An Analysis of the Unifacial Tool Assemblage from the Richardson Island Site, Haida Gwaii, British Columbia

by

Jennifer Storey
B.A., University of Victoria, 2001

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTERS OF ARTS

in the Department of Anthropology

Supervisory Committee

An Analysis of the Unifacial Tool Assemblage from the Richardson Island Site, Haida Gwaii, British Columbia

by

Jennifer Storey
B.A., University of Victoria, 2001

Supervisory Committee

Dr. Quentin Mackie, Department of Anthropology
Supervisor

Dr. April Nowell, Department of Anthropology
Departmental Member

Dr. Mark Ebert, Department of Archaeology and Anthropology
Outside Member

Abstract

Supervisory Committee

Dr. Quentin Mackie, Department of Anthropology
Supervisor
Dr. April Nowell, Department of Anthropology
Departmental Member
Dr. Mark Ebert, Department of Archaeology and Anthropology
Outside Member

Abstract

One of the primary research interests at many late Pleistocene/early Holocene sites has been the transition from bifacial technology to a focus on microblade technology. Relationships between sites in Asia, Alaska, British Columbia, Haida Gwaii and elsewhere are frequently discussed with reference to the presence or absence of these technologies. As the focus has largely been on bifaces and microblades, other technologies have received considerably less attention. However, many of these more expedient technologies comprise the majority of assemblages found at any given site and reflect a substantial portion of technological practice and behavior. At the Richardson Island site, in southeastern Haida Gwaii, the stone tool assemblage is largely composed of unifacially manufactured tools that remain somewhat prevalent throughout the record of site activity. In this thesis, I begin my analysis with an exploration of the amount of standardization present in the unifacial tool types using cluster analysis. Following cluster analysis, the artifacts are discussed within the context of a behavioral model, taking the tools through a life history approach from raw material procurement to discard. Finally, this thesis focuses on technological change and continuity, tracing unifacial technologies through the detailed record of site activity at Richardson Island.

Table of Contents

List of Tables

List of Figures

Acknowledgements

This thesis project would not have been possible without the encouragement and support of many people.

First of all, I would like to thank Dr Quentin Mackie, my supervisor, for continually providing guidance, support and encouragement along the way. I really appreciate all of the many hours you dedicated to meeting with me and for the opportunity to work in Haida Gwaii. I would also like to thank committee members Dr. April Nowell and Dr. Mark Ebert for providing comments and edits of my thesis draft and for taking the time to be part of my graduate committee.

The use of the Richardson Island stone tool assemblage would not have been possible without the hard work of many people. First and foremost, I would like to thank the Haida First Nation for allowing me to work in their traditional territory and to use the Richardson Island collection for my research. Thanks to Daryl Fedje, from Parks Canada, for the use of the Richardson material and for providing many of the maps, figures and data that helped my project immensely. I would also like to acknowledge the Richardson Island field crews of 2001 and 2002 for all of the extensive work that occurred at the site. Specifically, I would like to thank Nicole Smith and Martina Steffen for the valuable contributions you both made. The information gathered from both of your projects aided in the analysis and interpretation of my data.

In 2007, a small excavation project was conducted at the Richardson Island site through the University of Victoria, Parks Canada and the Haida First Nation. I would like to thank those that dedicated their time to this project including Brendan Gray, Charlotte Mackie and Adrian Sanders.

I was also quite lucky to have a wonderful group of people enter the graduate program with me. I would not have made it through without the friendship and laughter I shared with many of you. A special thanks to Darcy Mathews for taking the time to teach me the Access program and Clustan Graphics. I would also like to send a special thanks to Brendan “Binky” Gray for the many hours of talk and laughter both in and out of the field.

I want to thank my parents, without whom, I would have never arrived at this point. I will probably never be able to express my gratitude for everything you have done for me. Thanks you for all of your support and love. To my grandmother, Lois Storey, for your continued support and encouragement.

To Bejay, for knowing me so well and being there for me when I needed you.

Dedication

This thesis is dedicated to the memory of my grandfather, Elmer James Storey.

1 Introduction

Current research conducted in Haida Gwaii[1] on the outer coast of British Columbia has resulted in a dynamic picture of early human occupation within the archipelago. In turn, this information has added to the story of maritime adaptations and migrations of peoples through the evidence they left of their presence on the coasts of British Columbia, Alaska and Asia during the Late Pleistocene and Early Holocene. Although only representative of a small portion of the lives of early peoples as they moved through landscapes, the archaeological evidence left behind reflects people who were fully capable of using what was available to them. During a time of dynamic environmental changes i.e., the inundation of some areas and exposure of others as a result of sea level changes as well as shifts in ecological zones, early peoples may have been faced with changes in their resource base.

At the Richardson Island site, on the southeastern portion of Haida Gwaii (Figure 1), early peoples returned repeatedly over the span of several thousand years, leaving behind a substantial record of their activities. These activities span from 9300 BP until 3000 BP although the most intensive use of the site occurs between 9300 BP and 8000 BP. It is during the earliest phase of occupation when there is some evidence for shifts in technological behavior at the site; changes that may relate to the rapid rise of sea levels documented for the area. The presence of a fairly continuous record of use coupled with the story of sea level change makes the Richardson Island site an ideal location to gain a better understanding of the early peoples who lived in the shifting maritime landscape. Unlike many early archaeological sites that may only include a single cultural component, the Richardson site contains multiple cultural layers, each one containing a different composition of artifacts and features. Through this very detailed record, the behavior of the early peoples can be traced through a long period of time, revealing the variability in human actions, cultural continuity in practices and the ability to make use of the available local resources. Previous research on raw material use (Smith 2004), hearth

[1] Also known as the Queen Charlotte Islands.

features (Steffen 2006) and the transition from bifacial to microblade technology (Fedje et al. 2005; Fedje et al. 2008) has made use of the high resolution stratigraphy at the site in order trace human activities on a short-term time scale. These studies provide an ideal context within which to study other aspects of site behavior.

Although both the bifacial (n= 223) and microblade (n= 397) technologies recovered from the Richardson Island site have received the most attention, a large portion (approximately 56 %[2]) of the material remains left behind by people using the site consist of unifacially manufactured stone tools (n=1097). These are quite often the types of artifacts that, although common in archaeological assemblages, are relatively understudied. While both biface and microblade manufacture are a key focus for discussions of early human occupation in sites in Alaska and British Columbia, a better understanding of these technologies may be gained through more detailed analyses of the other tool types present as well as any associated debitage. At the Richardson Island site, the consistent occurrence of these unifacially manufactured artifacts suggests that these were the tools people relied on for everyday tasks; tools that would then be most indicative of site use across space and through time. The unifacial tool assemblage includes a wide range of shapes and sizes with very few "classic" tools noted during the preliminary analysis i.e., sidescrapers, endscrapers, or key-shaped gravers. Many of the tools are not well defined, appearing to lack in standardization without clear boundaries between different types. For this thesis project, several stages of analysis were conducted on the assemblage in order to expand on the technological behavior at the Richardson Island site. It is hoped that these results can also add to the history of the Haida peoples and, more broadly, to discussions of early human presence within British Columbia, Alaska and elsewhere.

In this thesis, analysis begins with the exploration of the level of structure underlying the unifacial tool assemblage using cluster analysis. Preliminary analysis suggested that the unifacial tool types did not segregate easily into neatly defined types

[2] This percentage includes all utilized flakes recovered from Richardson Island but does not include debitage.

and I wanted to find out whether or not some structure did exist. In the next stage of the research project, a behavioral model was created that could be used as a framework for following the unifacial tool types throughout their use-lives from raw material procurement to discard at the Richardson site. By incorporating the behavioral model into the discussion of unifacial tool production, I hoped to provide some explanations for the lack of typological structure present within this assemblage. After analyzing the unifacial tool assemblage as a whole, the artifacts were then separated temporally in order to establish any continuity or change through the record of site activity. The temporal record of the unifacial tools could then be compared to the distinctive shift noted between bifacial and microblade technologies.

Organization of Thesis Chapters

In Chapter Two, the documented paleoenvironmental and culture historical records for Haida Gwaii will be introduced and summarized setting the context for the Richardson Island site. These records provide a substantial amount of information on the past environments that early peoples lived in and traveled through. Paleoenvironmental research has also been instrumental in locating archaeological sites in the archipelago.

In Chapter Three, the Richardson Island site will be introduced. The research conducted on the site to date has continued to add to the record of site use. This chapter will provide the site setting, background to the archaeological work thus far, and describe the results of previous studies on site formation processes, features, fauna, flora and lithics.

Chapter Four will provide a summary of theory and methodology in lithic analysis. Some of the theoretical and methodological concepts covered in this summary will be drawn from in subsequent chapters. The final part of this chapter will summarize the most detailed studies on unifacial tools.

In Chapter Five, the unifacial tool assemblage from the Richardson Island site will be introduced. This chapter will begin by outlining the objectives of the research project and the methodologies chosen in order to meet each objective. After providing definitions for each unifacial tool type, under the Parks Canada typology, the variables selected for measurement will be discussed.

Chapter Six will examine the structure of the unifacial tools through the application of a cluster analysis computer program, Clustan Graphics. The chapter will begin with an overall summary of the different methods used for cluster analysis and the clustering method chosen for the unifacial tool assemblage. The remainder of the chapter is devoted to the application of cluster analysis to several aspects of the unifacial data set and the results generated from each clustering solution.

In Chapter Seven, a behavioral model will be used in order to help explain the lack of standardization in the unifacial tool assemblage. The life histories of the unifacial tools, from raw material procurement to tool re-use and discard, will be considered within the framework of this model. Four central hypotheses will be explored through several statistical tests including chi square.

Any changes or continuities in the unifacial tool assemblage at the Richardson Island site will be investigated within Chapter Eight of this thesis. Specifically, unifacial tools recovered from both the Kinggi Complex and the Early Moresby Tradition will be analyzed and set within the context of the biface/microblade transition that occurs at the site.

Chapter Nine will provide the conclusions to the thesis project and highlight some potential avenues for future research.

2 *The Paleoenvironment and Culture History of Haida Gwaii*

Introduction

Studies of the ancient shorelines, climatic conditions and ecology of Haida Gwaii are beginning to provide a more detailed understanding of the environment that affected and was affected by the early peoples that once occupied the rugged landscape of the archipelago. Reconstructions of the human occupation of specific locations within Haida Gwaii would remain limited without the inclusion of paleoenvironmental research. The discovery of sites within Haida Gwaii has been aided by the established paleoenvironmental record detailing the rise and fall of ancient shorelines. Interpretations of the material record found at sites discovered through archaeological survey at targeted elevations above the modern shoreline are guided by studies of the paleoenvironment. Analysis of the material record can provide a significant amount of information about the relationship between early peoples and fluctuating environments through time if aligned to studies of sea level changes, climate change and paleoecology. How did changes in sea levels within the archipelago influence or affect the lives of early peoples? How did people adapt to the changing environment or conversely, how did they exploit and alter this environment? What kinds of fauna, flora and marine resources were present and accessible to early peoples? More importantly for the current study, what can the material remains of stone found at the Richardson Island site reveal about the relationships between people and their environments at this period in human history? In this chapter, results of paleoenvironmental studies within the archipelago will be outlined and related to the established culture history of the ancestral Haida. This chapter will situate Richardson Island within its environmental and cultural context.

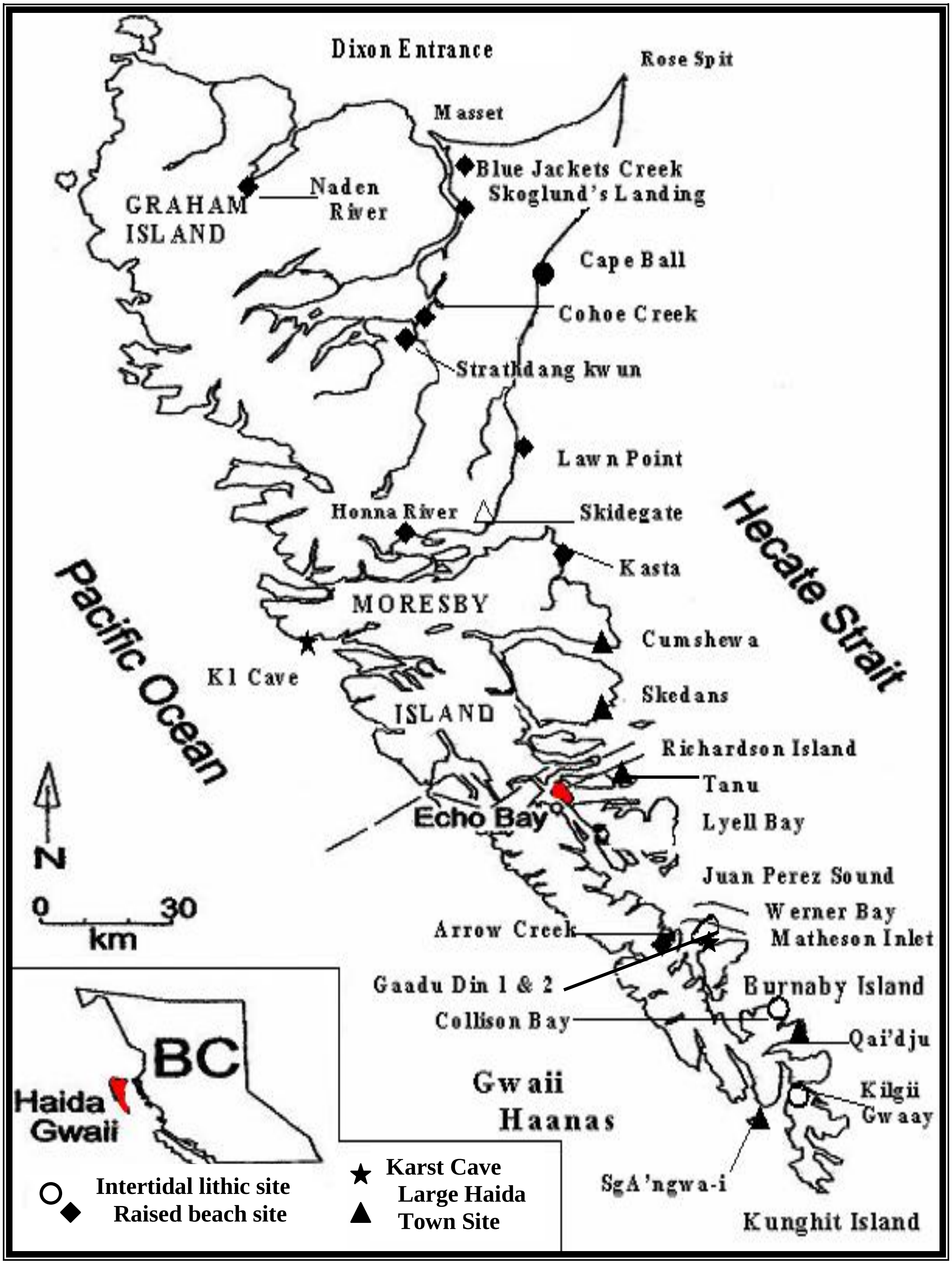


Figure 1: Map of Haida Gwaii showing sites and places mentioned in the text of this thesis (Modification of Fedje et al. 2005).

2.1 Location of Haida Gwaii

Haida Gwaii (the Queen Charlotte Islands) is an archipelago composed of more than 150 large and small islands situated 80 kilometers off the central coast of British Columbia (Mathewes 1989:486).The islands are located within the traditional territory of the Haida First Nation. Graham Island in the north and Moresby Island in the south are the largest and, along with the smaller islands, encompass a land area of approximately 6,000 square kilometers (Fladmark 1986:39). The modern coastline of the archipelago is densely forested with a wet hypermaritime environment in the western portion to a subhumid maritime environment in the eastern portion (Fedje et al. 1996:133). The islands are characterized by rugged mountains with narrow, moderate to steep coastlines. Within the National Park Reserve/Haida Heritage Site (referred to in this thesis as “Gwaii Haanas”), located in the southern extent of Haida Gwaii, the San Christoval mountains form a range of peaks that are vegetated by alpine tundra and mountain hemlock at higher elevations and dominated by dense forests of Coastal Western Hemlock, Sitka Spruce, Cedar, and Pine at lower elevations. The eastern side of Haida Gwaii is separated by the mainland of British Columbia by Hecate Strait which is 70 to 90 kilometers in width (Fedje and Christensen 1999).

2.2 Paleoshorelines, Paleoclimatic Conditions and the Paleoecology of Haida Gwaii

2.2.1 Paleoshorelines

Studies of the paleoshorelines of Alaska and Haida Gwaii are important for any discussions of environmental change and early human occupation during the late glacial (ca.16, 000 to 15,000 B.P.) and early Holocene (ca. 9000-5000 BP) periods in North America (Fedje et al. 2005). Paleoenvironmental studies by J.J. Clague (1983, Clague et al.1982; Clague et al. 2004) have been instrumental in providing a record of the growth and subsequent decay of continental glaciers in British Columbia during the Pleistocene. While this history of glacier activity has revealed certain areas of Haida Gwaii that would have been covered in ice sheets, this record has also shown evidence of ice free areas within parts of the archipelago and the surrounding straits during the last major glaciation (sometime between 25,000/30,000 BP and 13, 500/13, 000 BP). Sea level fluctuations during the late Pleistocene and early Holocene have been directly related to forebulge effects, eustatic lowering and isostatic uplifit as a result of receding glaciers (Clague 1983). Studies of landforms and sediments on the eastern side of Graham Island, situated in northeastern Haida Gwaii, have provided some limited information regarding the timing of sea level rise and fall in relation to the growth and retreat of the late Wisconsin Cordilleran glaciers (Clague 1983). Macrofossil and pollen analysis of late glacial peat discovered at Cape Ball, on eastern Graham Island (Figure 1), and from marine sediment cores recovered from Dogfish Bank in Hecate Strait, have expanded the terrestrial history of the area as far back as 15, 000 BP (Lacourse and Mathewes 2005). However, these studies have been limited to a small area of Haida Gwaii, resulting in an incomplete record documenting the paleoenvironment of the archipelago.

While most of British Columbia was covered by glaciers during the late Wisconsin period, it has been argued that some portions of Haida Gwaii remained unglaciated, providing a refugia for specific flora and fauna (Clague 1983; Fedje et al. 2005; Hetherington and Reid 2003). A detailed study of the marine ecology of the late Pleistocene and early Holocene in Haida Gwaii was recently conducted by Hetherington and Reid (2003) with a focus on sampling intertidal molluscs. Core samples taken at various intertidal locations within the archipelago has indicated that ground glacial ice was absent from specific locations during the last Pleistocene and that intertidal food was available to the early peoples of Haida Gwaii by at least 13 210 ± 80 calibrated radiocarbon years BP (Hetherington and Reid 2003). This refugium would have been present on the sea floor during the Last Glacial Maximum (Fedje et al. 2004).

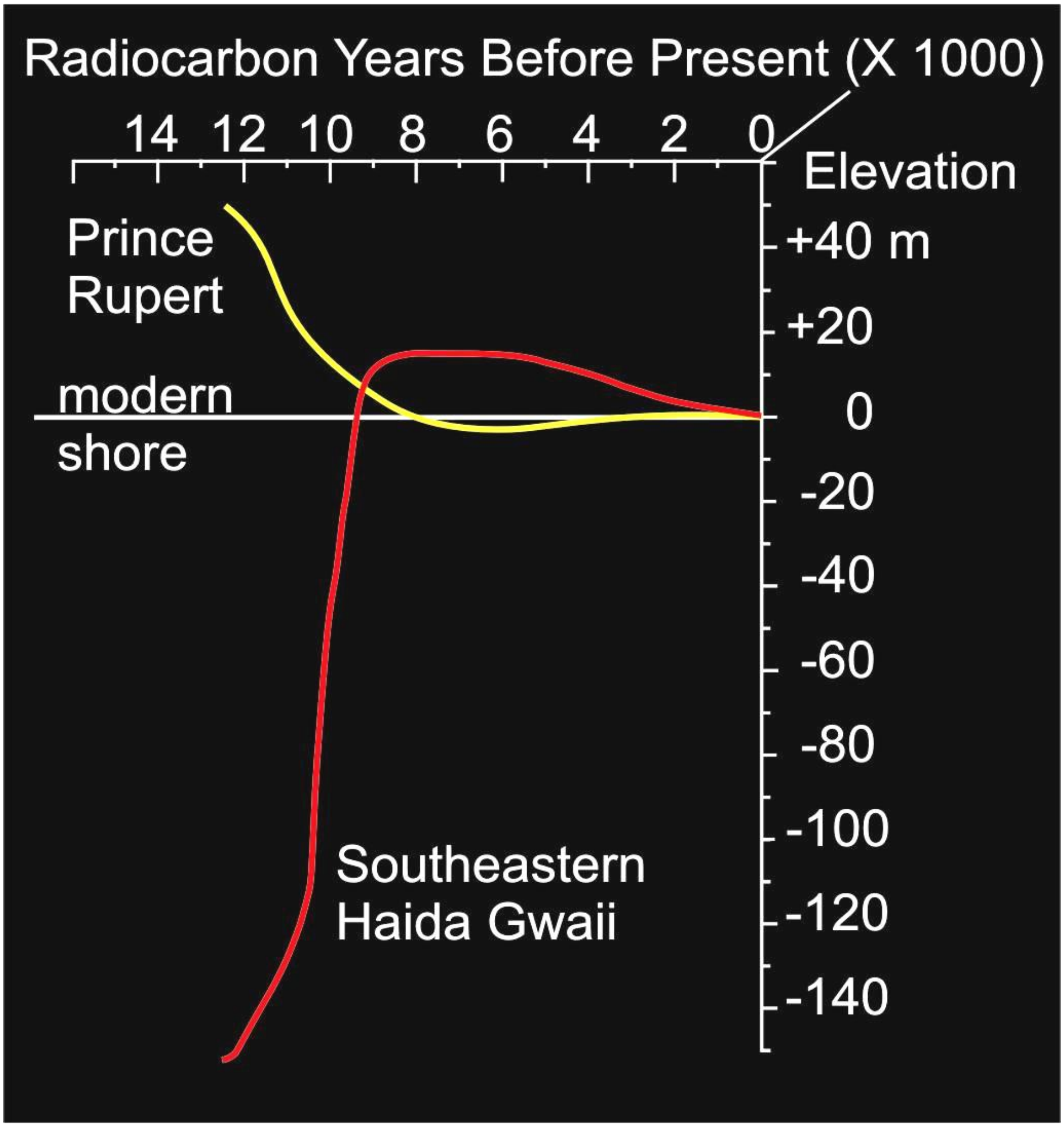


Figure 2: Sea level curve for southeastern Haida Gwaii (Image created by Daryl Fedje, reproduced with permission).

A record of sea level fluctuations for the shorelines of Haida Gwaii has been successfully correlated to the archaeological record in the archipelago (Figure 2). From archaeological surveys and paleoenvironmental research, evidence shows that archaeological sites are very closely associated with sea level history (Fedje et al 2005). Any evidence of early human occupation along the coast of Haida Gwaii ranging between 12, 500 and 9500 BP[3] would now be drowned. Any archaeological sites dating from approximately 9500 to 9400 BP would now be located within the modern intertidal zone and sites dating to between 9400 and 2000 BP would be situated well above the present sea level (Fedje et al. 2005). As a result of archaeological investigations that occurred in northern and central Haida Gwaii in the 1970's, several sites that date from 8000 to 5000 BP were discovered 12 to 14 meters above the present shoreline levels (Fladmark 1989; Fedje et al. 2005). Sea level research has become essential for surveys of archaeological sites in the archipelago providing a fairly reliable and effective strategy for discovering sites of human occupation dating from post-5000 BP. Surveys of raised beach locations and intertidal zones as well as some limited survey of drowned shorelines have revealed several significant sites dating back to 9000 BP and earlier (Fedje and Christensen 1999; Mackie and Sumpter 2005).

2.2.2 Paleoclimatic Changes

Paleoecological studies of coastal Alaska and British Columbia have revealed that between 11,000 and 10,000 BP the climate was cooler than at present (Mathewes et al. 1993; Lacourse and Mathewes 2005). Research indicates significant shifts in the vegetation as a result of climatic changes after 10,000 BP. The early Holocene climate along the Northwest Coast would have had relatively high summer temperatures, low winter temperatures and a low mean annual precipitation (Heusser et al. 1995; Pellatt and Mathewes 1997; Lacourse and Mathewes 2005). During the mid-Holocene, a gradual cooling occurred with increasing annual precipitation and relatively low temperatures. Between 4000 and 3000 BP, Haida Gwaii would have shifted to a cool and wet environment characteristic of the modern climatic conditions (Heusser 1985 et al; Pellatt and Mathewes 1997; Lacourse and Mathewes 2005).

[3] All dates mentioned in this thesis are in uncalibrated radiocarbon years before present unless stated as otherwise. For a cross-reference of radiocarbon years to calibrated age please refer to the radiocarbon calibration table in Appendix B.

2.2.3 Paleoecology of Haida Gwaii

Paleoecological studies have provided a significant amount of information about what kinds of habitats early peoples were living in and exploiting. Marine sediment cores retrieved from Dogfish Bank in Hecate Strait reveal a landscape that was treeless with areas of sedge tundra at 13, 200 BP (Lacourse and Mathewes 2005). Analysis of pollen samples taken from places such as Cape Ball on Graham Island in northeastern Haida Gwaii, have shown that around 12,500 BP the archipelago was covered in tundra and dwarf shrubs but was beginning to change to include coniferous forests. At 11,200 BP, lodgepole pine (*Pinus contorta*) and spruce (*Picea*) expanded followed by western hemlock (*Tsuga heterophylla*) at approximately 10,000 BP. After 9400 BP, spruce and western hemlock forests continue to expand and dominate until 5500 BP with the development of forest bogs. After 5500 BP, cedar (*Cupressaceae*), lodgepole pine and heath shrubs become more common with established forests of cedar and hemlock present by 3000 BP (Lacourse and Mathewes 2005). Sea cliff exposures at Cape Ball have shown evidence of plants that grew between 15,000 and 10,000 BP providing the earliest radiocarbon-dated record of plants during the late Wisconsin glaciation on the British Columbian coast (Lacourse and Mathewes 2005). This information is important because it lends support to the possibility of human occupation in areas that were ice-free and vegetated during the last glacial episode in Haida Gwaii (Lacourse and Mathewes 2005). While this paleoecological research can be applied to general discussions of the landscape in Haida Gwaii, future studies will need to focus on analyzing pollen samples from areas within southern Haida Gwaii in order to provide a richer analysis for the many archaeological sites found in the Gwaii Haanas.

The earliest evidence of vertebrate fauna present in Haida Gwaii is a fossilized black or brown bear femur that has been dated to 14,540 ± 70 BP recovered from K1 Cave on the northwest coast of Moresby Island (Ramsey et al. 2004). In the postglacial period (13, 500 to 9000 BP) there is increased presence of vertebrate remains. Evidence of brown bear, black bear and ungulate has been recovered from K1 Cave as well as mouse, caribou and Sitka black-tailed deer. Investigations in Gaadu Din, a cave on the east coast of Moresby Island have revealed the presence of shrew, mouse, bat, black bear, river otter, brown bear, canid and mule deer (Wigen 2005).

A variety of fish species recovered from Gaadu Din include salmon, rock-fish, greenling, smelt, buffalo sculpin, Irish Lord, herring, longfin sculpin, black prickleback sculpin, gunnels, tidepool sculpin and flatfish. At Kilgii Gwaay on Ellen Island, fish remains dating to the postglacial period predominately include rockfish, lingcod, dogfish, and cabezon while salmon, skate, herring, greenling, striped seaperch, and halibut are also present. Bird taxa during this period include two sizes of songbirds, murrelet and small duck (Wigen 2005). At the Richardson Island site, an analysis of fauna from hearth features found many of the same fish species noted above and included sablefish, starry flounder, hake and Pacific cod (Steffen 2006).

Studies of the vegetation and fauna of Haida Gwaii have revealed that plants and animals living in the archipelago today are quite distinctive and geographically restricted. These endemic species have seen a reduction in numbers in comparison to the species on the adjacent mainland. Island species often exhibit strong morphological and genetic differences from those of their ancestral populations (Reimchen and Byun 2005). Some of the species endemic to Haida Gwaii include the three-spined stickleback, black bear, marten, Haida short-tailed weasel, saw-whet owl, ground beetles and the now extinct Dawson caribou (Reimchen and Byun 2005). Population numbers within the five endemic land mammals present in the archipelago today have seen a decline since the historic period but evidence from K1 and Gaadu Din caves indicates that prior to 10,000 BP there were at least nine or ten endemic species (Wigen 2005).

2.2.4 Summary

Through continued paleoenvironmental study of the archipelago, archaeologists are gaining new information on when and where sea levels rose and fell, what types of flora would have been growing and available for foraging, what species of fauna early peoples could have hunted and the kinds of marine resources that could have been collected. As seen through paleoenvironmental studies, the eco-systems of the archipelago have changed dramatically over time resulting in changes in the resource-based activities of early peoples. The location of archaeological sites in Haida Gwaii have shown a relationship to environmental change although it is change that has also hindered a more thorough and accurate understanding of the history of the ancestral Haida. Sea level changes have resulted in the loss of archaeological sites, dense forests have limited the discovery of new sites, and poor preservation due to acidic soil conditions has led archaeologists to construct a culture history based on changes in artifact assemblages that could be biased due to the lack of organic artifacts and marine resources in early sites. While defining the general context for sites such as Richardson Island provides avenues for discussions of technological changes or continuities, it is important to acknowledge the taphonomic processes that have continued to affect the archaeological record, obscuring or emphasizing evidence of cultural processes. The following section will review what is known about the culture history of Haida Gwaii to date, situating Richardson Island within this context.

2.3 The Culture History of Haida Gwaii

The introduction of the culture historical approach to sites found in Haida Gwaii is largely the result of the work conducted by Knut Fladmark in the early 1970's. Fladmark's interest in the early excavations of sites such as Tow Hill, Lawn Point, Skoglund's Landing, Kasta and Blue Jackets Creek led him to create a general sequence that reflected the prehistory of the archipelago through known sites and assemblages. In *A Paleoecological Model for Northwest Coast Prehistory* (1975), Fladmark outlined the development of a regional cultural sequence that situated sites in Haida Gwaii and other areas of British Columbia both spatially and temporally, connecting the prehistoric cultures of the Northwest Coast (Fladmark 1975; Breffitt 1993). While further archaeological work within the archipelago has resulted in the revision of Fladmark's initial sequence, his research has been instrumental in providing a baseline for archaeologists to explore the changes and continuities seen through the material record at various sites and with variable assemblages.

2.3.1 History of Research

Archaeological investigations within Haida Gwaii have provided a significant amount of information regarding occupation by early peoples as they adapted and moved within the archipelago. These investigations have contributed to our understanding of early peoples living along the Northwest Coast and, more broadly, the peopling of the Americas. Explorations that occurred as early as the late nineteenth century provided an initial account of several sites within the archipelago (Dawson 1880; Duff and Kew 1958; Smith 1929). Later work by Fladmark (1971), Gessler and Watney (1976), Hobler (1976, 1978) Severs (1974) Acheson (1998) and Ham (1988, 1990) located several previously unrecorded sites and some limited testing and excavation occurred. Investigations increased in the 1990's with several surveys and some excavations conducted in Gwaii Haanas (southern Moresby Island) and northern Graham Island (Fedje et al. 1996) Most of the early Holocene sites recorded were situated at raised beach or intertidal locations (Mackie and Wilson 1994; 1995; Fedje et al. 1996; Christensen 1997; Stafford and Christensen 2000). More recent excavations conducted by Parks Canada, the University of Victoria and the Haida First Nation have continued to add new information to the prehistory of the area (Fedje and Christensen 1999; Stafford and Christensen 2000; Smith 2004; Steffen 2006; Fedje et al. 2008).

2.3.2 Haida Gwaii Culture History

Archaeological sites within Haida Gwaii have been divided into three distinct chronological components (See Table 1): The Kinggi Complex (dating from 10,600 to 8750 BP), the Moresby Tradition (dating from 8750 to 5000 BP), and the Graham

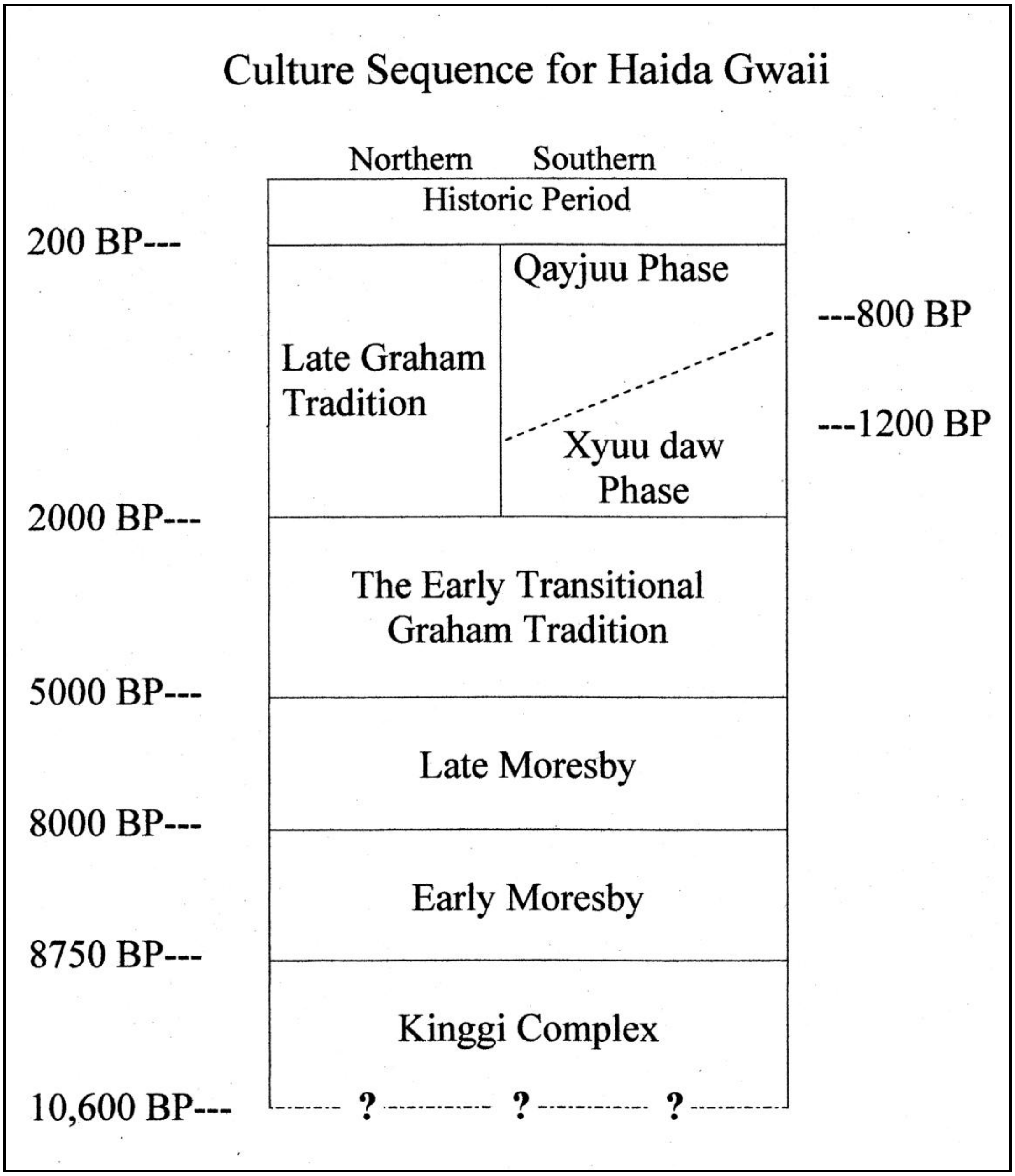


Table 1: Culture Historical Sequence for Haida Gwaii (Fedje and Mackie 2005; Orchard 2006)

Tradition (dating from 5000 to 200 BP) (Fedje et al. 2008). This cultural sequence has been established and revised based on the survey and excavation of several archaeological sites within the archipelago. While substantial artifact assemblages and other cultural remains have allowed for a moderately detailed culture history of sites extending as far back as 9500 BP, sites of earlier human occupations have provided very low numbers of artifacts and associated remains. However, information gathered from these earliest sites will ultimately lead to a better understanding of cultural occupations of later sites and it is therefore, very important to begin this section with a discussion of the limited information known from underwater archaeological investigations and from explorations in karst cave systems.

Prior to 9500 BP, evidence for human occupation is presently limited in the archaeological record, however, there are a few sites that have been dated to pre-9500 BP; K1 Cave, Werner Bay, Gaadu Din and Gaadu Din 2. Limestone caves found in Haida Gwaii provide ideal conditions for the preservation of faunal remains and artifacts from an early prehistoric context. Gaadu Din (10,500-10,000 BP), Gaadu Din 2 (11,030 to 10,220) and K1 (10,950 to 10,400 BP) caves are significant because they offer some of the earliest evidence for human occupation within Haida Gwaii (Fedje and Mackie 2005; Fedje et al. 2008) and the wider region. At K1 cave, on the west coast of Moresby Island, the bases of two large spear points were recovered along with a significant amount of bear remains. On the east coast of Moresby Island, two stone points and the tip of a bone point were recovered from Gaadu Din cave along with several bear and deer remains (Fedje et al. 2008). During recent fieldwork conducted in 2007, a new cave, Gaadu Din 2, was discovered also situated on the east side of Moresby Island. At Gaadu Din 2, a large, complete spear point and a bifacial knife were recovered and further excavation in the entrance to the cave, conducted in June, 2008, revealed a hearth feature, two biface tips and several flakes. Unlike K1 and Gaadu Din 1, there have been few faunal remains recovered from Gaadu Din 2. Preliminary dates from the cultural layers at Gaadu Din 2 range from 9500 to 11, 000 BP.

As discussed previously, the modeling of ancient shorelines in Haida Gwaii has revealed that sites of human occupation dating to earlier than 9500 BP would now be submerged underwater (Fedje and Christensen 1999) making the discovery of such early sites quite challenging. Investigations of submerged, early postglacial archaeological sites have focused on the topography of the sea floor on the eastern side of Hecate Strait, eastern Haida Gwaii. Aided by the technology of swath bathymetry, drowned subaerial features such as creeks, lakes, rivers, ponds, deltas and beaches can be analyzed and areas of archaeological potential can be targeted (Fedje et al. 2005). At some of these targeted locations, several pieces of wood including two tree stumps have provided evidence for a Pleistocene terrestrial landscape within Hecate Strait. An isolated artifact dredged from Werner Bay in Juan Perez Sound and dated to approximately 10,000 BP provides some potential evidence for human occupation on the drowned landscape (Fedje and Christensen 1999; Fedje and Josenhans 2000).

While evidence of the earliest human occupations of the archipelago is severely limited due to sea level history and poor preservation, continued archaeological surveys on land and on the sea floor will add to this largely unknown period of human history. In the following section, the known established culture historical sequence will be outlined (Table 2).

The Kinggi Complex (10,600 to 8750 BP) in Haida Gwaii is characterized by sites that are either intertidal or submerged (pre-9400 BP) and raised beach sites (9000 BP and after) that are now situated approximately 15 meters above the current shoreline. Surface surveys in the archipelago have also located 111 lithic scatters (Mackie and Sumpter 2005) in the intertidal zone that may date to the Kinggi Complex (Fedje and Christensen 1999; Fedje et al. 2008). The two most prominent sites of this complex are Richardson Island (Fedje and Christensen 1999) and Kilgii Gwaay (Fedje et al. 2001), both located in southern Haida Gwaii. The intertidal site of Collison Bay, on eastern Moresby Island, is also estimated to date to this early complex based on sea level history and because it shares many similarities to the technologies present at Kilgii Gwaay (Fedje et al. 2008). During this technological component, bifacial technology, large scrapers, scraperplanes or adzes, cobble choppers, gravers, large unifaces and spokeshaves are present while microblade technology is entirely absent. The artifact assemblage from Kilgii Gwaay reveals developed bone and wood technologies. Excavations at the intertidal site have uncovered bear bone awls, a small unilaterally barbed bone point, a tabular sea mammal bone percussor, splinter awls and some miscellaneous worked bone.

Culture History of Haida Gwaii		
Time Period	**Archaeological Sites**	**Characteristics**
Pre-9500, Kinggi Complex (Fedje et al. 2008).	K1 Cave, Werner Bay, Gaadu Din 1 and Gaadu Din 2	Large spear points, bifacial technology, bone points, faunal remains.
Kinggi Complex (10,600-8750 BP)	Richardson Island, Kilgii Gwaay, Collison Bay	Bifacial technology, scrapers, scraperplanes, cobble choppers, gravers, large unifaces and spokeshaves. Bone and wood technologies. Faunal remains.
Early Moresby Tradition (8750-8000 BP)	Richardson Island	Bifacial technology, microblade technology, flake tools, hearth features, faunal remains.
Late Moresby Tradition(ca. 8000 to 5000BP)	Lawn Point, Kasta, Skidegate Landing, Skoglund's Landing, Cohoe Creek, Richardson Island, Arrow Creek, Lyell Bay.	Microblade technology, pebble tools, flake tools, substantial shell middens, faunal remains.
Early (Transitional) Graham Tradition (5000-2000 BP)	Cohoe Creek, Blue Jackets Creek, Skoglund's Landing, Lawn Point.	Bipolar technique, ground, pecked and bifacially worked stone, shell midden sites, faunal remains, use of wood, bone, plant and shell.
Late Graham Tradition (2000-200 BP).	Blue Jackets Creek, *SgA'ngwa'I*, *Qai'dju*, Cumshewa, Skedans, Tanu, Chaatl and Kaisun and other historical Haida towns.	Ethnographic Northwest Coast culture emerges, large habitation structures, extensive trade, monumental and portable art, extensive warfare, reliance on organic artifacts, and relative absence of lithic technology.

Table 2: Table of time periods, archaeological sites and associated components in Haida Gwaii

Wooden tools and woodworking debris were also recovered due to the relatively good preservation of organics (Fedje et al. 2001; Fedje et al. 2005). It is probable that other early sites in the archipelago included wood and bone artifacts in their assemblages but are now absent due to highly acidic soil conditions. At Richardson Island, three fragmentary and calcined bone point tips were found in hearths dating to the Kinggi Complex (Steffen 2006; Fedje et al. 2008), providing limited evidence that people at the site were working with bone.

The Moresby Tradition (8750 to 5000 BP) occurs within a period of fairly stable sea levels and is divided into the Early and the Late Moresby Traditions based on the presence or absence of specific technologies. In the Early Moresby Tradition (8750 to ca 8000 BP) microblade technology emerges and begins to replace the established bifacial technology. By approximately 8000 BP, bifacial technology is relatively absent and microblade technology is prevalent (Fedje et al. 2008). Whereas this shift from bifacial to microblade technologies could be regarded as a replacement of one culture by another, information obtained from the high stratigraphic resolution at the Richardson Island site has led some researchers to argue that this shift was more gradual and represents adaptive rather than ethnic changes (Magne 2004; Smith 2004; Fedje et al. 2008). Analysis of lithic technologies and raw materials from Richardson Island suggests that microblades evolved from already established technologies (Smith 2004; Magne 2004; Fedje et al. 2008; Mackie et al. 2008). It is important to note that there are similarities between these early Haida Gwaii technologies and those of the Nenana complex of central Alaska. Commonalities between the tool assemblages suggest that these traditions or complexes possibly grew out of the same western Beringian technology (Fedje et al. 2008). Other archaeological sites that exhibit similarities with the mixed bifacial and microblade technologies seen in Haida Gwaii include Namu on the central coast of British Columbia (Carlson 1996) and On Your Knees Cave in southeastern Alaska (Dixon 1999). At On Your Knees Cave, microblade technology is present at 9200 BP, slightly earlier than in Haida Gwaii and at Namu, microblade technology arrives slightly later 9000 to 8500 BP. This is interesting in that it could be evidence of the expansion of microblade technology along the coast (Fedje and Mackie 2005).

The Late Moresby Tradition, formerly known as the Moresby Tradition (Fladmark 1989), beginning at ca. 8000 BP and ending at 5000 BP, is characterized by raised beach sites, microblade technology, pebble tools and flakes with an absence of bifacial technology (Fladmark 1989; Fedje and Mackie 2005). Archaeological sites containing components assigned to this tradition include Kasta, Lawn Point, Skoglund's Landing, Skidegate Landing and Cohoe Creek in northern Haida Gwaii (Fladmark 1971, 1986; Ham 1988, 1990; Christensen and Stafford 2005) and Arrow Creek, Lyell Bay and Richardson Island within the southern part of the archipelago (Fedje et al. 1996; Christensen 1997; Fedje and Christensen 1999). This is also the time period when substantial shell midden sites first appear in the archaeological record with evidence for a focus on marine resources as well as the use of caribou present at the Cohoe Creek site ca. 5500 BP (Ham 1990; Christensen and Stafford 2005).

The Graham Tradition (5000 to 200 BP) marks the end of microblade technology in Haida Gwaii and is associated with the Developmental Stage created by Fladmark et al. (1990). While there is the apparent termination of the microblade tradition, shell midden sites increase accompanied by large amounts of ground and pecked stone, faunal remains, wood, bone, plant and shell. During this tradition, the first evidence for decorative objects appears and there is a significant reduction in flake stone artifacts. There is also an increase in social complexity and ceremonialism at many Graham Tradition sites (Acheson 1998; Mackie and Acheson 2005). As well, sites occurring within this tradition have been characterized by a large percentage of various intertidal and marine species suggesting that people were using these types of resources more intensively than during earlier periods (Fladmark 1989; Fedje and Mackie 2005). However, relatively good preservation at the intertidal site of Kilgii Gwaay has indicated that the differences in the presence of marine resources at early and late sites are probably due to site formation rather than cultural processes. On northeastern Graham Island the sites of Blue Jackets Creek (Fladmark 1970; Severs 1974; Fedje and Mackie 2005) and Skoglund's Landing (Fladmark 1990) figure prominently in the archaeological information representing Graham tradition components. This tradition has been further divided into the Early or Transitional Graham Tradition and the Late Graham Tradition (Mackie and Acheson 2005).

The Early (Transitional) Graham Tradition begins around 5000 BP and continues to 2000 BP. During this phase, sea levels gradually fall and most of the sites occupied during this time tend to be raised beach locations situated 7 to 10 meters above the current shoreline. The lithic technology includes ground and some bifacially worked stone as well as evidence of a bipolar technique. Evidence for this transitional tradition comes from the upper levels of Cohoe Creek, Blue Jackets Creek, Skoglund's Landing, and Lawn Point (Ham 1990; Fladmark 1990; Breffitt 1993; Christensen and Stafford 2000; Fedje and Mackie 2005).

The Late Graham Tradition has been defined as the period from 2000 to 200 BP (Mackie and Acheson 2005) although recent research by Orchard (2006) has further subdivided this tradition into two phases for southern Haida Gwaii: the Xyuu daw Phase and the Qayjuu Phase. Orchard proposes a separation for Late Graham deposits at sites within the southern part of the archipelago based on changing subsistence patterns. Orchard (2006) finds that sites falling between 2000 and ca. 1000 BP (the Xyuu daw Phase) are dominated by a high percentage of rockfish remains with a relatively low amount of salmon remains and an overall lack of living-floors within deposits. In comparison, deposits that fall between 1200 BP and 800 BP (the Qayjuu Phase) appear to transition into a salmon-dominated subsistence pattern and components present after 800 BP are distinctly dominated by salmon remains with an increase in living-floors (Orchard 2006).

