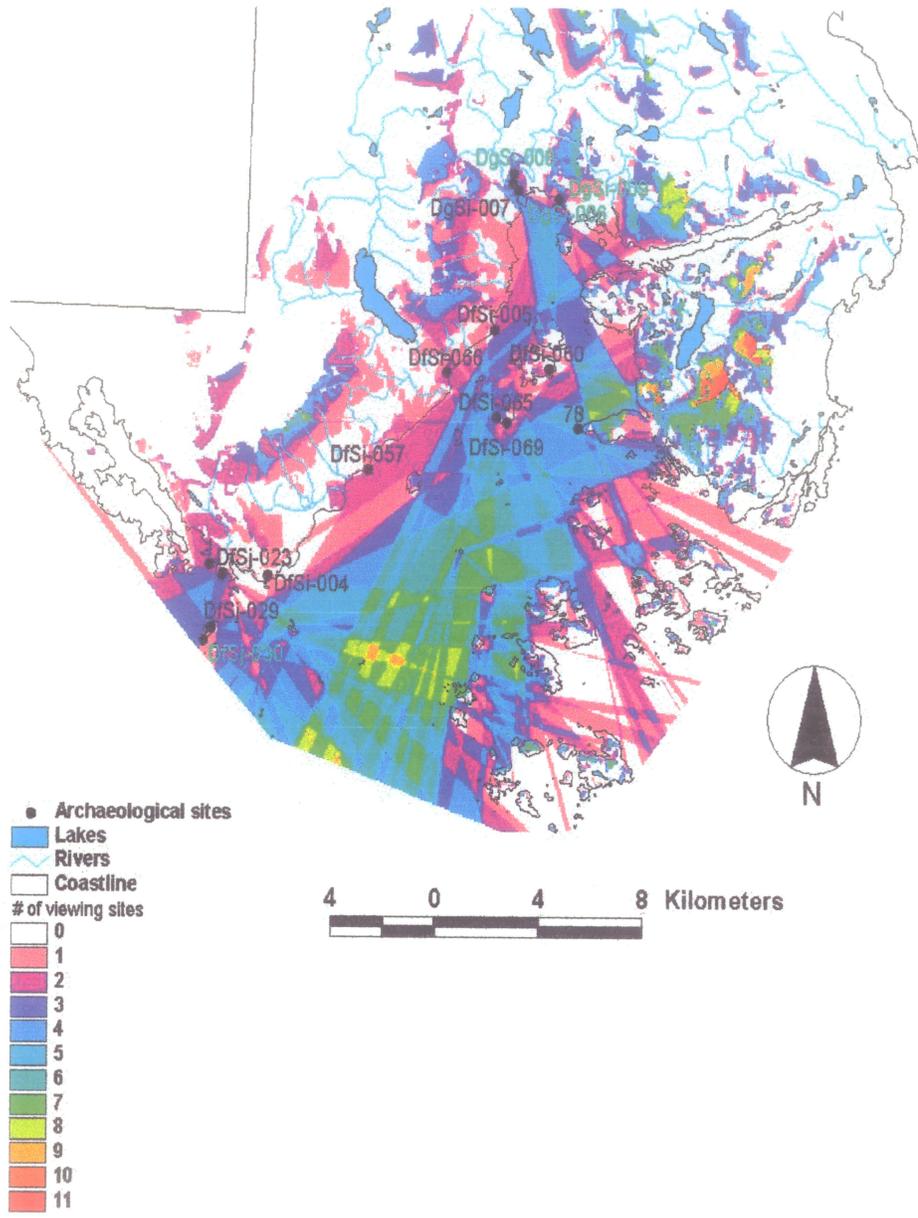


Figure 5.2.1: Combined viewed areas of archaeological sites

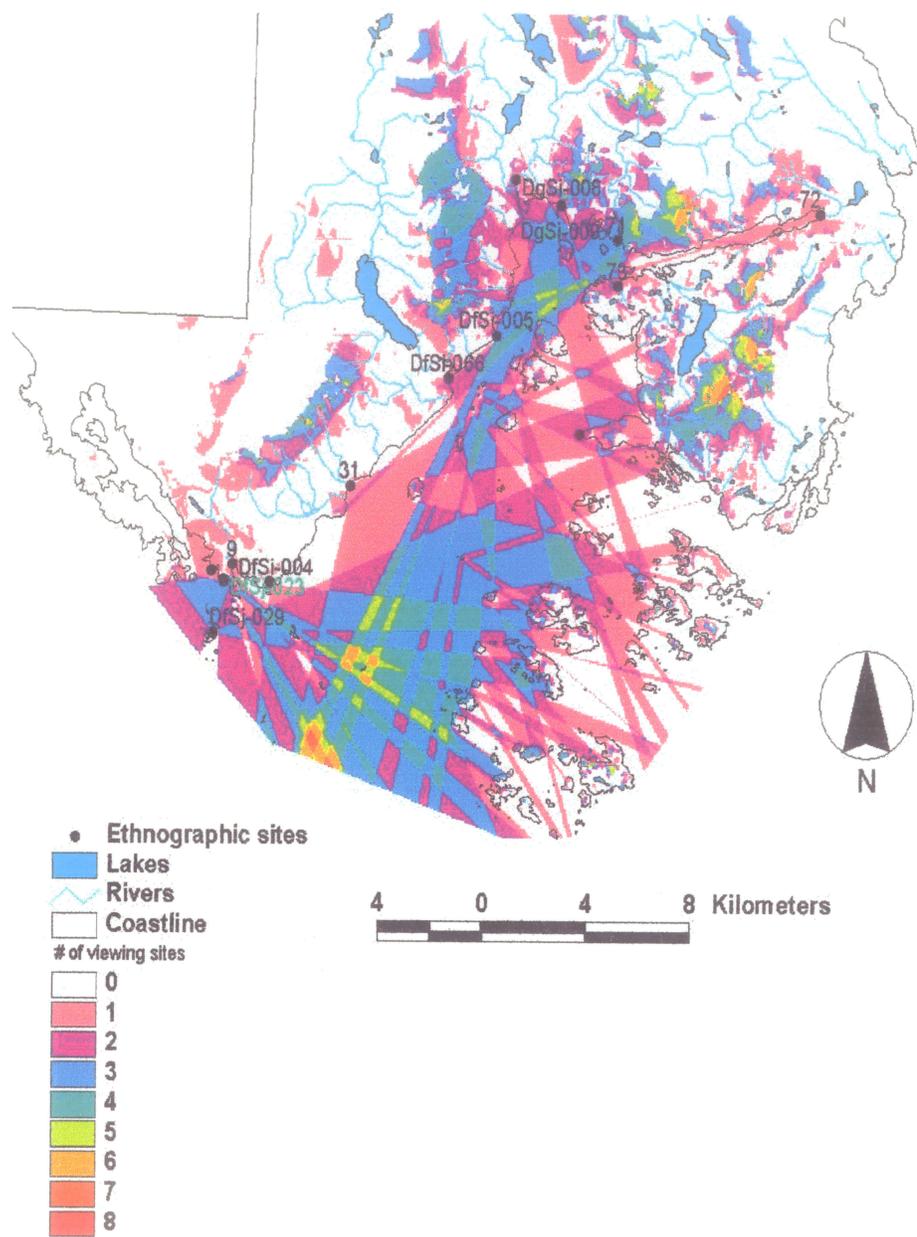


Figure 5.2.2: Combined viewed areas of ethnographic sites

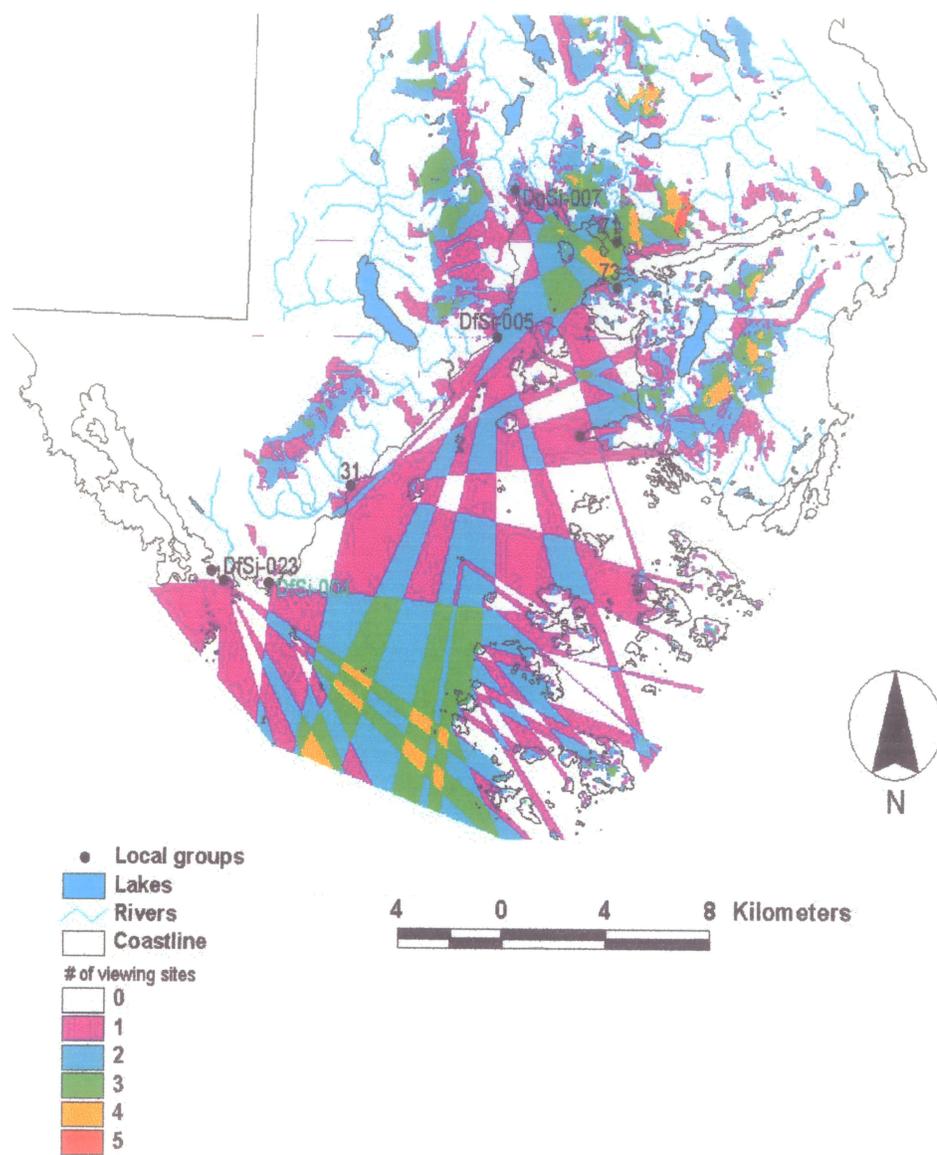


Figure 5.2.3: Combined viewed areas of local group sites

Of these two, only the first involves intervisibility with a major habitation site, that of DfSj 23 (T'ukw'aa) on the outer coast. This site looks across the water to DfSj-29, a defensive or lookout site located on the George Fraser Islands, tentatively identified with an ethnographically-occupied whale hunting camp. The second example involves two intervisible ethnographically-occupied fishing stations, albeit two that informants identified as the ancestral home of two Toquaht local groups. Based on the scarcity of examples, direct site intervisibility does not seem to be a major consideration of either the archaeological or ethnographic Toquaht settlement pattern. The implications of this lack of direct intervisibility will be discussed in Chapter 6, below.

The archaeological set of viewsheds provides the best explanation for why the high visibility of certain mountains may not be of significance beyond a simple factor of topography. The most highly-viewed portion of Barkley Sound from Toquaht lands is a set of mountain peaks within the territory of the Tseshaht, a neighbouring group to the Toquaht. The second most-viewed area, the entrance to Barkley Sound itself, is so distant (~16km) from many of the sites "viewing" it that the chance of being able to see events taking place there must be seriously questioned due to atmospheric extinction and other factors limiting visibility over long distances.

The comments regarding the set archaeological viewsheds are equally applicable to the set of ethnographic viewsheds, as regards regions of high visibility. Here again the entrance to Barkley Sound is highly visible, with the caveat that certain sites may not typically be able to afford views that far due to atmospheric effects. The presence of sites at the entrance to Pipestem Inlet serves to enhance the visibility of the inner regions of the TAP study area, that is, around the mouth of the Toquaht River.

Viewed areas among the Local Group sites again focused on the mouth of Pipestem Inlet due to the presence of Sites 71 and 73. Note that Site 71 and DfSi 5, while apparently in line-of-sight to one another, are actually blocked by the presence of a small unnamed island having a maximum elevation less than the minimum resolution of the 1:50,000 topographic maps used to prepare the DEM.

Table 5.2.1 presents the raw viewed area and angle data for each site data set.