More broadly throughout Haida Gwaii, it is during the Late Graham Tradition that the ethnographic Northwest Coast culture arises, characterized by the presence of large habitation structures, extensive trade, monumental and portable art, extensive warfare and an effective food procurement technology. A relative absence of lithic technology and a reliance on organic artifacts are characteristics of Late Graham Tradition sites (Fedje et al. 2008). Sites within the Late Graham Tradition have revealed the presence of a specialized woodworking technology. It is important, however, to note that evidence for woodworking has been found at the intertidal site of Kilgii Gwaay and it is possible that a more established woodworking technology was present at other early sites in Haida

Gwaii. Poor organic preservation at many early sites might explain the absence of certain technologies while the presence of shell middens at later sites results in the better preservation of organic artifacts.

Archaeological investigations conducted by Acheson (1998) from 1984 to 1986 revealed several town[4] sites within southern Haida Gwaii, the ancestral home of the Kunghit Haida. In the 1990's, survey was expanded and included site inventories for all of the Kunghit traditional territory (Acheson 2005). Excavations at several town sites combined with ethnohistorical information and oral traditions have shown that settlement patterns within southern Haida Gwaii consisted of small, widely dispersed, multi-lineage towns before European contact. Populations were dense along the coast with people living in large plank houses throughout the winter and dispersing into smaller groups in the spring, summer and fall to important resource collecting locations (Acheson 1998). Two of the largest, southern settlement sites known are *SgA'ngwa'i* and *Qai'dju* with *SgA'ngwa'i* representing the largest, oldest and last known occupied town. In Northern Haida Gwaii, there were several major historical towns occupied by other Haida peoples defined as "people of Skidegate Inlet." Some of the major towns include Cumshewa, Skedans and Tanu along the east coast and Chaatl and Kaisun on the west coast (Acheson 1998). Ethnographic and historical records indicate that after European contact and the growth of the maritime fur trade, there was increased violence and warfare amongst the Haida and a growing dependence on trade. The combination of this heightened conflict as well as the growing isolation of some towns resulted in population loss and many settlements were dissolved. When the last small pox epidemic arrived in the archipelago in 1862, town numbers were already decreasing (Acheson 2005).

2.4 Conclusions

There are many significant archaeological sites within Haida Gwaii and information collected from each location has led to a better understanding of the

[4] A village is referred to as a "town" in this thesis due to the Haida's preference for using this word to describe their settlements.

prehistory of the archipelago. To date, the established culture history sequence for the archipelago, specifically during the Kinggi Complex and Early Moresby Tradition, has emphasized changes in technologies and subsistence patterns over large spans of human history and through extensive environmental fluctuations. The presence of flaked stone, bone tools, worked wood, cordage, and basketry using a split root technique at sites such as Kilgii Gwaay provides direct evidence of the early use of these technologies in the archipelago. An accumulation of all of the archaeological data to-date also reflects a long term picture of the decline of flaked stone and increase in both ground bone and wood.

The site of Richardson Island, in southeastern Haida Gwaii, provides a unique opportunity to analyze human behavior through high resolution stratigraphy that spans at least 1000 years of intensive use and extends up until approximately 3000 BP. This site also provides a record of human activity that would potentially have been affected by rising and falling sea levels. In the next chapter, the Richardson Island site will be introduced, incorporating both paleoenvironmental and archaeological studies in order to situate the site within the broader culture history of the archipelago.

3 Richardson Island

Introduction

As discussed in Chapter Two, recent paleoenvironmental and archaeological studies initiated in the archipelago have led to more robust interpretations of early maritime adaptations in Northwest Coast prehistory. The Richardson Island site provides a unique opportunity to see human activities on a more “micro” level scale and remains the only site with a defined Early Moresby component. In this chapter, the Richardson Island site will be introduced and situated within the context of Haida Gwaii. The discussion will summarize the research conducted prior to this thesis; research that has brought various elements together towards a more complete understanding of the site. Included into this context will be a summary of the site’s stratigraphic record, providing an overall picture of the site formation processes that have been crucial to defining the cultural processes as seen in the archaeological record. Following this discussion, the chapter will focus on the lithic technologies recovered from the Richardson site, situating these technologies within the broader context of technological changes and continuities documented at other sites in the archipelago, the Northwest Coast of British Columbia, Alaska and Asia.

3.1 Location of Richardson Island

Richardson Island is steep sloped and small, situated within the Gwaii Haanas park in southeastern Haida Gwaii (Fig.1, Fig. 3.) The island lies between Moresby Island to the north, Lyell Island to the south and Tanu Island to the east. Situated in what has been defined as the Hecate Strait North Inner Coastal Region (Harper et al. 1994), Richardson Island and the surrounding area is characterized by moderate to steep coastlines with low wave action and is dominated by protected and semi-protected rock/gravel beaches although higher energy rock communities and sand beaches also occur. This zone exhibits larger drainage basins in comparison to other areas of the archipelago, resulting in a stronger influence of freshwater sources. The presence of several restricted channels throughout this zone has resulted in the occurrence of distinct intertidal zones containing diverse marine species. Estuaries are also common, encompassing several locations within this region and providing important diverse physiographic and biotic resources for the archipelago (Harper et al. 1994).

3.1.1 Site Setting (Richardson Island 1127T)

The Richardson Island site, 1127T, is located on the western side of Richardson Island, overlooking Darwin Sound, and situated on a debris-flow fan that covers approximately three hectares (Fedje et al. 2005:204)(Fig. 4). In its modern setting, the site is located in a dense forest dominated by cedar, hemlock and alder but at the time of site occupation, would have been forested by hemlock and spruce. Going still further back in time to the late postglacial, it would have once been characterized by a tundra of herbs and shrubs (Fedje and Josenhans 2000).

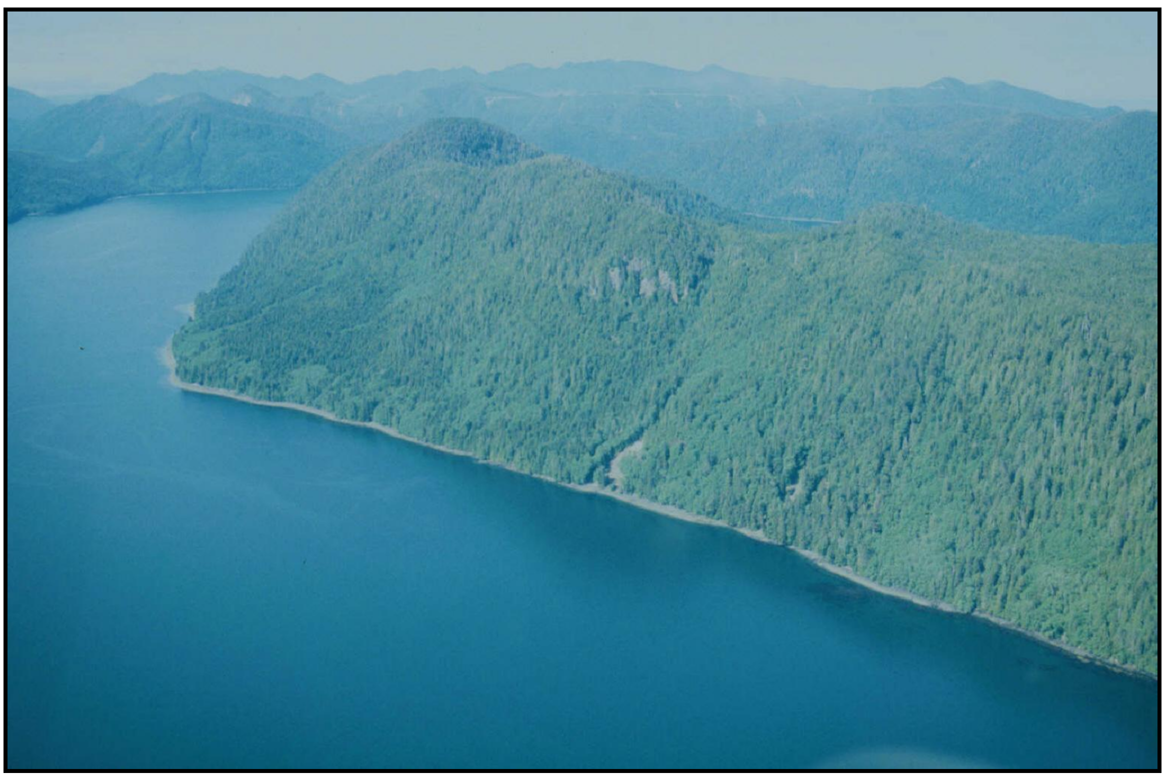


Figure 3: Aerial view of Richardson Island. Photo courtesy of Quentin Mackie, University of Victoria

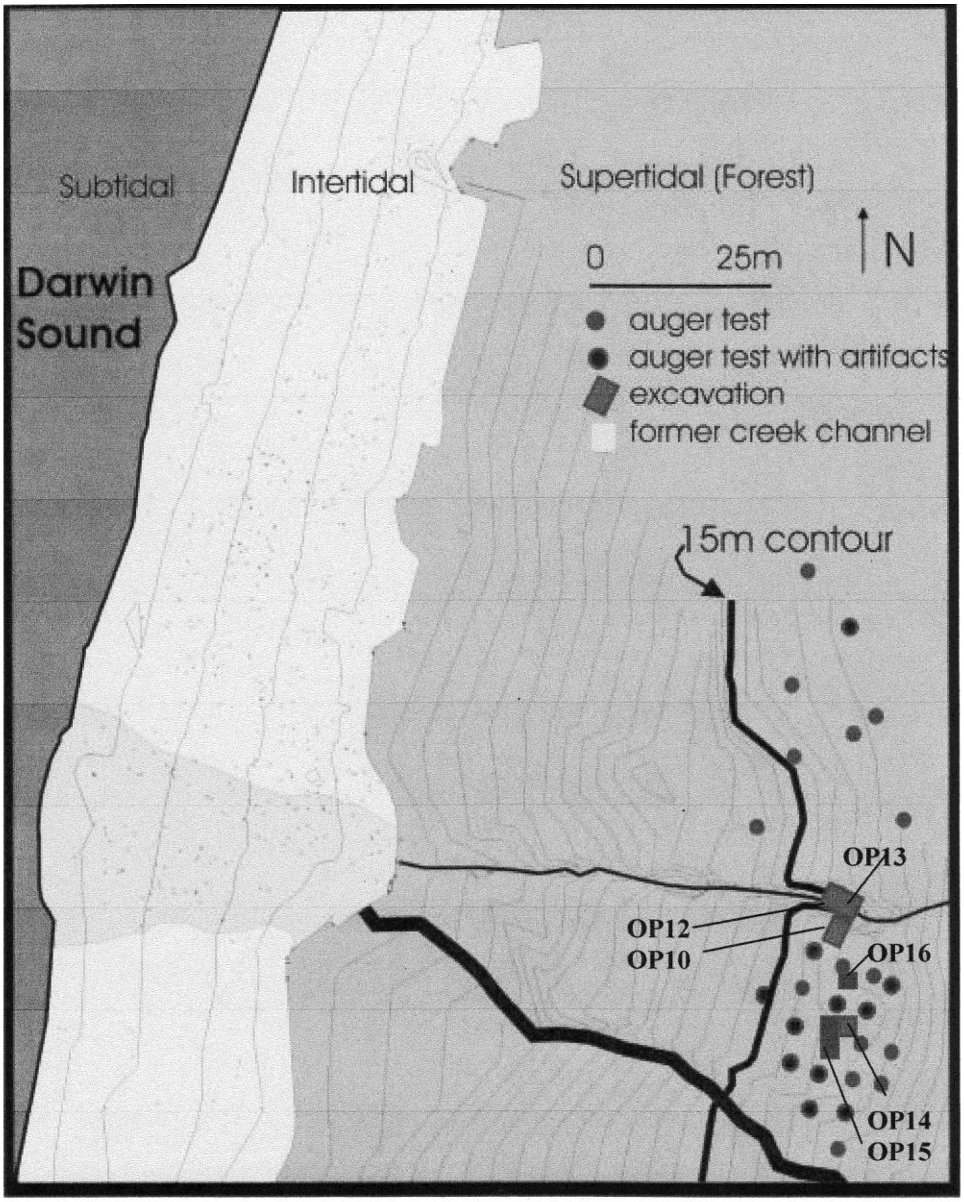


Figure 4: Richardson Island site map showing excavation units and auger tests (Modification of map created by Daryl Fedje, Parks Canada).

3.2 Discovery of the site

The site was first discovered as a scatter of lithics within the intertidal zone and exploration of the area revealed lithic materials eroding from a cut bank and adjacent stream bed. During a 1993 field season of the Gwaii Haanas Archaeological Project, surface survey, auger testing and test excavations were conducted at the site, defined as encompassing approximately one hectare that included the intertidal zone and a raised beach landform (Fedje et al. 1996). Further excavations instigated in 1995, 1997, 2001 and 2002 revealed the significance of the Richardson Island site due to, as previously emphasized, the high stratigraphic resolution and the ability to more precisely trace technologies during this time period. Thirty-five layers of depositional strata were defined during excavation at the site and twenty-six of these layers were defined as cultural (Fedje et al 2005). Precise dates for each cultural layer revealed a time period that spans from 9300 BP to 8500 BP. More recent excavations at the site have revealed evidence of human occupation up until approximately 3000 BP. Preliminary analysis of the stratigraphic profiles and artifacts from two excavation units suggests that there is some continuity in technological practice up until 3000 BP although there appears to be a significant decrease in the amounts of cultural material present in the uppermost deposits. This may suggest that the site was used less intensively during the later period of site use.

3.3 Site Formation Processes: The Creation of the Richardson Island Site

The stratification of cultural and non-cultural deposits at the Richardson Island site is quite complex but relatively consistent with the record of sea level history for the area. Understanding this complex stratigraphy is essential for any discussions of site use over time. Through the documentation of deposition at the Richardson site as a result of excavations conducted in 1995, 1997, 2001 and 2002, there is a fairly precise record of what kinds of processes took place within the span of approximately 1000 years. An analysis of the cultural remains discarded over time at the site must be discussed in relation to these environmental site formation processes for several reasons:

1) The relationship between humans and their environment is crucial to an understanding of the use of the Richardson site over time and through changing environmental processes.

2) It may be that technological changes have occurred due to these fluctuations and changes in the environment, specifically sea level rise and fall, in which case, an understanding of site formation processes can help to interpret this relationship.

3) The post-depositional processes have affected the preservation of many artifacts at the Richardson site and this must necessarily be taken into consideration during analysis. The extremely acidic soil conditions along with alluvial processes has limited some analysis and potentially obscured the presence of any organic material remains.

As emphasized above, site formation processes must be understood alongside stone tool technologies, raw material types and hearth features for a more complete understanding of the record of human occupation at the site. The complex and detailed site formation processes, well documented at the Richardson site, will now be summarized below. Following the summary on site formation, the defined site stratigraphy will be outlined.

3.3.1 Site Formation[5]

Before the human occupation of the Richardson Island site, the area consisted of a diamicton or debris-flow deposit dated to 9590 BP or earlier. Following this earliest record of the landform, a few layers of charcoal rich gravel and blackish-grey gravel were deposited. It was from 9290 BP (approximately) to sometime just after 9080 ± 60 BP when early peoples began using the site quite intensively, revisiting the location somewhat consistently. Between and possibly during each occupation of the site, both alluvial and cultural processes resulted in the build up of distinctive layers of 1) greasy black gravel rich in artifacts and 2) red-brown gravels. This sediment was both level and

[5] Based on Fedje et al. 2005.

gently sloping downslope (towards the ocean). These washes of red-brown gravels served to "cap" the cultural layers of greasy black gravels and artifacts. When people returned to the site, they would resume activities on top of a new layer of gravel. It is during these continued episodes of site use when early peoples appear to have conducted activities around hearths. This is also the period of time when several post moulds (11) found in archaeological context, are indicative of some kinds of structures, either for shelter or possibly for drying racks.

Significantly, at 13.5 m above the modern high tide levels, a massive depositional event occurred (sometime before or around 9220 ± 60 BP). During this event or episode, a very thick layer of red-brown gravel was deposited, creating a berm feature. This depositional event could have been the result of a tsunami, a storm, or several successive storms.

Sometime after 9080 ± 60 BP, colluvial processes resulted in the deposition of both non-cultural and cultural layers that sloped towards the landward side of the site. After the deposition of a layer of grey clay, including freshwater, brackish and marine species, a layer consisting of charcoal and artifact-rich gravel indicates the use of the Richardson site once again at approximately 8980 ± 60 BP.

At 14 m above the current high tide mark, a very large layer of red-brown gravel mixed with waterworn artifacts indicates another short term event such as a tsunami or subduction earthquake (sometime just after 8980 ± 60 BP)

After this depositional event, human activity at the Richardson site continues with distinct periods of site use (as indicated by thin layers of charcoal rich gravels and silts), interdispersed within a series of marine berm deposits represented by layers of blackish-grey gravel, red-brown gravel and olive-brown gravel. Each successive human occupation of the site was then "capped" by marine processes that deposited gravels, continually re-creating the landform (or adding to it). Sometime shortly before 8490 ± 70 BP, site use appears to decrease. After this, alluvial sands and gravels washed downslope (shoreward). At this time, the site was situated 16 to 17 m above the current high tide mark (Fedje et al. 2005). Three excavation units (EU14, 15 and 16) situated along the beach terrace at 11 m (EU16) and 18.65 m south (EU 14 and 15) of the gully, reveal that cultural use of the site continued until approximately 3000 BP. The uppermost cultural layers at the site represent the deposition of artifacts within a dark greasy organic matrix. This matrix is capped by a clay-rich colluvium and followed by the accumulation of an organic forest soil that covered the cultural deposits at the site.

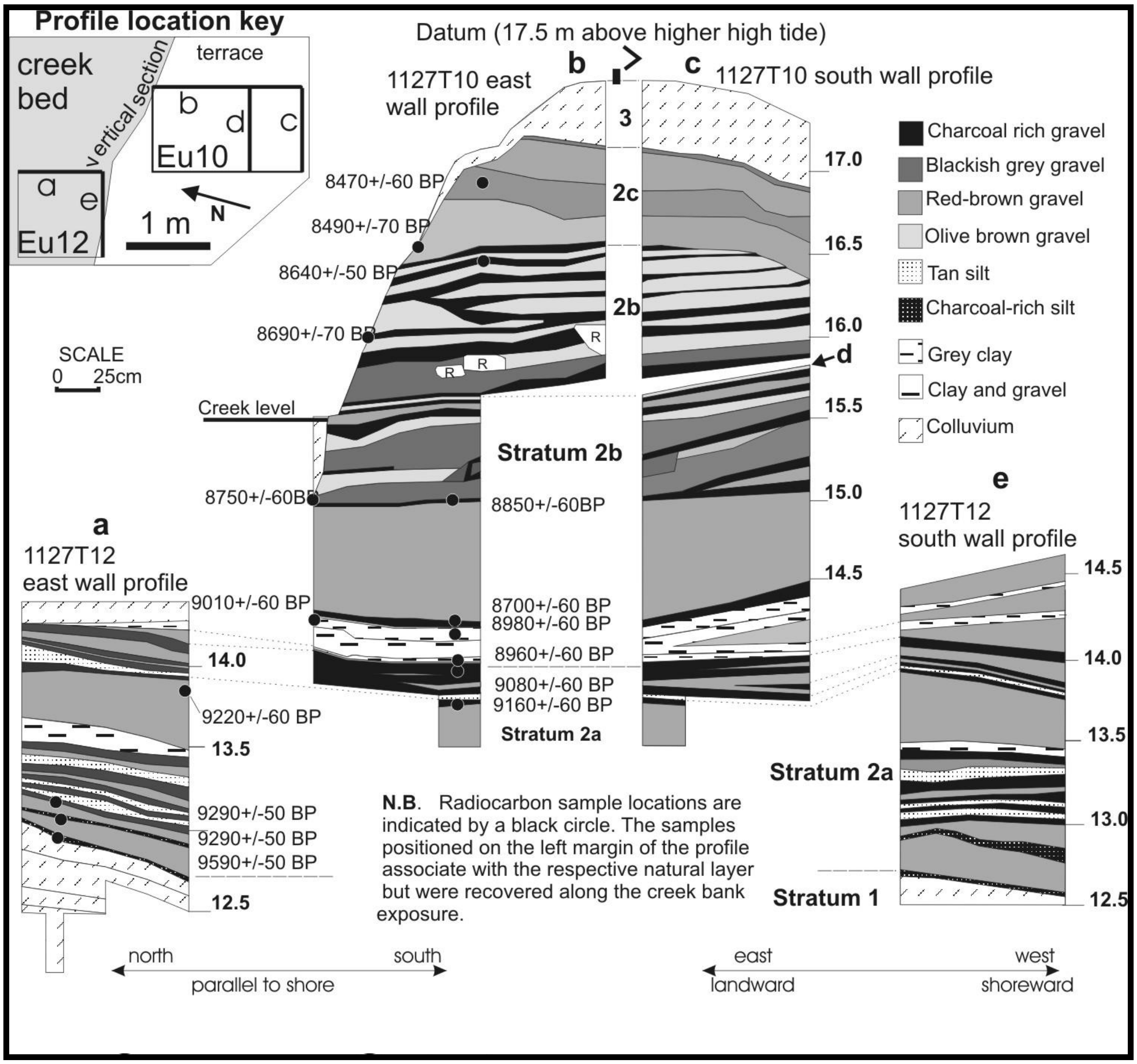


Figure 5: Stratigraphic profiles at the Richardson Island site. (Figure created by Daryl Fedje, Parks Canada and used with permission)

3.3.2 Site Stratigraphy

In order to delineate between the complex site formation processes, three major stratigraphic units were defined based on archaeological excavations; Stratum 1, 2 and 3 (Fig. 5). A charcoal sample taken from the surface of this stratum was dated to 9590 BP, representing the earliest known date for the site although the earliest reliable date for human occupation is slightly before 9290 BP at 12 meters above mean sea level. Above Stratum 1, a middle unit identified as Stratum 2 was defined. This stratum consisted of a minimum of thirty-three recognizably distinct and complex depositional layers. Cultural deposits were present, mixed with marine and terrestrial processes. This stratum contained 23 layers characterized by black greasy A horizons and was further divided into three groups: Stratum 2a, 2b, and 2c. Stratum 2a consisted of sediment that was both level and slightly sloping towards the shoreline and included greasy black gravel matrices rich in artifacts. This stratum exhibited evidence of some significant Aeolian or rain-wash processes identified based on the presence of downslope debris-flow deposits. Stratigraphy in this stratum consisted of intact, continuous layers of charcoal-rich sediment with in-situ features.

Stratum 2b consisted of marine berm deposits that dipped towards the landward side of the site and included cultural layers intermixed with non-cultural processes. At the bottom of this stratum, a layer of grey clay included a diatom representing freshwater, brackish and marine species. Above the clay layer, a charcoal and artifact-rich gravel paleosol occurred. At 14.0 meters above the modern tide line, a very large layer of gravel with some waterworn artifacts (10%) was indicative of another short term environmental event such as a tsunami. A series of berm deposits lay above this layer of gravel and continued until approximately 16 meters above sea level.

Stratum 2c consisted of alluvial sands and gravels that dipped shoreward and associated with a sea level of 16 to 17 meters above the current shoreline. Finally, Stratum 3 was identified as a clay-rich colluvium and an organic forest soil overlying the cultural deposits at the site (Fedje et al. 2005).

On Richardson Island, sea level rose approximately 4 meters within the first 1000 years that the site is known to have been occupied which could have affected how people were using the site, where they were manufacturing and discarding cultural materials and the conditions of these material remains after deposition. An understanding of the complex site formation processes, including the accumulation and erosion of berms and distinct stratigraphic markers of storm events, is crucial for beginning to interpret the artifacts, not as representations of static moments in time but as part of a continually shifting landscape.

3.4 Site Contents

3.4.1 Features

Several distinctive features were recorded during excavations at the Richardson Island site including post-moulds and hearths. The presence of these features provides evidence to indicate intact stratigraphy with cultural materials occurring in a primary context. There were eleven post mould features excavated from the Richardson Island site. These features were present in the lower layers of the Kinggi Complex and were generally small in size. All of the post moulds originated in the same layer in EU 13, layer 12 with the exception of one that began in layer 11 (Steffen 2006). These eleven features all extend into layer 11 and are associated with hearth features containing salmon remains suggesting that the processing and drying of fish was taking place at this time. The small post features may be indicative of some kind of drying rack (Steffen 2006).

Hearth features spanned from approximately 9290 to 9120 BP and represented both single and multiple burning events (Steffen 2006). A more detailed discussion of these hearths will be presented in the section on fauna introduced below.

3.4.2 Fauna

Initial studies of faunal remains from the Richardson Island site present during postglacial times revealed the presence of large land mammals such as caribou or bear, and some species of bird and fish species that include rockfish, dogfish, salmon, herring, prickleback, sculpin, greenling and possibly lingcod, halibut and hake (Wigen 2003; 2005).

A more recent, detailed analysis of calcined bones from several hearths at the Richardson site has recovered a wide variety of fauna (Steffen 2006)(See Table 3).The hearth features at the site represent a relatively short period of time, spanning less than 200 radiocarbon years, from approximately 9,290 BP to 9,120 BP. These hearths exhibit both single and multiple burning episodes. High resolution in the stratigraphy of the hearths has made it possible for Steffen to examine distinctive periods of use and provides a unique opportunity to observe what Steffen refers to as a "humanized timescale of faunal accumulation" (2006:2). Through her analysis, Steffen discovered that each hearth contained a different composition of taxa and that each use of a hearth appears to be of a short duration. Identification of the calcined bones indicated the presence of offshore or deep water species such as halibut and sablefish. While some taxa such as dogfish, rockfish, greenling, sculpin and herring are consistently present within the hearths, other taxa such as salmon show evidence of seasonality. Salmon remains recovered from specific hearths indicate that these hearths were probably used seasonally. Studies on the habitats of several taxa present in the archipelago today and found in the archaeological record at the Richardson site have shown that kelp and eelgrass beds were important to several of the species. It is therefore, probable that there was a similar habitat near the Richardson site during this earlier time of occupation (Steffen 2006). Other taxa identified through the analysis of hearths include starry flounder, Pacific cod, gunnel/prickleback, lingcod, hake, and cabezon. Steffen's research has concluded that the hearths at the Richardson site were used for short periods of time with each hearth having a different composition of taxa indicating that people were conducting very task-specific activities (2006).

NISP for Hearth Features from Richardson Island		
Fauna	NISP	Hearth Feature
Rockfish	1403	E11 F1, Q12 F1, U21 F1, J21 F1, H22 F1, G22 F1, J23 F1, S22 F1, R23 F1, R24 F1, R24 F2, R24 F3, T24 F1, K26 F1, K26 F2.
Salmon	59	Q12 F1, J21 F1, J23 F1, R24 F1, T24 F1.
Dogfish	75	Q12 F1, J21 F1, H22 F1, G22 F1, J23 F1, S22 F1, R23 F1, R24 F1, R24 F3, T24 F1, K26 F2.
Arrow Tooth Group (Flounder/hake/ cabezon)	172	E11 F1, E14 F1, Q12 F1, J21 F1, H22 F1, G22 F1, J23 F1, S22 F1, R24 F1, R24 F3, T24 F1, K26 F1, K26 F2.
Lingcod	34	J21 F1, J23 F1, R23 F1, K26 F1.
Starry Flounder	7	Q12 F1, J23 F1
Greenling	9	Q12 F1, G22 F1, J23 F1, K26 F1
Irish Lord	27	Q12 F1, G22 F1, J23 F1, S22 F1, R24 F1, K26 F1.
Herring	7	Q12 F1, J23 F1, S22 F1, R23 F1.
Halibut	2	Q12 F1, R24 F1.
Perch	8	H22 F1, R24 F1.
Prickleback	17	G22 F1, J23 F1, R23 F1, K26 F1, K26 F2.
Flatfish	3	G22 F1, S22 F1.
Sculpin	6	J23 F1, S22 F1, R23 F1, R24 F1
Cabezon	1	J23 F1
Pacific cod	2	R24 F1
Gunnel/Prickleback	3	G22 F1, R24 F1.
Mammal	156	E11 F1, Q12 F1, J21 F1, H22 F1, G22 F1, J23 F1, S22 F1, R24 F1, R24 F2, T24 F1, K26 F1, K26 F2.
Small mammal/bird	16	K26 F1, Q12 F1.
Bird	16	Q12 F1, U21 F1, J23 F1, S22 F1, R23 F1, R24 F1.

Table 3: NISP for fauna recovered from hearth features at Richardson Island. Based on Steffen 2006

3.4.3 Flora

Analysis of soil samples from the Richardson site has revealed the presence of flora including western hemlock, pine, sedge, rose family, blueberry/huckleberry, goosefoot, saskatoon and grass (Fedje et al. 2005) although more detailed research on the flora is needed. At Logan Inlet, located near to Richardson Island, pollen samples extend as far back as 12, 000 BP when lodgepole pine is dominant and ferns are also abundant. These samples indicate that mountain hemlock is also present in low frequencies before 11, 000 BP. Then around 11, 200 BP, there is a distinct transition from lodgepole pine to Sitka spruce. Green alder and ferns also increase in abundance (Lacourse and Mathewes 2005).

3.4.4 Lithics

The assemblage of lithics at Richardson Island represents a wide variety of tool types. Preliminary analysis of these lithics has suggested that many of the tool types appear to grade into one other and could have served multiple purposes (Smith 2004; Fedje et al. 2005; Steffen 2006). All of the lithics recovered since 1993 at the Richardson site have been classified using a Parks Canada typology (See Table 4 for types). This typology has been employed to classify all of the artifacts found at archaeological sites within the Gwaii Haanas National Park Reserve/Haida Heritage Site (Smith 2004). Similarly, for the purposes of cataloguing, the Parks Canada typology was used for this research project although the typological structure of the unifacial tools was revisited (See Appendix C).

Defined tool categories represented at the Richardson Island site include cores, microblade cores, microblades, scrapers, scraperplanes, scrapers, unifacial tools, utilized flakes, unimarginal tools, bifaces, bifacial preforms, choppers, bimarginal tools, spokeshave/notches, spall tools, gravers, burins, wedges, hammerstones and abraders (Table 5) (Fedje et al. 1996; Fedje and Christensen 1999; Smith 2004; Fedje et al. 2005). The frequencies of each artifact type, separated into the Kinggi Complex and Early

Frequencies of Artifact Types at the Richardson Island Site for the Kinggi Complex and the Early Moresby Tradition			
Artifact Type	Kinggi Complex	Early Moresby Tradition	Total
Unimarginal tools	310	57	367
Graver/Burins	271	40	311
Spokeshave/Notches	212	20	232
Scraperplanes	173	17	190
Scrapers	142	22	164
Unifacial tools	14	4	18
Choppers	9	3	12
Bimarginal tools	12	2	14
Biface sum	165	58	223
Microblade technology	3	394	397
Spall tools	2	0	2
Wedges	14	0	14
Utilized flakes	655	16	671
Cores	237	71	308
Abraders	181	0	181
Hammerstones	42	0	42
Bone point tips	3	0	3

Table 4: Frequencies of artifact types at the Richardson Island site.

Moresby Tradition, can be found in Table 4. This table includes only those artifacts found in excavation units 10, 12 and 13 and includes the three calcined bone point tips recovered in hearth deposits. Note that the large quantity of debitage collected from the site (n= approx. 47, 953) was not included in Table 4. While these tool categories are meaningful for the separation and analysis of lithics at the site, it is important to note that many of these types are not necessarily bounded entities but often exhibit multiple characteristics from more than one type. For instance, the category of unifacial tools encompasses cobble choppers, scrapers, scraperplanes, unifaces, unimarginal tools, spokeshaves/ notches, gravers and burins. Many of these defined types overlap with each other and probably served multiple purposes. Preliminary analysis of the relationship between unifacial tools and hearth features at the site (Steffen 2006) suggests that many of theses tools could have served various functions from cutting

Tool Types	Definitions
Core	Unidirectional or multidirectional flake scars on a block of raw material indicating flake removal for the manufacture of stone tools.
Biface	A tool that has been flaked on two surfaces, meeting to form one edge (Andrefsky 2005).
Bifacial preform	A biface in stages just prior to its finished form (Andrefsky 2005)
Microblade core	Cores that have been found in Gwaii Haanas are flat-topped, ranging in morphology from “bullet-shaped” to “conical” to “boat-shaped.” These cores exhibit crushing on their bases, have some lateral platform crushing and are moderately wide. May show evidence of rejuvenation by flute-face removals (Fedje et al. 2005).
Microblade	Small blades or flakes that exhibit parallel lateral edges, manufactured by a pressure technique. Often these blades are inserted into the side of slotted bone points or hafted to the ends of shaft and used as knives, projectile points or spears (Fedje et al. 2005).
Scraperplane	Large planar to dome shaped tools with steep working edges of 80-90º. Most are made on large pieces of igneous or metamorphic rock and sometimes these tools are made on large robust flakes.
Denticulate Scraperplane	Scraperplanes that exhibit one or more pronounced projections along their working edge (Fedje et al. 2005).
Scraper	A flake tool that has a retouched edge angle of between approximately 60-80º that is suitable for a variety of tasks including scraping hides, planning wood or bone, and cutting like a knife.
Chopper	Includes large, unifacially flaked cobbles most likely used for butchering, felling trees or woodworking (Fedje et al. 2005).
Unimarginal tool	Tools that have flake removals on one margin and one surface only.
Unifacial tool	Tools that have flake removal on one surface only (Fedje et al. 2005). Flake scars penetrate more than 1 cm from margin.
Bimarginal tool	Tools that have flake removal along a margin on both faces.
Spall tool	Unifacially flaked tools whose dorsal side consists of cortex.
Wedge	A thick flake, core fragment of piece of shatter that exhibits a tapered end with evidence of dulling on the edge angle and evidence of battering on the opposite end. A tool utilized for the splitting of bone or wood.
Utilized flake	A flake that exhibits use-wear such as edge rounding, microfracture, crushing or edge nibbling on one or more of its margins.
Graver	A tool characterized by the presence of one or more small projections, often isolated by unifacial flaking and frequently showing evidence of microflaking edge damage and polish. Often co-occurs with spokeshaves.
Spokeshave/Notch	A tool characterized by one or more unifacially flaked concavities. Possibly used to scrape, shape, and smooth bone or wood objects (Fedje et al. 2005).
Burin	A tool characterized as having a chisel-like edge produced by removing two flakes or spalls at right angles to each other (Andrefsky 2005).
Hammerstone	A rock exhibiting some form of damage such as crushed ends or edges, used in hard hammer percussion.
Abrader	Abrasive stones made from materials such as sandstone and used to work stone, bone, wood and shell. Their presence in sites in Haida Gwaii indicates the possible manufacture of items out of organic materials such as bone and wood. (Fedje et al. 2005).

Table 5: Tool typologies for Haida Gwaii (Smith 2004; Fedje et al. 2005)

and scraping to incising and perforating (Smith 2004; Fedje et. al 2005). The multifunctionality of the tools at the Richardson Island site will be discussed later in this thesis.

3.4.5 Raw Materials

Studies of raw material use at the Richardson Island site by Smith (2004) have revealed changes in material types over time in the archaeological record of site activity. Through a geochemical analysis of the materials used in stone tool manufacture, Smith finds that the most abundant raw material types at the Richardson site are siliceous argillite and shale/argillite but that these two materials are not evenly distributed over time. In a comparison of raw materials to tool types over time, Smith notes that there is more siliceous argillite being used in the Kinggi Complex and more shale/argillite being procured in the Early Moresby Tradition. While some materials present in the Kinggi Complex such as basaltic-andesite, andesite and wacke appear to decline or disappear through time, it is during the Early Moresby Tradition when new material types emerge such as chert, rhyolite 26, and chert/rhyolite. However, Smith states that the Kinggi Complex "has a predisposition to greater raw material diversity" (2004:164). Exploring the relationship between tool type and raw material, Smith finds that bifaces are the least flexible in terms of raw material availability as there is little change of raw material use with this tool type between the Kinggi and Early Moresby periods at the Richardson site. Scraperplanes and scrapers, however, do change material types over time. During the Kinggi Complex, scraperplanes tend to be manufactured from siliceous argillite while during the Early Moresby period, this material decreases and rhyolite use increases. Smith also finds that raw material use among unimarginal tools remains highly variable throughout time (2004: 149). After this very detailed analysis of material types used at the Richardson site, Smith argues that the changes seen in the use of raw materials during the Kinggi Complex and into the Early Moresby period were influenced by rising sea levels (115).

3.4.6 Association of stone tools and hearth features

In her analysis of hearth features from the Richardson site, Steffen (2006) investigates the presence or absence of specific types of stone tools around the hearths. Testing the relationships between artifacts and hearths, Steffen finds that there are more marginal and scraper tool types found in layers that have hearth features while spokeshave and graver types of tools are significantly less likely to be associated with hearth features (2006:206). Steffen suggests that activities such as fish processing, preparation of hides and bone and woodworking activities would have occurred adjacent to the hearths. The results of Steffen's analysis on the relationship between hearths and stone tools at the Richardson site relates only to a relatively short period of time (approximately 200 years) within the Kinggi Complex.

3.4.7 Site Chronology

Along with a well-documented and detailed stratigraphy for the Richardson site, sixteen accelerator mass spectrometry (AMS) dates were obtained from charcoal samples taken from each stratigraphic layer. The earliest date obtained was located on the surface of Stratum 1 with a date of 9590 BP. The earliest date for human occupation at the site was around 9290 BP (Fedje et al. 2005). More recently, six dates from excavations in 2007 revealed the continued use of the site up until approximately 3000 BP (Table 6).

3.4.8 Cultural Components

The Kinggi Complex and the Early Moresby Tradition are the most well defined periods at the site. As mentioned above, it is also within the Kinggi Complex when both hearths and post mould features are present. Through the cultural layers representative of the Early Moresby Tradition, there appears to be a decline in site use although this may be biased due to the spatial limits of the excavation. Excavations that occurred in 2007 were able to further trace the archaeological record up into the Early (Transitional)

Graham Tradition (ca. 5000-3000 BP) however only a small record of site activity was recorded.

Temporally, excavation at the site has revealed that some lithics are represented fairly consistently throughout the archaeological record at the site while other lithics increase or decrease in frequency. While bifaces are prevalent within the earliest levels at the site (9300 BP), these artifacts decrease at 8400 BP and seem to disappear by approximately 8000 BP, while microblade technology appears at 8750 BP and gradually increases over time. This shift in technologies is well-defined at the Richardson site due

Richardson Island (1127T) Radiocarbon Dates (radiocarbon years BP)				
Excavation Unit/Sample #	Stratum	Depth (cm)	Material	Age (BP)
Excavation Unit 10				
Sample #				
1127T10J3-61	2c	61	charcoal	8470 ± 60
1127T10N-108	2b	108	charcoal	8640 ± 50
1127T10N-251	2b	251	charcoal	8850 ± 60
1127T10S-325	2b	325	charcoal	8700 ± 60
1127T10S-329	2b	329	charcoal	8980 ± 60
1127T10S-347	2b	347	charcoal	8960 ± 60
1127T10S-354	2a	354	charcoal	9080 ± 60
1127T10S-374	2a	374	charcoal	9160 ± 60
Excavation Unit 12				
Sample #				
1127T12T18	2a	404	charcoal	9290 ± 50
1127T12T20	2a	421	charcoal	9290 ± 50
1127T12R21	2a	434	charcoal	9590 ± 50
Excavation Unit 15				
Sample #				
1127T15A2			charcoal	2950 ± 15
1127T15L6			charcoal	4770 ± 15
1127T15L8			charcoal	4970 ± 15
1127T15B11			charcoal	8585 ± 20
Excavation Unit 16				
Sample #				
1127T16A3			charcoal	3820 ± 20
1127T16A17			charcoal	8280 ± 20

Table 6: Radiocarbon dates for Richardson Island

to the high resolution of the stratigraphy, meaning that it is possible to see this technological change as a gradual transition rather than an abrupt replacement. Therefore, at the Richardson site, there is a strong indication that technological change occurred within the same group of people as opposed to reflecting an abrupt replacement of one cultural group for another (Magne 2004; Smith 2004; Fedje et al. 2005; Fedje et al. 2008).

An analysis of microblade technology in Gwaii Haanas and, specifically, at the Richardson Island site by Magne (2004) suggests that there are temporal patterns in the frequencies of certain artifacts and raw material types that support a theory of in-situ change versus ethnic replacement. These patterns are also seen at two other southern sites, Arrow Creek I and Lyell Bay, dating to a slightly later occupation than the Richardson Island site. The results of Magne's study indicate that biface and scraperplane technology decrease over time while microblade technology increases. Magne finds a negative correlation between bifacial and microblade technologies but a positive correlation between bifaces and scraperplanes at the site. Based on his results, Magne concludes that scraperplanes and microblade cores shared several morphologically similar attributes indicating that microblade technology could have arisen out of the manufacturing of scraperplanes in earlier levels (Magne 2004; Mackie et al. 2008).

While there have been recent studies of bifacial and microblade technologies (Magne 2004; Fedje et al. 2008), geochemical analysis of raw materials used at the site (Smith 2004) and a detailed examination of hearth features (Steffen 2006), there has only been a very preliminary analysis of unifacial tools found at Richardson Island. Significantly, unifacial tools are the most numerous portion of the assemblage and seem to occur fairly consistently throughout the earliest and into the latest levels excavated at the site. By only focusing on bifacial and microblade technologies, important questions regarding continuity and change at Richardson Island have not been properly addressed. Further analysis of these artifacts would fill a gap in the knowledge of human activity during this time period. A more rigorous study of unifacial tools might help answer broader questions regarding patterns of continuity and change, situating the Richardson site within the larger context of early peoples on the Northwest Coast.

3.5 Discussion

Detailed stratigraphic resolution reveals that people were intensively using the Richardson site for relatively short periods of time from 9300 BP to 8500 BP but that the use of the site continues up until approximately 3000 BP. Faunal remains from the hearths at the site confirm that people were exploiting a wide variety of resources, both seasonally and year round and were living in a diverse, marine environment. Evidence from hearth features also emphasizes the short term diversity of marine resource exploitation from year to year. An analysis of raw material use indicates that people were using a diversity of material types that could be found locally and that they experimented with these material types through time (Smith 2004).

3.6 Richardson Island in the Broader Context

Haida Gwaii

Richardson Island is just one of several sites that are located between 15-30 meters above the current shoreline in Haida Gwaii. Hobler (1978) located the lithic site of Arrow Creek 1, situated on a 15 meter terrace in southern Haida Gwaii (Figure 1), although most of the early archaeological surveys remained limited. The Gwaii Haanas Archaeology Project (1991-1996), that combined digital elevation models with archaeological survey and testing, discovered 17 previously unrecorded sites on terraces and elevated beaches (Fedje et al. 1996; Fedje and Christensen 1999). The site of Arrow Creek I, located adjacent to Matheson Inlet, Juan Perez Sound, on the east coast of Moresby Island, was discovered 17 meters above the modern high tide line. Similar to Richardson, shell and other organic materials are absent from Arrow Creek I with an artifact assemblage composed only of stone. The artifact assemblage includes many similar stone tool types that are recorded for the Early Moresby Tradition at the

Richardson Island site including microblades and microblade cores, cobble choppers, unidirectional cores, spokeshaves, hammerstones, multidirectional cores and utilized flakes (Fedje et al. 2005). Two raised beach sites situated in Lyell Bay, Lyell Bay South and Lyell Bay East, also revealed an assemblage characterized by microblades, unidirectional and multidirectional cores, and core and flake tools. Lyell Bay South had a range of 8400 BP to 6600 BP and Lyell Bay East a range of 8800 BP to 5000 BP (Fedje and Christensen 1999). Other raised beach sites on central and northern Haida Gwaii include Cohoe Creek, Lawn Point, Kasta, and Strathdang Kwun (Fedje and Christensen 1999).

British Columbia

Within British Columbia, the site of Namu, situated on the coastal mainland, exhibits some comparability to the assemblage at the Richardson Island site. With a basal date of ca. 9700 BP, extensive excavations at Namu (Carlson 1996) have revealed a developed microblade technology beginning between 9000 and 8500 BP and prior to 9000 BP, an assemblage consisting of bifaces and cobble choppers (Carlson 1996; Rahemtulla 2006). A single contracting-stemmed point, similar to some of the points recovered at the Richardson Island site, was found in the basal component at Namu (Fedje et al. 2008). A thorough analysis of stone tools and debitage recovered from the site argues for an early and well-established maritime adaptation at Namu (Rahemtulla 2006). Other comparable sites include Bear Cove, situated on Vancouver Island and dated as early as 8900 BP (Carlson C. 2003) and the Glenrose site, located in the lowlands of the Fraser Valley, with dates between 8500 and 5500 BP (Fedje and Christensen 1999). Recent archaeological investigations in the Dundas Islands, situated on the outer mainland coast of British Columbia, have resulted in the discovery of five sites dating to the early Holocene with the earliest evidence of human occupation occurring sometime between 9690 and 6185 BP. These sites are consistent with the sea level curve proposed for the archipelago (McLaren 2008). Research along the Stave River, in southwest British Columbia has also provided evidence for early human occupation with the earliest cultural component dating to 10, 150 BP (McLaren 2008).

Alaska

Further north, in southeast Alaska, several sites have been discovered in areas that would have once seen sea levels 8 to 15 m higher than at present. The sites of Ground Hog Bay 2, ca. 9500 BP, and Hidden Falls, ca. 9000 BP, both contain components that are similar in some respects to the assemblage at Richardson Island. At On Your Knees Cave, points of similar style to the Richardson Island specimens (the Kuuxil style) have been recovered (Fedje et al. 2008). In the Prince of Wales Archipelago, the Chuck Lake site exhibits a microblade tradition that is comparable to the microblade tradition seen in Haida Gwaii. Studies of the microblade cores found in Moresby Tradition components in Haida Gwaii have indicated that these cores share similar morphological characteristics with those from the Chuck Lake site (Magne 1996; Fedje and Christensen 1999). Evidence thus far has shown a distinct transition between biface to microblade technology in both Haida Gwaii and Alaska, however, this marked shift occurs earlier in Alaskan sites. In the interior of Alaska, several sites have been assigned to either the Nenana complex (ca. > 11,600-10,500 BP), the Denali complex (10,500-8000 BP) or, in some instances to both. The Nenana complex is characterized by triangular and "teardrop shaped" projectile points, lanceolate projectile points, end and side scrapers, burins, unifacial knives and by an absence of microblade technology. Broken Mammoth, located in the Tanana River Valley, is one prominent site that is included within the Nenana complex. In comparison, the Denali complex (ca. 10,500-< 7000 BP) has been defined based on the presence of microblade technology as well as the inclusion of bifacial knives, projectile points, endscrapers, large blades, burins, and worked flakes (Dixon 2001). Fedje et al. (2008) suggest that technologies represented in both regions may have evolved from one ancient western Beringian technology.

Western Canada

In western Canada, the assemblages at sites of Eclipse and Vermillion Lakes near Banff appear to also have some similarity to those from the Richardson Island site. The

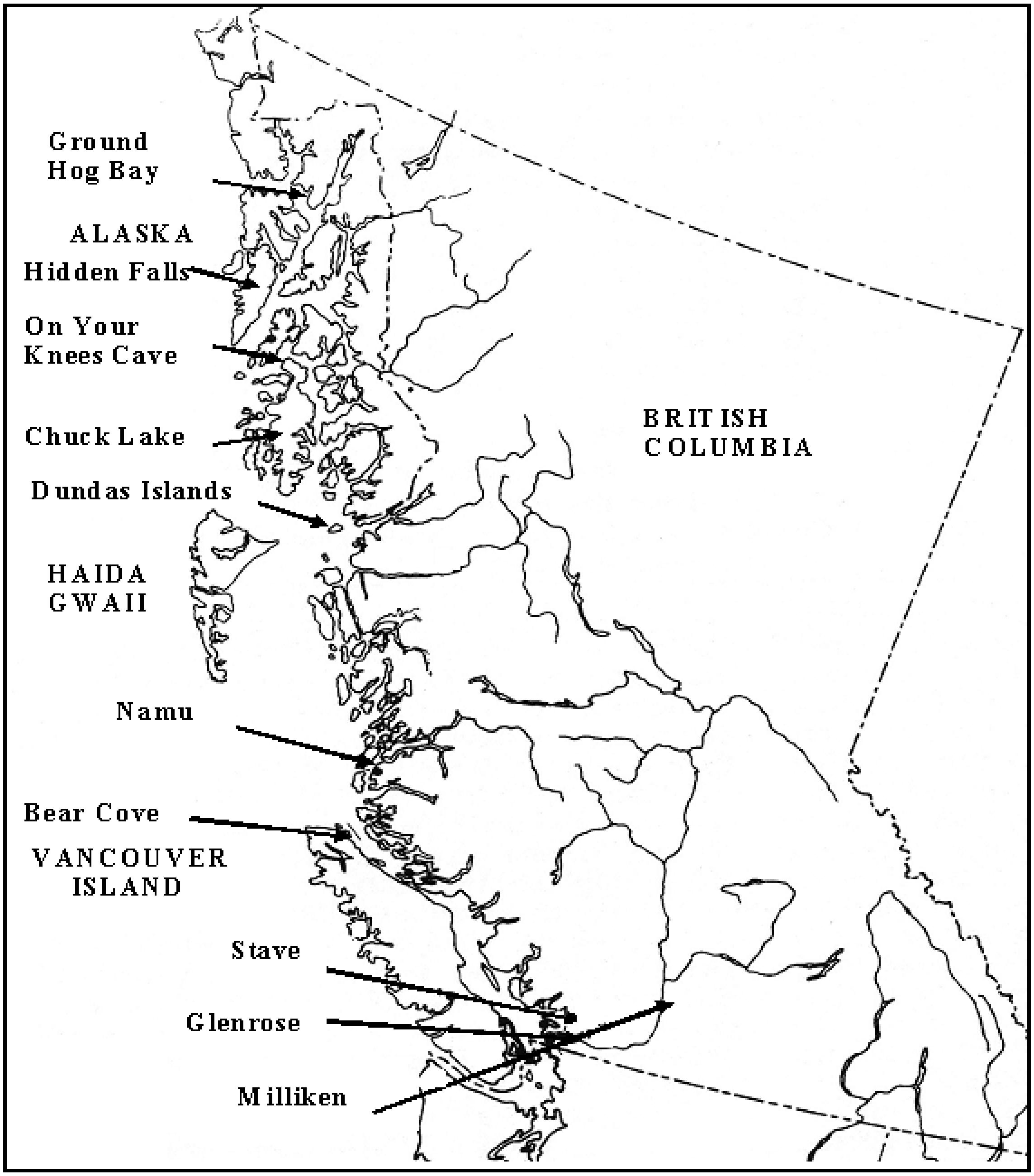


Figure 6: Map of British Columbia and Alaska showing some significant Late Pleistocene/Early Holocene archaeological sites outside of Haida Gwaii.

assemblages at these interior sites include choppers, scraperplanes and simple flake tools as well as contracting-stemmed points dating from 10,200 to 9700 BP (Fedje et al. 1995; Fedje et al. 2008).

Late Pleistocene/Early Holocene Sites on the Northwest Coast			
N.W.C. Archaeology Sites	Location	Earliest Dates ^{14}C	References
Gaadu Din 2 Cave	Southeastern Haida Gwaii	11, 030 BP	Mackie et al. 2008
K1 Cave	West Coast of Moresby Island, Haida Gwaii	10, 950 BP	Fedje and Mathewes 2005
Gaadu Din 1	Southeastern Haida Gwaii	10,660 BP	Fedje et al. 2008
On Your Knees Cave	Southeast Alaska	10,300 BP	Dixon 1999
Stave Lake sites	Southwest British Columbia	10, 150 BP	McLaren 2008
Namu	Coastal mainland of B.C.	9700 BP	Carlson 1996
Far West Point	Dundas Islands, mainland coast of British Columbia	9690 BP	McLaren 2008
Hidden Falls	Southeast Alaska	9500 BP	Ackerman 1996b
Kilgii Gwaay	Southern Haida Gwaii	9400 BP	Fedje et al. 2005
Gwaii Haanas intertidal sites (n=112)	Southern Haida Gwaii	9400 BP	Mackie and Sumpter 2005
Richardson Island	Southeast Haida Gwaii	9290 BP	Fedje et al. 1996; Fedje and Mathewes 2005
Ground Hog Bay, Site 2	Southeast Alaska	9200 BP	Ackerman 1996a, 1996b
Milliken	Fraser River Canyon	9000 BP	Mitchell and Pokotylo 1996
Glenrose Cannery	Lowlands of the Fraser Valley	ca. 8700 BP	Matson 1996
Chuck Lake	Southeast Alaska	8200 BP	Ackerman 1996b
Bear Cove	Northeastern Vancouver Island	8020 BP	C. Carlson 2003

Table 7: Late Pleistocene/Early Holocene archaeological sites on the Northwest Coast

Asia

In a recent analysis of projectile points from Haida Gwaii, Fedje et al.(2008) note that Kuuxil style points (contracting-stemmed points) from the Richardson Island site are similar to foliate points discovered at the Uptar site, in northern Priokhotye and the Ushki sites in Kamchatka, both in northeastern Asia. The Uptar site is situated on a fluvial terrace on the banks of the Uptar River and consists of a single cultural component. Most of the tools recovered from the site are bifaces and biface fragments (80%) but a small number of microblades and flake tools have also been found (Slobodin and King 1996). The Ushki sites are located on the southern shore of Great Ushki Lake in the Kamchatka Peninsula with evidence of use during the Late Pleistocene/Early Holocene. Bifacial technology and wedge-shaped microblade cores are both present at the sites as well as scrapers, drills, burins, unifacial knives, stone beads and pendants (Dikov 1996).

3.7 Summary

The Richardson Island site has provided a very detailed record of human activities during the Early Holocene in southern Haida Gwaii. Each new study that is conducted for the site adds new information to the complex cultural and environmental processes that formed the archaeological record. An analysis of hearth features by Steffen (2006) showed that people were conducting task-specific activities at the site and utilizing a diverse collection of marine resources. Smith's (2004) geochemical analysis of raw materials found at the site concluded that people were using a diverse selection of local materials in order to meet certain technological requirements. A shift from bifacial to microblade technology at the site showed some correlation to the history of sea level change for the area. This noticeable shift in tool technology during the inundation of landforms in the area may suggest that people shifted their behavior as a result of this fairly rapid environmental change. Ultimately, by gaining a more in-depth interpretation of the Richardson Island site, research will not only broaden archaeological knowledge in Haida Gwaii but serve to connect cultural processes seen in the prehistory of the archipelago with other sites in British Columbia, Alaska, Asia and elsewhere.

Conclusion

As discussions above have indicated, one of the primary research interests at many late Pleistocene/Early Holocene sites has been this transition from bifacial technology to a focus on microblade technology. Connections between sites in Asia, Alaska, British Columbia, Haida Gwaii and elsewhere are most frequently discussed based on the presence or absence of these technologies. As the focus has ultimately highlighted biface and mircoblade technology, other technologies that also represent cultural practices, behaviors and movements have received considerably less attention. In many instances, these technologies appear to be less standardized, less distinctive, more expedient and fairly continuous throughout time therefore, these technologies are not thought to reflect cultural change to the same degree as bifacial and microblade technologies. Importantly, however, many of these more "expedient" technologies comprise the majority of assemblages found at any given site. This should lead archaeologists to question the significance of these persistent technologies. At the Richardson Island site, the stone tool assemblage is largely composed of unifacially manufactured tools that remain somewhat prevalent throughout the record of site activity. While the emphasis has been on cultural change as reflected in bifaces and microblades, an analysis of the unifacial tools found at the Richardson Island site may help set the context for this change or may show a cultural pattern that is much more fluid and continuous over time.

In the next chapter, discussions will turn to the general topic of lithic studies. This will provide the theoretical and methodological framework for the analysis of the unifacial tool assemblage at the Richardson Island site.

4 Method and Theory in Lithic Studies

Introduction

Unifacial tools from the Richardson Island site reflect activities conducted over the span of several thousand years. While many of these tools have been considered expedient with minimal retouch and a lack of standardization within specific types, these unifacially manufactured tools represent the majority of artifacts in the assemblage and as such, are an important part of the story of early peoples in Gwaii Haanas. While the unifacial tools at Richardson can provide information on manufacturing processes as they occurred at the site over time, more broadly, these tools have the potential to reflect social actions in a context of meaningful relationships between individuals, groups and their environments. As Dobres (2000:96) states, technologies are always socially constituted and technological practice should be viewed as an experience that is engaged, meaningful, mediated and materially grounded. From this holistic perspective, the unifacial tools of Richardson Island can be analyzed, not only in terms of their functional forms or technical qualities, but also in terms of how these forms reflect both collective and individualistic actions over time. In order to interpret the unifacial assemblage, some general theoretical and methodological concepts within lithic studies should be discussed. Insights into the form/function debate, use-life histories, chaîne opératoire and design theory are of particular importance to this study of the Richardson Island unifaces.

4.1 Theory in Lithic Studies: The Technical and Social

Anthropologist Daniel Miller (1987) has argued that all objects have a biography. Objects can go through different stages, serving various functions over their lifetimes, assuming different roles and given new meanings. Some artifacts provide a single function over their use-life while others may be multifunctional or may change form throughout their lifespan. Dobres (2000:4) notes that, although artifacts may have a life history that is fixed in time, the technology that created that artifact reflects an unfinished and ongoing process; a process that sees materials, people and society together creating and recreating everyday life. Ingold (2000) describes the process of tool making and use as partly intuitive, personal and created within a context of experience. It is this practice of tool manufacture that is both "indistinguishably social and technical" (Ingold 2000: 369). In recent years, some anthropologists have argued that studies of technology have maintained a distinct separation between technical and social phenomena (Ingold 2000; Dobres 2000). Ingold (2000:318) has noted that the technical does not stand apart from the social; a tool is not merely a separate mechanical object reflecting a series of direct commands from the mind but rather, a tool is an extension of the whole person who creates the object. Dobres (2000), Ingold (2000), Schiffer and Skibo (1987) among many others, place an emphasis on the engagement of people in the process of making and using technologies.

The application of some aspects of social theory to studies of stone tools can be beneficial in both generating hypotheses and in the interpretations of technological behavior. Explanations for artifact variability in form across sites or within one site, as will be discussed below, have the potential to reflect the social actions of individuals and groups. An important point generated by theoretical considerations in social theory is that, an assemblage of stone tools from a particular archaeological site represents much more than can be easily detectable by the archaeologist. Aspects of social theory are found at varying levels in studies of lithics from archaeological contexts.

4.2 The Meaning of Form

4.2.1 Form (Emic or Etic?)

A prominent debate within lithic studies has revolved around the meaning of form. In this debate, types are either "emic", inherent in the material and representative of the mental template or intended form of the tool maker (Spaulding 1953) or these types are "etic", invented by the archaeologist and seen as "arbitrary divisions along a continuum of variation, divisions that are analytically useful but that have no necessary similarity to anything 'real' " (Ford 1954). Although the debate between Spaulding and

Ford brought forth a key issue in the creation of artifact typologies, many researchers were quick to emphasize that typological constructs involve both emic and etic components (Sneath and Sokal 1973). As Mackie (1995) notes, Ford's etic types are useful for understanding assemblages over broad spans of time and place; the arbitrary divisions in a group of artifacts may provide clearly defined and supportable results. However, Spaulding's emic types, while more limited to culturally-specific contexts, arguably provide a view into the past that can be understood by all archaeologists with the recognition that some level of distortion will always be present and must be taken into account (Mackie 1995). Adams and Adams (1991) argue that classifications of artifacts are, to a certain degree, both natural and artificial; the validity of these types ultimately lies in their value. Odell (1981:321) argues that a system of classification that is based on formal typology or morphological type is part of the foundation of archaeological methodology. While, as Nelson states (1991), typological analysis provides archaeologists with the ability to identify, describe and interpret relationships in specific archaeological contexts, Tomášková (2005:83) writes that types are often problematically thought of as discrete units that rely on a "principle of boundedness." However, Adams and Adams (1991) see boundaries in the creation of typologies as a practical means for sorting artifacts. The classification of specific types of artifacts can be challenged by forms that do not represent clear-cut distinctions; types that exhibit some morphological variation or appear to represent more than one defined type. How we choose to categorize or classify an object may affect our analysis and interpretations of the behaviors and activities represented at a specific site.

4.2.2 Variation in Form

One prominent debate that arose out of studies of stone tool assemblages centered on the explanation of variability in the stone tool types as defined by archaeologists (See Table 8). The analysis and interpretation of assemblages from the Mousterian provides an ideal example for discussion. In an analysis of different types of Mousterian stone tools recovered from various sites in France, François Bordes concluded that variations in tool forms occurred as a result of variations in cultural groups. Bordes found that similar types of tools were found at several independent sites indicating that these small cultural groups appeared to share a general Mousterian culture. Any variation in these generalized types might be attributable to differences between groups of people; these types might be representative of ethnic divisions (Bordes 1961). In contrast to Bordes, Binford and Binford (1966) saw the variation in Mousterian tools reflecting different ‘tool-kits’ due to different kinds of activities or types of sites. Instead of viewing variation in Mousterian tool forms as reflecting differences in ethnic identity as suggested by Bordes, the Binfords’ analysis centered on the cultural behavior of groups; how behaviour, as reflected through different kinds of activities, environments or practices, could result in varying types of stone tools (Binford and Binford 1966).

Explanations of Stone Tool Variability at Archaeological Sites	
General Explanations of Variability	**References**
Variation in types attributable to differences in cultural groups. Reflection of ethnic divisions.	Bordes 1961.
Variation in types as reflective of different "tool-kits" as a result of different kinds of adaptation. Reflective of differing activities, practices or environments.	Binford, L. and S. Binford 1966.
Variation in tool types reflecting differences in resharpening, reduction and access to raw materials.	Rolland and Dibble 1990; Dibble 1995a, 1995b.
Social theory. Variation due to conceptual, technical and economic factors. The influence of social factors such as age and gender on the variability of assemblages.	Dobres 2000; Morris 2004.
Variability in tool types as reflective of replacement of one group for another.	Powers and Hoeffecker 1989; Hoeffecker et al.1993; Dixon 2001; Goebel et al. 2003.
Variability in tool types representing "in-situ" development of technologies not ethnic replacement	Magne 2004; Smith 2004; Fedje et al. 2005.

Table 8: Explanations for Tool Variability in Archaeological Contexts

Differing explanations for tool type variation across sites and through time continues to be a readily debatable topic. In addressing questions of technological variability across sites within a region or change through time, stone tool assemblages are often seen as reflecting one ethnic group in opposition to another versus indicating variability and change due to factors such as environmental adaptations. Specifically, a significant amount of the archaeological study surrounding the peopling of the Americas has focused on explaining the differences between stone tool assemblages using ethnic replacement as the central factor (Powers and Hoffecker 1989; Hoffecker et al. 1993; Dixon 2001; Goebel et al. 2003). As mentioned in Chapter Three of this thesis, studies on technological change at the Richardson Island site have argued that change occurred in one group over time as opposed to indicating ethnic replacement (Magne 2004: Smith 2004; Fedje et al. 2008). This has wider implications for the emergence of microblade technologies within early archaeological contexts that contain both non-microblade and microblade components. Did one cultural group begin manufacturing this distinctive technology or does the presence of microblades suggest that a new group of peoples had arrived?

In light of the varying explanations for artifact variability across space and through time, the most meaningful interpretations will be those that allow for multiple factors to be taken into account. There may be several factors affecting each other in some way and leading to the variability seen in any given assemblage. How did the environment affect subsistence practices and vice versa? What were the activities taking place at a site and how might these practices have changed through time? How could social factors have influenced assemblage variability? In summary, how does the behavior of both groups of people and individuals living in and exploiting their environments lead to the changes and variable artifact forms recovered in archaeological contexts?

4.2.3 Form and Function

Of theoretical and methodological concern to lithic analyses is the contrast between form and function. Can archaeologists deduce function based on the observable forms that they see? The development of use-wear studies by Semenov (1964) was seen as a revolutionary methodology that fueled new interest into how a stone tool was utilized, leading to the concept of the multipurpose or multifunctional tool; that some tools were used, for example, for scraping, cutting and graving all in one. However, this multifunctionality may represent stages in the life of a tool rather than a tool that was created for the purpose of being multifunctional. As Rahemtulla (2006) notes, it can be very difficult for archaeologists to determine whether a stone tool exhibiting characteristics from more than one tool type (i.e., a scraper/graver tool) was created to be used as a multifunctional tool or whether the tool was designed with one function in mind and later reformed to serve a new purpose. Increasingly, many archaeologists have come to realize that many tools are not limited to one function and are constantly re-shaped and resharpened for specific tasks (Odell 1981; Rolland and Dibble 1990; Dibble 1995a, 1995b; Holdaway et al. 1996).

As more archaeologists conducted analysis of retouched tool edges, use-wear, metric attributes and amounts of reduction, many of the inconsistencies between the functional and formal categories were revealed. Studies conducted by Wylie (1975) on lithics from the Hogup Cave in Utah revealed a disjunction between the “expected” functions of the tools based on their functional names (scrapers and projectile points) and their actual uses. Wylie discovered that both defined tool types showed an unexpectedly high frequency of wear from cutting. This is a cautionary point for archaeologists studying any stone tool assemblage. Whether a tool is classified as a scraper, drill, spokeshave, biface, graver, projectile point or chopper, it does not necessarily imply only one function. Ethnoarchaeological work in Australia and New Guinea by Strathern (1969) and White (1967) revealed that, in many instances, the same stone tool could serve several different tasks. A large piece of chert could be used as a hammer, a scraper, a core, a plane and a knife or a flake may have functioned for cutting, gouging, scraping and plant fiber shredding. However, an ethnoarchaeological investigation conducted by

Hayden (1979) indicated that, for the study sample, there was a basic tool morphology for differing types of major tasks and that edge angle had a functional significance. As will be discussed below, the multifunctionality of many tools can be a challenge to interpretations of lithic assemblages but can also be an opportunity for understanding assemblages that have variable tool forms.

4.2.4 Style versus Function

In a discussion of typological forms in archaeology, there is always the question of how archaeologists should go about creating or defining archaeological units or types. The stylistic and functional attributes of a stone tool may co-exist to create a specific type or may be seen in opposition to one another. Dunnell (1978) refers to the use of both style and function in archaeology as a “fundamental dichotomy” emphasizing that style is often used as an explanation for similarity or to explain large scale phenomena while the term “function” is aligned to the use of an artifact. However, Adams and Adams (1991) define “function” as an “inferential variable” whereby the designation of a functional attribute on an artifact is an inference made by the archaeologist and may not reflect how it was really used in the past. Contrary to Dunnell (1978), Adams and Adams (1991) argue that there is no real dichotomy between formal and functional classification. They state that categories such as “chopper, “graver” and “scraper”, although classified according to a presumed function, are differentiated by way of their formal attributes and not because there is any secure knowledge of how these tools were once used (285).

As can be summarized from the discussions above, considerations of the forms of artifacts found both spatially and temporally in the archaeological record involve complex theoretical and methodological considerations. All archaeologists are confronted with the inevitability of having to organize their assemblages into some sort of framework or structure in order to interpret their results. The organization and categorization of specific forms will ultimately affect the interpretation of the assemblage, the site and the activities and behaviors of past peoples. Therefore, form, with all of its variability, remains a very concrete issue for lithic analysis. However, in order to further expand on the manufacture and use of stone tools and come to greater understandings of the forms that are discarded and discovered by the archaeologist, other studies must be incorporated.

4.3 Use-Life Histories

Within lithic studies, there has been an increasing abandonment of normative-empiricist views on cultural behavior towards recognizing the processes that led to the discard of lithics within the archaeological record (Dibble 1995a, 1995b). Early replication studies of flint knapping conducted by Crabtree (1977; Crabtree and Davis 1968) investigated how stone tools were manufactured and used and archaeologists such as Rolland and Dibble (1990) and Dibble (1995a, 1995b) began emphasizing the need to look at the variability within assemblages; reflecting stages in a process of reduction or a desirable end product. Tied to this interest in process was a need to understand the use-histories of stone tools from procurement of raw materials to final discard within the archaeological record. Attempts to explain variability in flaked stone tools included studies that focused on initial blank morphology (Kuhn 1992), resharpening and general maintenance processes for tools with dull edges (Dibble 1988), raw material scarcity and economizing behavioral patterns (Rolland 1981), or a combination of these and other factors.

4.3.1 Measuring Tool Reduction

As researchers such as Dibble (1995b), Kuhn (1990, 1992) and Tomášková (2005) among others have argued, many stone tools that have been previously separated into specific types may actually represent stages along a process of retouch or reduction. In a re-evaluation of scrapers from the Middle Paleolithic, Dibble (1995b) argues that the traditional interpretation of scraper classes is part of a normative-empiricist approach. These scraper "types" have been viewed as "cognitively real end products, purposefully manufactured according to cultural tradition to address specific functional needs" (1995b:

322). Breaking away from theoretical and methodological approaches that study stone tools as planned end products, reduction models are employed to understand how long a tool has been in use as well as its initial blank size, relationship to raw material sources and connection to mobility patterns. The intensity of use and re-use of a tool can reveal the availability of resources and the intensity of site occupation. Hiscock and Attenbrow (2003) have noted that the reduction-orientated approach to lithic analysis has increasingly challenged typological models and many recent studies seek to re-evaluate previously categorized tool types within archaeological records through the implementation of reduction indices (Kuhn 1992; Clarkson 2002; Eren et al. 2005; Hiscock and Clarkson 2005).

4.4 The Chaîne Opératoire

The concept of the chaîne opératoire is an attempt to explore technological variability with an emphasis on the cognitive aspects of technological processes. Seen as a meaningful methodology for lithic analysis, the chaîne opératoire has been defined as "the totality of technical stages from the acquisition of raw materials through to its discard, and includes the various process of transformation and utilization…Each technical stage reflects specific technical knowledge" (Böeda 1995: 43).

Described as an analytical grid by Close (2006), the ultimate purpose of the chaîne opératoire is to include social, economic and physical factors in order to provide a more holistic method for analyzing stone tools that emphasizes the cognitive abilities of the knapper. However, Dibble (1995b) has linked the concept of the chaîne opératoire to normative-empiricist approaches that assume that tools found in an archaeological context reflect desired end products. Dibble argues that those researchers who draw from the chaîne opératoire for their analyses use the assumption of desired end products as the "starting point of the entire analytical approach" (1995b: 305). While Dibble states that the chaîne opératoire ignores processes of procurement and theories of maintenance and discard (1995b: 304), Close sees commonly used "Americanist" methods as emphasizing "interpretation free" or "meaning-free" analyses, creating meaning-free types that serve no purpose (2006:6).

As invaluable as reduction models of the use-histories of stone tools has been in the evolution of lithic analysis, there might be more to the study of stone tools than simply focusing on reduction sequences based on maintenance and use. Tomášková (2005:84) remarks that "detailed studies of technological practice suggest that techniques involve cultural choices deeply entrenched in local tradition and history." If stone tools really do reflect the lives of the people who made them and if people are dynamic social beings that move through space and time, should lithic analysis focus on trying to make these connections and interpretations?

One question that arises quite quickly from attempts to provide a more socially focused analysis of stone tools is how exactly to interpret the social behavior of past peoples from the material record. While there are archaeologists who have attempted to provide a more socially engaged interpretation of stone tool assemblages (Morris 2004; Close 2006), there are many other archaeologists who argue that it can be quite challenging to provide meaningful interpretations by incorporating social theory, such as discussed by Dobres and Hoffman (1994), to an analysis of stone tools (Hayden et al. 1996; Rahemtulla 2006). Although, theoretically, the concept of the chaîne opératoire is often linked to an emphasis on individual choice (Dobres 2000: Morris 2004), many researchers remark on the challenges of actually isolating specific social structures. Morris (2004) notes that the implementation of social theory, specifically social agency, challenges the archaeologist to consider the motivations and actions of individuals as reflected through an assemblage. He concludes, however, that it becomes very difficult to make this concept tangible through archaeological data. Rahemtulla (2006) advocates for the use of an agency based approach as well as a need to look at the larger socio-economic picture when studying stone tools. A dynamic view of technological behavior and organization must explore multiple variables that may or may not have contributed to the final discarded form of a tool at a site.

4.5 Design Theory

There are several theoretical and methodological concepts that have evolved within lithic analysis to explain variations in tool designs and technological organization on a local, non-local or temporal scale. Researchers have used numerous techniques for recording technological organization including, but not limited to, studies of paleoenvironmental conditions and changes over time, spatial analysis, variations in stone tool morphologies, site types, raw material sourcing, use-wear analysis and experimental projects. Variation in the techniques employed for the analysis of technological organization exposes the different theoretical backgrounds of individual researchers. While some archaeologists emphasize technological processes as more of a system than a humanized process, other researchers (e.g. Morris 2004; Close 2006; Rahemtulla 2006) attempt to include the social aspects of tool designs. As with any archaeological analysis, it is important to recognize that, while there can be general trends comparable across assemblages and sites, each assemblage will be influenced by varied situations and differing contexts. Some general concepts emphasized in design theory can provide a base understanding for stone tool analysis but assemblages will not necessarily fit neatly into these concepts; many concepts might also overlap with each other.

The basic concept of design theory in lithic studies evolved out of design analysis formulated in the fields of architecture and engineering studies (Bleed 1986; Rahemtulla 2006). The primary focus of design theory as applied to archaeological assemblages is the idea that stone tools are a reflection of particular solutions generated to solve specific problems (Rahemtulla 2006). Under this concept, varying contexts will produce varying types of constraints and people will weigh different costs and benefits to solving the specific problems that arise out of these contexts (Bleed 1986). Rahemtulla (2006:40) states that one of the most significant features of design theory "is its operational basis that argues that artifact form is constrained by various factors," incorporating variables that are "interactive not independent" of each other (41). Design theory focuses on specific contexts instead of relying on universal codes of behavior (Rahemtulla 2006).

There have been several attempts to implement the concepts of design theory to lithic assemblages in recent years. Variables affecting tool design and production strategies have included time constraints (Torrence 1983), portability/mobility (Torrence 1983; Shott 1986; Nelson 1991), maintainability versus reliability (Bleed 1986), flexibility (Shott 1986; Nelson 1991), versatility (Shott 1986; Nelson 1991), and longevity and precision (Aldendorfer 1991). In particular, concepts of maintainability and reliability have received considerable attention within lithic studies.

4.5.1 Maintainability versus Reliability

Drawing on design considerations from engineering, Bleed (1986) attempts to apply the concepts of maintainable and reliable systems to the study of tool technology in archaeology. Bleed states that reliable technological systems are made so that they can be counted on to work properly when needed whereas maintainable systems are made to function whether they break or not, merely appropriate to the task at hand. To prove his point, Bleed incorporates ethnographic examples from hunter-gatherer societies, determining that these hunters use both reliable and maintainable systems in "optimal" situations. It is obvious that, for Bleed, tools discovered in an archaeological context reflect the desired end products of some intentionally planned design. Bleed states that "optimum designs maximize a significant desirable effect by achieving the best compromise between the costs and benefits of the total system" (1986: 738). However, can stone tools always be regarded as "optimally designed forms"? As Odell (1996) notes in concluding remarks on design theory, the implicit assumption that design of stone tools reflects the intentional action to create a specific design can be problematic. A specific tool form found in the archaeological record may not reflect any initial intentional design features allotted for a specific task requirement. An investigation of the use-life of a stone tool at a site may reveal that the artifact was subject to reduction as it was picked up and re-used, either for the same tasks or new purposes. The final form discovered by the archaeologist may look quite different from its original design.

In an analysis of the application of design considerations to a stone tool assemblage from Keatley Creek, British Columbia, Hayden et al. (1996) conclude that, while some of Bleed's criteria for maintainable and reliable tools can be useful for analyzing and interpreting a lithic assemblage, it remains difficult to operationalize these concepts. Aspects of reliable systems directly applicable to the study of stone tools include over designed parts or parts that are made to be stronger than necessary (e.g., tools that are thick and sturdy), evidence of carefully put together parts and good craftsmanship, and overall care in manufacture (Bleed 1986; Hayden et al. 1996). The concept of maintainable systems is based on stone tools that show evidence of some sort of maintenance, repair and replacement however, Hayden et al. (1996) argue that all chipped stone tools can be maintained and repaired making this category somewhat ambiguous.

The concept of "flexibility", originally introduced by Shott (1986) to measure the multifunctionality of tools, refers to changes in the forms of tools for different purposes or uses (Nelson 1991; Hayden 1996). The concept of "versatility" as discussed by Nelson (1991) reflects the number of uses a tool is designed for. However, criticism of the concepts of both versatility and flexibility has suggested that these are poor terms to apply to stone tool assemblages and that a more applicable term is that of multifunctionality (Hayden et al. 1996; Rahemtulla 2006). One important point emphasized by Nelson (1991) is that many of these defined concepts can be thought of as interconnected instead of being regarded as occurring independently of one another. A tool once considered expedient can then be transported to a different location and become part of a curated toolkit (1991:64). These technological systems are not mutually exclusive and should not always be viewed as reflecting planned options created to operate in differing conditions or contexts (Nelson 1991). The variability in technological behavior can result in the creation of stone tools that are difficult to define in terms of their main function, purpose or ultimate design. This variability is emphasized quite clearly in multifunctional tool forms.

4.6 Multifunctionality

As discussed above, there are many stone tools that can be classified as more than one tool type based on the presence of specific attributes. It may be that these tools were designed to serve a variety of tasks at once or that the multiple forms and edge angles were created opportunistically for various tasks as they arose. As Hayden et al. (1996) discuss, these tools can involve design considerations or not involve any intentionally planned designs. The difficulty for archaeologists then becomes trying to distinguish between these varying aspects of tool manufacture. Although Hayden et al. (1996) attempt to work around this problem by only describing the primary function of a tool as being its last use before discard, this can prove to be a difficult task. When analyzing a stone tool that may have been used as a scraping tool, graving implement and a knife, interpreting which aspect may have served as its primary last function may pose a challenge. The multifunctionality of stone tools will be discussed further within the context of the Richardson Island unifacial tool assemblage as a substantial number of these artifacts exhibit attributes from more than one tool type.

In summary, tool design is one way of attempting to better understand how specific tools are made, why they are made and why they are found in particular contexts. While some of the design considerations outlined above have aspects that seem both useful and non-applicable when directly applied to a stone tool assemblage, the application of some aspects of design theory seem quite relevant for interpreting technologies across sites and through time. As Rahemtulla (2006:54) clearly emphasizes, archaeologists must "realize the interactive nature of the variables that contribute to stone tool production" if there is to be any progress in the field of stone tool analysis and interpretation. Adding to this statement, stone tool analysis should account for all of the human behavior that is variable and fluctuating within time and space, realizing that there may be multiple design considerations reflected in a tool form or no design feature at all. Ingold (2000), while acknowledging that the manufacture of artifacts involves some sort of intentionality on the part of the maker, argues that the maker cannot "stand outside of history and treat the world as though it were a blank slate." Each tool maker is a product of his or her own time with all of the particular practices and objects present at that time and structured by the activities of predecessors; that it is from this lived experience that the design process occurs (Ingold 2000). Therefore, each stone tool assemblage should be analyzed from within its own unique context and any design considerations should be reflective of this particular context.

4.7 Technological Change

A prevalent focus for studies of stone tools is that of technological change or continuity over time at one site, several sites, or within a specific region. Marked shifts in the use of certain stone tool technologies often become the focus of archaeological investigations and interpretations; technological change becomes an indication of cultural change and is therefore, an aspect of the archaeological record worthy of study. A change in technological practices may represent a myriad of variables, either independent of one another or in combination. In order to explain technological change, archaeologists draw from variables such as changes in the environment, in social dynamics or interaction spheres, and political and economic factors. There are, of course, many different factors that will result in technological changes in stone tools at a site. Some of these changes may occur very rapidly, often correlated to the replacement of one cultural group for another, while other changes will occur more gradually over time. Some changes may represent purposeful shifts in the types of tools manufactured and used while other changes may arise independently of specific, planned outcomes. As Ingold (2000) states in discussions of continuity and variation in tool forms, there will always be innovations within existing technical designs as a result of either intentional or accidental actions. If a gradual shift in technological tool forms over time is regarded under the theme of "technological change", is this change to be regarded as the result of intended or unintended actions and practices? Ingold (2000) writes that gradual change comes about due to a large amount of small variations in forms over time. These small amounts of variation in individual actions over time are ultimately what lead to either a continuation of practices, behaviors and technologies or a gradual change through the span of thousands of years. While it is ultimately difficult to see human behavior on an individualistic scale, the recognition of individual action as an important component in variability and change in tool technologies is key to understanding technological behavior on a larger time scale.

4.8 Discussion

As outlined above, the theory behind lithic analysis incorporates a wide variety of approaches. Theoretical concepts of stone tool technologies continue to be revised as more studies reveal typologies that are less bounded and static and continually affected by numerous variables throughout the use-lives of tools. Many of these theoretical discussions are directly applicable to the unifacial tool assemblage at the Richardson Island site.

In the following pages, the most commonly studied unifacial tool types will be discussed, namely scraperplanes, scrapers, burins, gravers and spokeshave/notched tools. This outline of unifacial technology will provide a bridge between the more general review of lithic theory and methods and the introduction of the Richardson Island unifacial assemblage.

4.9 Unifacial Tools in the Broad Context

4.9.1 Studies on Scraper Technology

While studies on some unifacially manufactured tools such as spokeshave/ notches and gravers have received limited attention within archaeological studies, research on scraper tools has been widespread and numerous. Scraper tools have been recovered from archaeological contexts all over the world from different time periods and have largely been categorized as tools used for the working of hides (Hayden 1979; Andrefsky 2005). Much of the extensive research on scrapers has come from Europe, the Near East and Africa with specific attention paid to the Mousterian industries. Specific studies in Mousterian assemblages have led some researchers such as Dibble (1995a, 1995b) to argue that the unifacial tool types in the Mousterian reflect a morphological continuum instead of discrete typological units. Other studies in North America have noted the expediency of scraper tools sometimes defined as “heavy-duty” scrapers and other times, as chopping tools (Hayden et al.1996: 107). One significant debate within studies of scraper tools involves typological categories. The dominant view of scrapers in the past was that these artifacts would have only served one function (i.e., the scraping of hides) but more extensive studies such as use-wear analyses, have indicated that these scrapers were often multifunctional tools. Studies of scrapers have tended to focus on the intensities of reduction and retouch (Blades 2003), residue analysis, mobility structures/patterns, raw material constraints and variable site functions (Kuhn 1992; Rolland and Dibble 1990, Dibble 1995a, 1995b; Blades 2003).

4.9.2 Studies of Scraperplanes in the Archaeological Record

One defined tool type at Richardson Island is the scraperplane (See Figures 42 and 43 in Appendix A). Scraperplanes have been characterized as large planar to dome shaped tools with steep working edges of 80-90 degrees (Fedje et al. 2005). Although these lithics have been designated as tools under the Parks Canada typology and appear to be a distinct category, this specific classification of artifact type is not widespread. As Salls (1985) notes, some researchers have debated the interpretation that these lithics were used as tools and argue that they represent discarded unidirectional cores. Those that refute the interpretation of these specific artifact forms as tools argue that the perceived retouch represents nothing more than step fracturing from core platform preparation (Jackson 1977). Additionally, some sites that may have similar forms within their assemblages may have been categorized differently. A review of assemblages from sites in British Columbia and Alaska shows that a “core scraper” (Carlson 1996), a “quadrilaterally worked plano-convex tool” (Hamilton and Goebel 1999), a “large coarsely ground and flaked scraper-like adze” (Goebel and Slobodin 1999) or a “scraperplane” (Fedje et al. 2005; Rahemtulla 2006) may be used to describe the same or similar kinds of tools. Several prehistoric sites within Southern California as well as in

Oaxaca, Mexico have recorded scraperplanes in their assemblages and use-wear studies have shown evidence of utilization along the edges of these artifacts suggesting that they were, in fact, used at tools (Salls 1985). Analyses of the edges of these scraperplane tools in Southern California have revealed the presence of residue from the agave plant (Salls 1985).

Ethno-archaeological evidence of the use of these large planar to dome shaped artifacts as tools has been well documented in New Guinea. In an analysis of stone axes and flake tools from the New Guinea Highlands, Marilyn Strathern (1969) describes the varied uses of stone tools, noting however, the strong correlation between both size and edge angle to specific functions or tasks. Most interestingly, a photograph shows the use of, what is referred to broadly by the author as "an unhafted flake tool" by a man in the highlands. This "unhafted flake tool" bears a distinct resemblance to the scraperplane tools recovered from the Richardson Island site. The picture shows the man using the core-like tool to plane wood for the creation of a spear shaft (Figure 7). White (1967) also provides ethno-archaeological data, again from New Guinea, that includes a picture of an individual from the Legaiyu village shaping a black palm bow using what is described as a "chert bow-plane" (Figure 8).

Early ethnographic data obtained from Rogers (1939) from his work with the Diegueno peoples living in Southern California referenced the use of scraperplane tools to pulp fibers from the agave plant. Rogers (1939) noted that the scraperplane was used in the manner of a carpenter's plane in order to push out the pulp of the plant. While ethnographic inference can be problematic when interpreting the archaeological record, and specifically in the extrapolation of information from vastly different regions of the world, these examples from New Guinea still serve to argue for the inclusion of scraperplane artifacts as tools for the working and specifically, the planning of wood and possibly, as proposed by Salls (1985) for the processing or shredding of plant remains.

Figure 7: A flake tool being used for planing wood in a New Guinea Highlands society. (Strathern 1969: 325. Plate XV).

Figure 8: The use of a chert bow-plane for the creation of a black palm bow. Legaiyu village, New Guinea (White 1967: 415. Plate III).

4.9.3 Studies on Burins

The classification of burins has, for the most part, emphasized the morphological characteristics rather than the functional aspects and, as Barton et al. (1996) emphasize, a burin is defined by the way it is manufactured not by its possible use. Crabtree (1968:367) describes a burin as an artifact that has two right-angled edges that create a sharp triangular-shaped tip on the distal portion of a flake. The creation of this triangular-shaped tip is commonly discussed as the "burin-blow technique"; the removal of a longitudinal straight spall from the edge of a flake or blade (Tomášková 2005: 85). Traditionally, burins have been classified into three main morphological categories based on where the burin spalls have been removed; medial, lateral and transverse. Studies of burins are widespread and interpretations of these tools are continually in debate. More specifically, the burin has played a central role as a classic tool type in Paleolithic assemblages (Tomášková 2005: 85).

There is some debate over the burin both in terms of how it functions and how it is classified. Part of the difficulty arises in the large amount of variability in both the overall morphology and use-wear evidence present on burins from archaeological contexts. It is this high amount of variability, in possible functions and in forms, that has continued the debate over how to classify the burin. Tomášková (2005:81), after questioning what a burin really is, discovers that the answer is neither simple nor straightforward. Through use-wear studies of burins from several archaeological sites, Tomášková finds a large amount of versatility in the tools. Although the burin is usually defined as a graving implement, there is still a substantial amount of ambiguity surrounding the functions of the artifact type.

There have been many challenges to the concept of the burin as a defined and distinctive tool type (Barton et al 1996; Chazan 2001; Hays and Lucas 2000). In a study of burins from three late Pleistocene sites in southwest Asia, Barton et al. (1996) explore the possible functions of burins; 1) engraving, 2) cutting, 3) scraping, 4) as cores for the manufacture of burin spalls, and 4) as tangs for the hafting of artifacts. From the study of the use-life patterns, morphology, macroscopic evidence for edge modification, and association to other artifacts, Barton et al. 1996 emphasize the multifunctionality of burins. Similar to Dibble (1987, 1991) and Rolland and Dibble (1990), Barton et al. (1996) argue that the variability in burin morphology may reflect stages in the use and maintenance of these tools rather than distinctive sub-types. The versatility in burin use was also attributed to the varied contexts from which these artifacts were recovered. Use-wear analysis conducted by Barton et al. (1996) reveals the possibility that some burins were being used as graving tools while others were being used as scraping and carving implements. Both Barton et al. (1996) and Tomášková (2005) argue that the burin should not be separated as a distinctive tool type because of the high amount of variability present amongst these artifacts.

Although some studies of burins have challenged the creation of a burin tool class, the burin continues to prevail as a defined tool type in archaeological studies and sites. The variability and versatility of these tools may indicate the need to further define these artifacts however, as the burin is defined based on the technique of manufacture not on its function, the re-classification of these tools may not be necessary. What studies of burins and burin manufacture have indicated is that, similar to other “classic” tool types, there are numerous explanations for variability in morphology.

Rahemtulla (2006: 246) notes the apparent absence of “classic” burins in Northwest Coast sites. He suggests that many broken flakes could have been used in a burin-like manner. As the working of wood, antler and bone was prevalent on the northwest coast, it is likely that burin manufacture of some kind was present, at least in some assemblages.

The most important conclusion that can be reached based on a synthesis of burin studies is that there is a need to study archaeological collections as a whole rather than only interpreting a selective typological group. The burin, like any other tool type, must be studied within the specific context from which it was recovered. As Tomášková

(2005) emphasizes, archaeologists need to also be very cautious when making inter-regional comparisons of tool types.

4.9.4 Studies on Graver Tools

Similar to many of the other unifacial tool types discussed above, tools interpreted as graving implements are variable both in how they are classified and in how their functions are interpreted. Tomenchuk and Storck (1997) have noted that the function(s) of gravers have remained largely untested in archaeological study. Most commonly, these artifacts have been interpreted as tools for the piercing of hide or soft tissue or the engraving of bone, antler, wood or ivory. In an experimental use-wear study of a small collection of gravers recovered from the Early Paleo-Indian Fisher site in Ontario, Tomenchuk and Storck (1997) separate gravers into single and double-scribe compass and coring gravers. Both “compass” and “coring” gravers are defined as exhibiting either two or three spurs. Based on the location of use-wear on different specimens, Tomenchuk and Storck (1997) conclude that some of the tools were used to engrave single of concentric lines and may have been used for decorative purposes. These graving tools are further segregated based on their morphological characteristics. The authors recognize two forms of compass gravers, a single-scribe compass that has a double-spurred form and a double-scribe compass exhibiting a triple-spurred form. A coring graver, while also exhibiting two spurs is segregated from the compass gravers due to the location of the spurs on the end of a distinct shank and interpreted as serving a boring function (1997: 517).

In other archaeological studies, graving tools are simply referred to as “gravers” (Hoffecker et al. 1993; Fedje et al. 2005) or “perforators” (Powers and Hoffecker 1989; Rahemtulla 2006). The recognition of these tool types is often based on not only the presence of pointed or protruding attributes but also on both macroscopic and microscopic evidence of polish present on the tips of these pointed forms.

4.9.5 Studies on Spokeshave ("Notch") Tools

Most commonly characterized as expedient flake tools that exhibit a single notch or multiple notches that are not adjacent (Holdaway et al. 1996), these artifacts appear to have a substantial amount of variability in their morphologies. Some archaeologists, however, have attempted to further classify these tools into subcategories based on morphological similarities between specimens. In an analysis of notch tools from the Middle Paleolithic sites of Pech de l'Aze I, La Quina, and Combe-Capelle bas in France, Holdaway et al. (1996) examine the results of re-sharpening on single and multi-notched tools. Similar to Dibble's interpretations of Mousterian notched flakes (1988) and side scraper reduction (1995a, 1995b) that suggests differing rates of re-sharpening, Holdaway et al. (1996) find a correlation between tool blank length and the number of retouched notches present. This study suggests that notched tools reflect stages along a continuum of reduction rather than discrete types of notched tools i.e., single versus multi-notched tools. Other researchers, such as Close (1991) argue that notched tools should be separated as distinctive types. Close disagrees with Dibble's (1988) interpretation of denticulate flakes as indicative of notched tool re-use and reduction.

Other studies of "notch" tools have included the effects of raw material availability and the quality of materials on morphology. Holdaway et al. (1996) note that several studies of Mousterian collections reveal a preference for notched tools to be manufactured from locally available and poorer quality materials such as siliceous, calcareous (limestone) rock in contrast to side scrapers, often manufactured from higher quality flints. In the conclusions to the study conducted by Holdaway et al. (1996:386), notched tool re-use is correlated with sites that have a scarcity in raw materials suggesting that the occurrence of multiple notches on one flake blank may be related to economizing behavior.

Conclusions

In a brief discussion of prominent unifacial tool types that occur in varied archaeological contexts, a few common themes are present. These themes are as follows:

1) There is no standard agreement on any of these tool types. Even the most similar types of tools are often classified under different designations; interpretations of the function (s) of each tool type remain quite variable.
2) There is some debate over the separation of tool types into subtypes based on differences in morphological characteristics. Some archaeologists prefer to “lump” and some prefer to “split” these types.
3) There is also debate over whether the occurrence of variation in a tool type reflects different subtypes or stages along a continuum of reduction.

These three themes will continue to arise in studies of unifacial tools as archaeologists struggle to separate and define artifacts. The methods used to analyze and interpret unifacial tools may all have relevance depending on the specific context of an assemblage. While comparisons between these tool types across space are genuinely valuable for lithic analysis, specific studies of assemblages should rely more on the local context than on finding parallels between tools found in different regions. This point will become important for the analysis of the unifacial tools from Richardson Island. These tools are situated within a context in prehistory where early peoples living in Haida Gwaii remained somewhat isolated from the mainland of British Columbia. The unique environment of the archipelago resulted in technological behavior that appears to be distinctive from other assemblages in Northwest Coast contexts. In the next chapter, the unifacial tool assemblage from Richardson Island will be introduced along with the methodology employed to analyze these artifacts.

5 Objectives, Methodology and the Unifacial Tools from Richardson Island

Introduction

In this chapter, the main research objectives for the analysis of the unifacial tools from Richardson Island will be outlined and the methodology used will be discussed. After an introduction to the main research objectives, the chapter will focus on presenting the unifacial tool assemblage and summarizing the data collection process. The goals of the research project are fourfold and will encompass the remaining chapters of this thesis.

5.1 Objectives

In order to provide a better understanding of the unifacial tools found at the Richardson Island site, these primary objectives were established:

(1) To determine whether or not there is standardization within the unifacial tool assemblage at the Richardson Island site and, if some standardization is present, to explore the amount of structure.

(2) To explore the variability of the unifacial tools from raw material selection to discard in the archaeological record with reference to a behavioral model.

(3) To determine whether or not the unifacial tools reveal technological change or continuity throughout time.

(4) To include the results of each objective noted above in a discussion of the established culture history of Haida Gwaii.

To meet the objectives of this research project, a multivariate approach was initiated (See Table 9). This approach included 1) the application of a cluster analysis, 2) the investigation of a behavioral model using various statistical tests including chi square, and 3) the use of statistical tests to explore the temporality of the unifaces. This chapter will outline attribute selection for the analysis of the unifacial tools and the data collection methodology that was followed.

Objective	**Methodology**	**Thesis Chapter**
Level of standardization	Cluster analysis	Chapter Six
Explanation of tool variability	Behavioral Model; multivariate statistical tests; chi square.	Chapter Seven
Temporality of unifaces	Multivariate statistical tests; chi square	Chapter Eight
Discussion of Haida Gwaii culture history	Synthesis of results	Chapter Eight

Table 9 Objectives and Methodology for Thesis Chapters Six, Seven, and Eight.