Table 5.2.1: Viewed area and viewed angle for archaeological, ethnographic and local group site sets

Archaeological			Ethnographic			Local Group		
Site Name	Area	Angle	Site Name	Area	Angle	Site Name	Area	Angle
DfSi4	25299	90	Site 9	4930	30	Site 31	49363	135
DfSi5	35168	185	Site 31	49363	135	Site 71	17105	360
DfSi57	54434	175	Site 71	17105	360	Site 73	8691	60
DfSi60	20791	120	Site 72	5304	5	DfSi4	25299	90
DfSi65	42482	180	Site 73	8691	60	DfSi5	35168	185
DfSi66	25698	120	DfSi4	25299	90	DfSj23f*	10686	185
DfSi69	41155	155	DfSi5	35168	185	DfSj23v*	6053	150
DfSj23f*	10686	185	DfSi60	20791	120	DgSi7	14043	35
DfSj23v*	6053	150	DfSi66	25698	120			
DfSj29	30047	150	DfSj23f*	10686	185			
DfSj30	46122	360	DfSj23v*	6053	150			
DgSi6	14979	35	DfSj29	30047	150			
DgSi7	14043	35	DgSi8	15324	35			
DgSi8	15324	35	DgSi9	17956	120			
DgSi9	17956	120						

* Site DfSj 23 contains both a principal habitation site (v) and a defensive location (f). Since the defensive location's elevation will modify the angle and area that are visible, the two are separated for purposes of analysis.

To evaluate the degree of potential differences between the three data sets, a t-test of the mean area and viewed angle was run comparing each combination of pairs of data sets. The results are presented in Table 5.2.2.

Table 5.2.2: t-test of mean viewed area/angle by site data set

Data set	n	mean area	std. dev.	mean angle	std. dev.	T-tests:	P: Area	P: Angle
arch	15	26682.46667	14420.70561	139.66667	81.27262	arch/ethn	0.083279	0.318314
ethno	14	19458.21429	14959.80206	124.64286	83.12658	ethn/local	0.413054	0.272417
local	8	20801	15366.62047	150	85.61055	arch/local	0.184057	0.396057

None of the pairs of site groups have significant differences in either their mean viewed areas or mean viewed angles. The most different two means are those of the archaeological and ethnographic site groups, which differ at the $0.1 > P > 0.05$ level. This is greater than the $P=0.05$ level usually considered to be the minimum for statistical significance, and so it also is rejected as not being a significant difference. This high degree of similarity between sets of viewsheds means that through time, or at least between the three data sets, there is no significant difference in either the area viewed by the average site, or in the breadth of angle of land and sea that can be seen from the average site. The impact of these results will be further discussed in Chapter 6.

5.3 Nearest-Neighbour Analysis

Table 5.3.1 presents the measured nearest-neighbour distances for the set of archaeological sites. Recall that the n-th order of nearest-neighbour refers to the n-th nearest site to the site in the question. Thus the second order nearest neighbour of site DfSj 23 is site DfSj 29, and is 1823.691m distant. For the purposes of nearest-neighbour analysis, which precise site is the n-th nearest neighbour is not as important as the distance, hence the table presents only distances from which the nearest-neighbour statistics were calculated.

Table 5.3.1: Nearest neighbour (NN) distances (in meters) chart highlighting distances to sites DfSi4 and DfSi5.

Site	NN(1)	NN(2)	NN(3)	NN(4)	NN(5)	NN(6)	NN(7)	NN(8)	NN(9)	NN(10)
DfSj-030	531.979	2355.67	2940.285	3424.308	8874.613	13652.816	14102.123	14727.683	16007.003	16963.436
DfSj-029	531.979	1823.691	2408.306	2892.329	8342.634	13120.837	13570.144	14195.704	15475.024	16431.457
DfSj-023	584.615	1823.691	2096.41	2355.67	7546.724	12324.927	12774.234	13399.794	14679.114	15635.547
DfSi-004	2096.419	2681.034	2892.329	3424.308	5450.305	10228.508	10677.815	11303.375	12582.695	13539.128
DfSi-057	4778.203	5227.51	5450.305	5853.07	7132.39	7546.724	8131.339	8088.823	8342.634	8622.33
DfSi-066	2354.187	2427.174	3052.734	4234.946	4778.203	5821.994	7295.248	7442.697	10228.508	12324.927
DfSi-005	2354.187	2888.71	3129.284	3514.27	4941.061	5088.51	5389.179	7132.39	12582.695	14679.114
DgSi-007	2318.789	5088.51	7442.697	7977.22	8217.794	8602.78	10477.689	12220.9	17671.205	19767.624
DgSi-009	2318.789	4941.061	7295.248	7829.771	8070.345	8455.331	10330.24	12073.451	17523.756	19620.175
DfSi-065	625.56	2427.174	2861.313	2888.71	3394.82	5227.51	7829.771	7977.22	10677.815	12774.234
DfSi-069	625.56	2769.26	3052.734	3486.873	3514.27	5853.07	8455.331	8602.78	11303.375	13399.794
DfSi-060	2259.895	2861.313	3129.284	3486.873	4234.946	8070.345	8088.823	8217.794	13539.128	15635.547

The significance of the blue and yellow shading will be discussed further below.

Figures 5.3.1 to 5.3.3 present a selection from the full set of nearest-neighbour distances used for calculating nearest-neighbour statistics for habitation sites within the TAP study area. Presenting the full set of distances in map format would have overwhelmed the map with interconnections, making visualization difficult. The figures therefore present the shortest of the full set of nearest-neighbour distances. Recall also that “sites” 1 and 78 are not habitation sites, but markers for the endpoints of the study area.