5.2 The Richardson Unifacial Data Set

For this project, 1097 unifacially manufactured tools were analyzed and entered into a Microsoft Access 2003 spreadsheet. Unifacially manufactured tools from the Richardson Island site included scraperplanes, scrapers, gravers, spokeshave/notches, burins, choppers, unifacial* tools[6], unimarginals and bimarginals or some combination of these types. These artifacts were recovered from EU10 (EU = Excavation), EU12, EU13, EU15 and EU16 and reflect cultural behavior from 9290 BP up until 3000 BP. A summary of each tool type, under the pre-existing Parks Canada typology, is included below. A photo of each tool type can be found in Appendix A. Note that this analysis did

[6] In order to delineate between "unifacial tools" as representing the study tool assemblage at the Richardson Island site and "unifacial tools" as one specific tool type, those artifacts defined as a specific tool type (see Table 4 for the Parks Canada typology) are labeled as unifacial* tools for the remainder of this thesis.

not include the utilized flakes (n=671) or debitage (n= approx. 47, 953) recovered at the site primarily as the large quantities of these artifacts would have extended this thesis project significantly. The analysis of the debitage from Richardson Island is worthy of a research project in itself.

5.2.1 Parks Canada Typology

The Parks Canada typological classification was created in order to provide a somewhat standardized method for assigning types to the stone tools found within all Gwaii Haanas archaeological sites. This classification is well-established, having been used consistently since 1993. The assignment of specific tool classes is based on multiple factors including morphological attributes, manufacturing traits and functional traits (Smith 2004: 107). Note that some of the interpretations of the possible functions of the tool types are often casual assessments of potential uses for the artifacts and not based on any extensive use-wear analysis, experimental archaeology or ethnographic observations.

5.2.1.1 Unifacial Tool Types

Scraperplane

These artifacts are large planar to dome-shaped tools that exhibit retouched working edges with angles of approximately 80º to 90º. Scraperplanes are often manufactured on tabular metamorphic or igneous rocks but sometimes they also occur on flakes. When manufactured on tabular forms, the tabular surface is often left unmodified to act as the ventral plane of a tool (Fedje et al 2005: 226). In some cases, this tool type can resemble a unidirectional core or is manufactured on a core but can be defined as a scraperplane based on the presence of intentional retouch, edge rounding and use-wear along the surface of the planar edge (Smith 2004: 110). These tools may have been used for heavy duty planing, shredding or scraping on materials such as wood (Fedje et al 2005: 226).

Denticulate Scraperplane

A denticulate scraperplane exhibits one or more distinct projections along a working edge. This tool would possibly have functioned to remove mass from an object being worked in the same manner as would a rasp (Fedje et al. 2005: 226). This category is often subsumed under the general scraperplane tool type.

Scraper

Along with unifaces and unimarginal tools, scrapers are characterized as having flake removal on only one surface (Fedje et al. 2005). These artifacts are usually made on flakes that exhibit continuous unimarginal retouch to produce a shaped edge and are shallow in their overall thickness with flake scar lengths that equal the maximum thickness. This category includes denticulate scrapers (Smith 2004: 111).

Unimarginal tool

A unimarginal tool is described as an artifact that exhibits minimal flake removal on one surface of a flake. One or more flake scars measuring up to 1 cm in length may be present. This artifact type may be functionally similar to scrapers (Smith 2004; Fedje et al. 2005).

Bimarginal tool

This artifact is similar to that of a unimarginal tool except marginal retouch is present on both faces and originates from the same edge (Smith 2004).

Unifacial* tool

Characterized as a stone tool that exhibits retouch on one surface of a flake, this artifact is distinguished from a unimarginal tool based on the presence of flake scars that are over 1 cm in length. This artifact may have been used as a knife or in a manner similar to a scraper (Smith 2004: 111).

Spokeshave/Notch

A spokeshave/notch is a stone tool that exhibits one or more unimarginal or unifacial concavities. A concavity is formed through consistent unifacial or unimarginal flaking. The concavity or “notch” would have functioned as the working edge of a tool. This artifact may have been used to shape or scrape materials such as wood and bone (Smith 2004: 112), especially cylindrical shafts or other similar forms.

Graver

This artifact is defined based on the presence of one or more small projections often isolated by flaking. These projections often show evidence of polish and/or microflaking edge damage near to the tip (Fedje et al 2005: 229; Smith 2004: 112). Gravers often co-occur with scraperplanes and flake tools. These tools may have been used for engraving into wood or bone.

Burin

A burin is a flake tool created through the detachment of one or more flakes at an acute angle creating a chisel-like form that is unretouched. This tool may have been used for the fine working of bone and wood as well as for incising (Smith 2004: 112).

Chopper

A large tool often made on slabs of raw material or on large cobbles. Unifacial or bifacial flaking along one edge is usually quite crude or rough with a very acute angled working edge. These tools may have been used for heavy duty chopping of bone or wood, specifically for felling trees or butchering activities (Fedje et al 2005).

5.3 Data Entry

During data entry, each artifact was provided with a distinct ID number in the Access database as well as a separate data sheet page. Each data sheet page included all of the measured attributes shown in Table 10.

5.3.1 Recorded Attributes of Richardson Unifaces

All measurements of the unifacial tools were taken following Andrefsky (2005). The macroscopic methods for both flake tools and debitage summarized by Andrefsky (2005) were deemed appropriate for an analysis of the unifacial tools from Richardson Island. It was important to include the continuous variables such as length, width, thickness and weight in order to document the overall sizes of the tools as well as how size may relate to other variables such as raw material type or edge angle. It was also important to include variables that may provide evidence for manufacturing sequences; ordinal scale variables such as dorsal flake scar count, the amount of dorsal cortex present and flake termination type. Other variables were selected based on what they might reveal regarding the functionality of the tools; attributes such as edge angle, retouched edge length and retouched edge outline. Finally, some variables were selected in order to further describe the taphonomic processes that, in many cases, obscured and inhibited analysis. All of the variables measured for each unifacial tool are summarized below.

Length (mm)

Length was measured as the maximum distance between the proximal and distal end of a tool along a line perpendicular to the striking platform. In instances where unifacial tools were made on cores, cobbles, or tabular slabs, the maximum length of the specimen was recorded. Maximum length measurements were not recorded for specimens that were broken or incomplete.

Measured Attributes and Methods of Measurement	
Attribute	**Method**
Length (mm)	Maximum distance between the proximal and distal end taken using calipers.
Width (mm)	Maximum distance of a flake at its widest point using calipers.
Thickness (mm)	Maximum distance between the dorsal and ventral sides of an artifact using calipers.
Weight (g)	Standardized weight of an artifact in grams using a metric scale.
Material/Rock Type	Classification of material type based on Smith (2004)
Complete/Incomplete	Artifacts classified as complete or incomplete.
Flake Scar Count	Based on an ordinal scale. Flakes with no dorsal flake scars = 0. Flakes with one dorsal flake scar =1. Flakes with two flake scars = 2. Flakes with three or more flake scars = 3 (Andrefsky 2005).
Blank Form	Artifacts were recorded as Flake, Tabular, Tabular Core, Core or Cobble. Additionally, flake forms were categorized based on their types of distal ends: feathered, stepped, hinged or plunging.
Edge Morphology	Tools were classified based on the outlines of their retouched edges. Edges could be Convex, Concave, Pointed or Straight or some combination of these categories.
Location of Retouch	Presence of retouch on one margin, two margins, three margins, four margins, all margins, right margin, left margin, distal margin, proximal margin or some combination of these categories. In this instance "margin" refers to a tool's edge. Right and left margins were distinguished with the artifact positioned dorsal face up and proximal end closest to the observer.
Retouch Distribution	Tools could be classified as having either continuous or clustered retouch along one or more of their edges.
Amount of Dorsal Cortex	Based on an ordinal scale. Flakes with 100 % cortex = 3. Flakes where $50< x > 100$ = 2. Flakes where $x \leq 50$ = 1 and those flakes with no dorsal cortex present = 0 (Andrefsky 2005).
Retouch Type	The pattern of retouch flake scars along an artifact's edge. Retouch could be classified as feathered, stepped or smoothed (Andrefsky 2005).
Angle of Flake Scars	The angle of a retouched edge. Measured using a scale from 1 to 3. Edges of 0-45º = 1. Edges of 45-60º = 2. Edges of 60-90º =3.
Use-Wear Evidence	Using a hand-held magnifier 3X, those artifacts that exhibited some noticeable use-wear were recorded as edge rounding, polish, utilized, edge damage or some combination of these categories.

Table 10: Measured Attributes and Methods of Measurement

Measured Attributes and Methods of Measurement	
Attribute	**Method**
Notch Depth (mm)	For those artifacts exhibiting a distinctly retouched notch. Depth was taken using a 30cm ruler from the base of the notch to a perpendicular line running across the outer edges of the concavity.
Notch Width (mm)	For those artifacts exhibiting a distinctly retouched notch. Width was taken using a 30cm ruler across a straight line running from one end of the notch opening to the other end.
Number of Notches Present	Record of those artifacts exhibiting more than one notch.
Denticulate (yes/no)	A record of those artifacts that have one or more denticulated retouched edges present.
Post-Depositional Alterations	A record of those artifacts that exhibit some form of obvious alteration due to natural processes. These artifacts were categorized as weathered, waterworn, oxidized, burnt or some combination of these categories.
Comments	Any additional comments on each artifact. Unusual or distinctive specimens were further described.
Pictures	A record of any photographs taken of an artifact
Drawn	A record of any drawings completed for an artifact.

Table 10 continued: Measured Attributes and Methods of Measurement

Width (mm)

Width measurements were recorded as the maximum distance of the tool at its widest point and its perpendicular intersection with the flake length line. Those artifacts made on forms other than flakes were recorded based on their maximum width. Width measurements were not recorded for those flakes missing their proximal portions however, some width measures could still be accurately taken from flakes missing their distal ends.

Thickness (mm)

A measurement of thickness was obtained for each artifact by measuring the maximum distance between the dorsal to the ventral side.

Weight (g)

The weight of each artifact was measured using a metric scale in grams. Incomplete specimens were also measured.

Material/Rock Type

The material/rock type for each artifact as previously categorized by Smith (2004) was entered into the Access database from an Excel spreadsheet. Through geochemical analysis, Smith had provided a very detailed classification of material types used at the Richardson Island site and this information was used for this study.

Complete/Incomplete

Complete flake artifacts were designated based on the presence of both an intact proximal end and distal termination with no broken or missing elements. However, many unifacial tools at the Richardson Island site were manufactured from tabular pieces of material, making a decision about completeness quite difficult. These rough tabular slabs may represent complete tools or may have been broken during use. As well, it is highly probable that many unifacial tools were made on incomplete flakes, cores and tabular pieces. The categorization of an artifact as “complete” vs. “incomplete” is a somewhat problematic distinction. As the use-lives of these tools may have also changed through time, with the re-use of artifacts reformed into new tools, it can be impossible to truly define the amount of completeness. In some cases, incomplete specimens could still accurately be measured in terms of their lengths, widths, or thicknesses.

Flake Scar Count

In order to explore the selection of specific flake forms for the manufacture of unifacial tools, flake scar counts for each artifact were recorded. Following Andrefsky (2005), a four-value ordinal scale was used to measure the relative amount of flake removals from a specimen. Those flakes with a completely cortical dorsal surface received a value of “0”. Flakes exhibiting only one dorsal flake scar were assigned a value of “1”. Those flakes with two dorsal flakes scars present received a value of “2” and those with more than two flake scars were given a value of “3”. Only those unifacial tools manufactured on flakes were assigned along this ordinal scale. Those artifacts manufactured on other blank forms such as tabular slabs or cores were put in the category “n/a”.

Blank Form

As blank form has the potential to affect both the manufacture and morphology of a tool, it was important to account for how many and what types of tools were manufactured on tabular pieces versus cores, cobbles or flakes. Artifact blank forms were categorized as tabular, core, flake or cobble. Additionally, flake form distal ends were classified as feathered, stepped, hinged or plunging.

Edge Morphology

The edge morphology of a tool was recorded with the goal of examining the possible functions of tool types. Tools were classified as having edge outlines that were convex, concave, straight or pointed. As many of the artifacts exhibited characteristics of more than one type of tool, many were defined as exhibiting more than one outline morphology. Incomplete artifacts were not included unless their retouched edges were considered complete.

Location of Retouch

Also of interest for this study of unifacial tools was the degree of retouch occurring on each tool. Were the majority of artifacts retouched only on one edge or did tools exhibit multiple retouched edges? Under this category, artifacts could be assessed as exhibiting retouch along one margin, two margins, three margins, four margins, or all margins. Further, artifacts could specifically be defined as having retouch present on the right, left, proximal or distal margins or some combination thereof. All flake tools were assessed with the proximal end (platform bearing end) closest to the observer and the dorsal surface facing upwards.

Retouch Distribution

The retouch type of each artifact was categorized based on whether retouch was continuous along an edge or if retouch was clustered in certain areas along an edge. Artifacts could be characterized as continuous, clustered, continuous and clustered or, in cases of heavy weathering, indeterminate.

Amount of Dorsal Cortex

In addition to using flake scar count as a method for dividing the flake blanks used for the unifacial tools, the relative amounts of dorsal cortex on the flakes was recorded. Common in studies of debitage, measures of dorsal cortex amounts can give some indication of whether a flake was removed from a core in an early or later stage of reduction (Magne 2004; Andrefsky 2005). A flake with a large amount of dorsal cortex still present is believed to be representative of an early stage and a flake with no cortex, a later stage.

Similarly to flake scar counts, this measure was represented on an ordinal scale expressed as an absolute percentage of the dorsal surface. Flakes exhibiting 100 % dorsal cortex received a value of "3". Those flakes exhibiting greater than 50 and less than 100 % dorsal cortex were given a value of "2". Artifacts exhibiting greater than zero and less than or equal to 50 % dorsal cortex were classified as "1" and flakes that did not have any cortex remaining on the dorsal surface received a value of "0".

Retouch Type

An analysis of the retouch type can sometimes provide information about how the tool was manufactured, specifically, what technique of knapping was used. Retouch type refers to the general pattern exhibited by the retouch flake scars along a tool's edge. Although there are numerous retouch types that can be employed for classification, this project concentrated on three types; feathered, stepped or smoothed following Andrefsky (2005). Many of the unifacial tools exhibited more than one of these categories.

Edge Angle

The recording of the edge angle can be a difficult measure to accurately produce and a variety of techniques have been established and critiqued by archaeologists (Gould et al. 1971; Dibble and Bernard 1980; Andrefsky 2005). I have chosen to measure the angles of the unifaces using a more relative scale rather than trying to obtain measurements in specific degrees. For the purposes of this project, a scale from 1 to 3 was thought to be sufficient; retouched tool edges ranging from 0-45º were valued at “1”, edges ranging from 45-60º were valued at “2” and those working tool edges ranging between 60-90º were classified as “3” (Andrefsky 2005). The purpose of measuring the edge angles of tools relates most frequently to the possible function of an artifact. Tools with steep angled edges are often thought to reflect tasks more practically suited for scraping while tools with acute angled edges are usually associated with cutting tasks (Andrefsky 2005). Edge angle was one attribute used for the creation of some unifacial tool types at the Richardson site.

Retouched Edge Length

A measurement of the extent of retouch along each edge of an artifact was recorded for the database. The method of measurement was taken from Andrefsky (2005); a thin piece of string was used because it could most accurately follow the contours of an irregular edge. The length measured on the string was then compared to a ruler. If retouch was present along more than one edge of a tool, each retouched edge was measured independently; however, in instances when retouch appeared to be continuous along more than one edge, only one measurement was taken. Retouch was only recorded for complete specimens.

Use-Wear Evidence

Under this category, artifacts were analyzed using a (3X) magnifier for any evidence of use-wear. Microscopic analysis was not conducted on the assemblage. Tools could be classified as exhibiting edge rounding, polish, utilization, edge damage or some combination thereof. Tools that were too weathered, waterworn or simply did not show any obvious evidence of use-wear were categorized as “none” or “indeterminate.” As a large number of the unifaces range from minimally to heavily weathered, use-wear analysis was often inhibited. However, use-wear, specifically edge rounding and polish was evident on several tools.

Notch Depth, Width (mm) and Number of Notches

For all of the unifacial tools classified as spokeshave/notches, a separate category was created in order to record the dimensions. Only those artifacts exhibiting some obviously formed notch were measured. For notch depth, a measurement was taken from the base of the notched area to a line running perpendicular to the outer corners of this concavity. For notch width, a measurement was taken along a straight line running across the outer opening of the notch. Finally, if there was more than one notch exhibited on a single specimen, this was recorded under the heading “Number of Notches Present.”

Denticulate (yes/no)

Many of the unifacial tools in the Richardson assemblage exhibited denticulate edges. All unifaces with one or more denticulate edges were recorded. It is possible that many of the denticulate tools served some sort of tearing or shredding function in opposition to non-denticulate tools. The purpose of this category was to examine how many unifaces in the assemblage exhibited a denticulate form and whether a specific type of tool was more denticulate than another type.

Post-Depositional Alterations

From even a cursory glance at the Richardson tool assemblage it becomes obvious that a large percentage of the artifacts exhibit some post-depositional alterations due to natural processes (Smith 2004). In many cases, the effects of these post-depositional processes have greatly altered the appearance of an artifact and inhibited the recording of some attributes. Many of the tools exhibit heavy weathering to the point where retouch is barely visible and any further analysis becomes a challenge. Those unifaces that showed obvious post-depositional alterations were categorized as weathered, waterworn, oxidized, burnt or some combination thereof.

Comments/Picture/Drawn

Any additional comments, photographs taken or pictures drawn were included on the Access database form.

5.3.2 Discussion

The recording of each of the outlined variables noted above was, for the most part, a straightforward process. The main problem that arose during analysis was the high level of post-depositional effects on the assemblage that obscured many of the attributes to the point where they could not be accurately recorded. The high amount of oxidization as well as other weathering processes often obscured flake scars, retouch and any evidence of obvious use-wear.

I would also like to acknowledge the possibility of inter-observer errors and subjectivity in the process of assessing lithic attributes. Many of the statistical tests conducted in the following chapters will be based on the information recorded during the initial data collection process.

After entering all of the data for the unifacial tools recovered from the Richardson Island site using the Access database, this information was exported into Clustan Graphics 8.0 (Wishart 1999), a cluster analysis computer program. In Chapter Six, cluster analysis will be introduced and applied to the unifacial data set. The results of the cluster analysis will provide the basis for an exploration of tool variability discussed in Chapter Seven.

6 Implementation of Cluster Analysis to the Unifacial Tools from Richardson Island.

Introduction

In Chapter Five, the objectives and methods for the data collection of specific variables were introduced. These variables were entered into a Microsoft Access 2003 database and then exported into Excel. In Excel, several statistical tests were run on the variables relating to the morphologies of the unifacial tools as a complete assemblage and separated temporally. A major objective of the analysis of the unifacial tools from Richardson Island was to determine whether or not early peoples using the Richardson Island site were manufacturing tools based on some standardized form that may or may not have been apparent during a preliminary analysis. The first step was to explore just how standardized these tools were using cluster analysis.

This chapter will begin with an introduction to cluster analysis and the selection of specific measures for the unifacial dataset. Following this introduction, the process of imputing the data into a cluster analysis computer program and the results generated will be discussed.

6.1 Numerical Taxonomy: Cluster Analysis

Numerical taxonomy has been defined as “the grouping of numerical methods of taxonomic units into taxa on the basis of their character states” (Sneath and Sokal 1973:4). Although these methods can, themselves, be inherently problematic for various reasons, the application of these procedures can also produce meaningful results that may have otherwise never have been generated or explored. As discussed in the previous chapter, the arrangement of archaeological data into some degree of order must occur in order for the archaeologist to interpret and understand these data.

One principle aspect of numerical taxonomy, as defined by Sneath and Sokal (1973:6) is that "a *priori*, every character is of equal weight in creating natural taxa." This statement reflects the application of numerical taxonomy to the natural or biological sciences where these "natural" types or taxa are "discovered". Mackie (1995:25) notes two problematic aspects of Sneath and Sokal's principle for the discipline of archaeology: 1) First of all, the assumption of equal weights does not account for the possibility that some variables of an artifact may have had more importance than others and 2) that the idea of "natural classes" of artifacts leaves out a fundamental aspect for archaeological interpretation; the desire by the archaeologist to separate artifacts into types that would have been meaningful to the makers and therefore, part of "cultural" classes. Subsumed under the more general method of numerical taxonomy, cluster analysis is a multivariate approach that takes the information gathered from a sample of entities and tries to reorganize these entities into groups (Aldenderfer and Blashfield 1984). Shennan (1997) states that multivariate analyses are extremely useful tools for organizing and grouping objects together and distinguishing the links between multiple variables. Multivariate approaches, such as cluster analysis, can reveal any patterning that may exist in a data set that may have otherwise gone unnoticed by a researcher (Shennan 1997). There are several reasons why researchers apply the clustering method to their data sets. Aldenderfer and Blashfield (1984:7) outline four principal goals for using cluster analysis;

1) For the development of a classification or typology. In this instance, information from a sample of entities would be imputed into a clustering computer program with the goal of "discovering" patterns or groupings of entities that may be reflective of distinctive types.
2) For the exploration of useful conceptual methods for the grouping of entities.
3) Data exploration as a means to generate hypotheses. A grouping of entities through cluster analysis might reveal specific relationships between entities or differences between these entities and therefore, may lead to new questions, theories or interpretations of the dataset.

4) Testing of hypotheses or the validation of types that have already been defined through other methods of classification.

There are several different statistical methods underlying cluster analysis. The methods chosen for a given study will vary depending on the nature of the information gathered and the kinds of results hoped to be obtained. Results generated by a particular clustering solution will always be influenced by both subjective and objective properties; subjectivity in the particular variables selected to be clustered as well as in how this information was recorded and objectivity in the computation of the clusters. Ultimately, as noted by Shennan (1997:220), the "aim of classification studies is generally to *discover* the pattern of groupings in a set of data, with as few assumptions as possible about the nature of the grouping." Kaufman and Rousseeuw (1990:1) have, most appropriately, defined cluster analysis as "the art of finding groups in data."

Before entering data into a cluster analysis program, a specific clustering method must be selected. Each chosen method will be dependant on the nature of the data set. The varied clustering methods available for organizing data are summarized below.

6.1.1 A Measurement of Similarity or Dissimilarity

Before applying any cluster analysis method to a group of data, a decision must be made about the kind of measure that will most effectively express the relationships between the objects under study (Shennan 1997:222). This measure can be expressed as a similarity or dissimilarity coefficient. There are a wide range of options for similarity or dissimilarity coefficients as outlined by Sneath and Sokal (1973), Wishart (1987) and Shennan (1997). Some of these coefficients are most suited to qualitative presence/ absence data while others are more appropriate for quantitative numeric data (Shennan 1997:223). Some of the most frequently used coefficients include the Euclidian distance coefficient, the Simple matching coefficient, Jaccard's Coefficient and Gower's Coefficient of Similarity. While all of these solutions can be used with some degree of success on a data set, Gower's Coefficient of Similarity is the only technique designed to handle both quantitative, dichotomous and multistate variables and is thus, quite aptly suited for archaeological data (Gower 1971; Shennan 1997).

Baxter (1994: 153) has noted the absence of the use of Gower's Coefficient of Similarity in archaeological study despite its ability to deal with multistate variables. However, increasingly this solution is appearing in archaeological analysis (See Rice and Saffer 1982; Mackie 1995; Mathews 2006; Baxter and Beardah 2008). The applicability of Gower's coefficient to archaeological analyses comes with the ability to include variables that, under other statistical measures, would not be possible. Due to its potential in the current study of unifacial tools from Richardson Island, this method will be discussed in more detail below.

6.1.1.1 Gower's Coefficient of Similarity

$$S_{ij} = \sum_{k=1}^{v} s_{ijk} \Big/ \sum_{k=1}^{v} \delta_{ijk} .$$

In the formula representing Gower's coefficient of similarity (1971:859), *i* and *j* are compared over a series of variables (represented by *p*). S_{ijk} is the similarity being evaluated for each specific variable. All of the similarities are then summed at the end of the equation and the sum of these values is then standardized through the division of each variable by the sum of the 'weights' as symbolized by W_{ijk}. Weight is set to 1 when a comparison between objects *i* and *j* for the *k*th variable is considered valid and to 0 in cases where the variable value is unknown for either or both objects *i* and *j* (Sneath and Sokal 1973:135; Shennan 1997: 232).

In order to include all scales of measurement in cluster analysis, Gower's Coefficient uses three different methods of calculating similarity. These methods are used simultaneously for the creation of one clustering solution. Attributes entered into the clustering procedure are transformed into one single matrix of similarity without re-ordering or re-coding the data (Mackie 1995: 27).

For the inclusion of presence/absence variables S_{ijk} is set to 1 for those positive matches and to 0 for those mismatches. For qualitative or multistate variables, S_{ijk} equals 1 if the attribute states for both units are the same and 0 if these states are different (Gower 1971; Shennan 1997). Quantitative characters are represented by the formula $S_{ijk} = 1 - /x_i - x_j \mid / R_k$ where R_k is the range of character k; either a range in a population or a range in a given sample. In this calculation, if x_i is equal to x_j then $S_{ijk} = 1$. However, if x_i and x_j are at opposite ends of their range, S_{ijk} is set at a minimum of 0 (Gower 1971: 859). In more basic terms, Gower's Coefficient of Similarity combines three known similarity coefficients in order to account for multi-state variables; a combination of Jaccard's, Euclidian and a simple matching coefficient (Shennan 1997).

6.1.2 Clustering Algorithms

After choosing a matrix of resemblance that is deemed appropriate for a specific data set, the next stage is to select a clustering algorithm that will link the individual cases together. Algorithms can be either non-hierarchical or hierarchical and the grouping of entities can be non-overlapping or overlapping. These methods are discussed below.

6.1.2.1 Non-Hierarchical vs. Hierarchical Methods

A non-hierarchic clustering method can be interpreted as a technique in which classifications do not exhibit ranks that see subordinate taxa incorporated as members of larger taxa as seen with the hierarchic method. Sneath and Sokal (1973:206) note that a non-hierarchical method is preferable when the emphasis is on representing the relationship among the objects or entities under study rather than summarizing these relationships. An example of this method is a k-mean clustering solution. For k-means analysis, the observer chooses the number of clusters (k) that he or she wants to create. The computer proceeds to then cluster the data set so that it converges to match the desired partition of clusters (Wishart 1999:36).

The main characteristic of a hierarchical method is that it does not create a single partition with *k* clusters but rather, all values of *k* are incorporated at the same time (Kaufman and Rousseeuw 1990:44). In other words, this method ranks one entity above another with any member of a lower rank being also related to the higher ranked objects. The effect of this clustering method is successively fewer taxa with all taxa relating in some way or another to those objects that are ranked highest (Sneath and Sokal 1973).

6.1.2.2 Agglomerative Versus Divisive Methods

Under the agglomerative method, separate entities are grouped into successively fewer sets that eventually end at a single set containing all entities (Sneath and Sokal 1973). Agglomerative techniques will always begin with all objects apart from each other and then merge two clusters until they are joined into one single group (Kaufman and Rousseeuw 1990:44).

Another approach applied to cluster analysis for the grouping of individual entities and groups is the divisive method. Using the divisive method means that all of the objects under study will begin together in a single group and, with each step, two clusters will be subdivided until there are several distinctive clusters (Kaufman and Rousseeuw 1990). The use of a divisive method is mainly restricted to situations where data being used is dichotomous, i.e., all cases with a value of “1” are put into one group and all of those with a value of “0” are put into the other group (Shennan 1997).

Both methods are suited to different types of data and serve different kinds of outcomes. In both cases, however, the connection or separation of objects cannot be reversed. When two objects are joined to each other, as in the agglomerative method, they can no longer be separated. Similarly, when two objects are separated from each other, as in the divisive method, there is no way to connect them again (Kaufman and Rousseeuw 1990).

If the agglomerative method is chosen for a clustering solution, the next step is to then choose a clustering algorithm that will link cases together. There are several algorithms that can be chosen to determine exactly how each object will be clustered under the agglomerative method. Each algorithm will provide different kinds of clusters and therefore, different types of clustering results. The three most prominent algorithms chosen for agglomerative clustering solutions are single linkage, complete linkage and average linkage.

a) Single Linkage

This algorithm is also known as the "nearest neighbor technique" (Sneath and Sokal 1973:216) and is one of the simplest methods for linking groups of entities together (Shennan 1997). Under single linkage connections between units and clusters are created by single links between pairs of these units (Sneath and Sokal 1973). In order for an individual entity to join a group, this object must share a certain level of similarity with any one member in the group. Similarities between objects and groups or between two groups are then connected through the "nearest neighbors" (Shennan 1997). The linking of individuals and groups using this method can be problematic. Kaufman and Rousseeuw (1990) note that single linkage can lead to the "chaining effect" where clusters stick together resulting in drawn-out clusters or, as Sneath and Sokal (1973) describe them, "straggly" clusters (216).

b) Complete Linkage

Often referred to as the "furthest neighbor" or the "maximum method," a complete linkage algorithm clusters units based on their similarity to a cluster equal to its similarity to the farthest member in that cluster. Two clusters will be joined based on the similarity that exists between the furthest pair of members in the clusters. In complete linkage, tight, numerous discrete clusters are usually created. These clusters will most likely only join to other clusters at a relatively low overall level of similarity (Sneath and Sokal 1973).

c) Average Linkage

This method was developed in order to bypass the extremes of both single and complete linkage clustering techniques. In average linkage, units are computed on some level of average dissimilarity or similarity to a cluster and an extant cluster (Sneath and Sokal 1973). Each time a new unit is added or a pair of units is joined together, a new resemblance coefficient is computed. The new coefficient of resemblance represents the average of the coefficients of the members from a cluster. Unlike single linkage, average linkage does not produce the chaining of units or members because of its ability to re-average coefficients each time a new member is added to a cluster. At the same time, unlike complete linkage, average linkage does not create tight clustering structures that may be too exclusive (Mackie 1995).

Finally, data exported into a clustering solution can be either overlapping or non-overlapping. If an overlapping clustering method is chosen, taxa will be allowed to overlap with one or more entities per cluster permitting these taxa fall within the same rank. In contrast, in the selection of a non-overlapping method, taxa at any one rank will be treated as mutually exclusive. Entities grouped under one taxon may not also be grouped or part of a second taxon of the same rank (Sneath and Sokal 1973:207).

6.2 A Clustering Solution for the Unifacial Data Set

For the purposes of this study of the unifacial tool assemblage from the Richardson Island site, it was decided that a hierarchical, non-overlapping, agglomerative clustering approach using average linkage would be used. Due to the varied nature of the data set (i.e., variables that were nominal, ordinal, and continuous) Gower’s Coefficient of Similarity was chosen because of its ability to deal with variables measured on different scales. Average linkage was selected as the most appropriate algorithm for the study due to its applicability to archaeological studies and its wide spread use as a conservative alternative between the extremes of single and complete linkage.

As previously stated by Aldenderfer and Blashfield (1984:7), there are some principal goals for the application of cluster analysis to a specific assemblage or data set. For the purposes of this study on unifacial tools, Aldenderfer and Blashfield's third goal is the most applicable reason for the incorporation of cluster analysis:

> "Data exploration as a means to generate hypotheses. A grouping of entities through cluster analysis might reveal specific relationships between entities or differences between these entities and therefore, may lead to new questions, theories or interpretations of the dataset."

The main purpose of applying cluster analysis to the unifacial tool assemblage was to explore the structure of the artifacts independent from their defined tool types. Do the unifacial tools exhibit any underlying structure or none at all?

6.2.1 Application of Cluster Analysis to the Unifacial Data Set

Aldenderfer and Blashfield (1984:12) have outlined five basic steps to be taken for the implementation of cluster analysis. These steps are as follows;

1) The selection of a specific sample or data set that you want to cluster.
2) The selection of a specific, defined set of variables to represent the entities in the given sample.
3) The computation of groups of similar entities using a cluster analysis method.
4) The creation of groups of similar entities using a cluster analysis method.
5) And finally, the validation of the clusters formulated through a cluster analysis method.

6.2.2 The Unifacial Tool Data Set (n = 548 cases)

Of the 1097 unifacial tools recovered from Richardson Island and recorded in the Access database, 548 of these artifacts were selected for cluster analysis. These cases represent all complete unifaces having 75 % or more of the measured variables present in the database. Unifaces were imputed from Microsoft Access 2003 into Clustan Graphics without any type designations and labeled only by artifact number. Any missing values were coded 9999 in order to easily separate them in the clustering solution.

6.2.2.1 Selection of Variables for Cluster

While the purpose of applying cluster analysis to a data set is to organize objects or entities on an objective level, there will always be some amount of subjectivity in the selection of variables to include in the clustering process. There are two main methods for approaching variable selection: 1) Include all of the variables measured for each specimen in the cluster program or 2) include only those variables that are felt to be important or relevant to the typological structure of the data set. Sneath and Sokal (1973) recommend using the largest number of variables possible for any given classification of taxa; the more variables included in an analysis, the better the results will be. Therefore, it is more profitable to include as many variables as possible to cluster analysis. However, as Mackie (1995) notes, the inclusion of many variables should not result in an all inclusive approach; the selection of variables should still be focused on a specific purpose.

The variables chosen for the cluster analysis of the unifacial assemblage from Richardson Island are based on multiple characteristics that may define the stone tools. Selected variables encompass the overall sizes, shapes, raw materials, functionality and manufacturing processes of each tool. It was believed that each one of these variables would reflect some meaningful aspect of a specific tool type. For instance, if a specific type of tool was standardized, at least to some extent, this group would share similar characteristics such as overall size, shape, blank form and raw material type. In the end, the number of variables chosen for the clustering procedure was fairly conservative with only 12 variables imputed into the clustering solution. Some variables that were measured and entered into the Access database initially did not seem applicable for this analysis but were useful for other analyses. It is possible that there are other variables that could have proved useful for the measurement of the unifacial tools however, the overall variability of the artifacts resulted in some difficulties when additional measurements were included. While the number of variables may not be as extensive as some other applications of cluster analysis, it was believed that the variables chosen would be sufficient for finding groups within the data set and would leave out variables that were not meaningful for the research objectives.

	Variable	**Scale**	**Coded**
1	Length	Continuous	N/A
2	Width	Continuous	N/A
3	Thickness	Continuous	N/A
4	Weight	Continuous	N/A
5	Raw Material Type	Nominal	1-28
6	Blank Selection	Nominal	1-6
7	Location of retouch	Nominal	1-5
8	Retouched edge outline	Nominal	1-15
9	Retouch Distribution	Nominal	1-3
10	Edge Angle[7]	Ordinal	1-7
11	Amount of Dorsal Cortex	Ordinal	1-4
12	Dorsal Flake Scar Count	Ordinal	1-4

Table 11: Attribute Scale and Code for Cluster Analysis

[7] Note that edge angle is given a scale of from 1 to 7 instead of 1 to 3 as per the original data collection i.e. edge angles of 1 = 0-45 º and 3 = 60-90 º. Due to the multiple attributes that could occur on one artifact, a unifacial tool may have one acute edge and another edge that is quite steep. In these situations, a tool might be ranked from 4 to 7 in order to account for these multiple edge angles (See Table 12).

6.2.2.2 Coded Variables and the Selection of a Clustering Solution

Table 11 outlines the variables initially selected for cluster analysis and their associated codes. Each variable was coded on a nominal scale in an Excel spreadsheet and then imported into Clustan Graphics Version 8.0, a cluster analysis software program. After a consideration of the various clustering methods as outlined above, a non-overlapping, hierarchical agglomerative clustering method using Gower's Coefficient of Similarity and an average linkage algorithm was chosen for the unifacial data set.

Although Gower's Coefficient of Similarity can account for multi-scale variables, an initial exploration of the program revealed that the most effective method for importing multiple variables was to code everything on the same scale. All variables, excluding the continuous scale variables of length, width, thickness and weight, were coded on a scale from 1 to 28 (See Table 12).

Results produced a dendrogram or tree diagram of artifacts that were grouped together showing their potential similarities or dissimilarities to other members. There were several stages to the application of cluster analysis for the unifacial tool data set:

1) The initial inclusion of all 12 variables for the total unifacial assemblage.

2) The application of cluster analysis to the variables considered "functional" in the assemblage.

3) The application of cluster analysis to scraperplanes in order to look for any sub-types within this tool category.

4) The segregation of the unifacial assemblage into the Kinggi Complex and Early Moresby Tradition and the implementation of cluster analysis on each assemblage.

Coded Variables (Scale from 1-5)						
CODE	**SCALE**	**1**	**2**	**3**	**4**	**5**
Raw Material Types Coded	Nominal	Siliceous argillite sum	Rhyolite sum	Shale/argillite sum	Wacke/ Shale	Tuff 7
Retouched Edge Outline	Nominal	Convex	Concave	Pointed	Straight	Straight and Pointed
Edge Angle	Ordinal	0-45º	45-60º	60-90º	1 and 2	1 and 3
Blank Selection	Nominal	Flake	Tabular	Tabular Core	Core	Cobble
Location of Retouch	Nominal	One margin	Two margins	Three margins	Four margins	All margins
Flake Scar Count	Ordinal	1 Flake scar	2 Flake scars	3 or more Flake scars	No flake scars	
Amount of Cortex	Ordinal	0-50%	50-100%	100%	No cortex	
Retouch Distribution	Ordinal	Continuous	Clustered			
Length (mm)	Continuous					
Width (mm)	Continuous					
Thickness (mm)	Continuous					
Weight (g)	Continuous					

Table 12: Coded Variables (scaled 1-5) for Cluster Analysis (table continues on the next page).

Coded Variables (Scale 6-12)

CODE	6	7	8	9	10	11	12
Raw Material Types Coded	Sedimentary	Varvite 20	Dacite	S108-1	121	L29	Rhyolite (dacite) 21
Retouched Edge Outline	Concave and Pointed	Convex and concave	Convex and straight	Concave and straight	Convex, concave and straight	Convex and pointed	Convex, pointed and straight
Edge Angle	1,2 and 3	2 and 3					
Blank Selection	Pebble						
Location of Retouch							
Dorsal Flake Scar Count							
Amount of Dorsal Cortex							
Retouch Distribution							
Length (mm)							
Width (mm)							
Thickness (mm)							
Weight (g)							

Table 12 continued: Coded Variables (scaled 6-12) for Cluster Analysis (table continues on the next page.

Coded Variables (Scale 13-20)								
CODE	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Raw Material Types Coded	Basaltic andesite 15	G21	K25a	Combo	Beach Cobble	P12	Andesite	R24a
Retouched Edge Outline	Concave, pointed and straight	All Types	Pointed, Concave and Convex					
Edge Angle								
Blank Selection								
Location of Retouch								
Dorsal Flake Scar Count								
Amount of Dorsal Cortex								
Retouch Distribution								
Length (mm)								
Width (mm)								
Thickness (mm)								
Weight (g)								

Table 12 continued: Coded Variables (scaled 13-20) for Cluster Analysis (table continues on the next page.

Coded Variables (Scale from 21-28)								
CODE	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Raw Material Types Coded	L25	Agate	Wacke 16	A24	T23	Chalcedony	1127T12A2-10	Other
Retouched Edge Outline								
Edge Angle								
Blank Selection								
Location of Retouch								
Dorsal Flake Scar Count								
Amount of Dorsal Cortex								
Retouch Distribution								
Length (mm)								
Width (mm)								
Thickness (mm)								
Weight (g)								

Table 12 continued: Coded Variables (scaled 21-28) for Cluster Analysis

6.3 Cluster Solution 1: 12 Variables Selected

During the initial run of cluster analysis, all complete unifacial tools were entered into the software program and all 12 variables were included (Table 11). The solution was then partitioned at 34 groups and 64 groups.

6.3.1 Selection of the Best Cut

After the cluster program has shuffled and processed the necessary data and created a dendrogram or tree diagram, one is left with the seemingly daunting and potentially problematic task of deciding where to partition the diagram. This is known as taking the best cut. Whether a dendrogram is partitioned at 54 or 25 clusters will change the form of the groups of items; a 25 partition will group more items together while a partition at 54 will reveal smaller groupings. However, there is no purely objective method for determining where to make the best cut. There is a best cut function found in Clustan Graphics that generates what the computer believes to be the best partition but this feature seemed to include all of the items into one group rather than breaking the items into more focused groups.

Subjectively, a dendrogram can be partitioned based on what an observer deems to be an interesting group of items. Ultimately, this subjective partitioning of items may result in some exploration of different levels of cuts, comparing the groups displayed in the dendrogram to the items under study. For the unifacial tool analysis, the cluster solution was subjectively cut at both 34 and 64 groups based on the clustering patterns that were produced in the dendrogram. When all 12 variables were included in the clustering solution and partitioned at 34, the groups displayed remained quite inclusive but not too large as to not be able to distinguish distinct segregations between some clusters. At partition 64, entities were separated into much smaller groups but some distinct clusters remained evident. The partitioning of the data set using a number greater than 64 resulted in the loss of clustering structure. Groups of entities dissolved into too many separate entities.

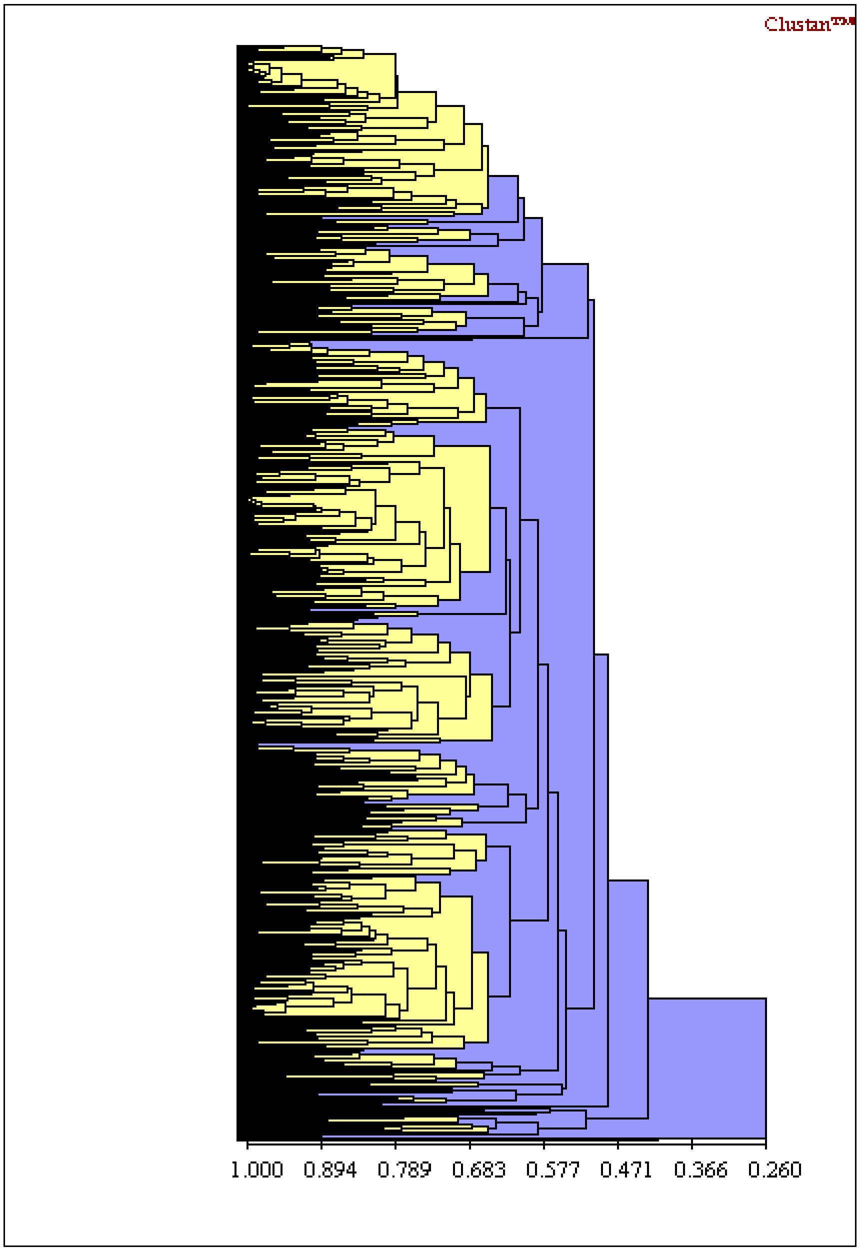


Figure 9: Dendrogram of the cluster solution at partition 34 for 12 variables. The unshaded areas represent the clusters.

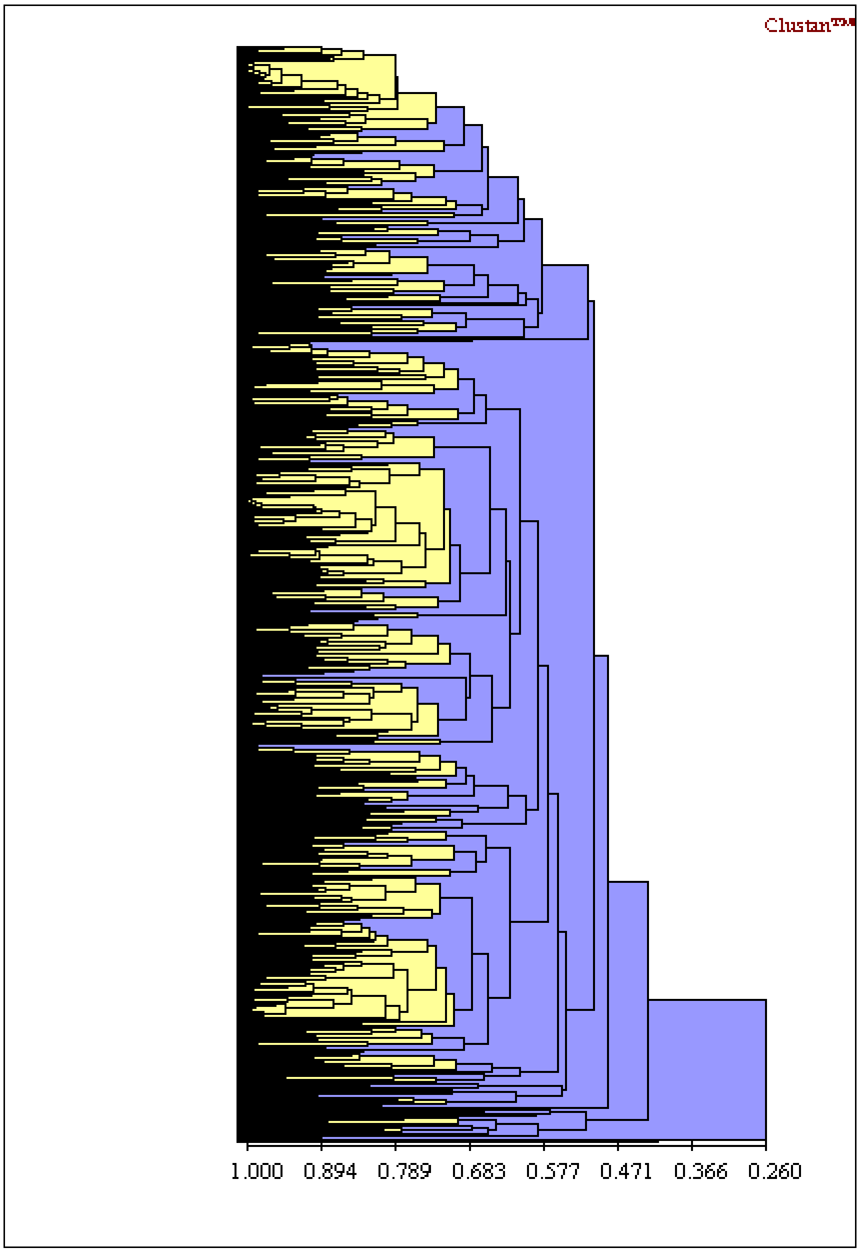


Figure 10: Dendrogram of the cluster solution at partition 64 for 12 variables. The unshaded areas represent the clusters.

6.3.2 Validation and Results

As cluster analysis will always produce some clusters, a further exploration of the validity of the resultant clusters was necessary. There are several different types of tests that have been developed to validate or test the results of a clustering solution (see Aldenderfer 1981). However, many of these validation tests have limitations and some archaeologists have, instead, chosen to validate their clusters using an intuitive method (Mackie 1995; Mathews 2006). For the purposes of this exploratory study of clusters, an intuitive method of validation was selected.

Clustan Graphics provides a profile summary and list of members for each cluster allowing for the visual investigation of each artifact in a particular group. The unifacial tools from each cluster were located and grouped together on trays in order to explore how Clustan had combined the artifacts. I wanted to see if the unifaces grouped into any visually distinctive types or forms through the cluster analysis.

Through this visual investigation of the cluster solution some conclusions were reached. The incorporation of the 12 variables for all complete unifaces in the Richardson Island assemblage to Clustan Graphics 8.0 revealed a very weak structure to the data set. Each cluster partition included some artifacts that were quite similar to each other however there were always several unifaces that did not appear to be similar enough to be included in the same category. These increasingly dissimilar artifacts shared some but not all of the same variables. For example, two artifacts appearing in the same cluster group may have been manufactured from the same raw material type, exhibited the same blank form and edge angle but may be different in size. Of all the variables selected for the cluster solution, raw material type seemed to outweigh size measurements. In many instances, the grouping together of the unifaces based on their raw material types did bring together artifacts that were similar in their general morphology, however, other artifacts that were less similar in their forms were also included.

For the most part, uniface types as defined by the Parks Canada typology were not reflected by the cluster analysis partitioning. As a distinctive type, only scraperplanes were somewhat segregated into their own groups, although in some cases, other types were also included. Scrapers, gravers/burins, spokeshave/notches, unimarginal, bimarginal, and unifacial* tools remained quite variable as to what cluster group they were placed in. These results did not change significantly between the partitioning of the cluster solution at the 34 group level or the 64 group cut. In both instances, only a very low level of tool standardization was present.

6.4 Cluster Solution 2: Functional Variables

As the inclusion of 12 variables for the cluster solution seemed to produce only a very weak structure for the unifacial tools, several variables were removed and the cluster procedure was run again. The selection of these six variables was based on the functionality of the tools. In the exploration of the previous clustering solutions discussed above, the artifacts that clustered into some meaningfully distinct groups were those that shared similarity in their raw material type as well as in their functional attributes. The variables selected were length, width, thickness, blank form, edge angle and rock type. For consistency, the dendrograms were partitioned at 34 and 64 as per the 12 variable solutions. Results are represented in a tree diagram (Figure 11 and 12).

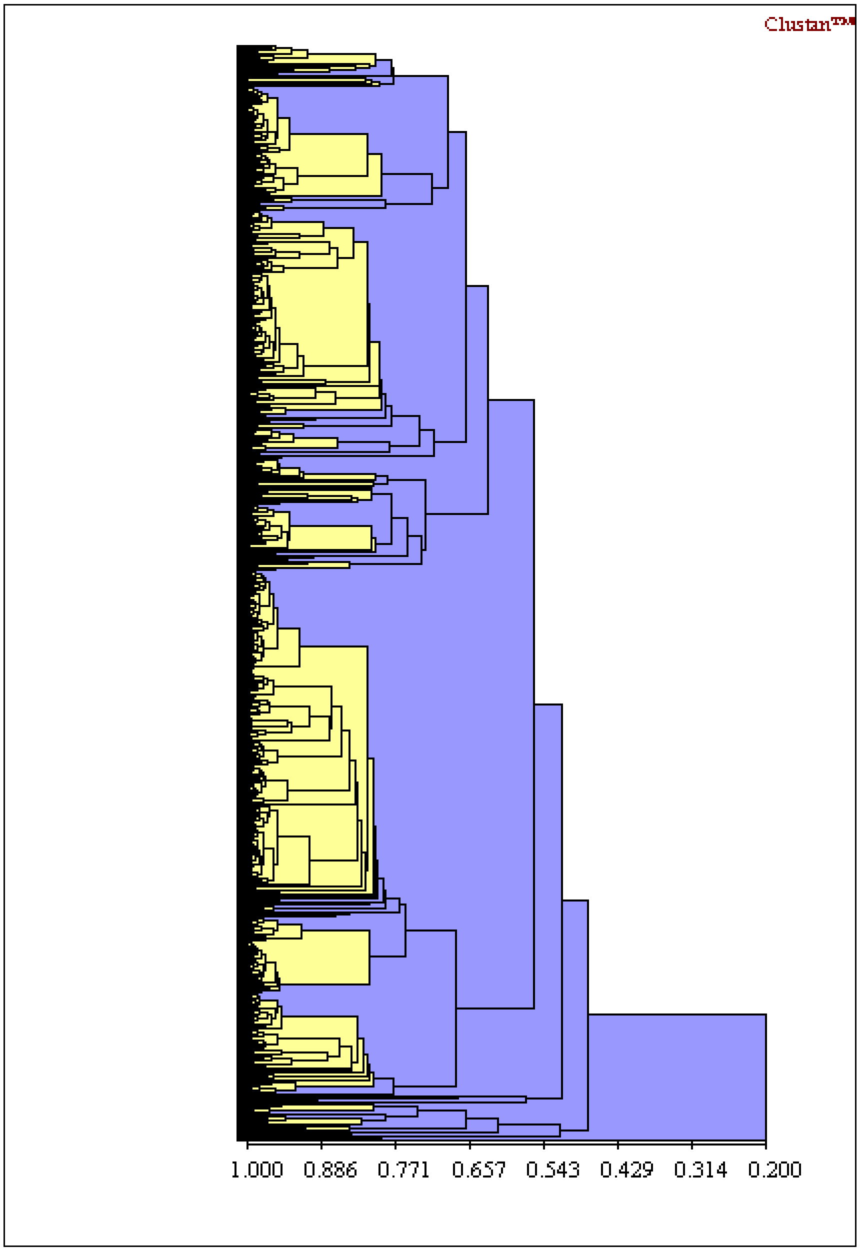


Figure 11: Dendrogram for the cluster partition at 34 for 6 variables. The un-shaded areas represent the clusters.

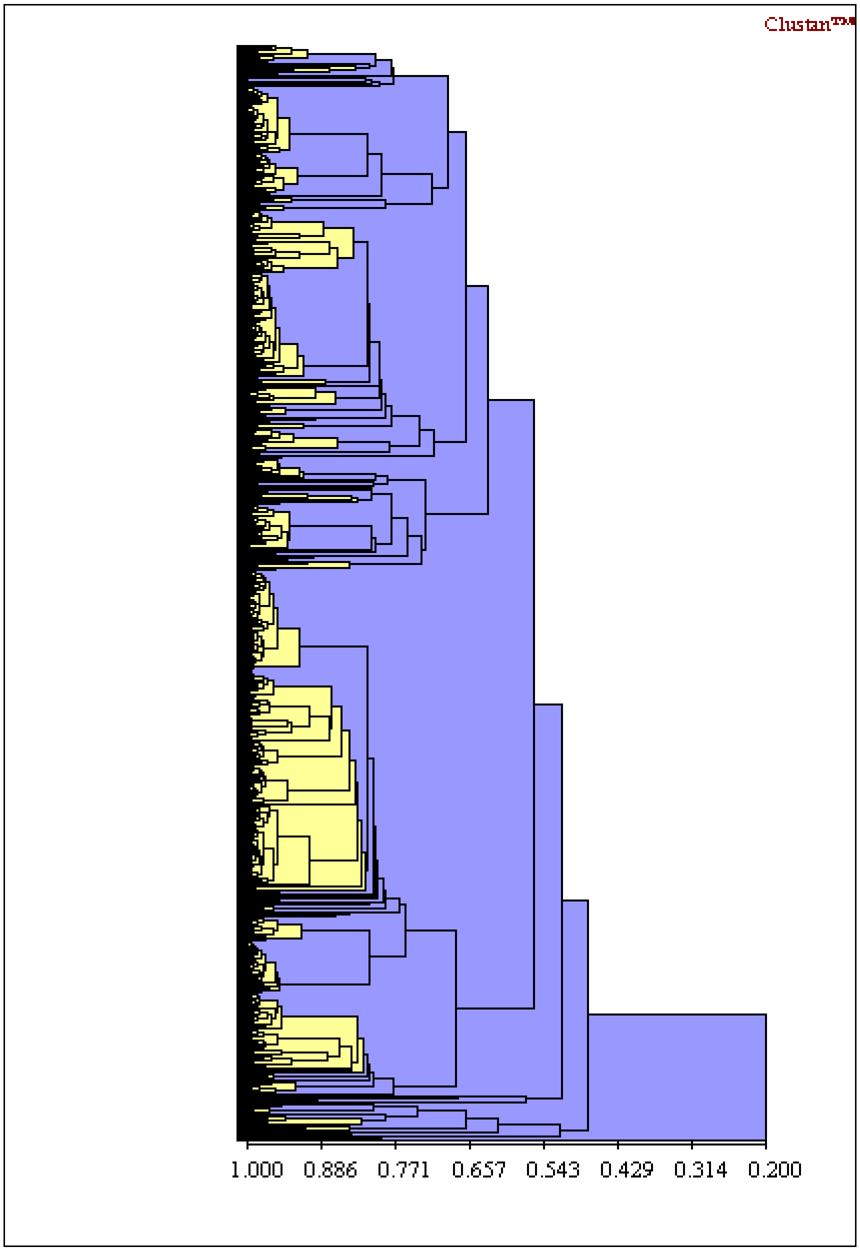


Figure 12: Dendrogram for the clustering solution at 64 for 6 variables. Unshaded areas represent the clusters.

The results of the clustering solution for 6 variables indicated a very weak structure to the data set. Again, as reflected by the 12 variable cluster analysis, the scraperplane tool type appeared to be the most cohesive as a separate group of artifacts. This may be due to the similarities in their overall size, tending to be much larger than many of the other tool types, their steep edge angles and their similar blank forms (many of them are made on tabular slabs or cores). Once again, the other unifacial tool types were highly variable in their group associations.

6.5 Application of Cluster Analysis to Scraperplanes

In order to further explore the structure of scraperplane tools as a separate tool class, all complete scraperplanes (n=99) were entered into Clustan Graphics 08 to investigate their level of standardization. Were there different sub-types of scraperplanes to be found within the Richardson assemblage or did this tool class occur at a low level of standardization? The clustering solution included the same 12 variables as previous investigations (Table 11) and was clustered at 34 and 64 partitions. Data were entered into Clustan Graphics using Gower's General Coefficient of Similarity and Average Linkage and the dendrogram below was produced (Figures 13 and 14).

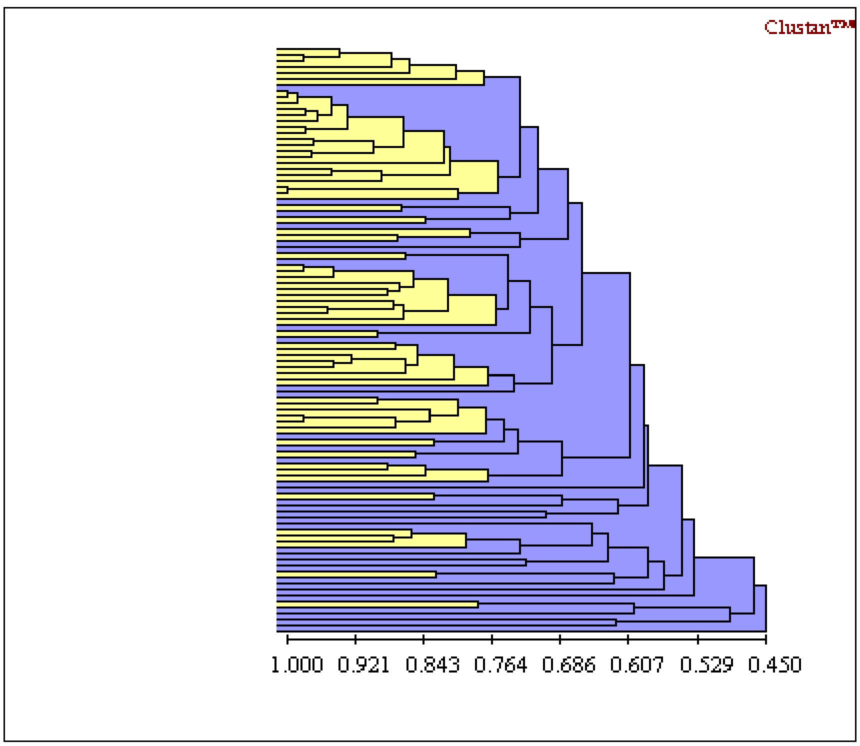


Figure 13: Clustering solution for scraperplanes at partition 34 with 12 variables. Clusters are represented by un-shaded areas.

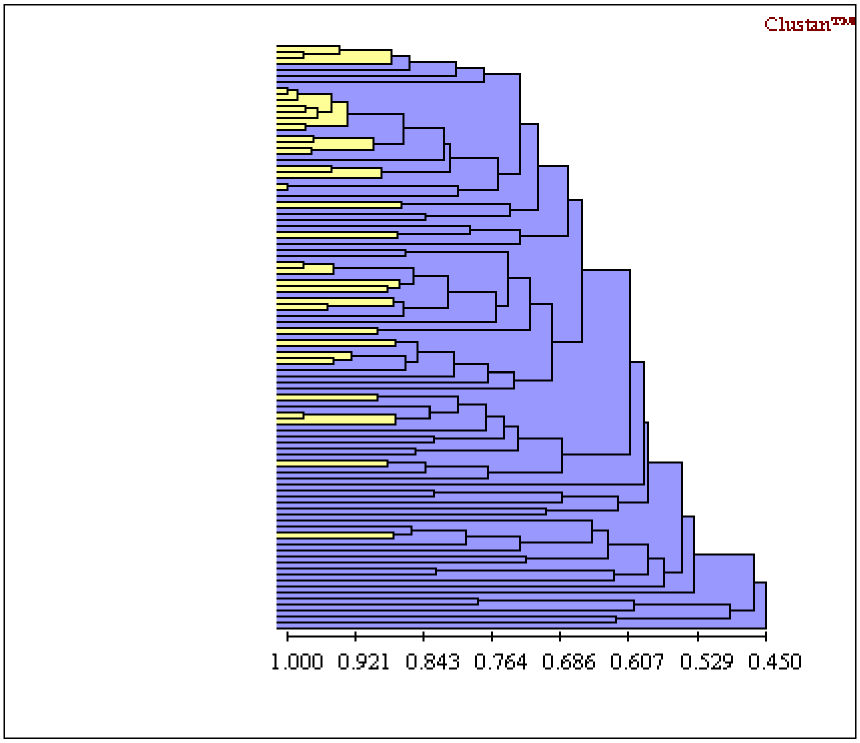


Figure 14: Dendrogram of the clustering solution for scraperplanes at partition 64 with 12 variables. Clusters are represented by un-shaded areas.

The results produced by Clustan Graphics indicate little internal cohesive structure to the scraperplane tools. The dendrogram was subjectively cut at both the 34th and 64th partition and a visual validation of the artifacts in each cluster was conducted. There were no discernable sub-types found within the 34th cut and the 64th cut produced very small groupings. It is possible that some typological structure could still exist and was subject to observer bias. However, beyond initially clustering fairly consistently into specific groups, scraperplanes do not appear to cluster into sub-types.

6.6 Application of Cluster Analysis Temporally: Kinggi Complex vs. Early Moresby Tradition.

The final application of cluster analysis to the unifacial data set explored the level of unifacial standardization on a temporal scale. The goal of segregating the unifacial tools into the Kinggi Complex and the Early Moresby Tradition and then clustering each assemblage was to investigate whether or not one of these assemblages would reveal more or less structure. Was there more structure to the unifacial tool assemblage in the earliest occupation of the site or did unifacial tools become more standardized through time?

For the Kinggi Complex unifaces, 425 complete artifacts were imputed into Clustan Graphics and 12 variables were chosen (Table 11). Gower's Coefficient was used as the matrix of similarity and average linkage was selected as the algorithm. The dendrogram produced was partitioned at the 34th cut (Figure 15). The same clustering solution was conducted for 72 complete Early Moresby unifaces. Initially the dendrogram was partitioned at 34 but, due to the small number of unifaces represented, was found to divide the artifacts into solitary units instead of groups. The dendrogram was then partitioned at cut 17, exactly half of 34, in order to be more inclusive. Figure 16 displays the resulting clusters from Early Moresby artifacts.

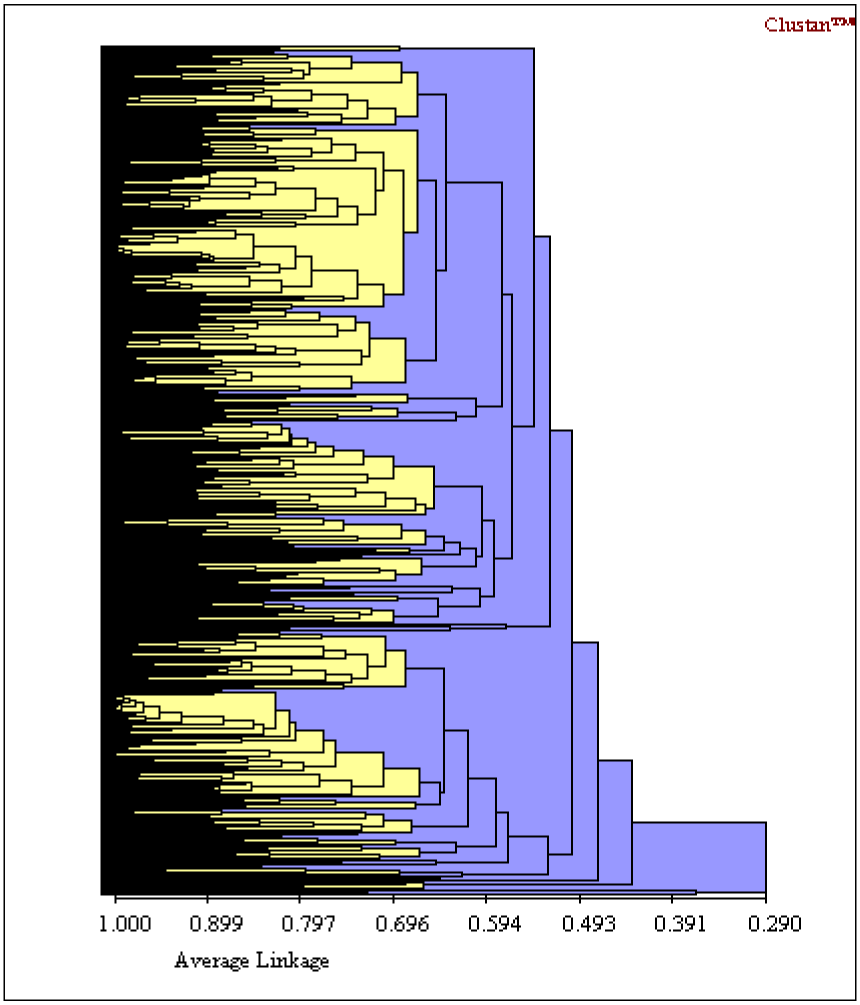


Figure 15: Dendrogram for Kinggi Complex unifaces clustered with 12 variables and cut at partition 34. Clusters are represented by the un-shaded areas.

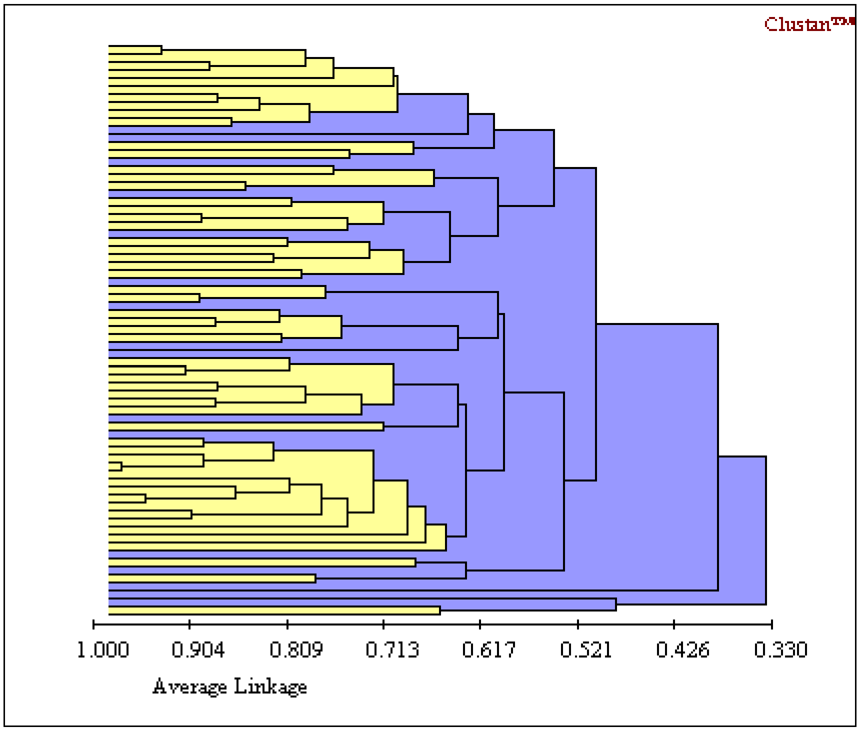


Figure 16: Dendrogram for Early Moresby unifaces clustered with 12 variables and cut at partition 17. Un-shaded areas represent clusters.

6.6.1 Validation and Results

Validation of the cluster results created by Clustan Graphics was conducted through a visual inspection of the individual artifacts as with previously discussed clustering solutions. Separation of the unifaces based on temporal units into the groups formed through cluster analysis revealed little structure to the data set. As an entire assemblage, the unifacial tools from Richardson Island did group some similar artifacts together, specifically scraperplane tools. The separation of the assemblage based on earlier or later occupation periods did not reveal any more standardization and in fact, it became more difficult to see any cohesive structure at all.

6.7 Potential Problems and Sources of Error

Although the use of Clustan Graphics for clustering the unifaces from Richardson Island appeared to be straightforward, there is still a potential for error both on the side of the observer and by the computer program itself. Each cluster solution was re-run five times consecutively and cluster profiles were re-checked to verify the accuracy of the computer's ability to work with multiple data types. As mentioned previously, visual inspection of the groups formulated by the procedure indicated that raw material type was more strongly weighted over continuous variables. In many cases, artifacts manufactured from the same material type were grouped together even if they varied in their sizes. It appears likely that the coded variables (all variables except continuous measurements) dominate over the continuous variables. There will be a higher number of artifacts that share the same material type, edge angle and blank form than share the same length, width, thickness or weight. Therefore, cluster analysis will potentially group those artifacts that share these more common variables first and include the continuous variables at a slightly lower level.

Conclusions

Cluster analysis was incorporated into this study of unifacial tools from Richardson Island with the main goal of data exploration in order to generate hypotheses and formulate new questions. Preliminary analysis of these tools had indicated a low amount of standardization and cluster analysis was used as an exploratory tool to further understand the amount of structure present within the assemblage. In the initial stages of this project, I had hypothesized that there was a potential for some standardization within these tools to be reflected through some of their morphological characteristics. Cluster analysis using a non-hierarchical, non-overlapping, agglomerative method with Gower's Coefficient of Similarity and Average Linkage was run on all of the complete unifaces in the total assemblage, on scraperplane tools as a separate entity, and on both Kinggi Complex and Early Moresby artifacts. Although some low level of standardization appeared during the clustering of all the Richardson unifaces, this clustering was suggestive of a very weak underlying structure. Further segregation of the unifaces resulted in an even lower level of structure. The clustering procedure did tend to cluster similar artifacts together although these groups of similar unifaces were most often only representative by two or three artifacts.

The incorporation of cluster analysis to the unifacial tool assemblage from the Richardson Island site indicates that there is very little underlying structure to the types as they have been defined. The next step is to question why these artifacts are so variable. Do these artifacts reflect differences in site activities over time? Is the variability found in the unifacial tools reflective of variability in the use of raw material or manufacturing processes or some combination thereof? In Chapter Seven, the variability of these stone tools will be analyzed within the framework of a behavioral model.

7 A Behavioral Model for Variability

Introduction

In Chapter Six, the introduction of cluster analysis to the unifacial data set revealed a very low amount of standardization. Unifacial tools from the Richardson Island site appear to be quite variable in their overall morphologies. The high amount of variability present within the Richardson Island assemblage sets it apart from similar studies of unifacial tools found in other archaeological contexts as demonstrated through the relative absence of few formed tools. Paramount to a better understanding of the unifacial tool typology is a more robust analysis of this unusual level of variability or lack of structure. Why are unifacial tool types, at least many of them, lacking in any apparent standardization? As the culture historical sequence for Haida Gwaii is primarily based on tool typologies, including tools that are extremely variable in form, explanations for this variability need to be explored. This chapter will introduce a behavioral model to be used as a framework for an investigation of unifacial variability as it relates to raw material selection, blank form, function/use and re-use of the tools recovered from the site.

7.1 Behavioral Model

Schiffer and Skibo (1997: 44) have argued that meaningful explanations of design variability must be built from a behavioral foundation, regardless of an archaeologist's theoretical stance. These "behavioral chain activities", as they are classified by Schiffer and Skibo, are enormously variable, encompassing a wide range of technical choices and affected by a variety of factors within different social, behavioral, and natural environments (1997: 45). Illustrating a behavioral chain through an assemblage of ceramics, Schiffer and Skibo outline various stages in their behavioral model noting that specific situational factors will vary and emphasizing the importance of not relying solely on explanations of style and function when discussing design variability. Rather, the variability in artifact design results "from people trying to solve the problems of everyday existence-conceptualized in terms of activity-specific interaction and performance…" (Schiffer and Skibo 1997:45). The interaction of people and their environments through the practice of tool production and use will have variable affects on the morphologies of artifacts. For example, tool production in one period of time might reflect activities based on the seasonal movements of people to exploit various resources. In other instances, environmental changes may affect the location of raw materials thereby affecting how people procure and use their materials for tool manufacture.

There are several models that been applied to lithic assemblages in attempts to explain the morphologies and occurrence of stone tools from one site or between several sites. While some studies on lithic variability focus on use-life histories of stone tools (e.g., Rolland and Dibble 1990; Dibble 1995a, 1995b), other studies refer to the chaîne opératoire or the "operational sequence" as the appropriate approach for exploring tool morphology (e.g., Bar Yosef et al. 1992; Boëda 1995; Bar-Yosef and Meignen 2003; Close 2006). As mentioned in Chapter Four, some archaeologists emphasize that the use of social theory in lithic studies enables them to more fully understand the people involved in the tool making activities (Close 2006; Rahemtulla 2006). For the purposes of the study of unifacial tools from the Richardson Island site, technological practice was approached at a midpoint between a technological reduction-orientated framework and one that incorporated social theory. Bar-Yosef and Meignen (2003) note that the "operational sequence" is often divided into three stages: a) raw material procurement, 2) core reduction strategies, and 3) tool manufacture/tool use. In this chapter, an operational sequence for the unifacial tools, from raw material procurement to discard in the archaeological record, will be created through the framework of the behavioral model.

A summary of variables chosen for discussion in the behavioral model is outlined in Table 13. A flow chart presenting the behavioral model applied to the unifacial tool assemblage is illustrated in Figure 17.

Variable	Reason for Inclusion in Analysis	References
Raw Material	A vital component of stone tool manufacture; procurement of raw materials, distance to and from, transport, and material properties affect stone tool technologies.	Dibble 1985; Rolland and Dibble 1990; Schiffer and Skibo 1997; Anoikin and Postnov 2005.
Blank Form	Can affect stone tool morphology therefore it is sometimes correlated to the variability seen in lithic assemblages.	Bar-Yosef 1991; Kuhn 1992; Andrefsky 2005.
Function/Use	Can look at some of the functional attributes as a guide to understanding how tools were potentially used e.g., edge angle, size, denticulate edges.	Crabtree 1977; Hayden 1979.
Tool Re-Use	Use-wear studies and measures of reduction have shown that tools can serve various purposes over their use-lives-this will inevitably affect the final tool morphology as seen in the archaeological record.	Shott 1989; Kuhn 1992; Rolland and Dibble 1990.

Table 13: Variables Chosen for Behavioral Model Analysis

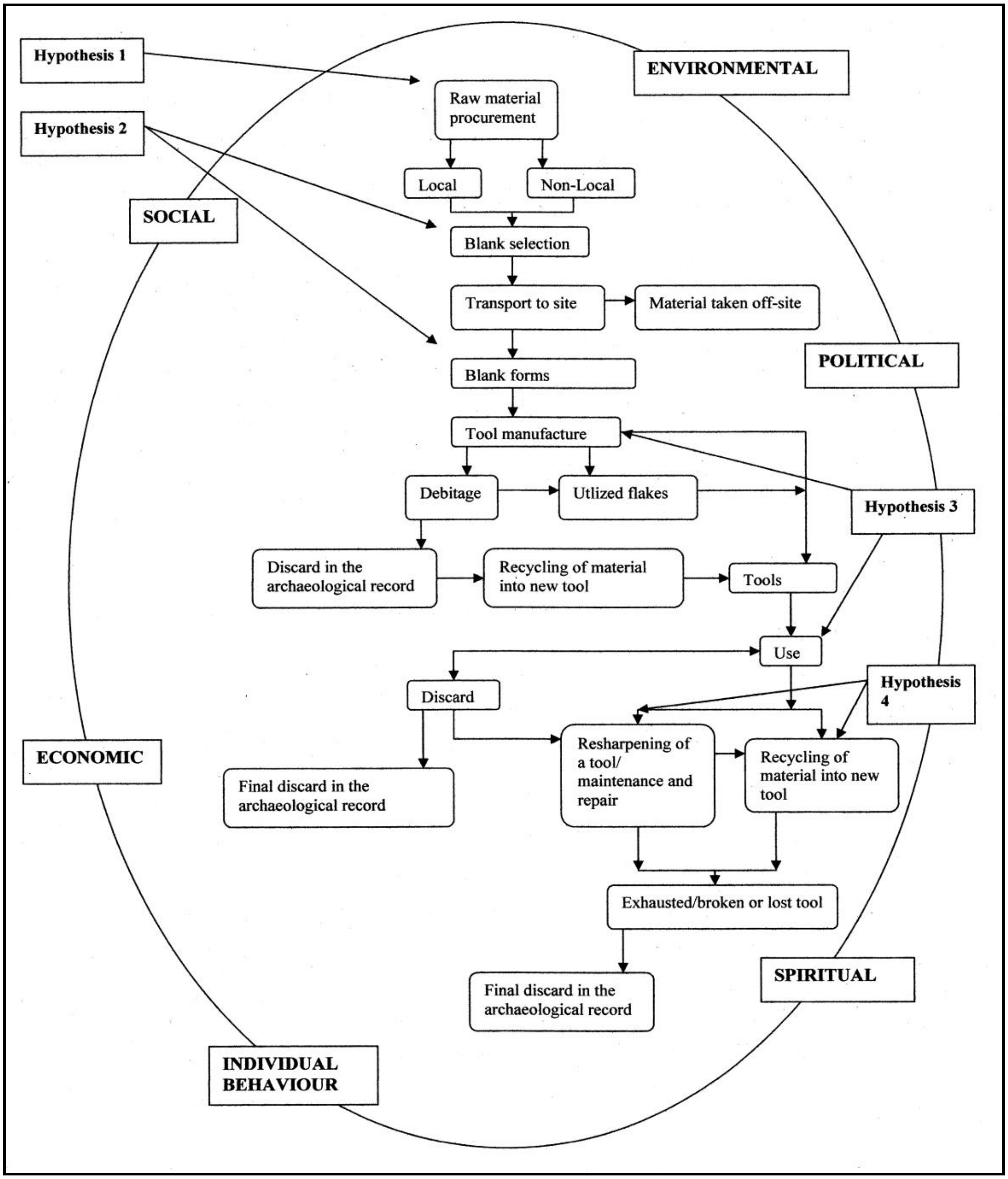


Figure 17: A Behavioral Model for unifacial tool variability. Each hypothesis connected to the model relates to one or more specific variables selected for the analysis of the unifacial tools discussed in this chapter.

There were several key variables outlined in the behavioral model that need to be further explored in order to understand variability and low standardization in the Richardson Island assemblage. Several hypotheses were formulated that have testable results for the analysis of the tools. Each one of these hypotheses is outlined in successive tables below.

Hypothesis 1: Raw Material Selection		
Hypothesis	Variables Selected for Testing	Reason
Raw material types explain some of the variability in tool morphology. Variable raw material use at the site shows some relationship to blank form, the size of the tools, the steepness of the working edge and tool type.	1. Blank form and raw material	Blank form predetermined by raw material. Relationship between raw material and blank form will be reflected in the assemblage.
	2. Flake scar count and raw material	As there is a range of material types used for the unifacial tools, flake scar counts on blanks will be associated with a range of material types. For instance, within one material type such as siliceous argillite, there will be flake blanks exhibiting early to late stages of tool production.
	2. Size and raw material	Could be determined by raw material nodules. Could also reflect a preference for specific materials when manufacturing certain tools.
	3. Edge angle and raw material	Raw material properties may result in some materials being more desirable for manufacturing steep versus acute working edges. May also relate raw material to functionality. Raw material may also predetermine edge angle.
	4. Tool type and raw material	Some materials may be more suitable for certain tool types than others. Raw material properties might also govern what types of tools can be manufactured on them.

Table 14: Hypothesis 1 of the Behavioral Model: Raw Material Selection.

Hypothesis 2: Blank Form		
Hypothesis	Variables Selected for Testing	Reason
Blank forms at Richardson were variable and "predetermined" some of the tool morphologies. Blank form has a significant influence on tool types. Blank form also "predetermined" by raw material type.	1. Size and blank form	There will be a relationship between blank form and the sizes of the tools that may reflect both material properties and the preference for large tools and tabular forms versus small tools and flake forms or some other combination.
	2. Flake scar count and blank form	Unifaces will be made on flake blanks in all stages of reduction. Whether a flake blank is produced during the early stages of tool production or during a later stage will have a different effect on the morphology of a unifacial tool.
	3. Edge angle and blank form	Extends the relationship between raw material and edge angle. Blank forms will vary in the steepness of the working edge.
	4. Tool type and blank form	Different types of tools will be made on similar blank forms i.e., a scraper will be made on more than one type of blank form. This will result in differences in morphology within one tool type, contributing to the lack of overall structure in the assemblage.

Table 15: Hypothesis 2 of the Behavioral Model: Blank Form.

Hypothesis 3: Function/Use		
Hypothesis	Variables Selected for Testing	Reason
Those attributes characterized as "functional" (i.e. size, edge angle and denticulate (serrated) edges) will show some prominent relationships to each other. There will be some patterns at this level of the behavioral model reflecting the preference for a tool of a certain size or edge angle for specific tasks. I also predict that there will be some unifacial types that reflect both small and large tools and a range of edge angles.	1. Size	Unifacial tools exhibit a large range of sizes.
	2. Edge Angle and size	May reveal some relationship between "functional" attributes. I hypothesize that there may be a relationship between the sizes of the unifaces and their edge angles.
	3. Tool type and length	May be a preferred size for certain unifacial tools but overall, each unifacial tool type will exhibit a range of sizes.
	4. Denticulate edge and raw material type	That denticulate tools will be made on different types of raw materials however, there may be some materials that are selected over others for the manufacture of these serrated edge.

Table 16: Hypothesis 3 of the Behavioral Model: Functionality

Hypothesis 4: Tool Re-use		
Hypothesis	Variables Selected for Testing	Reason
Re-use of tools, re-sharpening and re-shaping over time would have influenced the final forms of these tools before being discarded or lost. The presence of tools that exhibit morphological characteristics from more than one tool type i.e. multi-type tools will have a direct affect on any structure present within the unifacial assemblage.	1.Multi-type tool and length	Multi-type tools will be found on all sizes of unifacial tools. Adds to the weak structure in the unifacial tool assemblage.
	2.Multi-type tool and unifacial tool type	All unifacial tool types will be included in multi-type tools. The co-occurrence of several tool types on one artifact will add a large amount of dissimilar morphologies to the assemblage.
	3. Multi-tool type and raw material	Multi-type tools will be manufactured on all types of raw material. The combination of morphologically distinct multi-tools and different types of raw material will result in more "noise" within each type i.e., even less standardization of types.

Table 17: Hypothesis 4 of the Behavioral Model: Tool Re-Use

With these four hypotheses in mind, several statistical tests were conducted. The goal of each test was to accept or reject each of the four hypotheses and show that the behavioral model as illustrated in Figure 17 can be seen as a framework for understanding why the unifacial tools at the Richardson Island site are so poorly standardized. Chi square tests were conducted for many of the queries in order to assess the significance of relationships between variables. For some cases, chi square tests could not be conducted due to the small number of unifaces represented in a specific category. It was believed that, for the purposes of these analyses, leaving out one or two artifacts would not have a significant affect on the results produced. An assessment of the correlation between entities, the chi square test compares the distribution of observed values to expected values based on a theoretical expectation specified by the null hypothesis (Shennan 1997: 104). Results generated from the chi square test indicate the probability (*p* value) that there is a significant correspondence between distributions. It does not, however, indicate how strong or weak this correspondence is, only that there is some association (Shennan 1997:113).

There are, of course, many other factors that probably have contributed to the final tool forms found in the archaeological record; social, economic, political, environmental, spiritual and individual behavior. Examples of these factors are outlined in Table 18. Each one of these examples has the potential to relate to each stage presented in the behavioral model. For the purposes of this project, the focus will be specifically on the four hypotheses discussed above however, as always, it is important to recognize that these four aspects do not present themselves in isolation but are continually affected by various factors, including each other, throughout tool production and use.

Factors Affecting Unifacial Tool Behavior	
Factor	Examples
Environmental	Climatic changes/fluctuations, sea level changes, access to resources, changes in a resource base, catastrophic events i.e. earthquakes, tsunamis, alteration of the environment by people.
Social	Agency, family "traditions", collective memory, "habitus", oral histories, kin relations, relationships between individuals, marriage rights, health.
Political	Group status and wealth, conflict, warfare, inter-group and intra-group relations.
Economic	Territorial rights, access to resources, differentiations in wealth and status, trade, inter and intra-group conflict.
Individual	Individual behavior e.g., skill, agency, memory.
Spiritual	Sacred places, beliefs, ancestor worship, oral histories, spiritual healing and healers.

Table 18: Factors that may affect the Behavioral Model

7.1.1 Hypothesis 1: Raw Material Selection

	Variable from Behavioral Model	Hypothesis	Variables Tested	Test
Hypothesis 1	Raw Material Selection	Raw material types would explain some of the lack of structure in tool morphology.	1)Blank form 2)Size 3)Edge angle 4)Tool type	Chi square (X^2) test of significance

Table 19: Hypothesis 1 of the Behavioral Model: Raw Material Selection

The first stage in the process of tool making is raw material selection. As previous studies of lithics have noted, the selection of specific raw materials can provide insight into several key aspects of technological practice; the availability of raw materials, trade networks, transport of materials and raw material quality. For example, in a study of stone tools from several sites in France dated to the Middle Paleolithic, Rolland and Dibble (1990) found that variable quality of lithic materials affected the manufacture of the tools, the types of tools manufactured, and the intensity of tool reduction.

Specifically, they note the differential manufacture and use of coarse grained materials such as quartz versus fine-grained materials such as flint (484). An analysis of raw material use in Paleolithic industries of the Altai, Siberia, Russia by Anoikin and Postnov (2005) emphasized that the quality of the raw materials used was directly related to the morphologies of the stone tools (49). Anoikin and Postnov found a correlation between specific material types, their flaking properties and certain tool types and noted that, while some materials were only used for certain tool types, others were more variable or widely used (2005: 53-54).

For the Richardson Island site, Smith (2004) discovered that people were using only locally available materials sourced to both Richardson Island itself and areas located only a short boat ride away. People were using what was easily available to them and, due to the presence of large amounts of material at the site, appeared to have had access to an abundance of these resources (Smith 2004).

For the analysis of the Richardson Island unifacial tools, raw material selection was most likely a prominent factor in the variable morphology seen within the tool types. Specifically, the next section focuses on any relationships between the general morphology of a unifacial tool type and its raw material in terms of 1) blank form, 2) size, 3) functionality, i.e., size, edge angle and denticulate edges and 4) its defined tool type.

Raw Material Selection: Richardson Island Unifaces

A geochemical analysis of raw material types selected for the manufacture of stone tools at the Richardson Island site was conducted by Smith (2004). In her analysis, Smith separated many raw material types into several subtypes based on their chemical compositions (2004: 116) However, for a total analysis of these types, Smith condensed many of the subtypes into one overall material type; for example, siliceous argillite 9 and siliceous argillite 1 were combined into the category “siliceous argillite sum”. Smith identified 30 commonly occurring and distinctive raw material types and further assigned these types to 14 raw material categories. A summary of material types used for the manufacture of the unifacial tools at Richardson Island follows Smith's condensed method. Of the 14 raw material categories, only 11 are represented in the unifacial tool assemblage. Raw material categories and their frequencies in the unifacial tool assemblage are summarized in Figure 18.

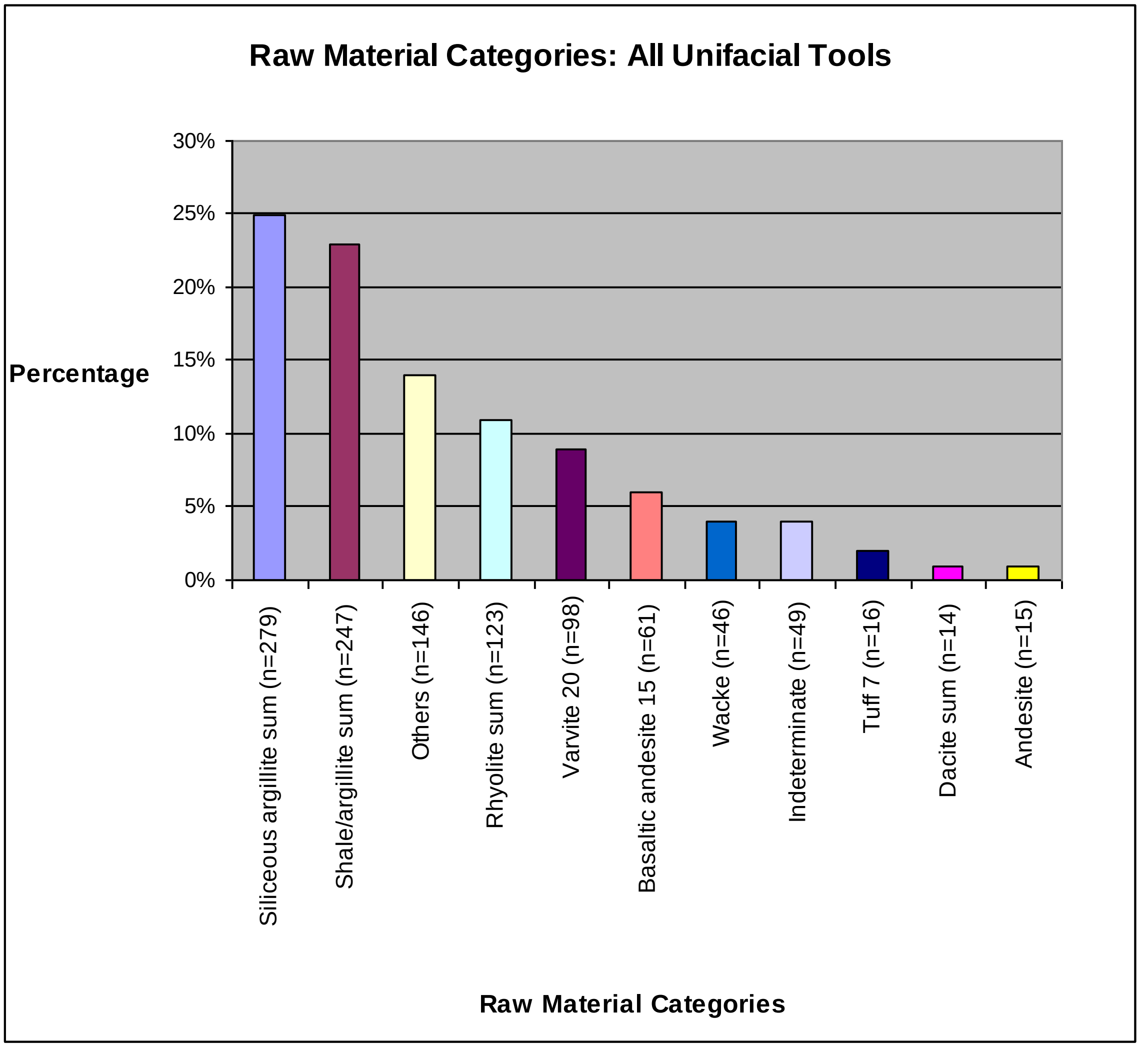


Figure 18: Percentage of raw material types for all unifaces (n=1097)

A summary of the percentages of raw material selection for the total unifacial assemblage indicates that siliceous argillite sum and shale argillite sum are quite clearly the most frequently selected types followed by rhyolite sum, varvite 20, basaltic andesite

15, wacke, tuff 7, dacite sum and andesite.[8] The category of "other" represents those materials that only occur in one or two unifaces and are therefore representative of the most variable raw material selection. Interestingly, the "other" category represents the third highest frequency of unifacial tools, an indication that there is a high amount of raw material variability for the manufacture of unifaces at the site.

Blank Form and Raw Material Type.

The first investigation conducted for the Behavioral Model analyzed the relationship of raw material type and blank form. Preliminary analysis suggested that certain raw materials used at the Richardson Island site were more heavily weighted towards one type of blank form over another based on their specific properties. Did raw material type predetermine the types of blank forms used for the manufacture of unifacial tools at the site?

As shown in Table 20 and Figure 19, a larger proportion of unifaces made on tabular forms appear to be manufactured from siliceous argillite while a larger proportion of unifaces made on flakes are made from shale/argillite. Results also indicate a substantially higher proportion of tabular forms correlated to rhyolite and a high proportion of unifaces manufactured from flakes on varvite material.

---

[8] From this point onwards, raw material type at Richardson Island will only be referred to by its name and not include "sum" although these categories will continue to represent the variable chemical subtypes. For example, siliceous argillite sum will be referred to only as siliceous argillite.

Blank Type and Raw Material Type					
	Flake	Tabular	Core	Cobble	Total
Siliceous argillite	150	91	2	0	243
Percentage	62%	37%	1%	0%	100%
Shale/argillite	169	7	22	0	198
Percentage	85%	4%	11%	0%	100%
Rhyolite	48	29	7	0	84
Percentage	57%	35%	8%	0%	100%
Varvite	60	6	3	0	69
Percentage	87%	9%	4%	0%	100%
Others	39	10	6	4	59
Percentage	66%	17%	10%	7%	100%
Wacke	23	9	4	0	36
Percentage	64%	25%	11%	0%	100%
Dacite	6	1	1	1	9
Percentage	67%	11%	11%	11%	100%
Tuff	9	4	1	0	14
Percentage	64%	29%	7%	0%	100%
Andesite	4	3	3	3	13
Percentage	31%	23%	23%	23%	100%

Table 20: Frequency and percentage of raw material to blank form.

Is there a significant difference between blank form and the different material types used for the manufacture of unifacial tools? The null hypothesis is that there is no difference between the proportions of tabular forms, flakes, cores and cobbles for each material type. Based on the frequencies and percentages displayed in Figure 20, I hypothesize that there will be a significant difference between the material types. Shale/argillite appears to have a high proportion of flake blank forms and a very low amount of tabular forms as does varvite. Both siliceous argillite and rhyolite have proportionally higher numbers of unifaces manufactured on tabular forms but also see relatively large amounts of flakes.