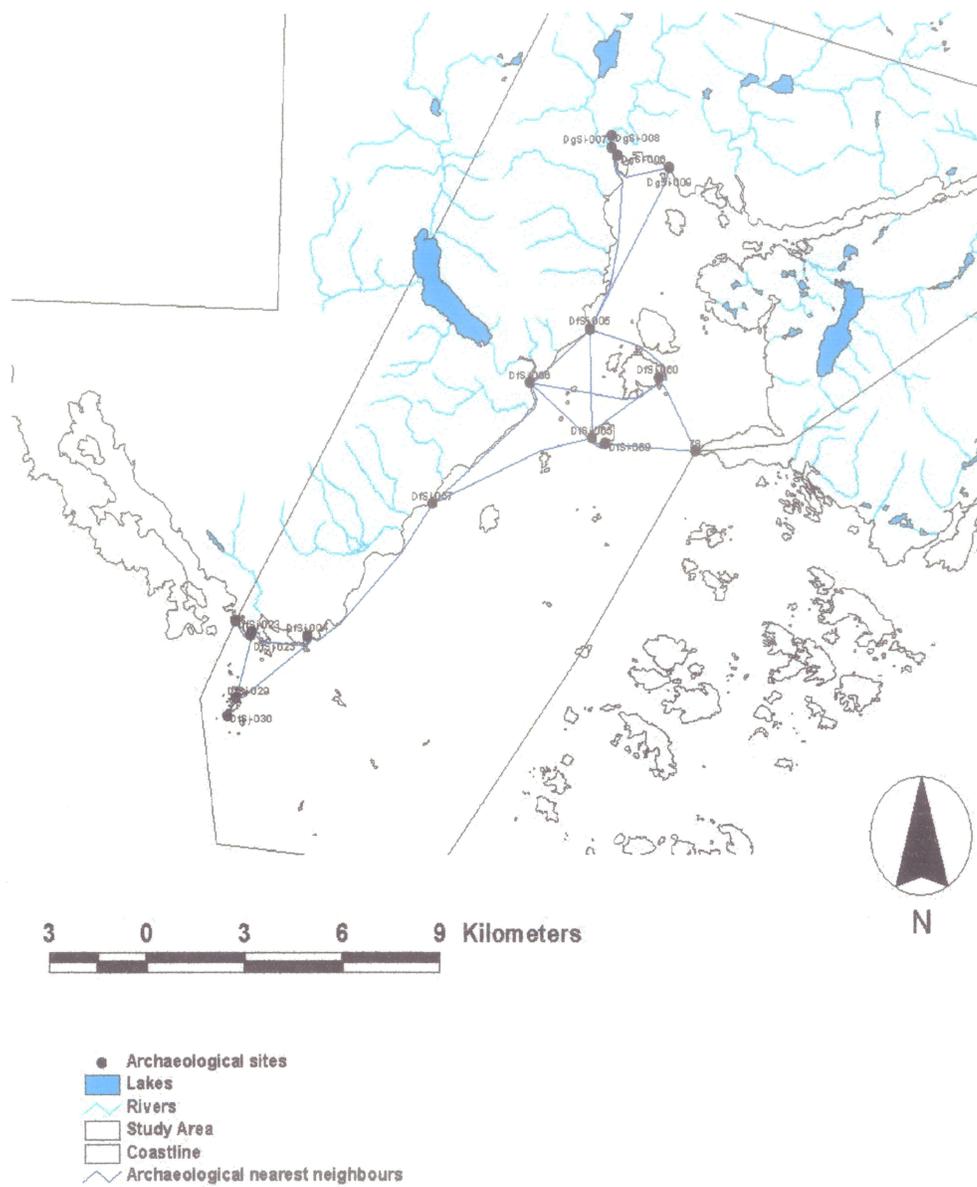


Figure 5.3.1: Map of nearest-neighbour distances for archaeological sites

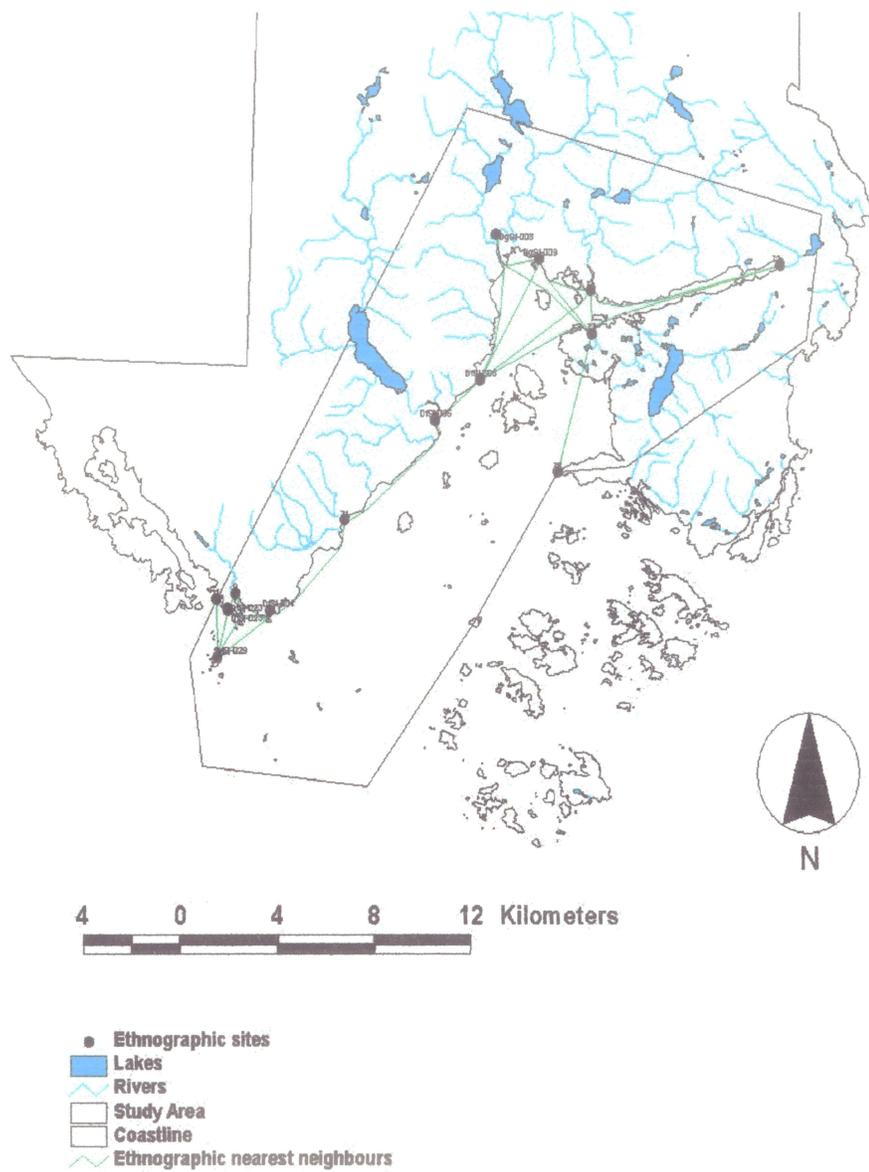


Figure 5.3.2: Map of nearest-neighbour distances for ethnographic sites

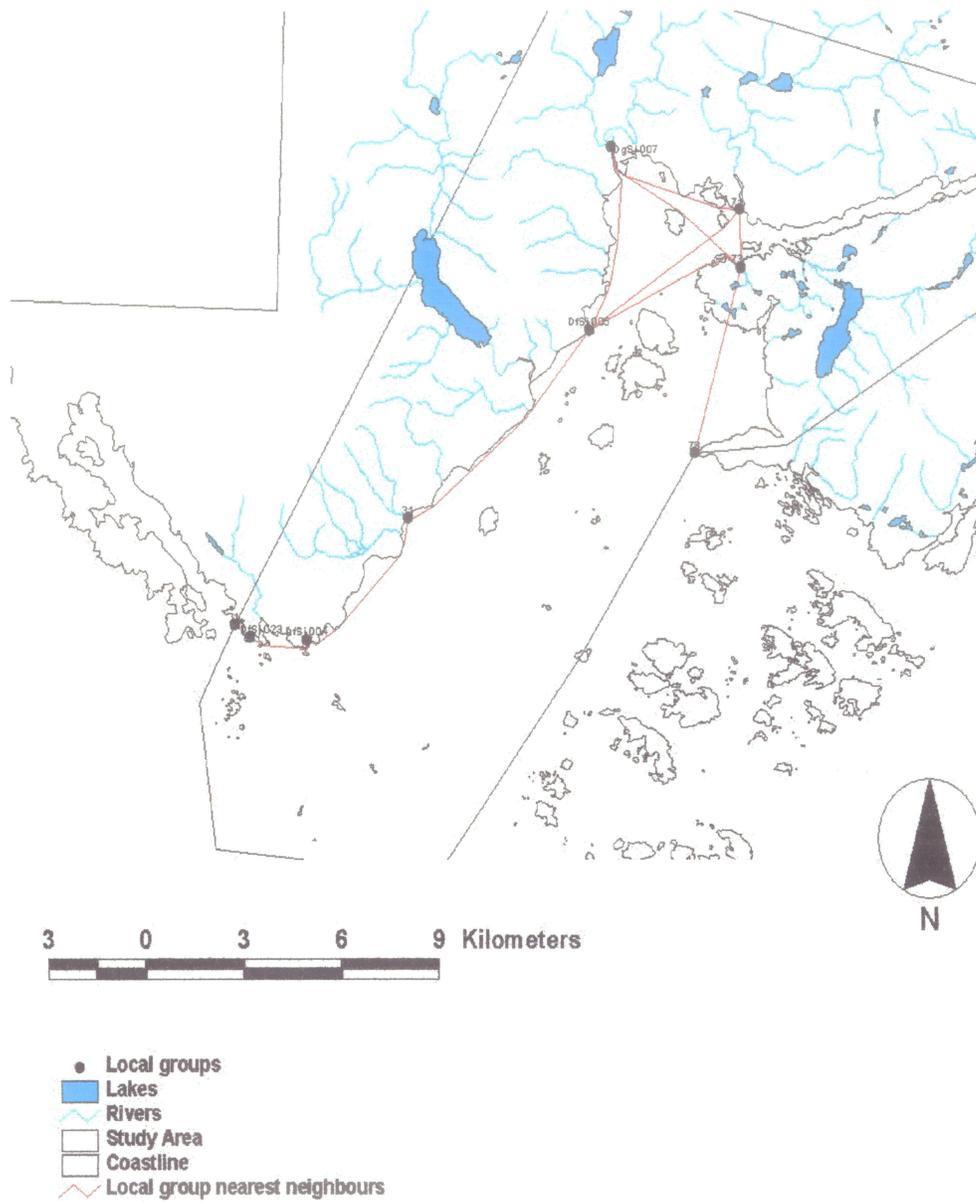


Figure 5.3.3: Map of nearest-neighbour distances for local group sites

The areal (two dimensional) nearest-neighbour statistics for all three data sets show an overall trend towards clustered spacing at lower orders of nearest neighbour when compared to the nearest neighbour distances calculated from the 100 random test cases.

Figure 5.3.4 presents the graph of NN statistics for archaeological sites prior to correcting for the effect of the coastline.

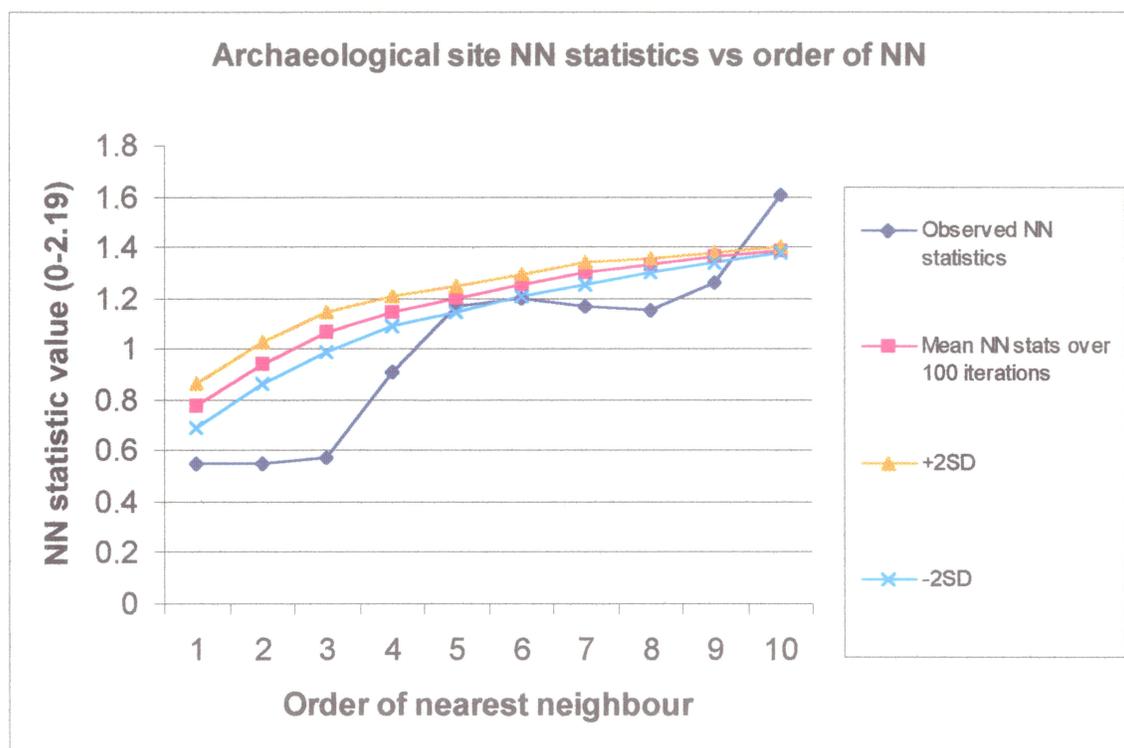


Figure 5.3.4: Archaeological nearest-neighbour statistics compared with random population samples nearest-neighbour statistics.

Note the overall trend in NN statistics for the 100 random test cases from slight clustering at low-order nearest-neighbours towards regularity of spacing at successively higher orders of nearest-neighbour. This trend was qualitatively similar for each of the random data sets generated from the three observed data sets. In subsequent figures

(5.3.5 - 5.3.7), all data will be forced to make the average of the random data sets equal to 1.0, a random distribution of points. This procedure is justified because the purpose of nearest-neighbour analysis is the comparison of point pattern distributions to a random distribution of points. Discussion of the chart results will follow Figure 5.3.7

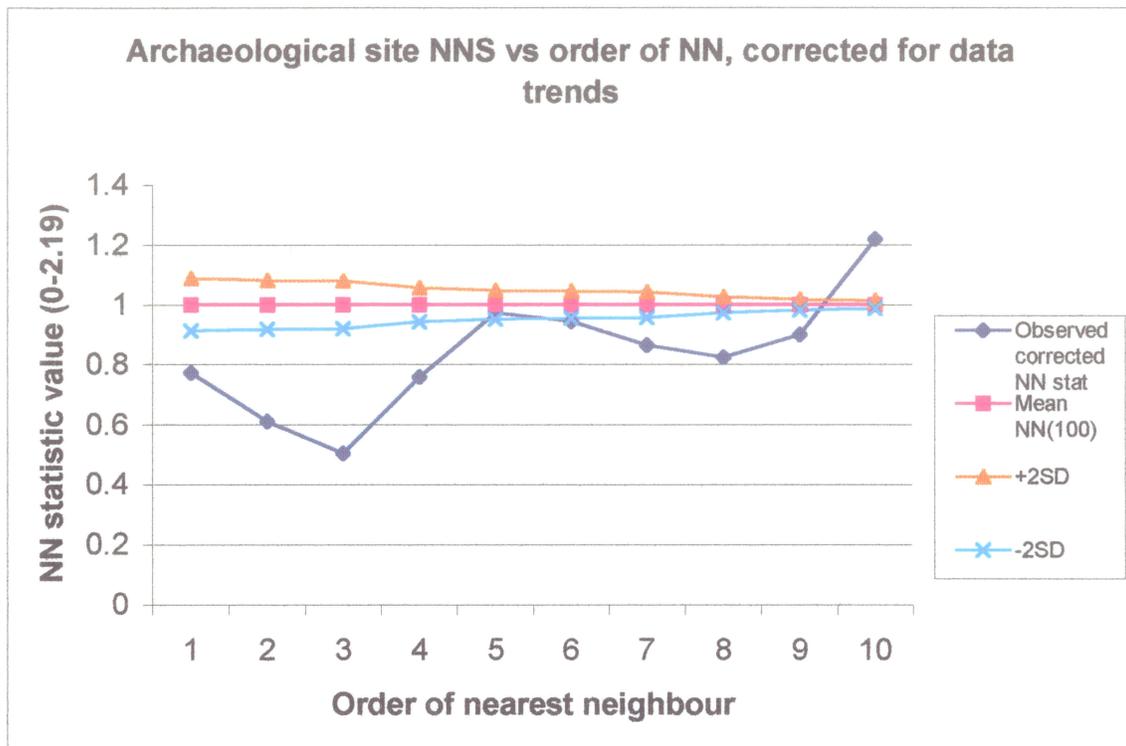


Figure 5.3.5: Detrended archaeological nearest neighbour chart

Figure 5.3.6: Detrended ethnographic nearest neighbour chart

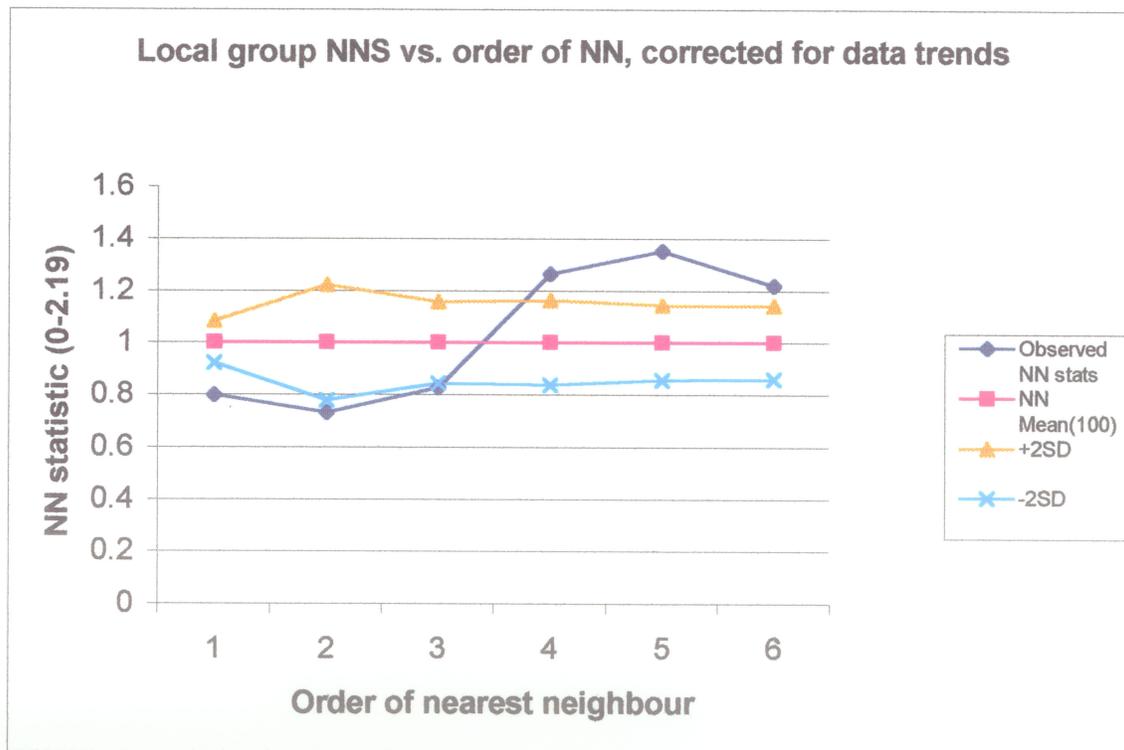
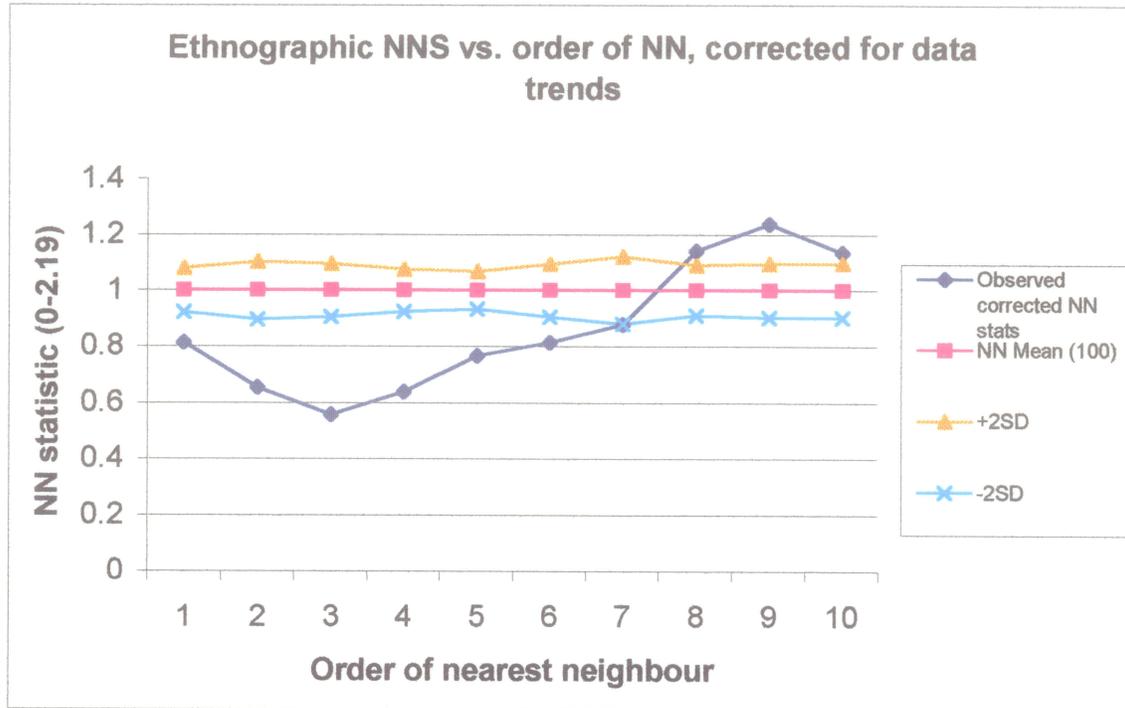