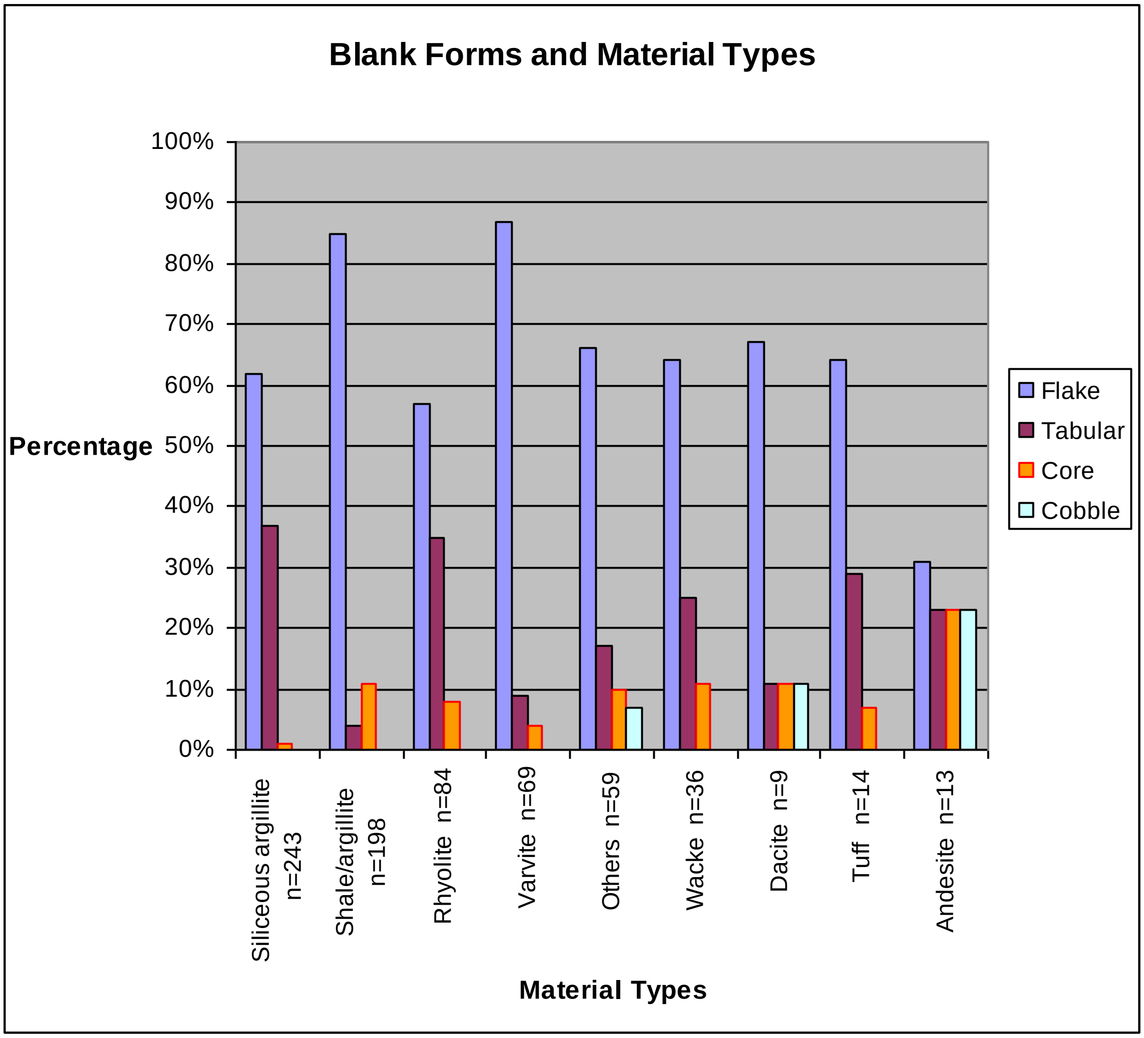


Figure 19: Proportions of blank forms to material types for all unifaces.

In order to validate the results illustrated in Figure 19, a chi square test was conducted. Due to a very low number of unifaces manufactured from wacke, dacite, tuff and andesite, these materials were not included in the chi square test. The test also did not include the blank form category "cobble" because of the small percentage of unifaces made from this type. Therefore, a test was only conducted for flakes, tabular forms and cores for siliceous argillite, shale/argillite, rhyolite, and varvite.

	Value	df	Significance (p value)
Chi Square χ^2	102	6	0.000
N of Valid Cases	594		

Table 21: Chi Square test for < 0.05 significance (p value)

Results generated from the chi square test reject the null hypothesis with a p value of 0.000 and indicate a significant difference between the four material types and their proportions of blank forms.

As the results above suggest, there is a relationship between the variable raw material types procured by the people who used the Richardson Island site and the blank forms used for the manufacture of the unifacial tools. The two most commonly procured materials for the unifacial tools, siliceous argillite and shale/argillite show differences in blank forms. Siliceous argillite is associated with a higher frequency of tabular blank forms and shale/argillite has a high frequency of flake forms and a relatively small amount of tabular forms. Rhyolite is most comparable to siliceous argillite in its proportions of blank forms and varvite is predominately associated with flakes over any other blank form. The next step in the analysis was to look at how the sizes of the unifaces (which appeared to have a large range of variability) might share a relationship to blank form type.

Raw material and length (mm) for all complete unifaces (n=548)

Is there a relationship between size measured in length (mm) and raw material type, or are all sizes of unifaces equally represented on all material types? I hypothesize that some materials were preferred for the manufacture of certain unifacial tools for specific tasks. Since larger unifacial tools may have functioned specifically for more heavy-duty tasks involving percussion, materials that are harder and tougher may have been more suited versus material types that are more brittle and fine-grained. The frequency of raw materials to length quartiles was plotted in a line graph with the 1st quartile representing the smallest unifaces and the 4th quartile reflecting the largest unifaces (See Table 22 of size quartiles for Richardson unifaces). Figure 20 illustrates the trend of the sizes of unifaces to their raw material types.

Quartile Rank	Length Range (mm)	Mean
1st Quartile	6.4 - 35.8	27.55
2nd Quartile	35.9 - 47.5	41.17
3rd Quartile	47.6 - 63.2	55
4th Quartile	63.3 - 159	82.98

Table 22: Length Quartile Range and Mean for all complete unifaces

Raw Material Types to Unifacial Tool Lengths (mm)				
	1st quartile	2nd quartile	3rd quartile	4th quartile
Siliceous argillite	49	38	36	17
Percentage	40%	30%	28%	13%
Shale/argillite	20	40	44	42
Percentage	16%	31%	35%	32%
Varvite	19	13	15	5
Percentage	15%	10%	12%	4%
Rhyolite sum	12	14	6	24
Percentage	9%	11%	5%	19%
Wacke	7	7	6	5
Percentage	6%	6%	5%	4%
Tuff 7	2	2	3	2
Percentage	2%	2%	2%	2%
Dacite sum	0	2	0	3
Percentage	0%	2%	0%	2%
Andesite	1	0	2	7
Percentage	1%	0%	2%	5%
Others	13	10	14	24
Percentage	11%	8%	11%	19%
Total	123	126	126	129
Total %	100%	100%	100%	100%

Table 23: Frequency and percentage of raw material types in each length quartile for all complete unifaces (n=548)

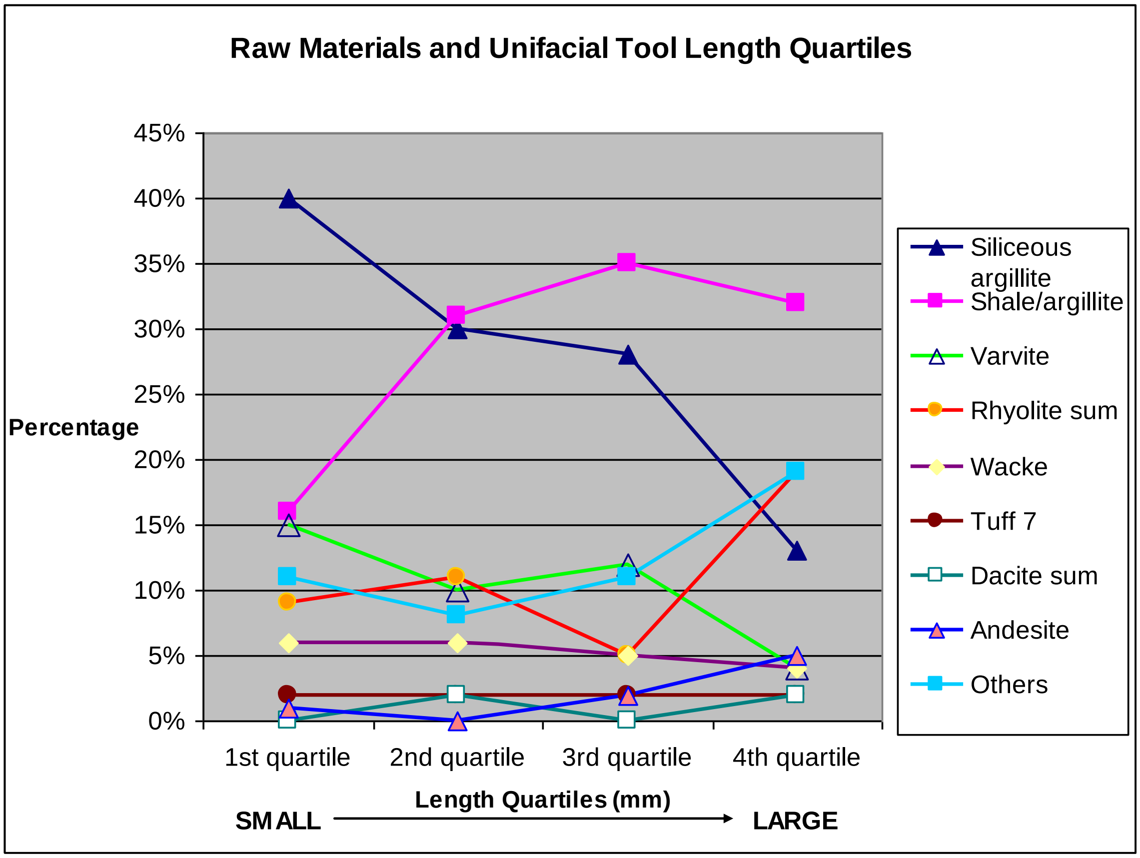


Figure 20: Frequency of length quartiles to material type for all complete unifaces

Frequencies of raw material to length quartiles produced some valuable results. Unifaces manufactured from siliceous argillite appear to be most often correlated to the 1st quartile or smallest unifaces with a decrease in frequency as these tools become larger in size. Shale/argillite, on the other hand, is more commonly associated with larger unifaces with a steady trend upwards to the 3rd quartile. Both varvite and rhyolite show a distinctive trend as well; the lengths of tools manufactured on varvite have the highest frequency for the 1st quartile or smallest unifaces and decline considerably at the 4th quartile. Rhyolite is more variable with unifaces that fall within the 1st and 2nd quartile, dropping significantly at the 3rd quartile and then rising substantially at the 4th quartile. Wacke, tuff and dacite are more variable in their lengths; however andesite does also show a significant trend upwards indicating that, although not representative of a large proportion of unifaces, this material type is mainly correlated to the largest unifacial tools. In the “others” category, there is a range of all sizes of unifaces although there seems to be a trend towards the larger end of the size spectrum.

In order to validate the results generated from this line graph, a chi square test was conducted. The null hypothesis is that there is no difference in the relationship between length and raw material between siliceous argillite, shale/argillite, varvite, and rhyolite. Note that the other material types were not included as they occurred only in very small numbers in those complete unifacial tools.

	Value	Df	Significance (*p* value)
Chi Square χ^2	45.8	9	0.000
N of Valid Cases	394		

Table 24: Chi Square test for < 0.05 significance (*p* value)

Results produced from the chi square test reject the null hypothesis and indicate that there is a significant difference between the sizes of tools manufactured on siliceous argillite, shale/argillite, varvite and rhyolite. For the 394 cases selected, the chi square value was 45.8 with nine degrees of freedom and the probability was 0.000. Siliceous argillite and varvite are more frequently associated with the smallest unifaces while shale/argillite and rhyolite are most frequently related to the larger unifaces.

Raw Material and Edge Angle

The next investigation involved raw material type in relation to functional attributes for the use of the unifaces. Was there a correlation between certain types of materials selected and unifaces exhibiting certain functional characteristics such as an acute edge? The steepness of the edge angle may relate to the kinds of tasks performed, i.e., steep edge angles for scraping and acute angles for cutting.

An investigation of the relationship between edge angle and raw material type was conducted. A bar graph was created showing the relative proportions of edge angle ranking (1, 2 or 3) for each material type (Figure 21). A summary of the frequencies and percentages of edge angle ranks for each material type can be found in Table 25.

Raw Material Type to Edge Angle					
	Acute (1)	Moderate (2)	Steep (3)	**Total**	Total %
Siliceous argillite	48	17	73	**138**	
%	35%	12%	53%		100%
Shale/argillite	58	9	66	**133**	
%	44%	7%	49%		100%
Others	17	6	32	**55**	
%	31%	11%	58%		100%
Rhyolite	15	7	30	**52**	
%	29%	13%	58%		100%
Varvite	26	10	15	**51**	
%	51%	20%	29%		100%
Wacke	11	3	11	**25**	
%	44%	12%	44%		100%
Tuff	3	1	5	**9**	
%	33%	11%	56%		100%
Dacite	1	1	3	**5**	
%	20%	20%	60%		100%
Andesite	2	1	6	**9**	
%	22%	11%	67%		100%
Basaltic Andesite	0	0	1	**1**	
%	0%	0%	100%		100%
Total Unifaces				**478**	

Table 25: Frequency and percentage of edge angle ranks for each material type.

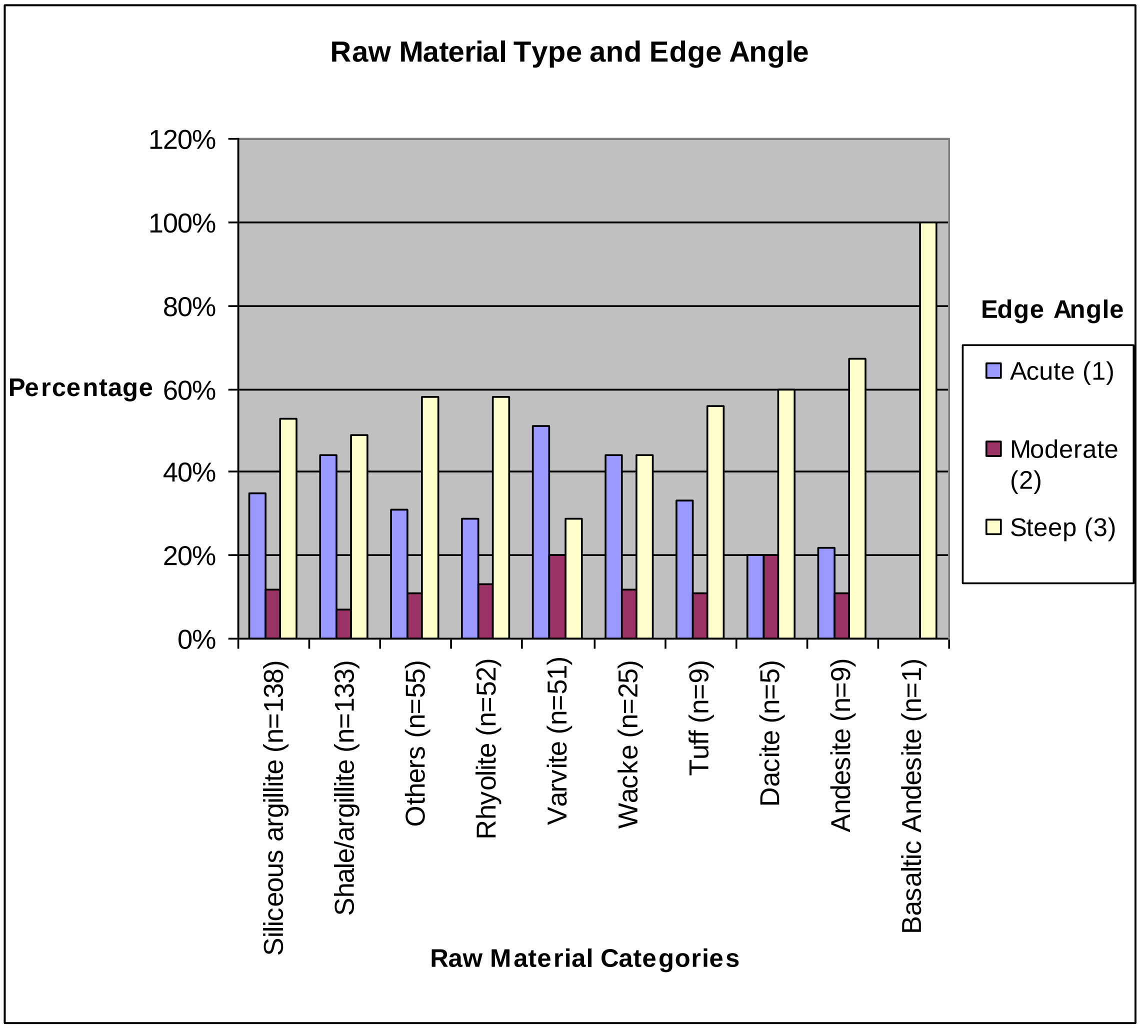


Figure 21: Proportions of unifaces with edge angles of 1, 2 and 3 for each raw material type.

In Figure 21, all prominent material types from Richardson Island are shown with the relative proportions of unifaces classified as having acute (1= 0-45º), moderate (2= 45-60º), or steep (3= 60-90º) edges. From this graph, we can see that most of the material types are dominated by unifacial tools with steep edge angles, followed by acute edge angles with moderate edge angles occurring in smaller percentages. Proportionally, dacite, andesite and basaltic andesite have the highest occurrence of unifaces with steep edges relative to acute and moderate types. Varvite, however, is the only material type that reflects a higher proportion of unifaces with acute angles relative to moderate and steep edges. As there appeared to be some difference in the proportions of edge angles between siliceous argillite, shale/argillite, rhyolite and varvite (and due to the fact that these materials were the most prominent in the assemblage), a chi square test for significance was conducted. Is there a difference in the steepness of the edge angle between siliceous argillite, shale/argillite, rhyolite and varvite? The null hypothesis is that there is no significant difference.

	Value	df	Significance (p value)
Chi Square χ^2	15.5	6	0.016
N of Valid Cases	374		

Table 26: Chi Square test for < 0.05 significance (p value)

An investigation of the relationship between edge angle and the most commonly selected raw materials indicates that there is a significant relationship between edge angle and raw material type. The calculated χ^2 value is 15.5 with a p value of 0.016 and therefore, the null hypothesis is rejected (Table 26). These results indicate some differences between material uses through the manufacture of acute, moderate and obtuse working edges. Unifacial tools manufactured from varvite have the highest proportions of acute edge angles while both shale/argillite and siliceous argillite have a higher frequency of unifaces with steep edge angles. The predominant edge type for rhyolite is steep angled; 58% of unifacial tools manufactured on rhyolite exhibit 60-90º edge angles alone. In the “others” raw material category, tools are dominated by steep edge angles and, although occurring in very small numbers, dacite, andesite and basaltic andesite collectively share a relationship to steep angled tools.

Raw Material and Tool Type

Is there a relationship between raw material and tool type in the unifacial tool assemblage? I hypothesize that some uniface types will be more frequently manufactured on certain material types but that the results will also show some significant variation in this relationship. The frequencies and percentages of artifacts manufactured from each raw material type within each tool type can be found in Table 27 and are illustrated in a line graph in Figure 22. In the line graph, the proportions of each material type for each unifacial tool type indicate that most of these tools are manufactured on all of the material types. There does appear to be some preference in the use of certain raw materials for specific unifacial tool types. Scraperplanes are most frequently manufactured on siliceous argillite followed by shale/argillite and the variable “others” category. Shale/argillite appears to be the preferred material for scrapers and siliceous argillite for both unimarginal and bimarginal tools. Chopper tools are most common on rhyolite and in the “others” category. The “others” category is quite interesting in itself; scraperplanes dominate this category and suggests that, while siliceous argillite and shale/argillite may have been used more frequently for this tool type, people also used a variety of less common materials as they became available.

Raw Material Type to Unifacial Tool Type										
	Siliceous argillite	Shale/argillite	Others	Rhyolite	Varvite	Wacke	Dacite	Andesite	Tuff	**Total**
Scraperplane	55	23	23	22	4	8	1	3	3	142
Frequency	39%	16%	16%	15%	3%	6%	1%	2%	2%	100%
Scraper	35	41	14	11	13	2	3	2	3	124
Frequency	28%	33%	11%	9%	10%	2%	2%	2%	3%	100%
Graver/Burin	122	66	18	32	26	16	6	4	6	296
Frequency	41%	23%	6%	11%	9%	5%	2%	1%	2%	100%
Spokeshave/Notch	84	50	15	14	11	8	1	2	0	185
Frequency	45%	27%	8%	8%	6%	4%	1%	1%	0%	100%
Unimarginal	100	86	23	26	44	1	5	2	5	292
Frequency	34%	29%	8%	9%	15%	0%	2%	1%	2%	100%
Bimarginal	6	0	1	1	1	0	0	1	0	10
Frequency	60%	0%	10%	10%	10%	0%	0%	10%	0%	100%
Unifacial* tool	5	5	0	1	0	0	1	0	0	12
Frequency	42%	42%	0%	8%	0%	0%	8%	0%	0%	100%
Chopper	0	1	2	4	0	0	0	2	0	9
Frequency	0%	11%	22%	44%	0%	0%	0%	22%	0%	100%

Table 27: Frequency and percentage of material types for each unifacial tool type

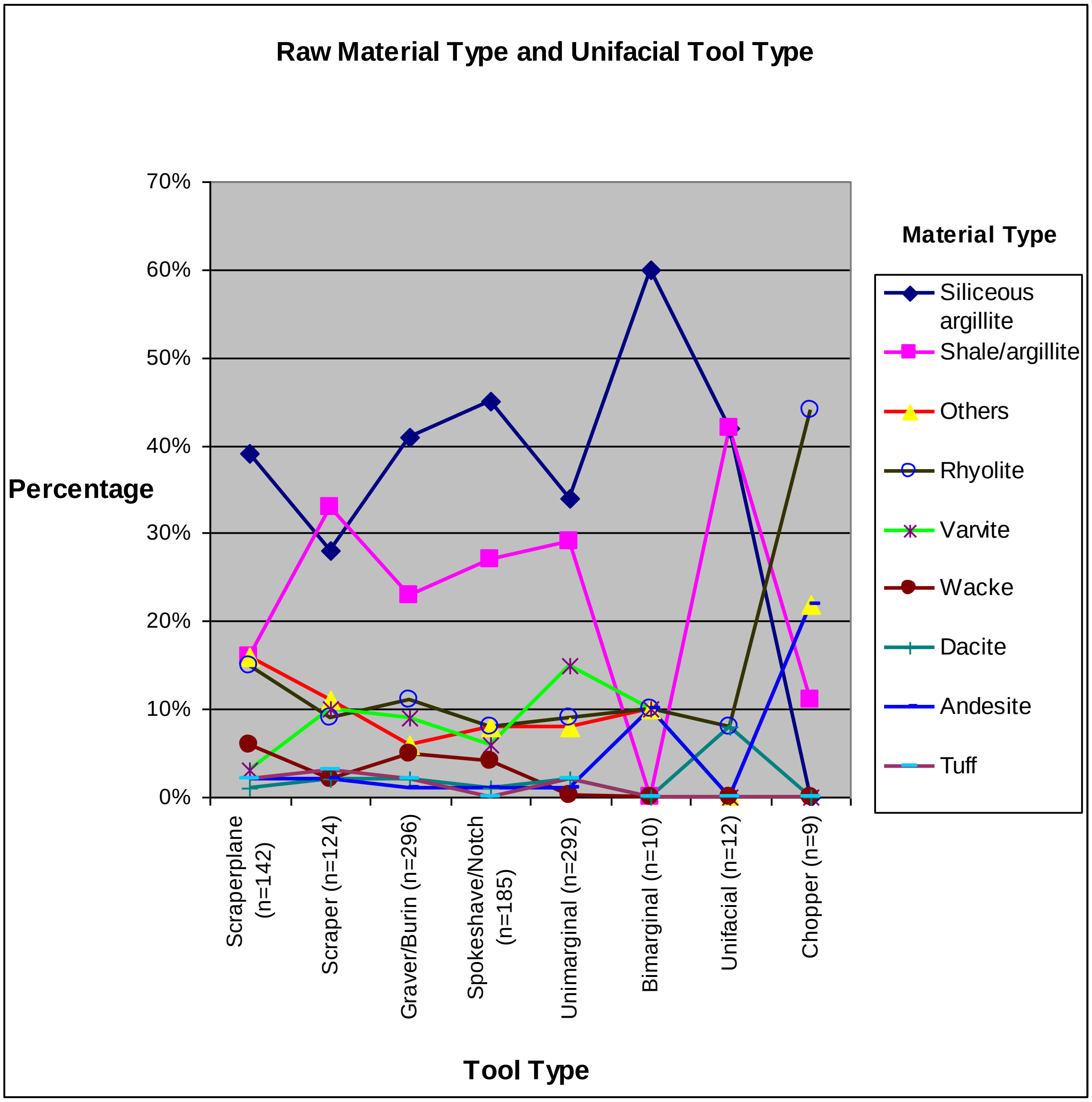


Figure 22: Percentage of raw material types for each unifacial tool type.

Hypothesis 1: Raw Material Results	
Variable	Result
I. Blank form and raw material type	There is a significant relationship between some raw material types and blank forms. Siliceous argillite, rhyolite and tuff have the highest occurrence of tabular forms than any other material types. Shale/argillite has a much higher proportion of flake blank forms relative to tabular forms as does varvite, wacke, dacite and the variable "others" category. Finally, although occurring in small numbers, andesite is quite consistent across the blank form types.
II. Size	Some materials showed a significant relationship to length quartiles while other material types were more variable. Specifically, unifaces manufactured from siliceous argillite and varvite were more frequently small in size while those made on shale/argillite and rhyolite were more likely to be large in size.
III. Edge Angle	Some materials shared a higher relative proportion of tools with steep working edges than others. Lots of variability with some indication of associations between certain material types and acute, moderate and steep edges. Specifically, varvite was often associated with acute working edges while siliceous argillite, shale argillite, rhyolite, dacite and andesite showed a relationship to steep edge angles. In the "others" category, there was also a high frequency of tools with steep working edges.
IV. Tool type	Most unifacial tools are manufactured on all of the prominent material types but there is also some indication of preference. Some tool types are more frequently manufactured on one raw material versus another. Most of the tool types are also found in the "other" category which represents the less common raw materials used at the site.

Table 28: Hypothesis 1: Raw Material results

.

Discussion

In summary, there is a large amount of variability in the raw materials selected for the manufacture of unifacial tools. Through this variability, there are also some patterns; raw material type shares a relationship to the blank form and overall size of a unifacial tool and there is some relationship between edge angles and raw material types. There is also a connection between raw material selection and tool type. Siliceous argillite shows some relationship to the smallest unifaces (1^{st} quartile) in the assemblage but interestingly, is also associated with a high proportion of steep angled tools. Graver/burins, unimarginal and bimarginal tools have frequently been manufactured from siliceous argillite followed by scraperplanes, spokeshave/notches and unifacial tools. Shale/argillite use shows some distinct patterns as well; larger unifaces are more frequently manufactured from shale/argillite and steep edged angles are the most common. Unifaces manufactured from rhyolite also have a proportionally distinct frequency of large tools (4th quartile) and seem to be most commonly associated with both scraperplanes and choppers. Varvite, however, is associated with small unifaces and 15 % of all of the unimarginal tools are made on this material type. Through these patterns, preferences between certain material types and specific kinds of tools or tasks can be seen. However, raw material types, sizes, edge angles and tool types also have substantial amounts of variety between them. Most of the tool types occur, to some degree, on all of the material types. There are both small and large unifaces represented for the most prominent material types. There are also edge angles of acute, moderate and steep occurring for most of the material types. Results from these queries suggests that people manufacturing unifacial tools at the Richardson Island site selected from a range of material types. The range of material types used for one unifacial tool type would have added to the overarching lack of structure in the assemblage.

7.1.2 Hypothesis 2: Blank Form

Research by Dibble (1984; 1988; 1991) and Kuhn (1992) note that blank form seems to affect the location of retouch on a stone tool. In many instances, blank size and shape may predetermine the overall morphology of the tool. Both the preference for certain blank forms and the constraints of these blanks will affect the process of tool production. For the purposes of this study of unifacial tools, I was interested in the correlation between blank form and several prominent variables in order to assess the influence of blank form on artifact variability. During the analysis, five key variables were compared to blank form; size, flake scar count, raw material, edge angle, and tool type.

Blank Form: Richardson Unifaces

	Variable from Behavioral Model	Hypothesis	Variables Tested	Test
Hypothesis 2	Blank Form	Blank forms at Richardson were variable and "predetermined" some of the tool morphologies. That blank form had a significant influence on tool types.	1) Size 2) Flake scar count 3) Flake scar count and raw material 3) Edge angle 4) Tool type.	Chi square (X^2) test

Table 29: Hypothesis 2 from Behavioral Model

In many cases, blank selection may have involved the purposeful selection of certain forms that would best suit specific functions or tasks. Unifacial tools at the Richardson Island site are made on flakes, tabular slabs, tabular cores, unidirectional, multidirectional and discoidal cores, cobbles and, in a few instances, from pebbles. It is important to note that blank form does not necessarily reflect the original form as it is entirely possible and, in some cases, quite likely, that the artifact form left behind in the archaeological record looks quite different in form from its original selection. However, with most specimens, it is still possible to place a tool within one of the defined blank form categories.

From a visual inspection of the unifacial tool assemblage, it appeared that there was some relationship between blank form and specific tool types. Many of those artifacts classified as scraperplanes were manufactured on large tabular slabs of material as well as on cores while many of the other tool types were manufactured mainly on flakes of varying sizes. As noted previously in this thesis, the Richardson Island assemblage includes a large quantity of debitage that may provide some indication of the initial sizes and shapes of unmodified flake forms. Unfortunately, an analysis and comparison of initial flake forms and tools was beyond the scope of this thesis project although this avenue of study would most likely provide information on blank form manufacture and reduction processes. For the unifacial tool assemblage, an investigation into blank form remained quite basic with the goal of determining what kinds of general blank forms were used for the manufacture of the tools as well as any relationships these forms shared to other variables.

Blank Form and Size (Length Quartiles)

Is there a significant relationship between the lengths of the unifacial tools and their blank selection type? I hypothesize that there is a relationship; larger unifaces will be more frequently correlated to tabular forms and cores while smaller unifaces will be more strongly correlated to flakes. Preliminary observations of unifacial tool types on some tabular forms and cores reflect a tendency towards larger tools. Many tabular pieces also tend to retain their forms and suggest that there is only minimal reduction of these blanks. Results from Table 30 and a bar graph illustrated by Figure 23 indicates that the smallest unifaces in the assemblage (1st quartile) have a much higher amount of unifaces made from flakes and decreases as the artifacts become larger. Tabular forms are less common in the smaller unifaces and are most prominent in the largest unifaces. In order to test this pattern, a chi square test was conducted.

	Blank Form Type and Length Quartiles				
	Flake	Tabular	Core	Cobble	Total
1st Quartile	132	0	0	0	132
Percentage %	100%	0%	0%	0%	100%
2nd Quartile	123	2	2	0	128
Percentage %	96%	2%	2%	0%	100%
3rd Quartile	89	30	9	0	128
Percentage %	70%	23%	7%	0%	100%
4th Quartile	42	37	38	12	129
Percentage %	33%	29%	29%	9%	100%

Table 30: Frequency and percentage of blank form types in each length quartile for all complete unifaces (n=548).

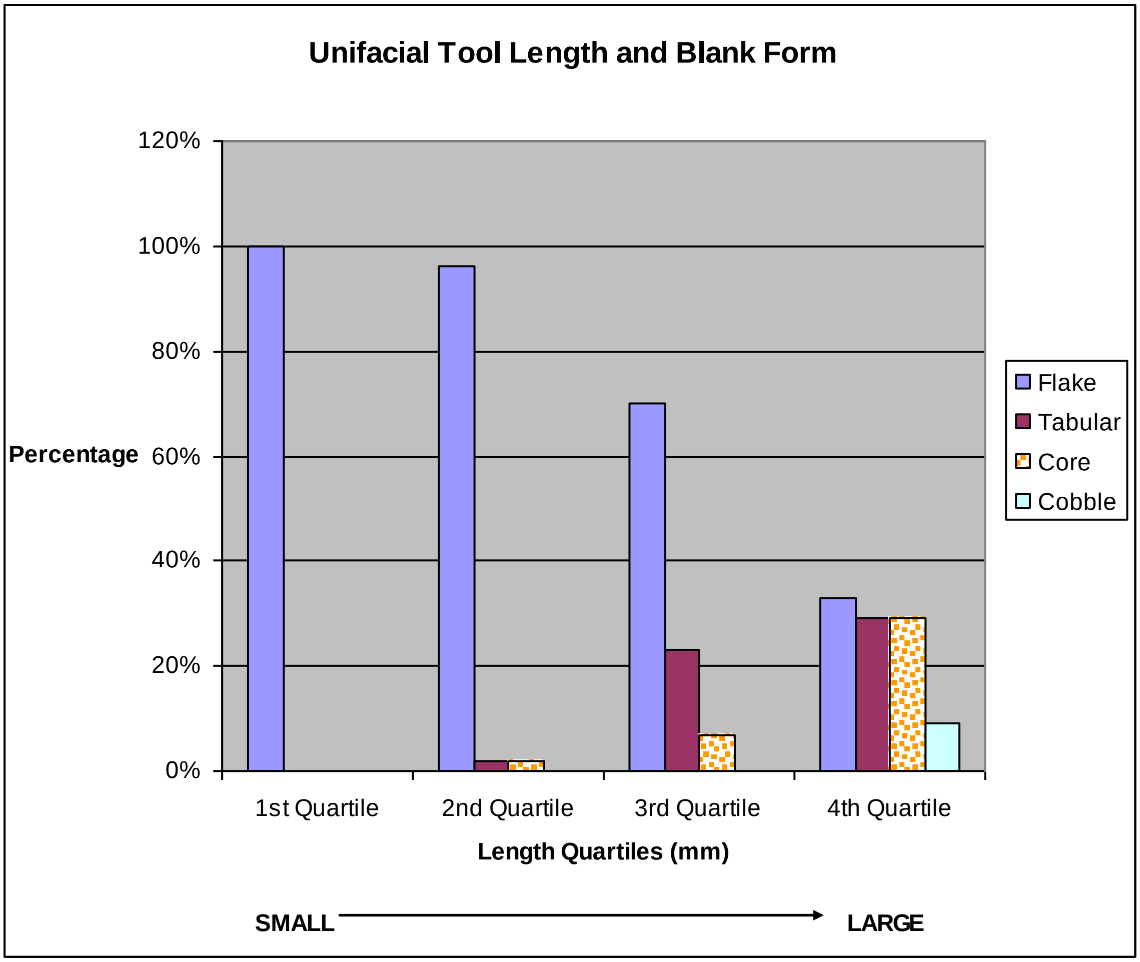


Figure 23: Length to Blank Form for all complete unifaces (n= 548).

	Value	df	Significance (p value)
Chi Square χ^2	226	9	0.000
N of Valid Cases	520		

Table 31: Chi Square test for < 0.05 significance (p value).

A Chi Square test was conducted on the mean length quartiles for all complete unifaces in relation to blank forms. The null hypothesis is that there is no difference between blank forms and their mean length quartiles. Results of this test indicate a significant relationship between artifact length and specific blank forms. The chi square value calculated was 226 for the 520 valid cases with 9 degrees of freedom and the probability was 0.000. This chi square test rejects the null hypothesis.

As results discussed above indicate, the smallest unifaces in the assemblage are made on flakes and the largest unifaces have almost equal proportions of unifaces manufactured from flakes, tabular forms and cores. This is an interesting result; while not surprising that tabular forms and cores would share a relationship to larger tools, there is an almost equal relationship between flakes and large tools as well. For all tool sizes, flakes are the preferred blank forms used at the site.

Flake Blank Forms: Flake Scar Count

A large percentage of the unifacial tools are manufactured on flake forms (51%) versus tabular (16%), core (5%) and cobble (1%) forms. In order to explore the flake blank forms in more depth, these flakes were separated based on their stages of reduction. Were people using flake blanks representing all stages of reduction or were there any differences in the use of, for instance, early stage versus late stage flake blanks? Were early stage flake blanks more commonly associated with one specific material type over another or were all types of flake blanks represented across all materials? As an initial test, the percentages of early, mid, and late stage flake forms for all of the unifacial tools were recorded. Results are presented in a bar graph (Figure 24).

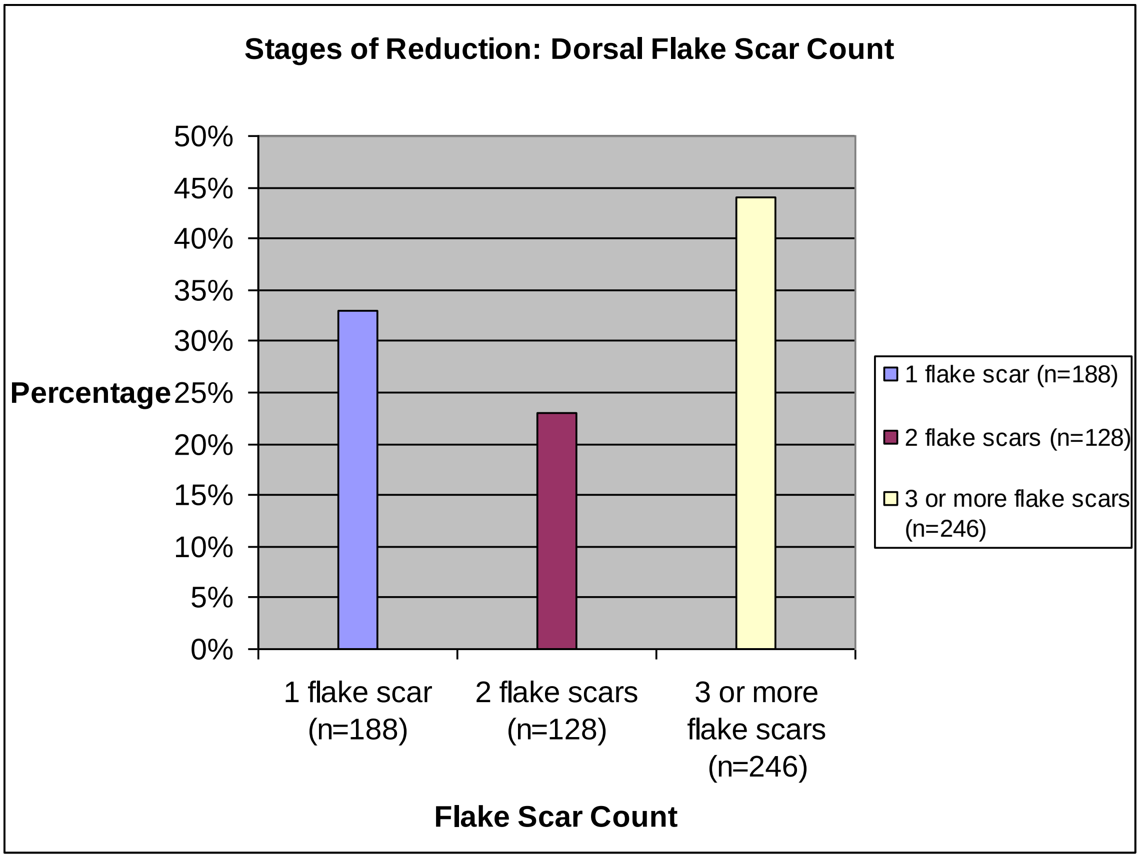


Figure 24: Percentages of dorsal flake scar counts for all complete unifaces.

Calculating both the raw frequencies and relative percentages for all complete unifaces (n= 548) to flake scar count indicates that unifaces from Richardson Island were most frequently manufactured from flakes exhibiting three or more dorsal flake scars. As dorsal flake scar count does often correlate with the stage in the reduction process (Andrefsky 2005), these results show that unifacial tools were more frequently made on relatively late stage reduction flakes versus flakes created during the early or mid-stages of reduction. However, over 25 % of the complete unifaces are also made on early stage reduction flakes (those exhibiting one flake scar) and 17 % are manufactured on mid-stage flakes (those exhibiting two dorsal flake scars). The overall results reflected by the collected data shows that unifacial tools were made using flakes in all stages of reduction. Unifaces may have been manufactured on flakes discarded during the initial reduction of a core or on flakes discarded in the process of shaping another tool.

Results produced from Hypothesis 1 of the Behavioral Model suggested that there was a relationship between raw material type and blank form in the unifacial tool assemblage. In order to further explore the relationship between raw material and the most common blank form type used for the manufacture of unifacial tools, flake scar count was compared to raw material type.

Flake Scar Count and Raw Material Type

Percentages of raw material types to flake scar counts on all complete unifaces (Figure 25) indicate that there are some noticeable differences between raw materials. Siliceous argillite and shale/argillite reflect opposing manufacturing stages. Unifaces manufactured from siliceous argillite most frequently exhibit only one flake scar while those manufactured from shale/argillite have a higher percentage of unifaces

Dorsal Flake Scar Count and Raw Material Type					
	No flake scars	1 flake scar	2 flake scars	3 or more flake scars	**Total**
Siliceous argillite	8	34	14	21	**77**
%	11%	44%	18%	27%	100%
Shale/argillite	3	31	28	66	**128**
%	2%	24%	22%	52%	100%
Rhyolite	4	15	7	17	**43**
%	9%	35%	16%	40%	100%
Varvite 20	2	18	10	16	**46**
%	4%	39%	22%	35%	100%
Others	7	19	9	19	**54**
%	13%	35%	17%	35%	100%
Wacke/Shale	0	7	4	8	**19**
%	0%	37%	21%	42%	100%
Tuff 7	0	3	3	0	**6**
%	0%	50%	50%	0%	100%
Andesite	1	1	2	4	**8**
%	12.50%	12.50%	25%	50%	100%
Dacite 30	0	2	2	0	**4**
%	0%	50%	50%	0%	100%

Table 32: Frequency and percentage of flake scar count ranks for each material type.

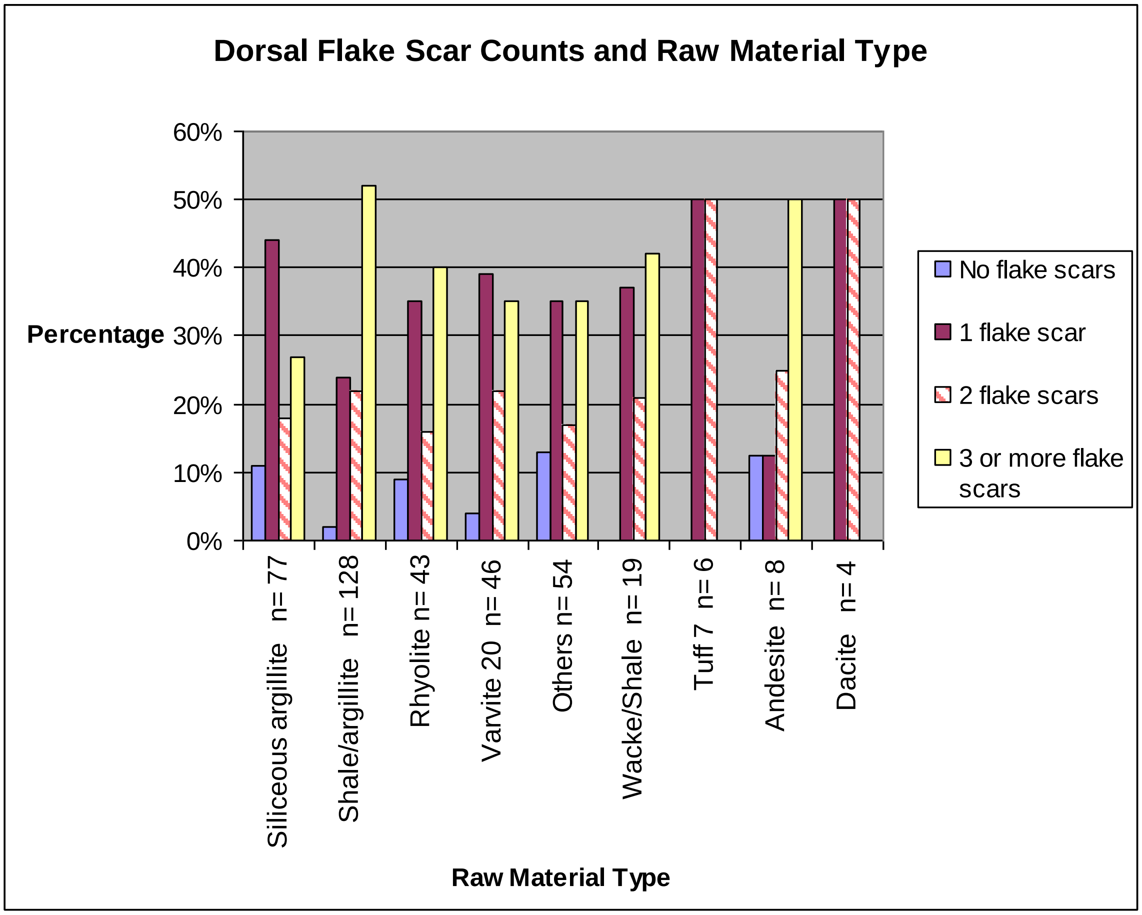


Figure 25: Frequency of raw materials to flake scar count.

manufactured on late stage reduction flakes. It is therefore possible that flake tools manufactured from siliceous argillite are, overall, more expediently manufactured in early stages of tool production than those made from shale/argillite. These results may also reflect different core reduction strategies for different material types.

In order to test the significance of the relationship between material types and their corresponding flake scar counts a chi square test was conducted (Table 33). This test did not include tuff, dacite or wacke due to their minimal presence and the category "no flake scars" was also left out of the solution because of low numbers. The null hypothesis is that there is no difference between material types in relation to flake scar counts of 1, 2, or 3+.

	Value	df	Significance (p value)
Chi Square χ^2	**35.6**	**12**	**0.000**
N of Valid Cases	**350**		

Table 33: Chi Square test for < 0.05 significance (*p* value)

The chi square test indicates that there is a significant difference in flake scar counts between different material types. For 350 cases, χ^2 was 35.6 with a p value of 0.000. Siliceous argillite is more commonly associated with flake blanks in early stages of reduction (1 flake scar) while unifaces manufactured on shale/argillite occur on flake blanks in late stages of reduction (3 or more flake scars). Rhyolite also sees a slightly higher proportion of early stage reduction flakes while varvite has a higher percentage of late stage reduction flakes. Most of the common material types used at the site include flake forms in all stages of reduction.

Blank Form and Edge Angle

Tests conducted thus far indicate that there is a relationship between raw material, blank form and size. The type of raw material is probably predetermining many of the blank forms that are found at the Richardson Island site. For example, siliceous argillite can be removed from its source along tabular bedding planes (Smith 2004). What is the relationship between the type of blank form and the steepness of the edge angles retouched at the site? Does blank form necessitate certain edge angles or are people manufacturing acute, moderate and obtuse edges on all shapes and sizes of blanks? The percentages of unifaces and their corresponding edge angles for each blank form type are represented in Table 34 and Figure 26.