Figure 5.3.7: Detrended local group nearest neighbour chart

The detrended archaeological data shows a tendency towards clustering of archaeological sites between the first and fourth order nearest neighbours. The highest degree of clustering is centered around the third order nearest neighbour. This clustering is followed by a tendency towards random spacing of fifth and sixth nearest neighbours, a return to clustering of sites of seventh through ninth nearest neighbour, to finish in a sudden switch from clustering to regularity at the tenth nearest neighbour.

The ethnographic sites show a similar overall trend of clustering at lower order nearest neighbours followed by regularity of spacing at higher orders. Here again the peak clustering takes place at the third nearest neighbour, and shows a similar jump from clustering to regularity occurs between the seventh and eighth nearest-neighbour. This jump is followed by a peak in regularity of spacing at the ninth nearest neighbour.

The local group habitation sites are again similar, but clustering occurs at lower orders of nearest neighbour, with peak clustering at the second nearest neighbour, and regularity of spacing by the fourth nearest neighbour. This compressed pattern may be due to the lower number of sites in this data set ($n=7$ vs. $n=11-12$ for the others). Here, the same two clusters are present as are in the ethnographic data, but with fewer cluster members. The lower number of sites present in this data set may account for the weaker trends to clustering and dispersal seen in Figure 5.3.7, which are at times only marginally outside the 2σ level.

The significance of the peak in clustering at a given order of nearest neighbour in each case is evidence of the size of clusters of sites that are present in that data set. For the set of archaeological sites, peak clustering is at the third nearest neighbour. This peak in clustering represents clusters of four sites that are more closely associated with each

other than with any other sites. Figure 5.3.8 shows the positions of these three clusters. The first cluster is centered roughly around site DfSj 23, on the outer coast. The second is the cluster of sites DfSi 5, 60, 66, and 69 on the Stopper Islands and the adjacent mainland. The third is the cluster of sites DgSi 6, 7, 8, and 9 at and around the mouth of the Toquart River. The equivalent clusters in the ethnographic site data are the DfSj 23-centered cluster on the outer coast, and the combination of sites 71, 73, DgSi 8, and DgSi 9, all at the head of the Sound and near the mouth of Pipestem Inlet (Figure 5.3.9).

The archaeological nearest-neighbour statistics also show a second peak in degree of clustering at the eighth-order NN (Fig. 5.3.5). This peak in clustering is almost certainly an echo of the lower-order clustering, caused by the intermediate and inside clusters being located much more closely to each other than to the outside site cluster. Proof of this echo effect can be found in the lack of a similar secondary peak among the ethnographic sites, where the intermediate cluster is no longer present.

A second finding came from inspection of which habitation sites within a given data set tended to be more frequently represented at certain orders of nearest neighbour. The pattern for the archaeological data set is marked with blue and yellow shading in Table 5.3.1.

Two major habitation sites, Ch'uumat'aa (DfSi 4) and Macoah (DfSi 5) are positioned such that they are the ninth nearest neighbour of virtually all other sites. Also, of the sites that do not have DfSi 4 as ninth nearest neighbour, DfSi 4 is on average their $4 \times 2 + 3 \times 2 / 4 = 3.5^{\text{th}}$ nearest neighbour, while for DfSi 5 the non-ninth nearest neighbour sites on average have DfSi 5 as their 3.14^{th} nearest neighbour. It appears that these two major sites are situated at some sort of inflection point in the network of habitation sites,

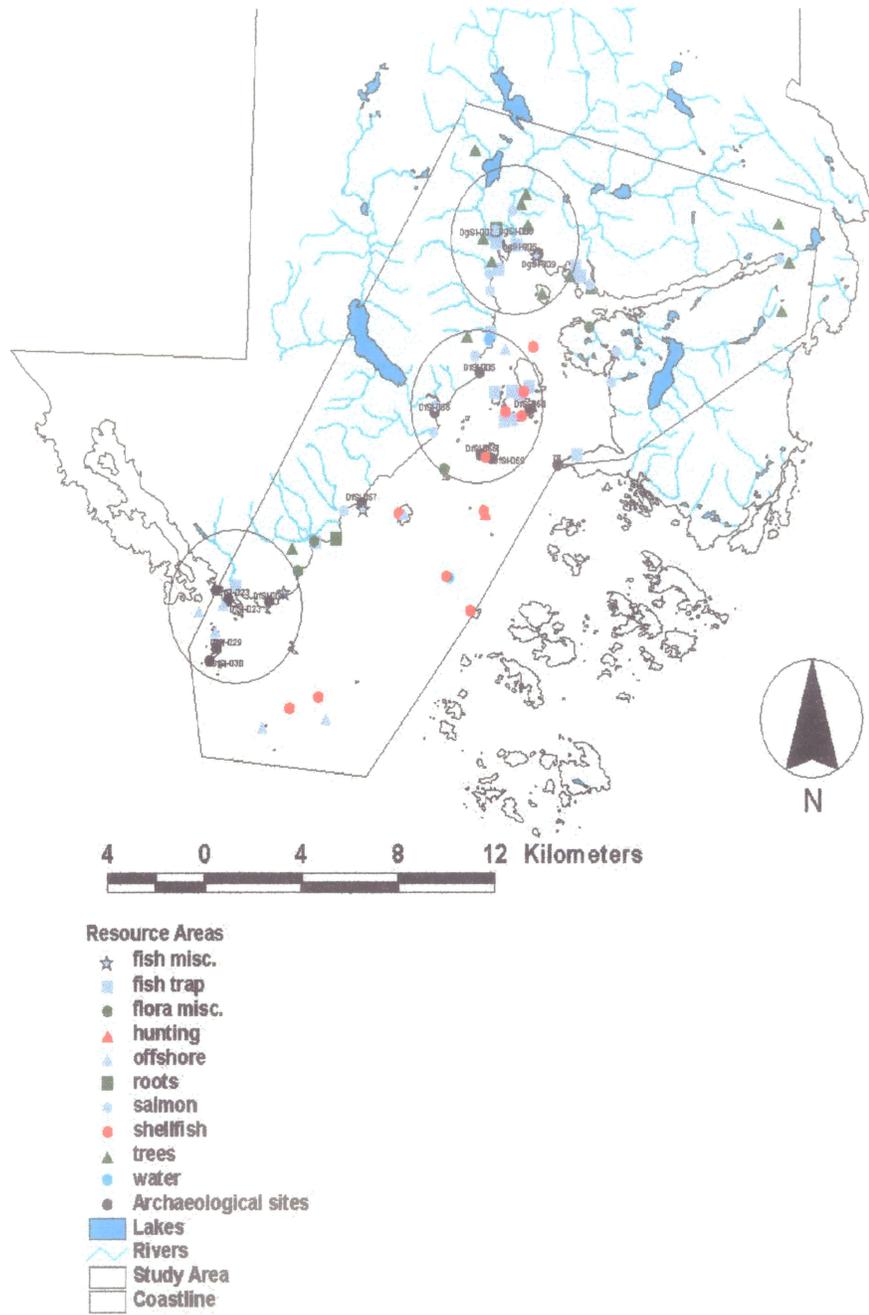


Figure 5.3.8: Map showing three clusters of archaeological sites

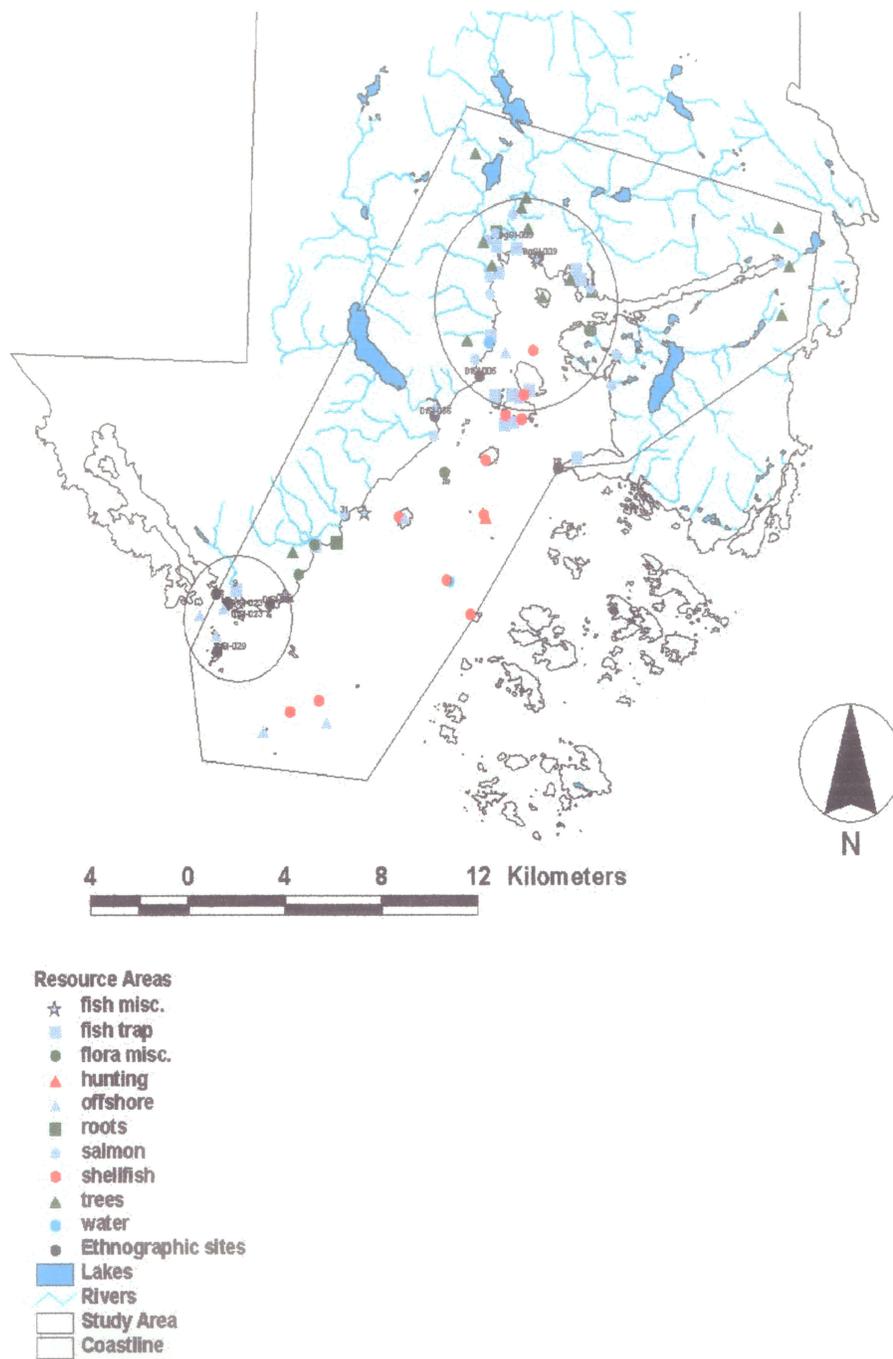


Figure 5.3.9: Map showing two clusters of ethnographic sites

where they represent endpoints of a line of sites past which the site interconnections open up and become multiple rather than single. This is particularly visible in the map of the ethnographic data set (Figure 5.3.2). Between DfSi 4 and DfSi 5, sites are arranged linearly, while beyond each of these sites the network of sites is no longer linear, with multiple sites located similar distances from these two sites and multiple possible travel paths existing between them. While other sites also find themselves more frequently the n -th nearest-neighbour of the set of all sites, DfSi 4 and DfSi 5 are the only two that almost symmetrically divide all the sites as ninth nearest-neighbour to one or the other. The possible significance of this in relation to the span of occupation and to the importance of these two sites will be discussed further in Chapter 6.