	1	2	3	1 & 2	1 & 3	2 & 3	1,2 & 3	2 & 3	Total
Flake	192	47	85	10	17	0	14	6	371
Percentage	52%	13%	23%	3%	4%	0%	4%	1%	
Tabular	4	1	64	0	1	1	0	0	71
Percentage	6%	2%	90%	0%	1%	1%	0%	0%	
Core	0	2	45	0	0	1	0	0	48
Percentage	0%	4%	94%	0%	0%	2%	0%	0%	
Cobble	2	2	4	1	0	0	1	2	12
Percentage	17%	17%	33%	8%	0%	0%	8%	17%	
Total									502

Table 34: Frequency and Percentage of edge angles for each blank form type. 1 = 0-45º, 2= 45-60º, 3= 60-90º

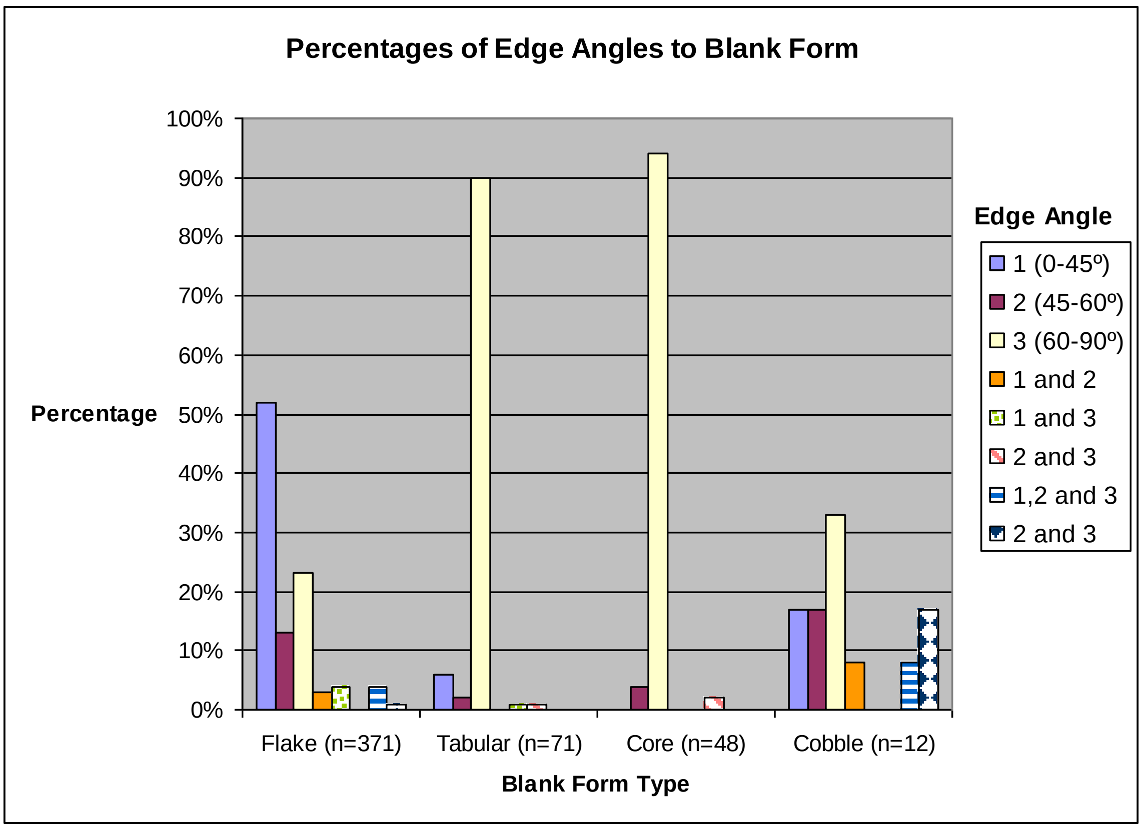


Figure 26: Percentage of edge angles (1, 2 or 3 or some combination thereof) to blank form type.

The bar graph illustrates that while flakes have the highest percentage of unifaces with edge angles of 1 (0-45º), those on tabular, cores and cobbles are most frequently manufactured with edge angles of 3 (60-90º). While unifaces manufactured on flakes and cobbles appear to exhibit the most variety in edge angles, both tabular and core forms are much more limited in edge angle ranks. Also of interest is the variety present within the unifacial assemblage. The graph reveals that, for each blank form, there are some artifacts that exhibit two or more types of edge angle; a reflection of the multi-type tools present in the assemblage.

Blank Form and Tool Type

A final query into blank forms at the Richardson Island site tested blank form type in relation to specific unifacial tool types. Preliminary analysis of the assemblage suggested that certain types of unifaces were primarily manufactured from flakes while other types were more frequently made on tabular forms. In Figure 26, there also appears to be a lot of diversity in edge angle manufacture on each blank form type. Both flake forms and cobbles exhibit the most diversity while tabular forms and cores are mostly associated with steep angled working edges. These results may suggest that tabular and core forms constrained what kinds of tools could be manufactured from them or that people were most likely to manufacture tools on these blanks because the forms already had naturally steep edges that could be easily and minimally modified. I hypothesize that certain tool types, specifically scraperplanes, will be more frequently made on tabular forms or cores and other tool types will more frequently occur on flakes.

Tool Type to Blank Form Type					
	Flake	Tabular	Core	Cobble	Total
Scraperplane	28	101	42	2	173
%	16%	59%	24%	1%	100%
Scraper	93	23	2	2	120
%	77%	19%	2%	2%	100%
Graver/Burin	223	36	7	0	266
%	84%	13%	3%	0%	100%
Spokeshave/Notch	142	37	11	0	190
%	75%	19%	6%	0%	100%
Unimarginal	243	25	3	1	272
%	89%	9%	1%	1%	100%
Bimarginal	12	0	0	0	12
%	100%	0%	0%	0%	100%
Unifacial* tool	5	2	1	2	10
%	50%	20%	10%	20%	100%
Chopper	1	5	4	5	15
%	7%	33%	27%	33%	100%
Total Unifaces					1058

Table 35: Frequency and percentage for unifacial tool types and blank forms

A tally of the frequencies and percentages for unifacial tool types and associated blank forms as represented in Table 35 as well as plotted frequencies in Figure 27 indicate that scraperplanes are most frequently manufactured on tabular pieces and cores while scrapers, gravers/burins, spokeshave/notches, unimarginal and bimarginal tools are more frequently manufactured from flakes. However, scraperplanes aside, there are several other unifacial tool types that are made on tabular forms. Graver/burin, spokeshave/notch tools and scrapers are present on tabular forms and, to a slightly lesser extent, unimarginal tools. Cores occur in proportionally small numbers across the unifacial tool types and are most frequently associated with scraperplanes and choppers.

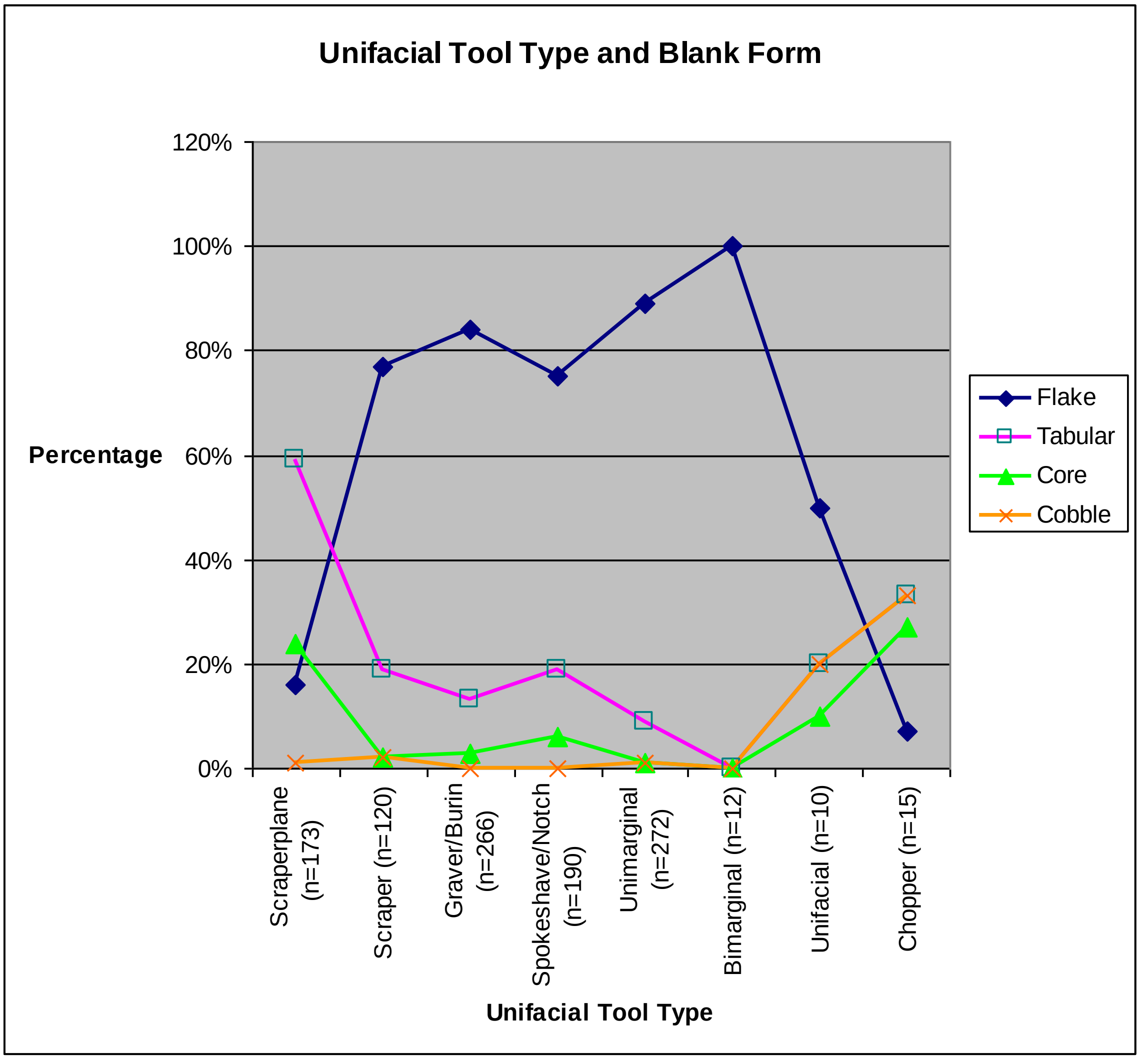


Figure 27: Percentages of blank form types for each unifacial tool type.

Hypothesis 2: Blank Form	
Variable	Result
I. Size	There is a significant relationship between blank form types and the lengths of the unifacial tools. Unifaces made on tabular pieces, cores and cobbles are most commonly grouped in the 4th quartile (large unifaces) while tools made on flakes occur most frequently in the 1st quartile (small unifaces).
II. Flake Scar Count	The unifacial assemblage includes flakes in all stages of reduction. For dorsal flake scar count on flake blank forms, later reduction stages of tool production are represented in a higher proportion than earlier stages. However, in general, people are using flake blanks from early, mid, and late stages for the manufacture of unifacial tools.
III. Flake Scar Count and Raw Material Type	Some material types are more often associated with early stages of reduction and others with later stages.Tools manufactured from siliceous argillite and varvite are most frequently made on flake blanks in early stages of reduction, those exhibiting one dorsal flake scar only. Shale/argillite, rhyolite, wacke/shale, and andesite are more frequently associated with late stage reduction flakes (3 or more flake scars).
IV. Edge Angle	There is variety in the edge angles manufactured on different blank forms. Tabular, core and cobble forms do have a higher frequency of steep working edges while flakes include a much higher frequency of acute angled edges. Many of the blank forms have more than one edge angle type.
V. Tool Type	There is some indication of blank form preference for certain tool types however, overall, a lot of overlap between tool types and their blank forms. Scraperplanes are most frequently manufactured on tabular pieces and cores while scrapers, graver/burins, spokeshave/notches, unimarginal and bimarginal tools are more often made on flakes. Graver/burin and spokeshave/notch tools are also present on tabular forms and, in smaller frequencies scrapers and unimarginal tools.

Table 36: Hypothesis 2 results

Discussion

Interestingly, of the 51% of unifacial tools manufactured on flake blank forms, 44% of these are made on flakes in late stage reduction. There does seem to be some difference between raw material type and stage of tool reduction as reflected through siliceous argillite and shale/argillite. Flake tools made from siliceous argillite trend towards being both small (1^{st} quartile lengths) and made on early stage reduction flake blanks. These results can be compared to the information gathered from tests on raw material and tool type (See Table 27, Figure 22). Unimarginal tools, an expedient and relatively small tool type, are most frequently manufactured from siliceous argillite while more moderate to large flake tools such as scrapers are more commonly made on shale/argillite. This suggests that many of the flake blank forms used for the manufacture of unimarginal tools reflect reduction strategies that produce quantities of early stage flakes. As siliceous argillite has been associated with biface production (Smith 2004), it is possible that the waste material produced during the early stages of biface production was then used for unimarginal tools either 1) due to its availability at the site or 2) because these blank forms were desirable for certain tasks.

The results of the relationship between unifacial tool type and blank form reveal that, while specific blank forms may have been selected for the manufacture of specific tool types, there is some moderate level of variability across the types. Scrapers, graver/burins, spokeshave/notches, and unimarginal tools occur on both flake and tabular forms indicating that there will necessarily be variability in morphology within each tool type. A scraper made on a flake will exhibit different morphological characteristics from a scraper made on a tabular slab. Importantly, it is the blank form that may add to the very low level of standardization found with many of the unifacial tools. While tabular slabs may have been selected for the manufacture of scraperplanes at the Richardson Island site, it appears that the blank forms for other tool types were more variable.

Summary

In summary, the reliance on specific raw materials and their properties included the blank forms available for people to select for tool manufacture. Blank form, in turn, may have helped determine the morphologies of the unifacial tools. The low standardization seen within the unifacial tool assemblage could have been strongly affected by blank form. If one of the material types most suited for tool manufacture and use came in large slabs, such as siliceous argillite, tool morphology may have been adjusted to suit this blank form. As discussed above, scraperplane tools occur more frequently on tabular slabs than any other defined tool type. Scraperplanes also appear to be the most standardized tool type as revealed through cluster analysis. Therefore, scraperplanes may have been preferably manufactured on these tabular slabs. However, other unifacial tool types are also manufactured on tabular slabs including spokeshave/notches and gravers.

7.1.3 Hypothesis 3: Function/Use

	Variables from Behavioral Model	Hypothesis	Variables Tested	Test
Hypothesis 3	Functionality	There will be some patterns at this stage of the behavioral model relating to defined "functional" attributes such as size, edge angle and denticulate edges. Unifacial tools will reflect the need to have a large tool or a steep working edge in order to conduct specific tasks. There will also be a range of sizes, edge angles and denticulate edges within each tool type category.	1)Size 2)Edge angle and size 3)Tool type and length 4)Denticulate edges and raw material	Chi square (χ^2) test

Table 37: Hypothesis 3 from Behavioral Model.

In many cases, it may not have really mattered whether a unifacial tool was manufactured on a flake versus a tabular slab in an early or late stage of reduction as long as the tool had the appropriate working edge and size for performing the specific task at hand. Some of the functional qualities or attributes exhibited by the unifacial tool assemblage include the angle of the retouched edge, the overall size of the artifact and the presence of a denticulate edge. In an ethnographic study of New Guinea Highlands societies, Strathern (1969) observed that people recognized two important aspects of flake tools: 1) size for the suitability of heavy work or for light, delicate work and 2) the type of edge needed to perform different tasks (316). However, Strathern also noted that there was a range of tool sizes that could be used to carry out the same task. Through observations of use-wear marks on the edges of various Paleolithic tools, Crabtree (1977) emphasized the importance of the obtuse angle as a functional edge. Crabtree noted that tools with obtuse angled edges could perform certain tasks that would be less possible to complete using an acute-angled tool (40).

Size of Unifaces

	Range	Mean	SD	C.R.V.
Length (mm)	223.6	51.63	23.86	0.46
Width (mm)	127.6	43.15	18.03	0.42
Weight (g)	710.8	65.56	111.27	1.7

Table 38: Summary of statistics for the length, width, and weights of all complete unifaces (n=548)

A basic analysis of the lengths, widths and weight figures for all of the unifaces from the Richardson Island site indicates that there is a large range of variability in size. Results displayed in Table 38 show the range, mean, standard deviation and coefficient of relative variation (C.R.V.) and indicate that width is the least variable while weight has a very large range and standard deviation. Length measurements have a slightly larger relative variability than does width. These statistics reveal that size was quite variable for the unifacial tools. Were there any connections between the sizes of these tools and the tasks they performed? Was there any way to connect the relative sizes of the tools to their possible functionality?

Length (mm) and Edge Angle

An exploration of the functional qualities of the unifacial tools was initiated in order to reveal any patterns within the assemblage. Were certain forms of tools at the Richardson Island site better suited for specific tasks? Were larger tools manufactured for activities that necessitated steep working edges or were acute and obtuse edge angles equally represented on large and small tools?

Is there a relationship between size in length (mm) and edge angle? I hypothesize that there is a relationship, with the larger unifacial tools exhibiting very steep edge angles and the smaller unifacial tools exhibiting more acute angles. Larger tools will be needed for heavy-duty tasks such as woodworking that might necessitate obtuse edges for planing, chopping or splitting wood (similar to an adze). For unifacial tools with acute edges for activities that necessitate the use of a knife-like tool, a smaller size may be more suitable.

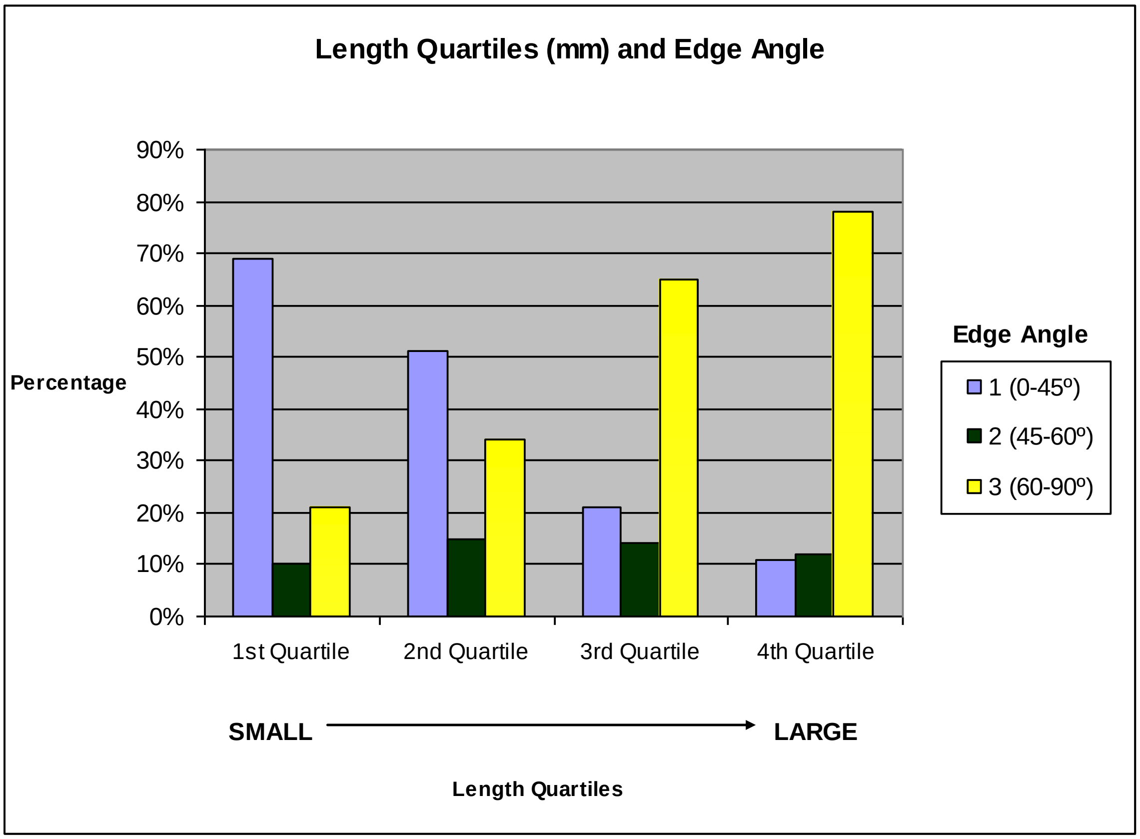


Figure 28: Length to Edge Angle (1= 0-45º, 2= 45-60º, 3= 60-90º). All complete unifaces.

In Figure 28, the unifacial tool lengths (mm) were grouped into quartiles; the first quartile representing the smallest unifaces and the fourth quartile representing the largest unifaces. The proportions of edge angles of 1 (0-45º), 2 (45-60º), and 3 (60-90º) for each quartile were then plotted in the bar graph. Results displayed in Figure 28 indicate a prominent relationship between small unifaces and acute angled edges and large tools with very steep edge angles. There is a noticeable trend between the 1st quartile unifaces and edge angles classified as "1". Similarly, there is a distinct trend between unifaces in the 4th quartile and edge angles classified as "3". Edge angles classified as "2" or between 45-60^o are present in more consistent percentages across unifacial tool size. A chi square test of significance was applied to this data. The null hypothesis states that there is no significant relationship between the size of a unifacial tool and its edge angle.

	Value	df	Significance (*p* value)
Chi Square (χ^2)	130	6	0.000
N of Valid Cases	519		

Table 39: Chi Square test for < 0.05 significance (*p* value).

Results from the chi square test reject the null hypothesis with a p value of 0.000 therefore; there is a significant relationship between edge angle and length in the unifacial assemblage. Smaller unifaces more frequently have acute working edges while the largest unifaces are primarily associated with steep working edges.

Unifacial tool type and length

After testing the relationship between length (mm) and edge angle, Table 40 was created representing the relative frequencies and percentages of each unifacial tool type in each length quartile. Figure 29 illustrates the results of this query.

Unifacial Tool Type and Length Quartiles (mm)					
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	**Total**
Scraperplane	0	7	38	74	**119**
%	0%	6%	32%	62%	100%
Scraper	11	18	33	20	**82**
%	13%	23%	40%	24%	100%
Graver/Burin	70	49	39	16	**174**
%	40%	28%	22%	10%	100%
Spokeshave/Notch	34	37	27	22	**120**
%	28%	31%	23%	18%	100%
Unimarginal	49	66	41	22	**178**
%	28%	37%	23%	12%	100%
Bimarginal	1	3	2	3	**9**
%	11%	33%	23%	33%	100%
Chopper	0	0	0	12	**12**
%	0%	0%	0%	100%	100%
Unifacial* tool	0	0	2	4	**6**
%	0%	0%	33%	67%	100%

Table 40: Frequencies and percentages for complete unifacial tool types in each length quartile.

As both Table 40 and Figure 29 indicate, there is some relationship between tool type and size. Scraperplanes, unifacial tools and choppers are most frequently present in the 4th quartile (largest unifaces) while unimarginal tools, graver/burins and spokeshave/notch tools are most common in the 1st and 2nd quartiles (smallest unifaces). Scraper lengths have the highest frequencies within the 3rd quartile. Excluding chopper tools, the unifacial tool types are found in all length quartiles. Both spokeshave/notches and scrapers are somewhat variable in size and although both graver/burin and unimarginal tools occur in smaller frequencies within the largest quartile, they are still moderately present. These results suggest that there was a preferred size for certain unifacial tools such as scraperplanes but that most of the unifacial tool types were manufactured within a range of sizes. For some tasks, it may have been important to have a tool that was quite large or small and delicate while, in other instances, size was not as important as merely having an appropriate edge or projection.

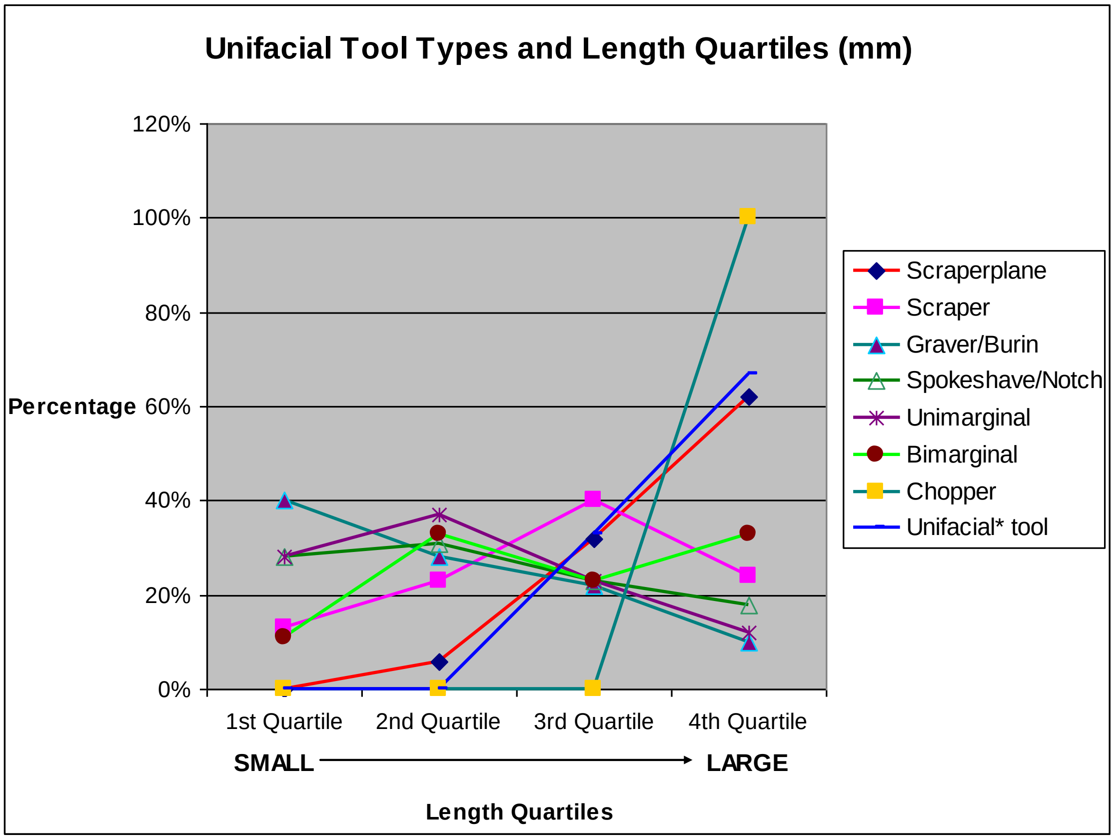


Figure 29: Percentages of complete tool types to length quartiles.

Denticulate Edge and Raw Material Type

Calculating the number of unifaces that exhibited one or more denticulate retouched edges revealed that 13 % of the total assemblage for the unifacial tools was classified as denticulate. Of these 139 unifaces, 20% were manufactured on shale/argillite and 42 % were manufactured from siliceous argillite. The remaining 38 % were dispersed amongst several other more variable material types. People may have actively selected siliceous argillite for denticulate tools. This material type could have allowed for the easy manufacture of nicely serrated edges due to the properties of the rock, i.e., breaking into sharp, jagged edges. However, it may also be that flaking on pieces of siliceous argillite caused some unintentionally serrated edges. In either case, the presence of a denticulate edge may be correlated to task specific activities and could then be correlated to certain unifacial tool types. The frequencies of denticulate edges for each type for the 139 denticulate tools were calculated (Table 41, Figure 30).

Denticulate Unifacial Tools	
Tool Type	**Denticulate**
Scraperplane	57
Percentage	41%
Scraper	37
Percentage	27%
Graver/Burin	14
Percentage	10%
Spokeshave/Notch	23
Percentage	17%
Unimarginal	43
Percentage	31%
Bimarginal	3
Percentage	2%
Chopper	2
Percentage	1%
Total Unifaces[9]	179
Total Artifacts	139

Table 41: Frequency and percentage of unifacial tool types for all denticulate artefacts (n= 139)

A distinct relationship can be seen between some of the scraperplanes and denticulate edges. As "Denticulate Scraperplane" was a defined Parks Canada tool type, this result is not surprising. There appears to be a relationship between denticulate edges, siliceous argillite and scraperplane tools. Unimarginal and scraper tools also see a relatively high occurrence of denticulate edges while graver/burins, spokeshave/notches, bimarginal and chopper tools have much smaller proportions of edges classified as denticulate. The occurrence of denticulate edges within the graver/burin or spokeshave /notch tool type may reflect multi-type tools rather than a graver or spokeshave alone. It is more likely that these numbers are reflecting a graver tool that has also been classified as a scraperplane or a spokeshave that is also a scraper. This result highlights a common theme within the unifacial data set; the occurrence of multiple attributes for multiple

[9] Total unifaces (n=179) represents a total count for each individual tool type. Due to the occurrence of more than one type on one denticulate artifact, some artifacts were counted more than once as they were separated into the different tool types. For instance, a scraperplane/unimarginal tool that is denticulate would be counted twice, once for a scraperplane and once for a unimarginal tool. The actual number of artifacts represented was 139.

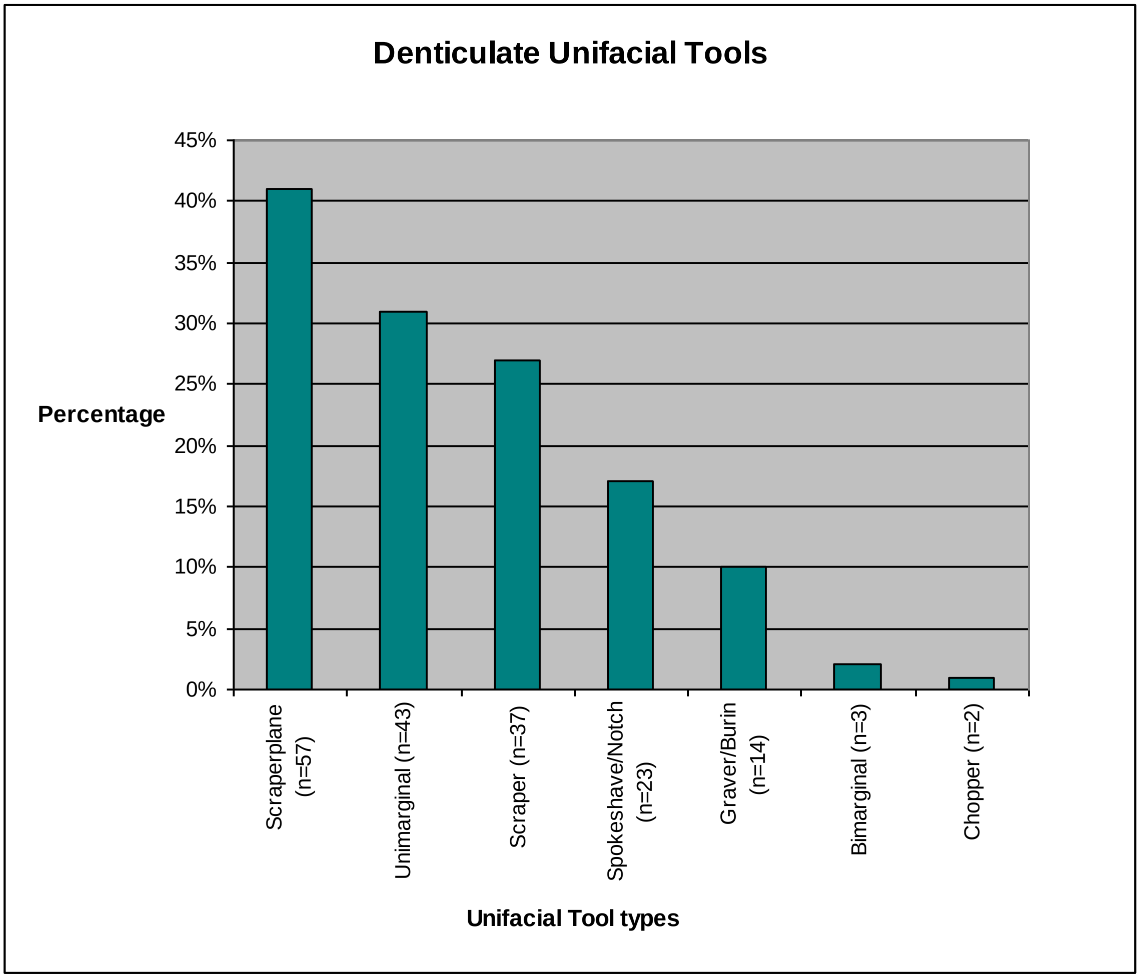


Figure 30: Percentage of unifacial tools with denticulate edges.

"types" of tools to serve one or multiple purposes at one time or through time. The multiple attributes recorded for one uniface will ultimately create more variation within the tool assemblage. The characteristics of multi-type tools at Richardson Island will be discussed further in this chapter.

Hypothesis 3: Function/ Use	
Variable	Result
I. Size	Unifacial tools have a large range of sizes. Weight and length have the largest range while width is more cohesive.
II. Edge angle and size	There is a significant relationship between edge angle and length in the assemblage. Smaller unifaces have more acute angled working edges; the largest unifaces have a higher percentage of steep working edges. These results suggest that people were actively manufacturing unifacial tools to be a certain size with a specific working edge angle for at least some of the tasks conducted at the site.
III. Tool type and length	There is a relationship between tool type and size. People may have preferred certain sizes for some of the unifacial tool types i.e., scraperplanes manufactured to be large in size. Some tool types such as spokeshave/notches and graver/burins tend to be manufactured on all sizes of forms suggesting that size may not have been an important factor for these tools.
IV. Denticulate edges and raw material	Lots of the raw material types include tools with denticulate edges. There are however, a high percentage of denticulate tools made on siliceous argillite. This result may be an indication that this material type was preferred for denticulate edges over other material types or may also sometimes been an unintentional result of material properties.

Table 42: Hypothesis 3 results: Function/Use

Discussion

As has been shown above, there is a substantial amount of variability in raw material use and blank form selection represented by the unifacial tool assemblage. There is also a large range in the overall lengths, widths and weights of these unifacial tools. However, there does appear to be a relationship between the steepness of the working edge and the relative tool sizes. Larger unifaces have steeper working edges than smaller unifaces. A line graph of unifacial tool types to length quartiles indicates that there is some relationship between certain defined types and size but that there is also a lot of flexibility within these relationships. Results indicate that people at the Richardson Island site had specific preferences for stone tool production but that tool manufacture was also flexible and dynamic; people actively modified and experimented based on the situational context and the availability of materials at the site.

7.1.4 Hypothesis 4: Tool Re-Use at Richardson Island

Measuring Tool Reduction

Analysis so far has provided information on what types of materials and blank forms were selected for the manufacture of the unifacial tools and what kinds of attributes may have been important for tasks undertaken at the site. However, a unifacial tool may have served several purposes over its use-life; characteristics that may now be obscured by its new use. Can the amounts of reduction be calculated in these tools accurately? As mentioned in Chapter Four, many recent lithic studies have attempted to generate an index for the invasiveness of reduction therefore quantifying the amount of use and re-use a tool has undergone throughout its use-life (Kuhn 1992; Clarkson 2002; Eren et al. 2005; Hiscock and Attenbrow 2005). Many of these studies of invasiveness have been measured on standardized tool kits, i.e., side scrapers or end scrapers.

One potential problem with measuring the amounts of reduction on the unifacial tool assemblage from Richardson Island is that, as results of cluster analysis indicated, the tool kit exhibits a very low level of standardization. There are very few "classic" unifacial tools in the assemblage and a high amount of variability. Without an overall morphology that is common across several artifacts, it is difficult to properly measure reduction levels. As mentioned for Hypothesis 2 of the model, an analysis of the debitage and specifically, the comparison of unmodified flake forms to the unifacial tools may result in a better understanding of reduction processes. Although I was not able to expand analysis to include the Richardson Island debitage, it is hoped that further studies into technological practice at the site could include both an analysis of these artifacts as well as the utilized flakes.

A visual analysis of the unifacial tools during data collection has indicated a low level of reduction, particularly for unimarginal, bimarginal, graver and spokeshave tools. Many of these defined tool types have very minimal amounts of retouch and occur on rough flake forms. However, it is much harder to interpret the intensity of reduction from scraperplane and scraper tools. It is quite possible that many of these scraping and planing tools may have been retouched and rejuvenated several times over their use-lives as edges became dull or were broken. The re-shaping and re-sharpening of tools would have meant that morphologies were also in constant flux. It is possible to see this constant, dynamic process of tool re-use at the Richardson Island site, though only in a small sample of waterworn unifaces.

Waterworn Unifaces

Interestingly, a small percentage of the unifacial tools in the assemblage exhibit non-waterworn retouch over waterworn flake scars; evidence of their re-use at a later time. It is likely that many of these waterworn artifacts were selected off of the beach at the Richardson Island site and further modified for use. Table 43 reveals the percentages of waterworn specimens and tool types. Although only representative of a very small portion of the overall unifacial assemblage at the Richardson site (n=41), these waterworn artifacts provide a small glimpse into what was probably a more extensive practice of tool re-use through time.

Frequency of Waterworn Uniface Types						
Tool Type	**Not Waterworn**	**Waterworn**	**Waterworn with Tool Re-use**	**% with Tool Re-use**	**Waterworn without Tool Re-use**	**% without Tool Re-use**
Scraperplane	184	10	3	2%	7	4%
Scraper	131	39	12	9%	27	21%
Graver/Burin	276	54	7	3%	47	17%
Unimarginal tool	312	69	10	3%	59	19%
Spokeshave	194	47	8	4%	39	20%
Bimarginal tool	10	5	1	10%	4	40%
Total Tool Types	**1107**	**224**	**41**		**183**	

Table 43: Frequencies of waterworn and non-waterworn tools.

Post-Depositional Processes

Another factor contributing to the difficulty in interpreting tool re-use is the heavy weathering effects present on many of the tools from the Richardson site. In some cases, heavy weathering obscures many of the characteristics present on a tool including the extent of retouch. Figure 31 reveals the percentages of unifacial tools exhibiting one or more types of post-depositional processes. In many instances, the effects of these natural processes on the unifacial tools have altered the final forms seen in the archaeological deposits. Artifacts that exhibit weathering, oxidization or are heavily waterworn will further diversify the appearances of the unifacial assemblage as a whole.

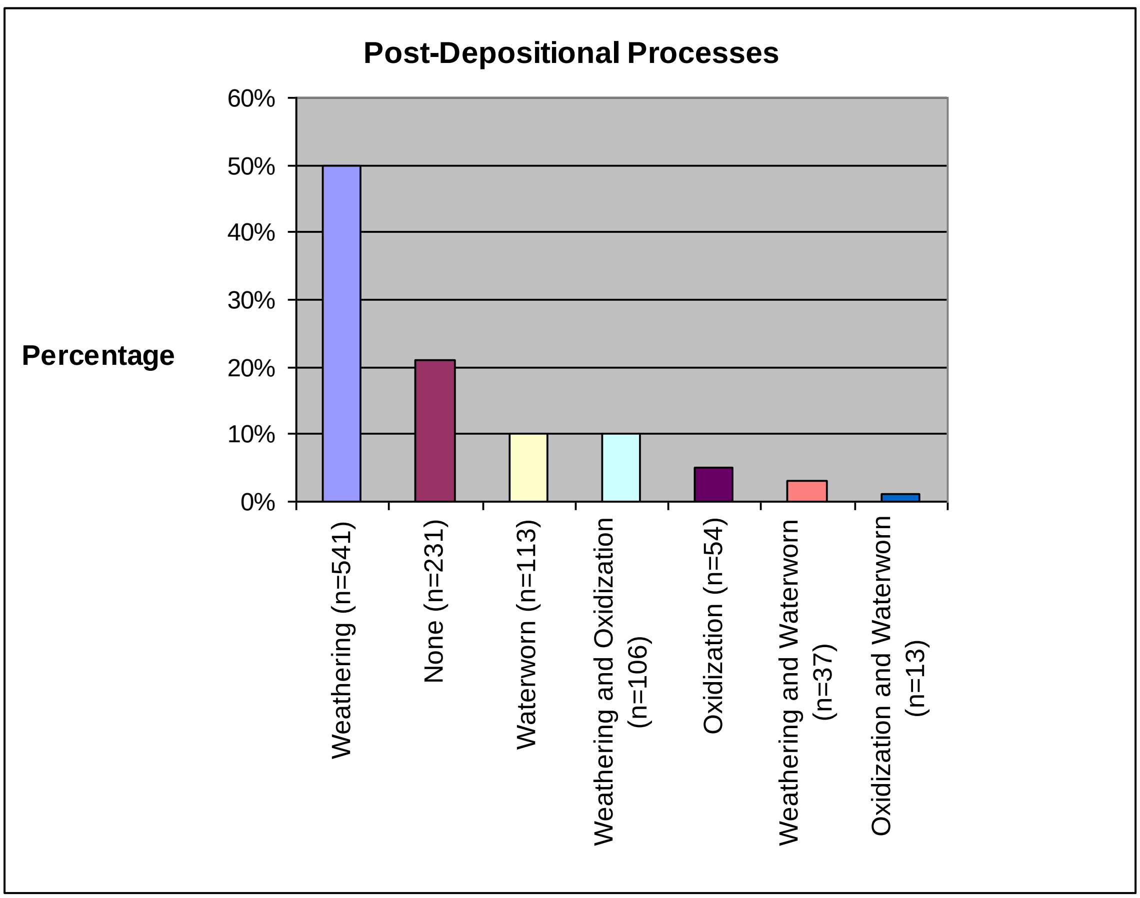


Figure 31: Post-depositional processes for all unifaces.

Hypothesis 4: Tool Re-use and Multi-type Tools

	Variables from Behavioral Model	Hypothesis	Variables Tested	Test
Hypothesis 4	Tool Re-use: Multi-type tools.	Re-use of tools, re-sharpening and re-shaping over time would have influenced the final forms of these tools before being discarded or lost. Multi-tools are a significant factor to the low standardization of tool types.	1)Multi-type tools and size 2)Multi-type tools and tool type 3)Multi-type tools and raw material	Chi square (χ^2) test

Table 44: Hypothesis 4 from Behavioral Model

As mentioned in previous chapters, many of the unifacial tools exhibit morphological characteristics of more than one defined type. One artifact may be classified as a scraper, graver and spokeshave tool all in one. It is possible that some of these multifunctional tools were manufactured with the intention of using them for varied tasks. However, it is also highly possible that the tools became multifunctional due to their re-use over time. Twenty percent of the overall unifacial assemblage is composed of these multi-type tools. The remaining eighty percent of the tools are only representative of one defined tool type. The frequencies and relative percentages of these multi-type tools are shown in Table 45. These numbers reflect both the complete and incomplete unifaces in the assemblage. The “others” category represents those multi-types that only include one or two artifacts. Figure 32 displays the percentage of each multi-type.

Frequency and Percentage of Multi-tool Types		
Multi-type Tools	Frequency	%
Graver/Spokeshave	69	32%
Graver/Unimarginal	46	21%
Spokeshave/Unimarginal	20	9%
Scraperplane/Spokeshave	17	8%
Graver/Spokeshave/Unimarginal	10	5%
Scraper/Graver	9	4%
Scraper/Unimarginal	9	4%
Scraperplane/Graver	5	3%
Scraperplane/Graver/Spokeshave	4	2%
Scraperplane/Scraper	4	2%
Others (only 1 or 2 each)	21	10%
Total	214	100%

Table 45: Multi-tool types in the unifacial assemblage (n=214)

Multi-type tools and size (length)

After a general tally of the numbers of unifaces classified as one, two, three or four different tool types was completed, analysis was more narrowly focused on exploring multi-type tools in relation to specific variables. Were the multi-type tools reflecting all sizes of unifaces equally or was there a relationship between the size of a tool and it's classification as more than one tool type? A bar graph, shown in Figure 33,

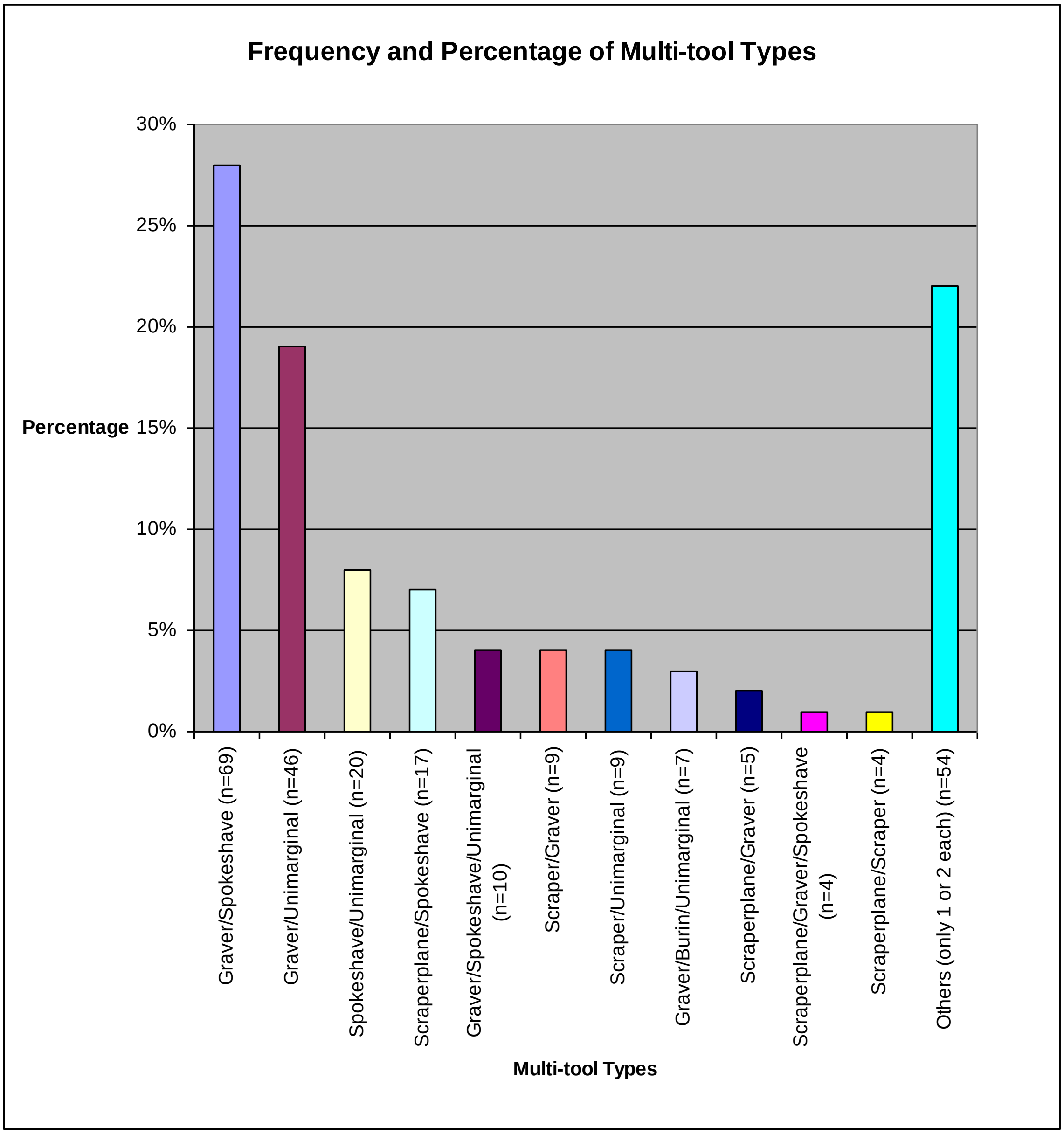


Figure 32: Percentage of each multi-tool type in the total unifacial assemblage.

depicts the proportions of unifaces classified as two, three or four types for each length quartile; the 1st quartile representing the smallest unifaces and the 4th quartile reflecting the largest unifaces.

Multi-Types and Length Quartiles (mm)				
	Two Types	Three Types	Four Types	Total Multi-types
1st quartile	49	2	1	52
%	94%	4%	2%	100%
2nd quartile	39	14	0	53
%	74%	26%	0%	100%
3rd quartile	29	9	0	38
%	76%	24%	0%	100%
4th quartile	19	9	3	31
%	61%	29%	10%	100%

Table 46: Frequency and percentage of length quartiles for each multi-type category.