5.4 Spatial Association

Pielou's coefficient of segregation, S , was used to evaluate which combinations of resource extraction locations were either strongly segregated from or associated with the distribution of habitation sites in each of the three data sets. S test results range from +1 to -1, with negative values indicating lack of segregation exemplified by the ideal example of pairs of associated sites. Positive values indicate higher degrees of segregation, exemplified by the ideal example of two distributions spatially removed from one another. Recall that here, a coefficient of segregation of at least +/- 0.25 has been chosen as sufficient to indicate some degree of segregation/association.

Table 5.4.1: Pielou's coefficient of segregation (S) results meeting the strength of segregation/association criterion.

Data Set	NN(1)	NN(2)	NN(3)	NN(4)
arch vs. all fishing	-0.035912	0.01961	-0.271186	0.06832
arch vs. all flora	0.325	0.286	0.406	-0.021201
arch vs. salmon/trap/tree/shell	-0.041616	0.264	-0.132191	0.00538
arch vs. shell	0.188	0.426	0.10714	-0.471
arch vs. traps	0.01691	0.279	-0.100209	0.01691
arch vs. trees	0.429	0.417	0.14286	0.14286
	NN(1)	NN(2)	NN(3)	NN(4)
ethno vs. all fishing	-0.348	-0.203	-0.123328	0.10783
ethno vs. all flora	-0.064516	0.08696	0.18596	-0.304
ethno vs. all food	-0.285	-0.154499	-0.099905	-0.046642
ethno vs. salmon	-0.308	-0.076923	0.231	0.07692
ethno vs. salmon/tree/shell	-0.272	-0.219	0.01131	-0.030303
ethno vs. shell	0.497	0.417	0.09589	-0.068493
	NN(1)	NN(2)	NN(3)	NN(4)
local vs. all fishing	-0.184211	-0.226	-0.217	0.252
local vs. all flora	-0.235	-0.008299	0.03571	-0.315
local vs. salmon	-0.176	-0.284	-0.012658	-0.022727
local vs. shell	0.507	0.0137	0.0137	0.294
local vs. trap	-0.157895	0.12903	-0.212	0.256

Table 5.4.1 gives the results of Pielou's S that met the strength of segregation/association criterion. Archaeological sites are segregated from floral resource areas, particularly trees. At the second order nearest neighbour archaeological sites are segregated from shellfish and fish traps, as well as from the combination of salmon, fish traps, trees and shellfish resources. The strong ($S=-0.471$) association of archaeological sites from shellfish resources at the level of fourth order nearest neighbours may be a result of the archaeological occupation of the Stopper Islands. Sites on the Stopper Islands are located close to several shellfish collecting locations. This places shellfish and archaeological sites in such a way as to make them more likely to be a particular nearest neighbour, in this instance the fourth nearest neighbour. Overall, the archaeological pattern of S -values seems to indicate that proximity to resources was not a critical aspect of site location. This lack of proximity to resources in the archaeological dataset suggests that other environmental or social factors were more influential in conditioning site selection decisions.

Ethnographic sites are strongly segregated ($S=0.497$ and 0.417 at the first and second order NN) from shellfish resources. In contrast to the archaeological pattern of segregation for 1st-3rd NN, ethnographic sites are associated with floral resource areas at the fourth NN. Ethnographic sites are associated with fishing, particularly salmon, resources and food resources in general at the first NN despite the segregating influence of shellfish being included in with the food resources. This is almost the complete opposite to the archaeological pattern of segregation from food resources at the second NN. The association between sites and salmon fishing locations suggests a shift in economy preferring habitation sites located close to salmon resources in ethnographic

times. This increased emphasis on salmon is supported by faunal analysis of the three excavated sites in the TAP study area (I. Streeter 2002, pers. comm.). Overall, the association between sites and resources suggests that proximity to resources, particularly food resources, became very important in selecting site locations in ethnographic times (post-contact). The segregation of sites from shellfish resources may imply that locations near seasonally abundant resources such as salmon and herring were considered most important.

Local groups are associated suggestively, but not significantly ($S=-0.184$ to -0.217), with fishing resources at the first through third nearest-neighbour, and segregated at the fourth nearest-neighbour. There is a suggestive ($S=-0.235$) association with floral resources at the first nearest-neighbour, and a stronger association ($S=-0.315$) at the fourth nearest-neighbour. As with ethnographic sites, there is again strong segregation ($S=0.507$) from shellfish resources, which can be seen in the pattern of shellfish resources offshore distant from the coastal habitation sites. Finally, there is a slightly suggestive ($S=-0.157$) association with stone fish traps. If we consider all the suggestive segregations and associations, we see that the local group sites are located close to fishing locations, particularly salmon, but also fish traps, as well as floral resources. One situation which could give rise to this pattern is a series of independent groups making use of only local resources, and located themselves to be close to as many critical resources as possible (salmon, trees, fish traps, etc.).

Testing those combinations of habitation sites and resource extraction locations revealed as strongly associated or segregated by Pielou's S using Fisher's exact test

yields the following significant results (highlighted in green). The Fisher exact test in this case is measuring the difference in proportion between the number of sites that have other sites as their n-th nearest neighbour and the number of sites that have resource areas as their n-th nearest neighbour. Fisher's exact test results range from $P=0.000^+$ to 1, with 0 indicating perfect correlation between row and column values of the 2x2 table, and 1 indicating no significant correlation between table values. For this test, $\alpha=0.05$ was the significance criterion.

Table 5.4.2 Combined table of Pielou's S and Fisher exact test results

Data Set	NN(1)	NN(2)	NN(3)	NN(4)
arch vs. all fishing	-0.03591	0.019608	-0.27119	0.068323
arch vs. all flora	0.325	0.286	0.406	-0.0212
arch vs. salmon/trap/tree/shell	-0.04162	0.264	-0.13219	0.005376
arch vs. shell	0.188	0.426	0.107143	-0.471
arch vs. trap/tree/shell	0.1	0.231	-0.04762	0.021277
arch vs. traps	0.016913	0.279	-0.10021	0.016913
arch vs. trees	0.429	0.417	0.142857	0.142857
	NN(1)	NN(2)	NN(3)	NN(4)
ethno vs. all fishing	-0.348	-0.203	-0.12333	0.107826
ethno vs. all flora	-0.06452	0.086957	0.185958	-0.304
ethno vs. all food	-0.285	-0.1545	-0.0999	-0.04664
ethno vs. salmon	-0.308	-0.07692	0.231	0.076923
ethno vs. salmon/tree/shell	-0.272	-0.219	0.011309	-0.0303
ethno vs. salmon/trap/tree/shell	-0.241	-0.15489	-0.09071	-0.04664
ethno vs. shell	0.497	0.417	0.09589	-0.06849
	NN(1)	NN(2)	NN(3)	NN(4)
local vs. all fishing	-0.18421	-0.226	-0.217	0.252
local vs. all flora	-0.235	-0.0083	0.035714	-0.315
local vs. salmon	-0.176	-0.284	-0.01266	-0.02273
local vs. shell	0.507	0.013699	0.013699	0.294
local vs. trap	-0.15789	0.129032	-0.212	0.256

* Yellow shading highlights the values of Pielou's S meeting the +/-0.25 criterion. Blue shading highlights the values of Pielou's S that do not meet the +/-0.25 criterion, but do meet the $P=0.1$ significance level of Fisher's exact test. Green shading highlights values of Pielou's S meeting both criteria.

Table 5.4.2 indicates a difference in the degree and kind of correlations between the distributions of archaeological, ethnographic and local group sites and the resource areas

that are interleaved with them on the landscape. Not all of the segregations and associations detected by Pielou's S are matched by significant results from the Fisher test.

Among the ethnographic sites, first nearest neighbours tend to be resources, particularly fishing resources, and tend not to be shellfish harvesting areas. In contrast, archaeological sites are ambiguous in the segregation of their distribution with resources. Local group sites are even less clearly correlated with any site types, although, as in the ethnographic dataset, there is a significant level of segregation of habitation sites from the distribution of shellfish resources.

Only the archaeological data set presents significant results among higher-order nearest-neighbours (NN). Among second order nearest-neighbours, archaeological sites are significantly segregated from trees, shellfish beds and the combined set of salmon fishing, fish traps, trees and shellfish beds. Third order nearest-neighbours find archaeological sites associated with fishing locations as a whole, and segregated from known floral resources. Finally, archaeological sites are associated with shellfish beds at the level of the fourth nearest-neighbour.

Many inferences can be drawn from these results. First, the set of ethnographic sites seems to be much more closely associated with resources than are the other two sets of sites. Any given ethnographic site tends to be more closely associated with the set of all resource extraction areas than with other ethnographic sites, although shellfish beds are the one exception. The strongest Fisher's exact test values are found between ethnographic sites and all fishing resource areas ($P=0.011$, $S=-0.348$), and between ethnographic sites and all food-related resource areas ($P=0.015$, $S=-0.285$). This strong

association with food resources in the ethnographic dataset may indicate a selection of site locations to be as close as possible to critical resources.

All three sets of habitation sites tend not to be found near shellfish gathering beds offshore, at least at low orders of NN (1st-2nd). This may be an accident of geography because ethnographically-known shellfish harvesting locations are found mostly on small islands offshore. The lack of congruence between habitation sites and shellfish locations may also indicate that shellfish beds were simply not a prime consideration in site location at any time.

Trees tend to be less strongly associated with archaeological habitation sites than with habitation sites in the other two data sets. Examining a map, CMTs are located in clusters around the Toquart River and at the head of Pipestem Inlet. These locations for CMTs removes them from a close association with a large number of sites, particularly those on the Stopper and George Fraser Islands and on the outer coast. The reason for this segregation correlation may be that trees were unimportant in conditioning site selection. If a seasonal pattern of movement was in place, trees may have represented a seasonally-harvested resource, so they would be associated with sites occupied during a particular season. Or, if sedentary local groups were present and making use of nearby resources, trees could have been an item of trade, as they were elsewhere on the coast in the form of canoes (de Laguna 1990:208). This possibility of trading for trees might also remove the need to be located near a good stand of trees. Finally, initial European logging may have removed the CMTs nearest to the coastline, which would bias the present sample of CMTs in favour of ones further from habitation sites.

Fishing locations are associated with archaeological sites at the level of third-order nearest-neighbours ($P=0.045$, $S=-0.271$). This third-order association may indicate that fishing locations, while important as a source of food, were not required to be near at hand when selecting a place to live.

At the fourth-order nearest-neighbour level, archaeological sites are associated with shellfish gathering sites. This fourth-order association is in contrast to the segregation among second-order nearest neighbours discussed above. This association at a greater average distance may imply that travel to these sites was not considered difficult to accomplish; that is, being located near a shellfish bed was at most a very minor consideration for site location. This association may also be a result of the archaeological occupation of the Stopper Islands, placing some sites in closer proximity to shellfish beds than in the ethnographic or local group data sets.

5.5 Summary

Results from the tests outlined in Chapter 4 have been presented and briefly interpreted. The following chapter will examine these results in detail, and present an interpretation of their significance regarding Toquaht site patterning and changes to these patterns through time.

Catchment area analysis indicates the presence of three groups of habitation sites based on the composition of resources present in the catchment areas. These groups are most visible when examining 8km catchment radii. These three groups of habitation sites are present in each of the Archaeological, Ethnographic and Local Group data sets. This

implies a lack of change in settlement pattern over time, at least in terms of how settlement locations are selected to make use of resources.

Viewshed analysis indicates no significant difference in the mean viewed areas and angles of the three data sets of habitation sites. This implies that considerations of visibility were either not a major concern in any particular time period, or that these considerations did not change over time from pre- to post-contact.

Nearest-neighbour analysis indicates the presence of clusters of sites of varying size in each of the data sets. In each data set an initial trend towards clustering at lower orders of nearest neighbour reverses itself to regularity of spacing at the highest orders of nearest neighbour. The peaks in clustering occur at the third-, third- and second-order nearest neighbours for the Archaeological, Ethnographic and Local Group data sets. This corresponds to cluster sizes of four, four and three habitation sites respectively.

Measures of spatial association between habitation sites and resources present a complicated series of segregations and associations at different orders of nearest neighbour. Ethnographic sites tend to be closely associated with resource areas, particularly food resources, while archaeological sites and local group sites tend to be less closely associated with these same resource areas.

Chapter 6: Discussion and Interpretation

6.1 Friction Surface Catchment Areas

Three groups of sites can be differentiated based on the composition of their catchment areas. These groups are locationally-defined, corresponding to sites located on the outer, intermediate, and inner coastline of the study area. In contrast to these locational differences in catchment composition, the resource catchments of the archaeological, ethnographic and local group sets of habitation sites are not statistically different, nor are those of the sets of large, medium and small sites. The resource base in the Toquaht region, then, is a function of location, and not size of site or period of occupation. In other words, large, medium and small-sized sites are distributed equally and evenly over the coastline in all three of the data sets.

The implications of these findings are twofold. First, there is no difference in terms of catchment area composition between sites known to have been used archaeologically and sites known to have been used during ethnographic, i.e. post-contact, times. There is no preference for placing large archaeological sites on the outer coast nor small ethnographic sites on the inner coast. Consequently, on the basis of catchment area composition, there is no good evidence for major changes in settlement pattern at the precontact/postcontact transition, at least in the absence of finer-grained data on site contemporaneity. Second, since virtually all the resources available in the study area seem to be exploited in the time period represented by each data set, it seems reasonable to infer that the settlement pattern present was one that exploited all potential niches within Toquaht traditional lands.

It is therefore impossible to say from catchment data alone what changes in settlement pattern, if any, took place during the transition from pre- to post-contact times in Barkley Sound. It is similarly impossible to state with any certainty how long the seasonal movement pattern of settlement has been in use by the Toquaht.

6.2 Spatial Analytical Techniques

6.2.1 Viewsheds

The only two groups of viewshed data that differ significantly enough to warrant consideration are the viewed areas of the archaeological and ethnographic site groups, which differ at the $P < 0.1$ level. At the same time, the large standard deviations ($1\sigma = 54\%$ to 77% of the mean) signify that the average archaeological and ethnographic viewed areas are well within one standard deviation of each other. On the basis of these large standard deviations and the lack of substantial numbers of intervisible sites which could be compared between data sets, it is difficult to extend these findings into a strong conclusions regarding changes, or lack thereof, in viewed area between time periods. At most, it may be reasonable to suggest that the presence of sites on offshore islands in the archaeological data set that are not present in the ethnographic data set may be the cause of the difference in mean viewed area. At least some of these sites look across the Sound towards the Broken Group Islands, and these serve to increase the mean viewed area for the archaeological data set.

The lack of substantial site intervisibility in itself may provide insight into site selection by local groups living within the study area. Since in general sites do not look towards any of their neighbours, or since these lines of sight are typically blocked by

headlands and islands, it can be argued that some notion of privacy or concealment from observation may be conditioning site selection. This possible emphasis on site privacy is particularly interesting in light of the presence of lookout and defensive sites in the study area, which also are not generally able to see neighbouring habitation sites or be seen by them.

Based on these results, interpretations such as Maschner's (1996), in which earlier period sites were selected for shelter and later period sites were selected for maximum defensibility, cannot be made for the Toquaht region. The overall implication is that settlement pattern, at least in the manner in which it conditions and is conditioned by considerations of visibility, does not appear to have changed through time in the Toquaht region.

6.2.2 Nearest Neighbours

There is an overall trend running from clustering at lower-order nearest-neighbours towards regularity of spacing at successively higher-order nearest neighbours. This trend is represented to varying degrees in all three sets of habitation sites. Among the archaeological sites, three clusters are present, each of them containing four sites, while among the ethnographic sites two clusters are present, largely due to the abandonment of sites on the Stopper Islands. The local group data set contains the same two clusters as the ethnographic set but with fewer members.

This change in number of clusters from archaeological to ethnographic times implies a change in settlement pattern from pre- to post-contact times, characterized mainly by the lack of sites on the Stopper Islands. The exact reason for this abandonment

is not clear, especially since the shellfish beds of the Stopper Islands seem to continue to be used in ethnographic times by the residents of Macoah (G. Monks, pers. comm.). In an overall climate of sporadic warfare, and with the presence of the expanding Tseshaht to the east, it is possible that the habitation sites in the Stopper Islands became too susceptible to attack during the ethnographic period. They could be abandoned in favour of resource-gathering “day trips” from the mainland due to their close proximity to major habitation sites such as Macoah.

The sudden shift from clustering towards regularity at the highest order of nearest neighbour is caused by large numbers of sites having the same site(s) as their higher order nearest neighbours. These data are presented in Section 5.3, Table 5.3.1. Past these sites, the pattern of the inter-site network of distances “opens up”, changing from a simple line to a true network of interconnections. This pattern may provide some evidence for the historical importance of the village sites of Macoah (DfSi 5) and Ch’uumat’a (DfSi 4).

The true size of Macoah (DfSi 5) is obscured by the presence of modern houses and roads. It could measure in the vicinity of 30 000m² according to the map published by McMillan and St. Claire (1993:84 map). This would make it both the largest site, in spatial extent, within Toquaht territory, potentially the largest site in Barkley Sound, and would make it substantially larger than Yuquot in Nootka Sound (McMillan 1999:130). In ethnographic times Macoah was a very important site for the Toquaht that included a defensive palisade (Sapir & Swadesh 1978b:437). It also has been referred to by informants as “a sort of headquarters for all the creeks around” (St. Claire 1991:163).

Ch'uumat'a is a much smaller site (roughly 8400m²) but one with an occupation history spanning the past 4000 years. It is one of only two published sites (with Yuquot) and one of only three in the Nuu-chah-nulth area to have deposits of this age present (McMillan 1999:71; G. Monks pers. comm.). Macoah, in contrast, has an initial date of roughly 2000BP, and large-scale occupation seems to have come late in the pre-contact period, *circa* 600 BP (McMillan 1999:66, 74).

Each site is situated close to an endpoint of what is an otherwise relatively straight coastline (Fig. 5.3.2). The presence of sites at the endpoints of this straight section means that numerous direct site-to-site travel routes from these sites to points outside the straight coastline are possible. It is suggested that their unique location within the study area may be the reason for the importance of DfSi 4 and DfSi 5 both archaeologically and historically. Any travel along the coastline would have either to pass close by these two sites or take a large detour specifically for the purpose of avoiding them. The length of the detour required to bypass a site located at a bend in a stretch of coastline is substantially larger than the detour required to avoid a site along a linear coastline.

Inspection of the map of archaeological sites reveals that the third major site in the Toquaht region, T'ukw'aa (DfSj 23), is also located at a bend in the coast. In T'ukw'aa's case this location is the point where travel routes from Ucluelet Arm and further north on the outer coast will have to pass by prior to entering Barkley Sound. Here, the importance of the site to the Toquaht may lie in its strategic position to control access to Barkley Sound from the north, rather than its potential to control movements within the northwest region of the Sound.

It is perhaps impossible to infer whether these three sites were selected for their strategic value intentionally or whether this strategic value merely enhanced the site's usefulness, thus causing large villages to develop. Whether strategic value influenced site location or site location benefited from strategic location is, in effect, a "chicken and egg" question, one that analysis of site pattern cannot answer until there is better knowledge of chronology and a better knowledge of population movements in the past.

6.2.3 Spatial Association

Results from the tests of spatial association are more elaborate and complex than those from the other measures above, and so their interpretation is correspondingly more tentative.

Ethnographic sites tend to be located near resources, especially fishing resources, at the first nearest neighbour. However, they are segregated from shellfish harvesting areas. The inference is that ethnographic sites are located to place them in close proximity to resource areas, particularly food resources, and especially seasonally-available foods such as salmon and herring.

Archaeological sites seem have a more complex relationship with resource areas. They tend to be segregated from floral resources, implying that proximity to them was not considered important in choosing a habitation site. Perhaps the known location of floral resources made obtaining them a simpler and more reliable exercise than hunting or fishing. Travel time to floral resources then would be a lesser consideration, especially if large quantities of them could be quickly and reliably obtained.

The tendency towards spatial association observed between archaeological sites and fishing and shellfish harvesting locations at higher orders of NN imply that while some proximity to these resources was desirable, locating one's village directly next to a resource area was again not considered necessary. It can be inferred that salmon resources were slightly more important than shellfish by their higher order of correlation, that is, third instead of fourth.

The results from calculating Pielou's coefficient of segregation are very similar to those for Fisher's exact test. Here again the ethnographic sites show varying strengths of significant association, particularly with food resources. Conversely, there is a segregation from shellfish resources. The implication again is that ethnographic site decisions were strongly influenced by a desire to be located directly on, or very near, resource locations and to be located nearer those resource areas than to neighbouring habitation sites. Judging by strength of association, food in general, fishing in particular, and especially salmon resources, were the preferred resource areas to be living beside.

The archaeological sites are again more varied in their associations, with strong segregation from floral and tree resource areas, and segregation in second order nearest neighbours from trees, shellfish and fishing areas. Associations exist between archaeological sites and fishing locations at the third nearest neighbour, and between sites and shellfish locations at the fourth nearest neighbour, mirroring the Fisher's test results.

The differences between the archaeological and ethnographic data sets are interpreted as representing a shift in settlement to place sites in closer proximity to resource locations during post-contact times. In the archaeological data, there is a distinct tendency for habitation sites to be segregated from resources. The overall

implication for the archaeological settlement pattern is that proximity to resources was not an important consideration in selecting site locations. This type of pattern might be expected in a situation where habitation sites were used as base camps from which people traveled to a variety of local resource areas to extract the resources and return them to the habitation site. Site location would be conditioned either by non-resource factors such as shelter or defensibility, or the presence of a generalized availability of resources to a central place. Mobility of settlement is not likely because mobile settlements would be more efficient if located close to particular resources so as to reduce the travel time of the resource collectors.

The difference in degree and kind of association observed between the sets of archaeological and ethnographic habitation sites can be seen as a real increase in the proportion of habitation sites that have resource locations as their n -th nearest neighbour in ethnographic times. There is also a corresponding decrease in the proportion of habitation sites that have other habitation sites as their n -th nearest neighbour. Assuming as this study does that resource extraction locations have been stable over the time frame of the study, a homogenization of settlement spacing may be taking place. Sites in the ethnographic period are spread more evenly over the coastline than those of the archaeological period, thus reducing the proportion that have other habitation sites as a nearest neighbour.

This "homogenization" can be traced to the apparent abandonment of some sites around the Toquart River and the Stopper and George Fraser Islands during the transition from archaeological to ethnographic times. Ethnographic informants make mention of one village site at the mouth of the Toquart River, while archaeological survey has found

traces of three habitation sites of unknown ages. In the George Fraser Islands two archaeological middens were found and subsequently excavated, but only one is known to have been used ethnographically. Finally, the ethnographic sites include a fishing camp at the head of Pipestem Inlet, but no sites in the Stopper Islands.

The selection of the ethnographic set of sites for habitation indicates a shift from a settlement pattern governed by non-resource-based factors, to one where resource availability is of greater importance. One way in which resources could increase in importance in governing site selection is if the people using the resources are moving seasonally. Seasonal movement between sites in order to extract resources would make living directly at the resource extraction point a more attractive option, because this would minimize the extra effort required to extract the resource in question. Simply put, if one is going to move all one's possessions several times a year, it is more efficient to move to exactly where one needs to be each season, rather than move and then make numerous resource extraction trips. This shift is interpreted as a pattern of seasonal movement rather than localized sedentism. This claim is made on the basis of the main associations being between habitation sites and seasonally available fishing resources, rather than food resources available year-round, such as shellfish. Shellfish, in the ethnographic period, are segregated from habitation sites, placing them relatively more distant than in the archaeological period. This contrasts with Haggarty's findings for Hesquiat Harbour, where use of local resources in later archaeological times was interpreted as increased sedentism with social circumscription. Under Haggarty's model we would expect association between habitation sites and a number of food resources,

indicating that habitation sites were being selected to offer a range of resources, rather than a few seasonally-available ones.

The Toquart River and Stopper Island sites, lying in close proximity to one another, show up as increased clustering of sites with respect to one another in the archaeological data set. While the reasons for the abandonment of some of these sites are unclear, it is possible that population loss during the contact period made it unnecessary to occupy multiple sites on the Toquart River during the salmon runs, because the reduced Toquaht population may have been able to reside in one location.

6.3 Models of Toquaht Settlement Pattern

The most notable changes in Toquaht settlement pattern from archaeological to ethnographic times are the apparent abandonment of the habitation and defensive sites in the Stopper Islands, the increased emphasis on living in close proximity to food resources, and the associated change from three clusters of sites to two clusters of sites. In the case of the Stopper Islands, this does not mean that the islands were unused, as ethnographic informants note the continued presence of food resources, particularly shellfish resources, on and around the islands. During the period covered by informants' information, it may be that these islands were the location of very minor harvesting camps resulting from overnight trips to the islands to bring back shellfish and perhaps make use of fish traps.

The tests applied to the sets of habitation sites and resource locations are split in their results with respect to the models outlined in Section 4.3. The lack of change in resource coverage and viewsheds between the three sets of habitation sites is evidence in

favour of Dewhirst's model of cultural continuity from archaeological through to ethnographic times. At the same time, different sites are occupied in each of the three data sets, and their degree of association both with each other and with resource extraction locations does change. In particular, the closer association of habitation sites to food resources may be taken as evidence for the emergence of a seasonal pattern of movement, in the interests of minimizing energy expenditure in gathering seasonally abundant resources for storage. This would favour Inglis and Haggarty's model of social upheaval brought on by European contact.

The Local Group set of habitation sites does not seem to have much predictive strength. It was intended to approximate a late precontact settlement pattern, and perhaps give insight into what a sedentary pattern of large villages would look like in the study area. The Local Group pattern appears at times to resemble the archaeological pattern, at others the ethnographic. The reason for this ambiguity may be traced to this data set's origin in the place-name studies conducted by St. Claire. With informants increasingly far removed from memories of pre-contact times, the ambiguity observed here may reveal the limitations of ethnographic narratives when extended into the past.

Alternatively, if the Local Group data set does accurately reflect a transitional period between the deep archaeological past and the ethnographic present, it might reasonably show some characteristics of each period.

Because of this ambiguity, it is difficult to assess the validity of Haggarty's Hesquiatic Harbour model for the Toquaht region. The Local Group set of habitation sites does not provide sufficient evidence to say for certain whether there exists a late precontact change in settlement in favour of small sedentary habitation sites making use

of exclusively local resources. Similarly, it is difficult to assess whether Marshall's pattern of small, local, sedentary sites for some of the territories of the Ucluelet and Tseshaht is a good characterization of the situation in the adjoining Toquaht region.

The shift to the ethnographic pattern of two site clusters, one on the outer coast and the other around the Toquaht River, as well as the closer association and correlation between sites and resource areas, could be a result of amalgamation of the various local groups into the Toquaht, and the attendant development or adoption of the "traditional" seasonal round of movement between habitation sites to take advantage of all the resources enjoyed by the formerly-independent local groups. This is the pattern of economic change that is claimed to have followed early nineteenth-century amalgamations in other regions of Barkley Sound, and there is reason to suspect that a similar system could have developed a century earlier, prior to European contact.

The following changes in settlement pattern and social landscape are thought to have occurred between archaeological to ethnographic times:

Table 6.3: Toquaht archaeological and ethnographic settlement patterns.

Archaeological (pre-contact, pre-amalgamation)	Ethnographic (post-contact, post-amalgamation)
Three regions (inside, outside, intermediate)	Two regions (inside, outside)
High population density	Lowered population density (depopulated from conflict, disease)
Sedentary local groups	Seasonally mobile group
Year-long use of local resources	Movement to exploit seasonal resources
Lack of strong direct association of sites with resources	Close association of habitation sites with resources (esp. fishing)
Independent local group organization?	Single amalgamated polity organization

Chapter 7: Conclusions

The principal questions which were to be addressed by this thesis are:

1. To what extent does spatial analysis provide a useful description of Nuu-chah-nulth spatial behaviour?
2. Do Nuu-chah-nulth settlement patterns change over time?
3. If there is change in settlement pattern, what shifts occurred and what is the antiquity of each pattern?

7.1 Conclusions

The difficulty in interpreting settlement pattern changes in Toquaht territory lies in accurately placing the various events separating the full archaeological and full ethnographic settlement patterns. There is good evidence for a shift from one to the other, but the specific order of local group amalgamations, increased mobility, European contact, depopulation from warfare, depopulation from disease, and shifts in site usage cannot be determined on the basis of examining the two settlement patterns. Because of these limitations, spatial analysis alone cannot provide a complete picture of Toquaht spatial behaviour. This does not, however, doom the techniques of spatial analysis to uselessness, because they do provide new information that can be used in conjunction with other lines of inquiry to evaluate changes in land and resource uses through time.

Settlement patterns on the West Coast seem to have undergone changes through time, and these changes were not evenly distributed and common to the entire region. Local situations either caused or permitted both the formation and breakup of larger political structures, and the disruptions brought on by European contact merely intensified these changes rather than necessarily causing them to begin. In the case of the Toquaht it would seem that the ethnographically-derived claims to an amalgamation predating European contact are likely correct. This is based on the presence of evidence

supporting both stability in settlement pattern and also the presence of certain changes to that pattern, between pre- and postcontact (archaeological and ethnographic) times.

The Toquaht situation falls somewhere between that of the Nootka Sound groups and that of the Tseshah or Ucluelet of Barkley Sound. Where the Nootka Sound groups seem to have formed a large, multigenerationally-stable polity as many as several hundred years prior to European contact, the ancestors of the present-day Tseshah and Ucluelet bands were still living in small, stable local groups at the time of European contact. The Toquaht, in contrast to these other groups, seem to have amalgamated some time before European contact, or to have been in the final stages of doing so. This early but not earliest amalgamation may have permitted the Toquaht to dominate their neighbours in Ucluelet Arm until the vagaries of disease and war ultimately reduced their numbers to such a point that they became one among the many newly-amalgamated groups living in Barkley Sound and Alberni Inlet.

It appears that the late pre-contact amalgamation of local groups to become the Toquaht caused a subtle shift in settlement pattern and that this pattern persisted into the post-contact period. This shift in settlement pattern was linked to the need to exploit seasonal resources within the Toquaht region, at first perhaps to feed the large amalgamated population, and later perhaps to maintain claims to those seasonal resources despite a decline in population due to conflict and disease. The precise timing of the amalgamation event is difficult to assess in the absence of more detailed and extensive chronological information about span of occupation of individual sites, but may have taken place in the mid- to late-eighteenth century.

The shift in settlement pattern represents a shift in group practice. It also implies a potential change in group *habitus* which was intensified by contact with Europeans. The short length of the ethnographic period, and especially the short length of the maritime fur trade, means that while more malleable aspects such as group practice may have changed, the underlying *habitus* may show less, or even no change in that span of time. The ethnographic period, including the period of intense intergroup conflict in Barkley Sound, would then represent attempts to reconcile a new situation (new wealth, depopulation, heightened conflict) within a group *habitus* which was increasingly ill-adapted to the situation at hand. The ultimate result, which is beyond the scope of this study, would be a renegotiation of group *habitus* to fully accommodate these stresses.

7.2 Suggestions for Improvements

The first, and most obvious, problem with the data set is its limited chronological control. Since only three sites have radiocarbon dates associated with them, the vast majority of habitation sites in the study area are only of indeterminate age. In some instances, relative age of sites was possible to infer by the presence and amount of overburden and erosion. However, this determination was tentative at best and was confined to the sites at the mouth of the Toquart River. These sites may have been occupied sequentially. In any case, with no means of relating this relative chronology back to the radiocarbon-dated sites, there was no means of establishing contemporaneity. As a result, this study was forced to make use of a monolithic pre-contact “archaeological” data set. An attempt to get at pre-amalgamation settlement pattern was made on the basis of ethnographic informants’ claims about the locations of local groups’

principal residences; however, the chronological depth and applicability to the remote past of this settlement pattern is open to debate.

A second improvement that could be made over the present study would be to more carefully select a data set with which to work. The Toquaht data's main strength lies in its level of completeness, which is almost unheard-of in Northwest Coast archaeology. At the same time, the data is spatially limited to one section of Barkley Sound, which prevents direct comparisons with neighbouring groups such as the Ucluelet and Tseshaht. A substantial improvement in the quality of the results obtained would come from considering events in the wider political climate of Barkley Sound and Alberni Inlet.

The methodology of this study is basically sound. It was not possible to predict in advance what analytic techniques would bear fruit, and so a wide range of analyses were attempted. In terms of data types, a database of possible site locations could have been developed, making use of information about the presence and composition of shorelines. A model of areas suitable for village construction could have been compared to the known distributions of sites to evaluate what proportion of available habitable area was used in different time periods.

Finally, a more thorough and lengthy study would have to consider not only settlement pattern, but other archaeologically-known sources of information. These would include seasonality of site use based on faunal evidence, evidence for changing political affiliation, the negotiation of group roles through the use of material culture, and the potential effect of population movements through the region. This is especially true if the Toquaht are revealed to be ancestral to all the other Barkley Sound groups.

7.3 Recommendations for Further Research

Archaeological studies of the Nuu-chah-nulth have in the past focused on teasing out the regional patterns present in a single sound along the coast of Vancouver Island and suggesting their application to the entire Nuu-chah-nulth area. On the basis of both this study and past work, it would seem that future studies should aim to determine patterns of settlement at a multitude of scales, from overall trends covering the entire Nuu-chah-nulth area over large expanses of time, to minor regional occurrences that may be spatially and temporally limited. In this, it is the fine-grained analysis which is key, because the major pattern of Nuu-chah-nulth settlement and the changes brought about by European contact are coming to be better known. What remains is to evaluate how the population of each Sound responded differently or similarly through time, both pre- and postcontact, to the problems of making a living, finding shelter, and dealing with neighbours. In light of this recommendation, studies attempting to replicate and verify the results obtained by Marshall and Mackie would be of interest. In Marshall's case this could take the form of an extension of her analysis of site structure to cover larger areas of the coast, to examine whether her three generalized settlement patterns have wider applicability than to the areas studied. In Mackie's case, this could involve examining in more detail whether his Location/Allocation nodes have a corresponding importance within the archaeological record, beyond the considerations of site size which Mackie employed as a proxy for site importance.

It is perhaps taking the easy way out for an archaeological study to recommend further excavation and survey work as the solution for the unanswered questions it poses.

However, archaeological research in Nuu-chah-nulth territory has until comparatively recently been neglected. The particular nature of the region, with each Sound following its own trajectory of polity growth and decline, and its own responses to the pressures of accommodating European presence, requires the attention of a research project covering the region as a whole.

The timing of the amalgamation movement that brought about the existence of the present-day Toquaht presents an interesting opportunity to archaeologists. It is not clear exactly what prompted Nuu-chah-nulth local groups to amalgamate and form larger polities in the archaeological past, although the forces and pressures that brought about amalgamation during ethnographic times are relatively well-documented. The Toquaht therefore represent the possibility of bridging that gap in explanation. If further excavation with a goal to elucidate finer-grained sequences of site occupation in Toquaht territory succeed in teasing out successive sequences of occupation documenting the process of amalgamation in detail, it may be possible to shed more light on the pressures that led to the formation of other large-scale polities among the precontact Nuu-chah-nulth.

Bibliography

- Aldenderfer, Mark
1996 Introduction. in *Anthropology, Space and Geographic Information Systems*, M.Aldenderfer & H.Maschner (eds.), pp.3-18. New York: Oxford University Press.
- Ames, Kenneth M.
1981 The Evolution of Social Ranking on the Northwest Coast of North America. *American Antiquity* 46(4):789-805.
- Ames, Kenneth M. and Maschner, Herbert. D. G.
1999 *Peoples of the Northwest Coast: Their Archaeology and Prehistory*. Thames and Hudson, New York.
- Arcas Consulting Archaeologists Ltd.
1991 Archaeological Investigations at Little Beach Site, Ucluelet, B.C. Report on file, Archaeology Branch, Victoria B.C.
- Arima, Eugene Y.
1983 *The West Coast (Nootka) People*. Victoria: BC Provincial Museum.
- Arima, Eugene Y. and John Dewhirst
1990 Nootkans of Vancouver Island. in *Handbook of North American Indians. Vol. 7, Northwest Coast*. W.Suttles (ed.), pp.391-411. Washington, D.C.: Smithsonian Institution.
- Bender, Barbara
1978 Gatherer-hunter to farmer: a social perspective. *World Archaeology* 10:204-222.
- Binford, L. R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.
- Boots, Barry N. and Arthur Getis
1988 *Point Pattern Analysis*. Scientific Geography Series Vol. 8. Beverly Hills: Sage Publications.
- Bourdieu, Pierre
1977 *Outline of a Theory of Practice*. New York: Cambridge University Press.
- Boyd, Robert T.
1990 Demographic History, 1774-1874. In *Handbook of North American Indians. Vol. 7, Northwest Coast*, W.Suttles (ed.), pp.135-148. Washington, DC: Smithsonian Institution.
- Burrough, Peter A. and Rachael A. McDonnell
1998 *Principles of Geographic Information Systems*. Oxford: Oxford University Press.
- Buxton, Judith M.
1969 Earthworks of Southwestern British Columbia. Unpublished MA thesis. Calgary: University of Calgary Department of Archaeology.
- Carmichael, David L.
1990 GIS predictive modelling of prehistoric site distributions in central Montana. in *Interpreting Space: GIS and Archaeology*, K.Allen, S.Green & E.Zubrow (eds.), pp.216-225. New York: Taylor & Francis.

- Calvert, Sheila Gay
1980 *A Cultural Analysis of Faunal Remains from Three Archaeological Sites in Hesquiat Harbour, BC*. Unpublished PhD dissertation. Vancouver: University of British Columbia Department of Anthropology and Sociology.
- Calvert, Sheila Gay and Susan Crockford
1982 Analysis of Faunal Remains from the Shoemaker Bay Site (DhSe 2). Appendix IV in *Alberni Prehistory: Archaeological and Ethnographic Investigation on Western Vancouver Island*, A. McMillan & D. St. Claire (eds.), pp. 174-219. Penticton: Theytus Books.
- Canada
1992 "An Act to establish a federal environmental assessment process", in *Statutes of Canada*, chapter 37, p.937-990.
- Chou, Yue-Hong
1997 *Exploring Spatial Analysis in Geographic Information Systems*. Santa Fe: Onword Press.
- Clark, P.J. and F.C. Evans
1954 Distance to nearest neighbour as a measure of spatial relationships in populations. *Ecology* 35:445-453.
- Clarke, David (ed.)
1977 *Spatial Archaeology*. New York: Academic Press.
- Croes, Dale R.
1989 Prehistoric Ethnicity on the Northwest Coast of North America : An Evaluation of Style in Basketry and Lithics. *Journal of Anthropological Archaeology* 8:101-130.
- Dalla Bona, Luke
1993 A Predictive Model of Prehistoric Activity Location for the Souris River, Saskatchewan, Unpublished MA thesis. Winnipeg: University of Manitoba Department of Anthropology.
- Dewhurst, John
1980 *The Indigenous Archaeology of Yuquot, a Nootkan Outside Village*. National History Parks and Sites Branch. Ottawa: Parks Canada.
- Diggle, Peter J.
1983 *Statistical Analysis of Spatial Point Patternss*. Toronto: Academic Press.
- Donald, L.
1985 On the Possibility of Social Class in Societies Based on Extractive Subsistence. In *Status, structure and stratification: current archaeological reconstructions*, Thompson, M., et al. (eds.), pp. 237-243. Archaeological Association of the University of Calgary, Calgary.
- 1997 *Aboriginal Slavery on the Northwest Coast of North America*. University of California Press, Berkeley.
- Drucker, Philip
1951 *The Northern and Central Nootkan Tribes*. Bureau of American Ethnology Bulletin no.144. Washington, DC: Smithsonian Institution.

- Gaffney, Vincent, Zoran Stancic, and Helen Watson
 1996 Moving from Catchments to Cognition: Tentative Steps Towards a Larger Archaeological Context for GIS. in *Anthropology, Space and Geographic Information Systems*, M.Aldenderfer & H.Maschner (eds.), pp. 132-154. New York: Oxford University Press.
- Gibson, James R.
 1992 *Otter Skins, Boston Ships and China Goods :The Maritime Fur Trade of the Northwest Coast, 1785-1841*. Montreal: McGill-Queen's University Press.
- Haggarty, James C.
 1982 The Archaeology of Hesquiatic Harbour: The Archaeological Utility of an Ethnographically Defined Social Unit. Unpublished PhD dissertation, Department of Anthropology, Washington State University.
- Higgs, E.S. and C. Vita-Finzi
 1972 Prehistoric economies: a territorial approach. in *Papers in economic prehistory*, E.Higgs (ed.), pp.27-36. Cambridge: Cambridge University Press.
- Hodder, Ian and Clive Orton
 1976 *Spatial Analysis in Archaeology*. Cambridge: Cambridge University Press.
- Inglis, Richard I. and James C. Haggarty
 1986 *Pacific Rim National Park: ethnographic history*. Unpublished report, Ottawa: Parks Canada.
 2000 Cook to Jewitt: Three Decades of Change in Nootka Sound. in *Nuu-chah-nulth Voices, Histories, Objects & Journeys*. A.Hoover (ed.), pp.92-106. Victoria: Royal British Columbia Museum.
- Ingold, T.
 1988 Notes on the foraging mode of production. in *Hunters and Gatherers: History, Evolution and Social Change*, T.Ingold, D.Riches & J.Woodburn (eds.), pp.269-285. Oxford: Berg.
- Jewitt, John R.
 1974 *The Adventures and Sufferings of John R. Jewitt, Captive Among the Nootka, 1803-1805*. Derik G. Smith (ed.). Toronto: McLellan & Stewart.
- Johnson, Gregory A.
 1982 Organizational Structure and Scalar Stress. in *Theory and Explanation in Archaeology*. C.Renfrew, M.Rowlands & B.Seagraves (eds.), pp.289-421. New York: Academic Press
- Kvamme, Kenneth
 1985 Determining Empirical Relationships between the Natural Environment and Prehistoric Site Locations: A Hunter-Gatherer Example. in *For Concordance in Archaeological Analysis*, C.Carr (ed.), pp.208-238. Kansas City: Westport Publishers.
 1988 Using Existing Archaeological Survey Data for Model Building. In *Quantifying the Present and Predicting the Past*, Limp, F. & C. Carr (eds.), pp. 301-323. Washington, D.C.: U.S. Gov't Printing Office.
 1999 Recent Directions and Developments in Geographical Information Systems. *Journal of Archaeological Research* 7(2):153-201.

- de Laguna, Frederica
1990 Tlingit. In *Handbook of North American Indians*, Vol.7, *Northwest Coast*, W.Suttles (ed.), pp.203-228. Washington, DC: Smithsonian Institution.
- Leacock, Eleanor
1982 Relations of production in band society. in *Politics and History in Band Societies*, E.Leacock & R.Lee (eds.), pp.159-170. Cambridge: Cambridge University Press.
- Lock, Gary R. and Trevor M.Harris
1996 Danebury Revisited: An English Iron Age Hillfort in a Digital Landscape, in *Anthropology, Space and Geographic Information Systems*, M.Aldenderfer & H.Maschner (eds.), pp. 214-240. New York: Oxford University Press.
- Lourandos, Harry
1997 *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory*. Cambridge: Cambridge University Press.
- Mackie, Quentin
1998 The Archaeology of Fjordland Archipelagos. Unpublished PhD dissertation, Department of Archaeology, University of Southampton.
- Marshall, Yvonne
1993 A Political History of the Nuu-chah-nulth People: A Case Study of the Mowachaht and Muchalaht Tribes. Unpublished PhD dissertation, Department of Anthropology, Simon Fraser University.
- Maschner, Herbert D.G.
1996 The Politics of Settlement Choice on the Northwest Coast: Cognition, GIS and Coastal Landscapes. in *Anthropology, Space and Geographic Information Systems*, M.Aldenderfer & H.Maschner (eds.), pp. 175-189. New York: Oxford University Press.
- Matson, Richard G. and Gary Coupland
1995 *The Prehistory of the Northwest Coast*. San Diego: Academic Press.
- McMillan, Alan D.
1999 *Since the Time of the Transformers: The Ancient Heritage of the Nuu-chah-nulth, Ditidaht, and Makah*. Vancouver: UBC Press.
- McMillan, Alan D. and Denis St. Claire
1982 *Alberni Prehistory: Archaeological and Ethnographic Investigations on Western Vancouver Island*. Penticton, BC: Theytus Books.
- 1993 *The Toquaht Archaeological Project: Report on the 1991 and 1992 field seasons*. Unpublished report submitted to the Toquaht Band, Ucluelet, and the Archaeology Branch, Victoria.
- Mitchell, Donald H.
1990 Prehistory of the Coasts of Southern British Columbia and Northern Washington. In *Handbook of North American Indians*. Vol. 7, *Northwest Coast*, W. Suttles (ed.), pp. 340-358. Washington, DC: Smithsonian Institution.
- Monks, Gregory
1993 Preliminary Faunal Report. in *The Toquaht Archaeological Project: 1991 and 1992 Reports*. by A.McMillan & D.St. Claire, pp.154-169. Unpublished report submitted to the Toquaht Band, Ucluelet, and the Archaeology Branch, Victoria.
- 2001 Personal communication.

- Monks, Gregory, McMillan, Allan and Denis St. Claire
2001 Nuu-chah-nulth Whaling: Archaeological Insights into Antiquity, Species Preference and Cultural Importance. *Arctic Anthropology* 38(1):60-81.
- Moore, David S. and George P. McCabe
1993 *Introduction to the Practice of Statistics*, 2nd ed. New York: W.H. Freeman.
- Moss, Madonna L. and Jon M. Erlandson
1992 Forts, Refuge Rocks, and Defensive Sites: the Antiquity of Warfare Along the North Pacific Coast of North America. *Arctic Anthropology* 29(2):73-90.
- Mozifio, Jose Mariano
1970 *Noticias de Nutka : An Account of Nootka Sound in 1792*. Seattle : University of Washington Press.
- Parker, Sandra
1985 Predictive Modeling of Site Settlement Systems Using Multivariate Logistics, in *For Concordance in Archaeological Analysis*, C. Carr (ed.), pp.173-207. Kansas City: Westport Publishers.
- Parslow, Carla
1999 *Identifying past hunter-gatherer settlement patterns in the southern Yukon: a geographical information systems approach*. Unpublished MA thesis. Winnipeg: University of Manitoba Department of Anthropology.
- Pethick, Derek
1980 *The Nootka Connection: Europe & the Northwest Coast, 1790-1795*. Vancouver: Douglas & McIntyre.
- Pielou, E.C.
1969 *An Introduction to Mathematical Ecology*. Toronto: John Wiley & Sons.
- Pinder, D.A. and M.E. Wethrick
1975 A Modification of Nearest-neighbour Analysis for Use in Linear Situations. *Geography* 60(266):16-23.
- Platt, Colin
1996 *The Castle in Medieval England and Wales*. New York: Barnes & Noble.
- Price, T. Douglas and James A. Brown
1985 Aspects of Hunter-Gatherer Complexity, in *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity*, T.D.Price & J.A.Brown (eds.), pp.3-20. Toronto: Academic Press.
- Robinson, Guy M.
1998 *Methods & Techniques in Human Geography*. Toronto: John Wiley & Sons.
- Ruggles, Amy J. and Richard L. Church
1996 An Analysis of Late-Horizon Settlement Patterns in the Teotihuacan-Temascalapa Basins: A Location-Allocation and GIS-Based Approach. in *Anthropology, Space and Geographic Information Systems*, M.Aldenderfer & H.Maschner (eds.), pp. 155-174. New York: Oxford University Press
- Sapir Edward and Morris Swadesh
1978a *Nootka Texts*. New York: AMS Press.

- 1978b *Native Accounts of Nootka Ethnography*. New York: AMS Press.
- St. Claire, Denis
1991 *Barkley Sound Tribal Territories*. in *Between Ports Alberni and Renfrew: Notes on West Coast Peoples*, E.Y. Arima et al. (eds.), pp.13-202. Canadian Ethnology Service Mercury Series Paper 121. Ottawa: Canadian Museum of Civilization.
- Service, Elman R.
1962 *Primitive Social Organization*. New York: Random House.
- Shaeskin, David J.
1997 *Handbook of Parametric and Nonparametric Statistical Procedures*. Boca Raton: CRC Press.
- Sproat, Gilbert Malcolm
1987 *The Nootka: Scenes and Studies of Savage Life*, edited and annotated by C.Lillard. Victoria: Sono Nis Press.
- Stark, Barbara L. and Dennis L. Young
1981 *Linear Nearest Neighbor Analysis*. *American Antiquity* 46(2):284-300.
- Streeter, Ian
2002 *Seasonal Implications of Rockfish Exploitation in the Toquaht Area, B.C.*, Unpublished MA thesis. Winnipeg: University of Manitoba Department of Anthropology.
2002 Personal communication.
- Testart, A.
1982 *The significance of food storage among hunter-gatherers: residence patterns, population densities and social inequalities*. *Current Anthropology* 23:523-537.
- Trigger, Bruce J.
1989 *A History of Archaeological Thought*. Cambridge: Cambridge University Press.
- Turner, Nancy J.
1995 *Food Plants of Coastal First Peoples*. Vancouver: UBC Press.
- Turner, Nancy J. and Barbara S. Efrat
1982 *Ethnobotany of the Hesquiat Indians of Vancouver Island*. Cultural Recovery Paper No. 2. Victoria: British Columbia Provincial Museum.
- Vita-Finzi, C. and E. S. Higgs
1970 *Prehistoric economy in the Mount Carmel area of Palestine: site catchment analysis*. *Proceedings of the Prehistoric Society* 36:1-37.
- Warren, Robert E.
1990 *Predictive modelling in archaeology: a primer*. in *Interpreting Space: GIS and Archaeology*, K.Allen, S.Green & E.Zubrow (eds.), pp.90-111. New York: Taylor & Francis.
- Warren, Robert E. and David L. Asch
2000 *A Predictive Model of Archaeological Site Location in the Eastern Prairie Peninsula*. in *Practical Applications of GIS for Archaeologists: A Predictive Modeling Kit*, K. Westcott & R.J.Brandon (eds.), pp. 5-32. London: Taylor & Francis.

- Westcott, Konnie L. and James A. Kuper
2000 Using a GIS to Model Prehistoric Site Distributions in the Upper Chesapeake Bay. in
Practical Applications of GIS for Archaeologists: A Predictive Modeling Kit, K. Westcott
& R.J.Brandon (eds.), pp. 59-72. London: Taylor & Francis.
- Willey, Gordon R.
1953 *Prehistoric Settlement Patterns in the Virú Valley, Perú*. Bureau of American Ethnology
Bulletin no. 155. Washington D.C.: Smithsonian Institution.
- Woodburn, J.
1982 Egalitarian Societies. *Man* 17:431-451.