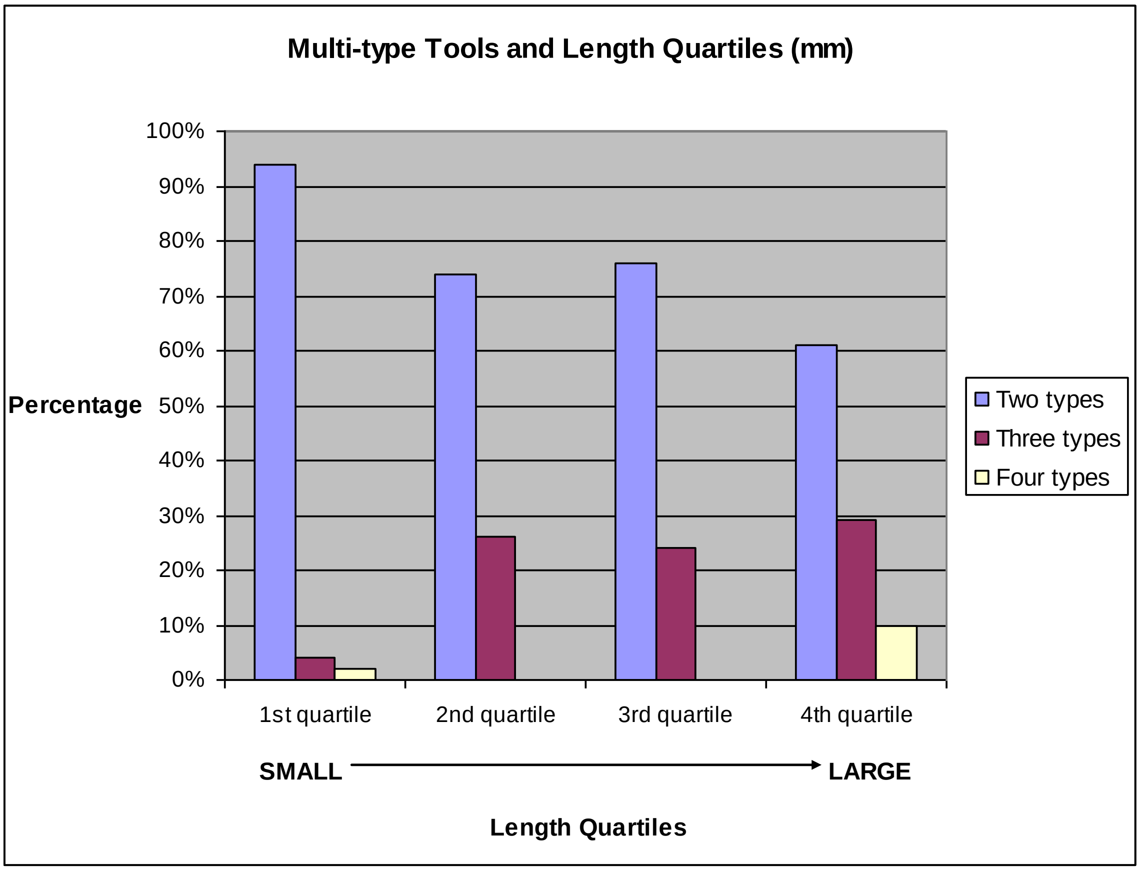


Figure 33: Multi-type tool percentages to length quartiles (mm) for all complete unifaces (n=174).

From Figure 33, a relationship between unifaces exhibiting two different types of tool and the smallest lengths is apparent while the largest unifaces show an increase in multi-tools classified as three and four types. However, there is little difference between the 2nd and 3rd quartile suggesting that there is a large range of tool sizes represented by multifunctional tools. A chi square test was conducted on the frequencies of multi-type tools for each length quartile. I hypothesize that there is a difference in the sizes relative to the multi-type tools, mainly evidenced by the smallest and the largest tools and that this difference will show a significant relationship. All of the complete unifaces were included in the chi square test.

	Value	df	Significance (*p* value)
Chi Square χ^2	22.1	6	0.001
N of Valid Cases	348		

Table 47: Chi Square test for < 0.05 significance (*p* value)

Results from the chi square test indicate that there is a significant difference between size and multi-type tool with a p value of 0.001 and a chi square value of 22.1. The multi-type unifaces predominately exhibit two types of tool while the largest unifaces have a higher frequency of multi-types exhibiting three and four types on one tool. Tools exhibiting four different unifacial types on one artifact are present in both the smallest unifaces (1^{st} Quartile) and largest unifaces (4^{th} Quartile) but are absent from both the 2^{nd} and 3^{rd} quartiles.

Multi-type and tool type

In the next stage of the analysis, the occurrence of multi-types in correspondence to specific tool types will be reviewed. Are there any specific tool types that are more frequently found on multi-types than other unifaces or is there an equal representation of multi-forms across all of the types? A bar graph (Figure 34) was created to display the results of the query.

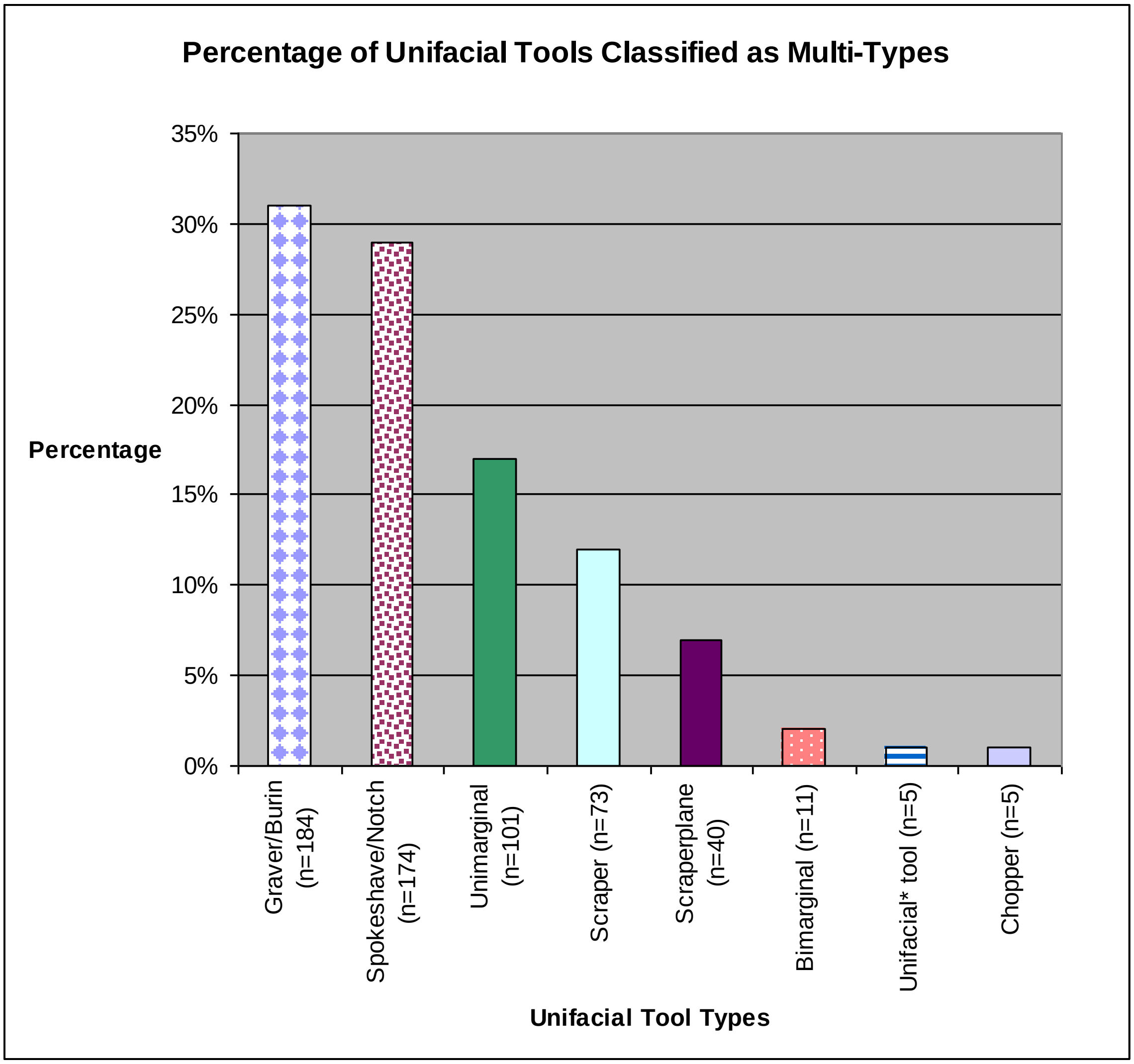


Figure 34: Percentage of unifacial tool types classified as multi-types.

As shown in Figure 34, graver/burins and spokeshave /notch tools have the highest frequencies of multi-type tool designation followed by unimarginals, scrapers, scraperplanes, bimarginal, unifacial* and lastly, choppers. Both graver/burins and spokeshave/notches co-occur most frequently with other uniface types. Although the other unifacial tool types reflect a more modest amount of multi-attributes, all of the unifacial tools include artifacts designated as multi-types. Therefore, there is more variability within not just one or two but all unifacial types.

Multi-type and Raw Material

The occurrence of multi-types on specific raw materials was the final query conducted for Hypothesis 4. Were certain materials more likely to be manufactured into multi-types over others or was there a somewhat even distribution of these multifunctional tools across materials? I hypothesized that the multi-types would occur on many different material types due to their already variable qualities such as size and tool type.

Multi-Type Tools and Raw Material Types										
	Shale/ argillite	Siliceous argillite	Rhyolite	Varvite	Other	Wacke	Andesite	Dacite	Tuff	Total
2 types	26	38	15	13	13	5	2	2	2	116
%	22%	33%	13%	11%	11%	4%	2%	2%	2%	100%
3 types	14	6	1	2	2	3	1	1	2	32
%	44%	19%	3%	6%	6%	10%	3%	3%	6%	100%
4 types	2	0	2	0	0	0	0	0	0	4
%	50%	0%	50%	0%	0%	0%	0%	0%	0%	100%
Total										152

Table 48: Frequency and percentage of material types for each multi-type.

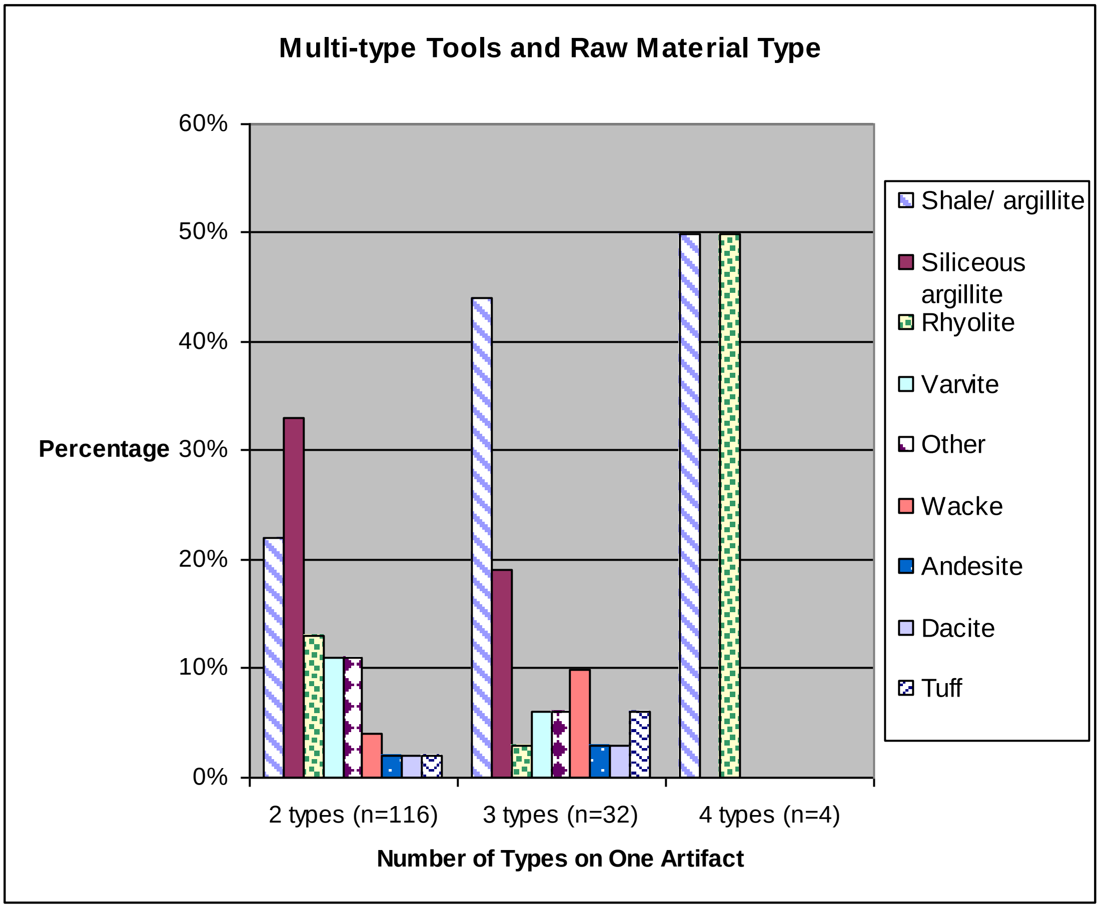


Figure 35: Percentage of material types for each multi-type.

Results produced in Table 48 and displayed in Figure 35 indicate that multi-type tools occur on many different raw materials. Tools that represent two types and three types are present for most of the materials. Tools exhibiting four types only occur in very low numbers for both siliceous argillite and rhyolite.

Hypothesis 4: Tool Reuse Results	
Variable	Result
I. Multi-type and length	Multi-type tools are manufactured in all unifacial tool sizes. The smallest multi-tools include more unifaces classified as 2 types while the largest unifaces include more unifaces classified as 2, 3 and 4. There appears to be more flexibility in the larger unifaces; these tools have a more equal frequency of two, three and four types.
II. Multi-type and tool type	Multi-type tools are associated with all of the unifacial tool types. These multipurpose tools seem to be more common in certain tool types i.e., graver/burins and spokeshave/notches.
III. Multi-type and raw material	Multi-type tools occur on all of the commonly used materials at Richardson. Many of the material types used for the unifacial tools are present in the multi-type tools for both two and three types. Multi-type tools exhibiting two types most frequently occur on siliceous argillite while those exhibiting three types are more often found on shale/argillite.

Table 49: Results of Hypothesis 4

Discussion

Many of the unifacial tools from the Richardson Island site can be classified as more than one type of tool; what has been referred to in this thesis as a multi-type tool. The occurrence of multiple attributes on one artifact could be the result of intentional planning on the part of the knapper to create a multi-purpose tool or it could be due to the re-use of material at the site over time. In either instance, these multi-type tools add more variability to the overall assemblage with twenty percent of the unifacial artifacts classified as multi-types. What these multi-tools emphasize most importantly is the variable nature of tool use; a point that is often ignored in the need to create distinctive tool types. The tools from the Richardson Island site remind us that a tool’s use-life is often complex and dynamic. The presence of these multi-types within the assemblage has resulted in many artifacts that look morphologically different from one another but may have been manufactured to serve the same function. This makes some sense in regards to cluster analysis; a graver tool that is also a scraper tool may not group very easily with another artifact that is just a graver.

7.1.5 Summary

Concluding Results of Behavioral Model	
Behavioral Model	Concluding Results
H1[10]: Raw Material	There was several different material types used for the manufacture of unifacial tools at the site. These materials were used for most of the unifacial tool types but there were also some patterns exhibited through the most common types; siliceous argillite, shale/argillite, rhyolite and varvite. Raw material properties may have influenced tool morphologies significantly. Analysis revealed a relationship between blank form and material type. Siliceous argillite has a higher frequency of tabular forms while shale/argillite has a higher frequency of flake forms. In many instances, raw material seems to predetermine blank form. In summary, people at Richardson Island had found ways to use the local materials to their advantage.
H2:Blank Selection	Amongst the variability, there are some patterns that emerge between blank type, flake scar count, raw material, size, edge angle and tool type. People actively selected certain blank forms for specific types of tools or tasks but these forms may have also determined what kinds of tools could be manufactured on them. Unifacial tools were made on flake blanks reflecting all stages of tool reduction. There is a significant relationship between some material types and flake blanks in different reduction stages which may be indicative of specific tool manufacture, i.e., biface production or core reduction strategies.
H3:Function/ Use	There is a large range of sizes for the unifacial tools. There is a significant relationship between the working edge angle and the lengths of the unifaces suggesting that, for instance, large tools were more suitable for heavy duty scraping tasks that required very steep edges versus, a small tool used for cutting fish that may have required a sharp, acute edge.
H4: Re-use	Difficult to measure the amounts of tool re-use at the Richardson site due to heavy weathering processes on the majority of the tools however, there is a small sample of waterworn unifaces that reflect tool re-use. Some tool re-use may be reflected through the presence of multi-type tools. These multi-types account for some of the variability seen in the assemblage i.e., the lack of standardization. Multi-types occur on all sizes and material types and include all unifacial tool types.

Table 50: Concluding results of Behavioral Model.

The Behavioral Model

After conducting various tests on the data set for each hypothesis, there are several conclusions that can be made. First of all, the behavioral model illustrated at the beginning of this chapter (Figure 17) provided a working guideline to understanding the low standardization and variability exhibited by the morphologies of the unifacial tools.

---

[10] H1 = hypothesis one from the behavioral model, H2 = hypothesis two and so on.

Although there are probably multiple factors that would have contributed to this variability, I chose to focus on four prominent stages from the behavioral model; raw material, blank form, function/use, and re-use. My main hypothesis was that each one of these stages aided in the variability seen in the unifacial tools from the Richardson Island site. Reflecting back to the Behavioral Model in Figure 17, there are several aspects that can be elaborated on based on the results generated in this chapter.

H1and H2: Raw Materials and Blank Forms

Results of the tests conducted in this chapter indicate that raw material played a significant role in unifacial tool morphology. Within the behavioral model, raw material selection was linked to blank form and function/use. A summary of the procurement of raw material types for the manufacture of unifacial tools found that, overall, there was variety in the materials selected with siliceous argillite and shale/argillite occurring most frequently. However, analysis of these artifacts revealed a significant relationship between raw material types and the sizes of the tools. Certain material types were used for tasks that may have required smaller or larger tools.

Blank form showed a distinct relationship to raw material type in the unifacial tool assemblage. Some materials, specifically siliceous argillite, had a high occurrence of tabular blank forms while others, such as shale/argillite, were more often found in flake forms. Results also noted that unifacial tools were most commonly manufactured on flake blanks. The flake blanks selected for unifacial tool manufacture represented all stages of reduction although later stage flakes were most common. In a comparison of raw material type and flake scar count, there was a relationship between some materials and stages of reduction. Specifically, siliceous argillite had a large number of unifaces classified as early stage flakes while other materials, such as shale/argillite, were primarily associated with late stage reduction flakes. There was also some indication that certain material types were more commonly manufactured with steep working edges than others. In the analysis of denticulate artifacts, those unifaces exhibiting denticulate edges were more common on pieces of siliceous argillite (42%) than both shale/argillite (20%) and other variable types (38%). Finally, although there appears to be a lot of variety in the raw materials used for specific unifacial tool types, there were some tool types more commonly made on certain materials as opposed to other types; shale/argillite was the most preferred material type for scraper tools while siliceous argillite may have been the preferred material for scraperplanes.

As discussed by Smith (2004), certain material types may have been selected for specific types of tools due to their natural properties. After testing various relationships between variables, it seems likely that the specific properties of each material type can explain a lot of the variability seen in the unifacial assemblage. The most obvious relationships can be seen with both siliceous argillite and shale/argillite which may be partly due to their prominence at the Richardson Island site. In an analysis of these material types Smith (2004) discovered that siliceous argillite has the highest silica content of all of the materials found at the site making it brittle with fracturing often occurring along "planar laminations."(157). At the same time Smith notes that weathering processes may have weakened the quality of the material resulting in unpredictability when flaking (158). Shale/argillite, in contrast, has a low silica content making it less brittle and less conducive to breaking. The unpredictable nature of certain raw materials may have meant that these materials were harder to knap or were used for specific tasks over others. At the Richardson site, people were both adapting to the materials that were easily accessible to them and also manipulating these materials in order to perform tasks as they arose. From raw material and blank form came variable tool morphologies that often accentuated the natural properties of the rock or also may have constrained the desired product.

H3: Function/Use

In an analysis of lithic variability at several Middle Paleolithic sites, Bar-Yosef and Meignen (2003) include blank selection, processes of retouch or resharpening and tool use under the third stage of their "operational sequence"; tool manufacture/ tool use. At this stage in the behavioral model, there is some overlap with both raw material and blank form; certain blank form sizes may be needed in order to manufacture a tool of a relative size or with a specific edge angle. With hypothesis two of the behavioral model, results indicated that some blank forms were more likely to be large in their lengths while others showed a tendency to be small. Similarly, some blank forms were associated with steep working edges while other forms more frequently exhibited acute edges.

H4: Tool Re-use

The re-use of unifacial tools at the Richardson site was one part of the behavioral model that was more difficult to assess. A small collection of waterworn unifaces exhibiting non-waterworn retouch revealed some indication of tool re-use over time; people may have found a tool on the beach and retouched it to create a new tool. It is likely that many of the unifacial tools were re-used and re-shaped obscuring any previous attributes. Included under processes of tool re-use are the unifaces classified as multi-type tools in the assemblage. In the analysis of the multi-type tools from the Richardson site, these artifacts were found to occur on many different material types and sizes with all unifacial tool types represented. There were not only one or two multi-types but numerous combinations that were recorded in the unifacial assemblage. Some tool types occurred together more frequently than others and some combinations of types were only represented by one or two artifacts. The presence of these multi-types reflects the fluidity of these tools during their manufacture and use. Some of these tools may have been manufactured to serve more than one task and many of them may be a reflection of an afterthought. A tool used for one purpose can quite easily be retouched into another tool. It is these multifunctional tools that contribute to the lack of structure present within the unifacial tool assemblage. As artifacts, it is difficult to separate a multi-type tool into distinct types but also confusing to lump these types into one tool. Although these unusual tool forms serve to obscure the overall structure in the assemblage, they also have a unique importance for the study of technological behavior at the site. These tools were used for not just one, but a variety of tasks. Certain tasks may have required the use of a tool that was both a graver and a spokeshave or a scraper and a unimarginal tool. Many of these tools may also have also been used for purposes unknown.

Tool Discard

Although not a central variable in the behavioral model, discard would have been a constant factor throughout the process of tool production and use. In Figure 17, discard is situated below tool manufacture, use and re-use of a tool. There are multiple reasons a tool could have been discarded including breakage, exhausted forms, raw material flaws, being lost or simply no longer needed. Many of the tools manufactured on site may have also been carried off-site and then discarded. After the final discard in the archaeological record at the Richardson Island site, many of the unifacial tools were affected by post-depositional processes. The acidic, iron-rich sediments present at the site resulted in the oxidization of many of the artifacts. The location of the site on a beach front resulted in ongoing fluctuations of marine processes, i.e., wave action or sea surges that may have affected the tools lying in the beach gravels. Lastly, the affects of wind, rain and the movement of downslope debris may have further weathered the unifacial tools. Differential weathering affects has served to further obscure any of the morphological similarities present between tools.

Discussion

The behavioral model as outlined in Figure 17 is useful as an operational sequence for beginning to understand the tool processes that led to the weak structure of the unifacial tool assemblage. In light of the analyses that were conducted in this chapter, this model should be regarded as a more fluid representation of behavior than a top to bottom flow chart. There is much more overlap between variables than was originally outlined; all stages in the model have the potential to affect each other. As mentioned above, there is movement upwards as well as downwards. Both raw material and blank form may continually affect the manufacture, use and re-use of tools. Even after the final discard in the archaeological record, raw material may still affect the morphology of a tool; weathering processes may vary depending on the type of material.

Conclusions

Although many of the unifacial tools can be characterized as expedient, results from the analysis indicate some level of planning on the part of the flint knapper. Although there is variability, there are also several significant relationships between variables. It is likely that, on a very low level, some standardization in unifacial tools reflects specific preference. For example, larger tools may be needed for heavy-duty scraping or chopping tasks, therefore, a relationship exists between length and edge angle. Similarly, tabular blank forms may have been more suitable for creating steep angles for scraping, therefore, a relationship exists between tabular forms and specific tool types such as scraperplanes.

What the unifacial tools from the Richardson Island site represent then, is a large amount of variability created through a tool's use-life with some minimal amount of cohesiveness between certain attributes. It is possible that unifacial tools may have been more standardized if available raw material types and subsequently blank forms were not as variable. This chapter has focused on the potential explanations for the weak typological structure present in the unifacial tool assemblage. Some of the information gathered through the analysis of specific variables has helped expand on the tool types recovered from the Richardson Island site. For the behavioral model, all unifacial tools were included as one group, neglecting any changes that might have occurred through time at the site. In the next chapter, the temporality of the unifacial tools will be explored and results will be situated within the context of the established culture history of Haida Gwaii.

8 Change and Continuity in Unifacial Tool Use

Introduction

In the previous chapter, an analysis of the unifacial tool assemblage from the Richardson Island site was primarily concerned with data gathered from the assemblage as a whole, without accounting for any changes that may have occurred temporally. In this chapter, the focus will be on an investigation of the unifacial tools through time. It is the association between changes and continuities in technology that has played a central role in defining the culture history of Haida Gwaii.

8.1 The Biface to Microblade Transition

One of the most defining features of the Richardson Island site to date is a distinctive technological change from bifacial to microblade manufacture that occurred between 9400 and 8000 BP. This shift in technological behavior has been the focus of ongoing research in the archipelago and has been used to refine the established culture history for the area (See Table 1 in Chapter Two). While outside of Haida Gwaii, similar technological change between bifaces and microblades has led to explanations of cultural ethnicity and differing site use, in Haida Gwaii, this shift in technology has been regarded as an in-situ development (Magne 2004; Smith 2004; Fedje et al. 2008; Mackie et al. 2008, in press). This technological change, as defined by the archaeological record in Haida Gwaii, has served to divide early prehistory into two periods; the Kinggi Complex and the Early Moresby Tradition. As mentioned previously in this thesis, the unifacially manufactured tools at the Richardson site can also be seen as indicators of change through time. For this stage of analysis, the goal was to determine whether the technological shift seen with bifaces and microblades could be defined with other tool types as well.

8.1.2. Unifaces through Time

In order to explore how unifacial tool types might have differed between the earliest (Kinggi Complex) and the later time period (Early Moresby Tradition), the unifacial tools and their recorded attributes were separated and then compared. The separation of the tools was based on the approximate transition to the manufacture of microblades as it has been defined at the Richardson Island site, occurring sometime around 8730 ± 20 BP. The layer that contained the earliest evidence of microblades at the site was marked as the transitional layer. All tools recovered from stratigraphical deposition below this defined transition are grouped as Kinggi Complex and those recovered from deposits above are grouped as the Early Moresby Tradition. Although there were many queries run on the data set, the next section will focus on only a few prominent variables. These variables are as follows:

1) The size of the unifaces between the two time periods. Do the unifaces change in their general sizes through time?
2) Raw material and blank selection for the unifaces. Do the raw materials and blank forms selected for uniface manufacture change through time?
3) The functional attributes of the unifaces. Is there a noticeable shift in those variables that represent functional attributes through time?
4) The frequencies of the unifacial tool types between the Kinggi and Early Moresby Tradition. Do the defined unifacial tool types change through time or remain relatively consistent?

8.2. Continuity through Time

8.2.1. Continuity in Size

For a temporal analysis of the unifacial tools, size was one of the first variables to be tested. Although there may be variability in the sizes of tools classified as one type or another, size can be an important attribute in the selection of tools for specific tasks. This may relate to whether the tool is being used to cut down a tree versus to fillet a fish. The general size might also relate to the act of tool use. Some archaeologists take note of whether or not a tool can be comfortably held in the hand (Rahemtulla 2006). In a general analysis of all of the unifacial tools from the Richardson Island site, size (length, width and weight) was found to have a large range. Size can be reflective of many different factors. It can relate to the availability of raw materials, tool design and function, and the re-use of a tool. Therefore, I chose size as an indicator for change through time at the site. If there were changes in artifact forms from the Kinggi Complex, into the Early Moresby period and later, these transitions may be reflected in the general sizes of the tools.

One important point to make note of during this process was that the separation of the Kinggi Complex unifaces from the Early Moresby unifaces divided these artifacts into substantially unequal numbers. Out of the 1097 unifaces recovered from the site, 910 of these came from Kinggi Complex layers while only 131 of these were found in Early Moresby period layers. Those unifaces recovered during the 2007 field project (EU 15 and EU16) numbered only 56 unifaces in total although these low numbers may reflect a spatial bias at the site rather than a temporal one. In any case, while preliminary analysis of the tool sizes indicated that there were more large unifaces manufactured in the Kinggi Complex in comparison to the Early Moresby Tradition, I hypothesized that there was not a significant difference in size between these two periods.

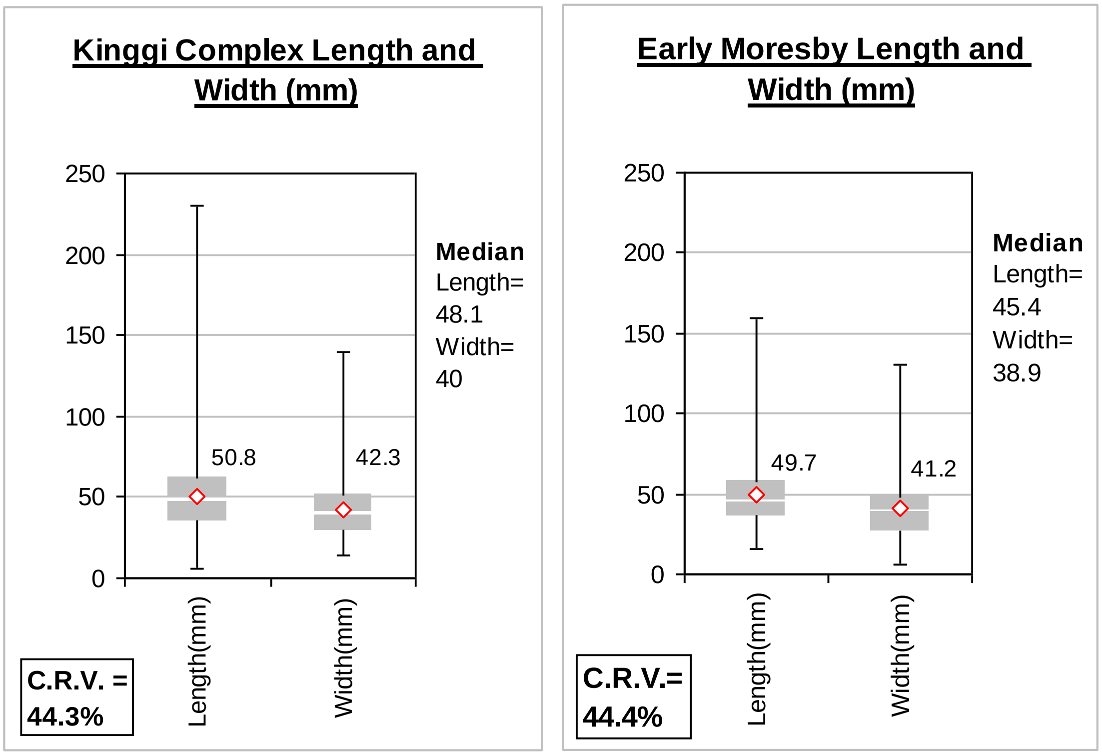


Figure 36: Box and Whisker charts of length and width measurements for Kinggi Complex and Early Moresby unifaces.

Figure 36 displays the range, mean and medians of length and width measurements for unifaces grouped into each time period. Although the Kinggi Complex unifaces exhibit some larger unifaces than occur in the Early Moresby period, the mean measurements for both length and width remain quite similar through time. A simple calculation of the coefficient of relative variation (C.R.V) for each period indicates that the amounts of variation within each time span are proportionally very similar to each other (Figure 36). Therefore, the relative sizes of the unifacial tools do not change significantly over time.

8.2.2. Continuity in Raw Material Selection

In Chapter Six, an analysis of the raw material selection for the manufacture of the unifacial tools indicated that both siliceous argillite and shale/argillite were the most common materials but that selection included a wide variety of types. People may have actively selected certain materials for certain types of tools however, people seemed to use what was available at the time. A behavioral model for the manufacture of unifaces emphasized raw material as a guiding component of tool morphology.

A temporal analysis of raw material types selected for the unifacial tools was conducted in order to make comparisons between the Kinggi Complex and Early Moresby Tradition. Occurrence of material types in each time span is summarized in Figure 37.

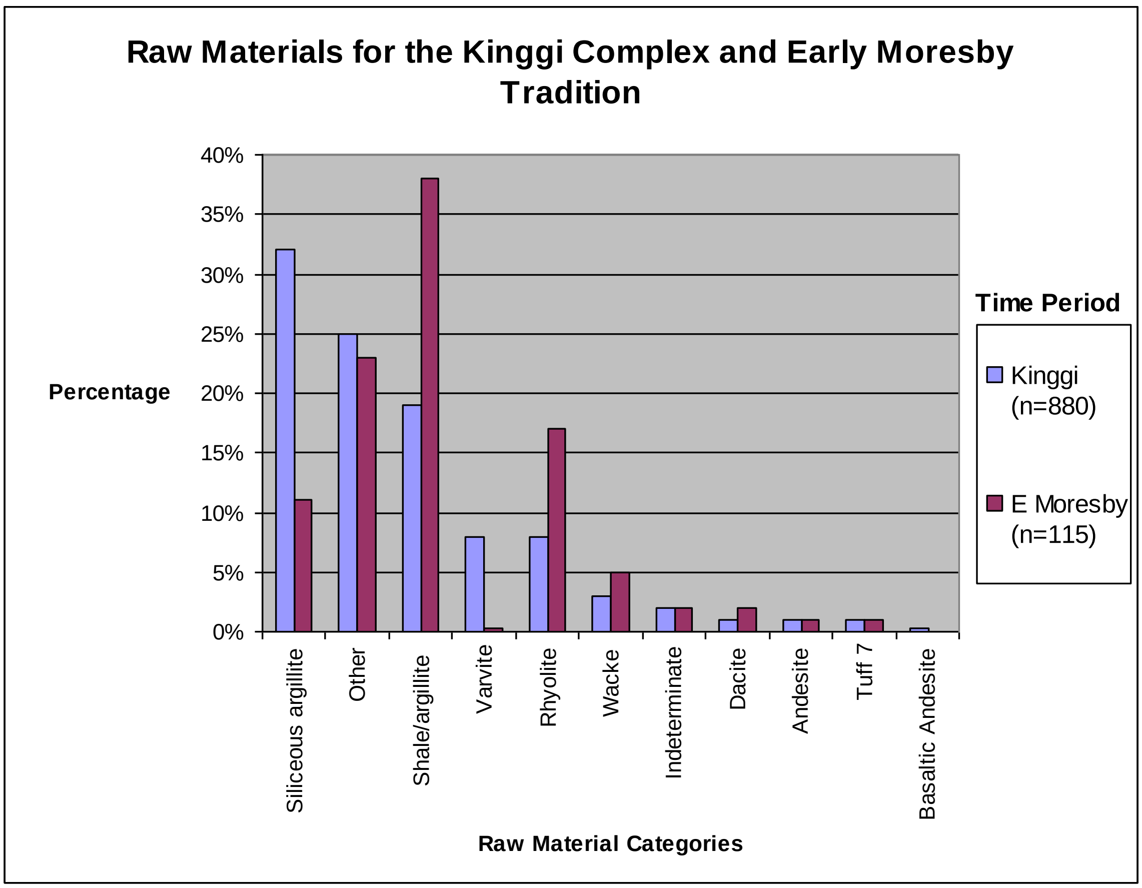
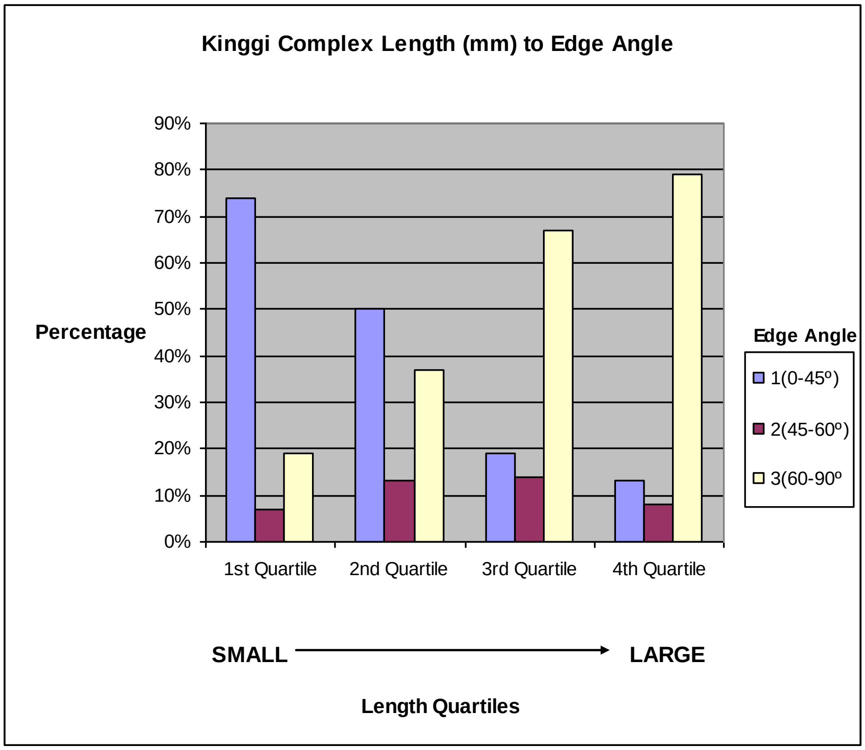


Figure 37: Percentage of raw material types for the Kinggi Complex and Early Moresby Tradition.

Results indicate a higher proportion of siliceous argillite occurring in the earliest occupation of site use (the Kinggi Complex) and an increase in the use of shale/argillite during the Early Moresby Tradition. These two preferred material types appear to change places in selection during the two time periods. Similarly, the use of rhyolite and varvite change through time. Varvite selection is more prominent in the Kinggi Complex and rhyolite use is more prominent in the Early Moresby Tradition. Wacke and dacite also occur in slightly higher proportions in the Early Moresby period. Both andesite and tuff do not change in preference through time and basaltic andesite is only present in a very low level during the Kinggi Complex. Although there is some change in raw material use there is also continuity. People using the Richardson Island site consistently use many of the same materials for the manufacture of unifacial tools.

8.2.3. Continuity in Functional Attributes

The most distinctive relationship between attributes, defined during analysis of the unifacial assemblage as a whole, was the length of a uniface in relation to its edge angle. In order to explore this relationship temporally, a bar graph was created to compare the Kinggi versus the Early Moresby artifacts. Results indicate that there is a noticeable relationship between small unifaces and acute working edges and large unifaces with very steep angled edges (Figures 38a and 38b). This relationship of length to edge angle is most noticeable in the smallest and the largest unifaces. In the Early Moresby Tradition, there appears to be some moderately large tools (represented by the 3^{rd} quartile) that have a higher frequency of acute edge angles rather than steep working edges. Although slightly unusual, the contrast between small and large unifaces based on their edge angles is still present.



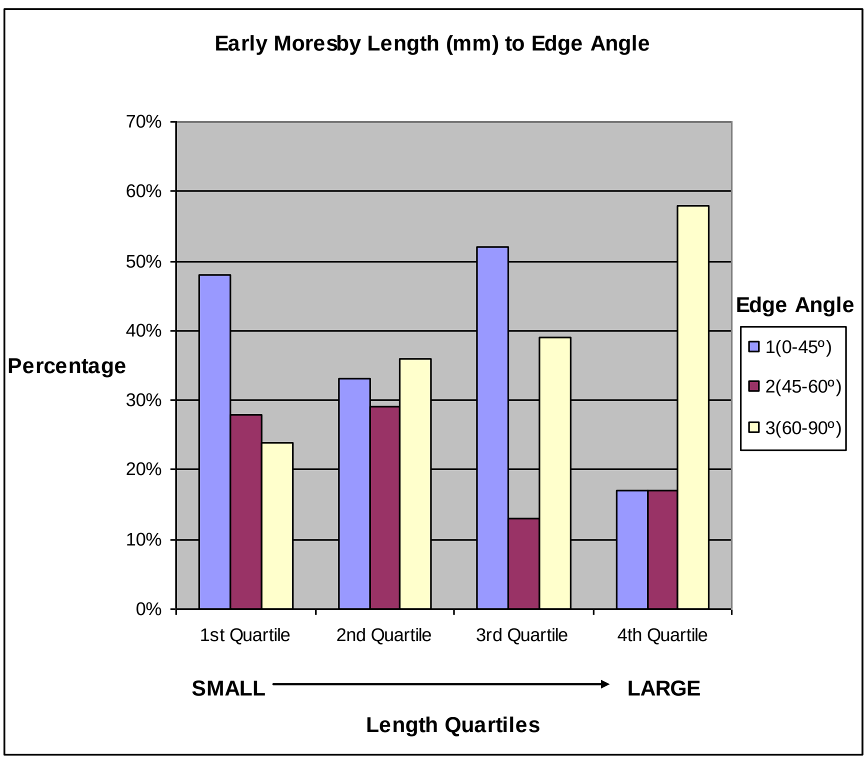


Figure 38: Length quartiles to edge angles for all complete unifaces in the Kinggi Complex and the Early Moresby Tradition.

8.2.4. Continuity in multi-functionality

In the aggregate analysis of the unifacial tool assemblage, the multifunctionality of the tools was emphasized. Many of the tools were classified as more than one type of artifact, a characteristic that could reflect the intentionality of the knapper to create a multipurpose tool or simply reflect the re-use of material at the site. The occurrence of these multi-type tools in the Richardson assemblage led to the exploration of these artifacts through time. A temporal analysis of the percentage of unifacial tools exhibiting 1, 2, 3 and 4 types was conducted for all complete unifaces (n=548). These results are displayed in Figure 39 and suggest that there is little difference between the proportions of unifaces classified as one type, two types, or three types. Unifaces in the Early Moresby Tradition show a slightly higher proportion of multi-type artifacts but this difference is minimal.

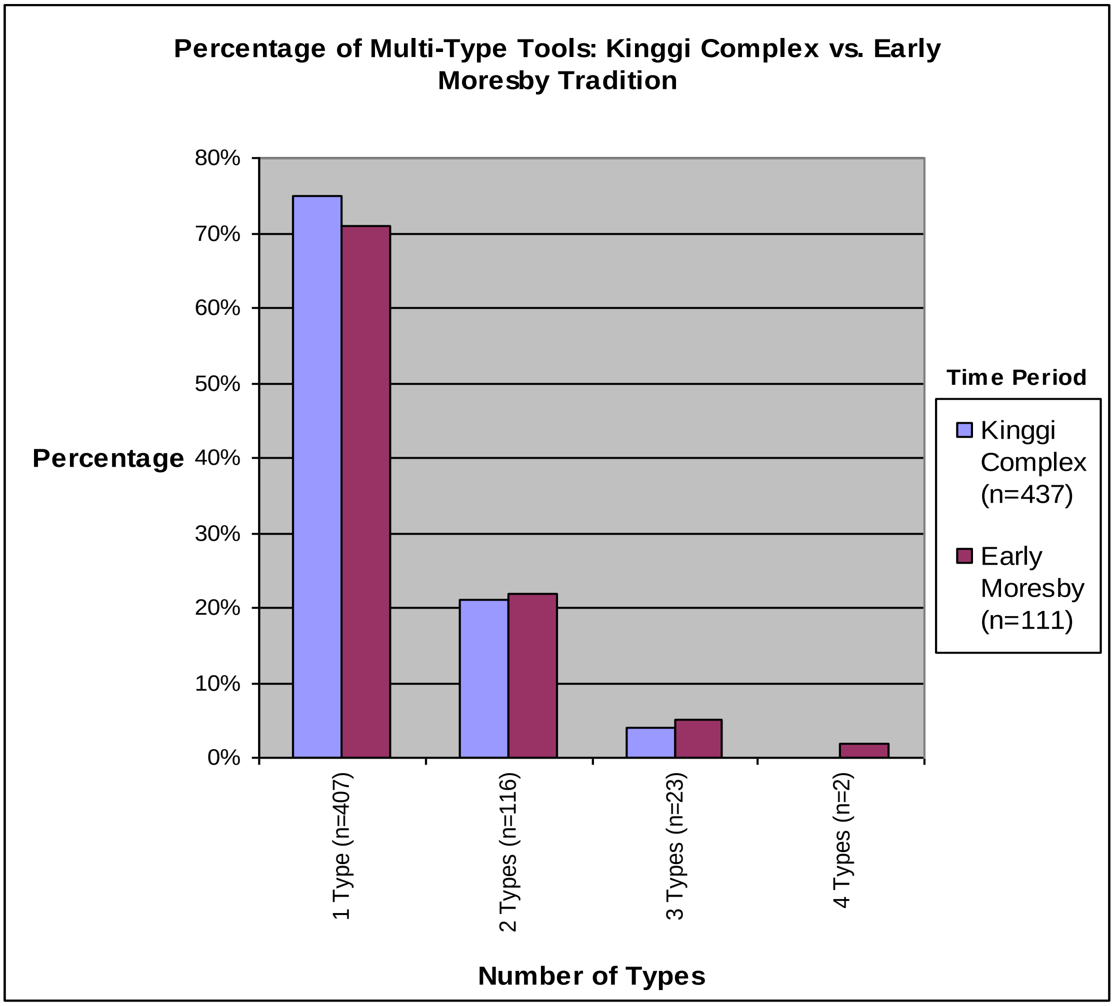


Figure 39: Multi-type tools: Kinggi Complex vs. Early Moresby Tradition.

8.2.5. Continuity in Unifacial Tool Types

Many of the unifacial tool types recorded at the Richardson Island site appeared to continue on through time. A tally of the frequencies and relative percentages of each unifacial tool type recovered from Kinggi Complex as well as Early Moresby layers was conducted (Table 51). This information is displayed in Figure 40. Note that the number of cases for the Kinggi and Early Moresby Tradition (n=1143 and n=165) represent a count of unifacial tool types not a count of artifacts. For example, an artifact classified as a spokeshave/graver was counted as two tool types. Therefore, the unifacial tool type frequencies are higher than the actual artifacts found for each period.

Tool Types: Kinggi Complex vs. Early Moresby Tradition		
	Kinggi (n=1143)	Early Moresby (n=165)
Scraperplane	173	17
%	15%	10%
Scraper	142	22
%	12%	13%
Graver/Burin	271	40
%	24%	24%
Spokeshave/Notch	212	20
%	19%	12%
Unimarginal	310	57
%	27%	36%
Bimarginal	12	2
%	1%	1%
Unifacial* tool	14	4
%	1%	2%
Chopper	9	3
%	1%	2%
Total	**1143**	**165**
Total %	100%	100%

Table 51: Frequency and percentage of Unifacial Tool Types in the Kinggi Complex and Early Moresby Tradition
.

In Figure 40, the relative percentages of unifacial tool types from each time period reveal that all of the unifacial tool types continue to be present from the Kinggi Complex into the Early Moresby Tradition. However, scraperplanes and spokeshaves show higher percentages for the Kinggi Complex than the Early Moresby Tradition and the relative percentage of unimarginal tools increases in the Early Moresby Tradition. Both unifacial* tools and choppers show a slightly higher occurrence in the later period or Early Moresby Tradition while scrapers, graver/burins and bimarginals reveal little change through time.

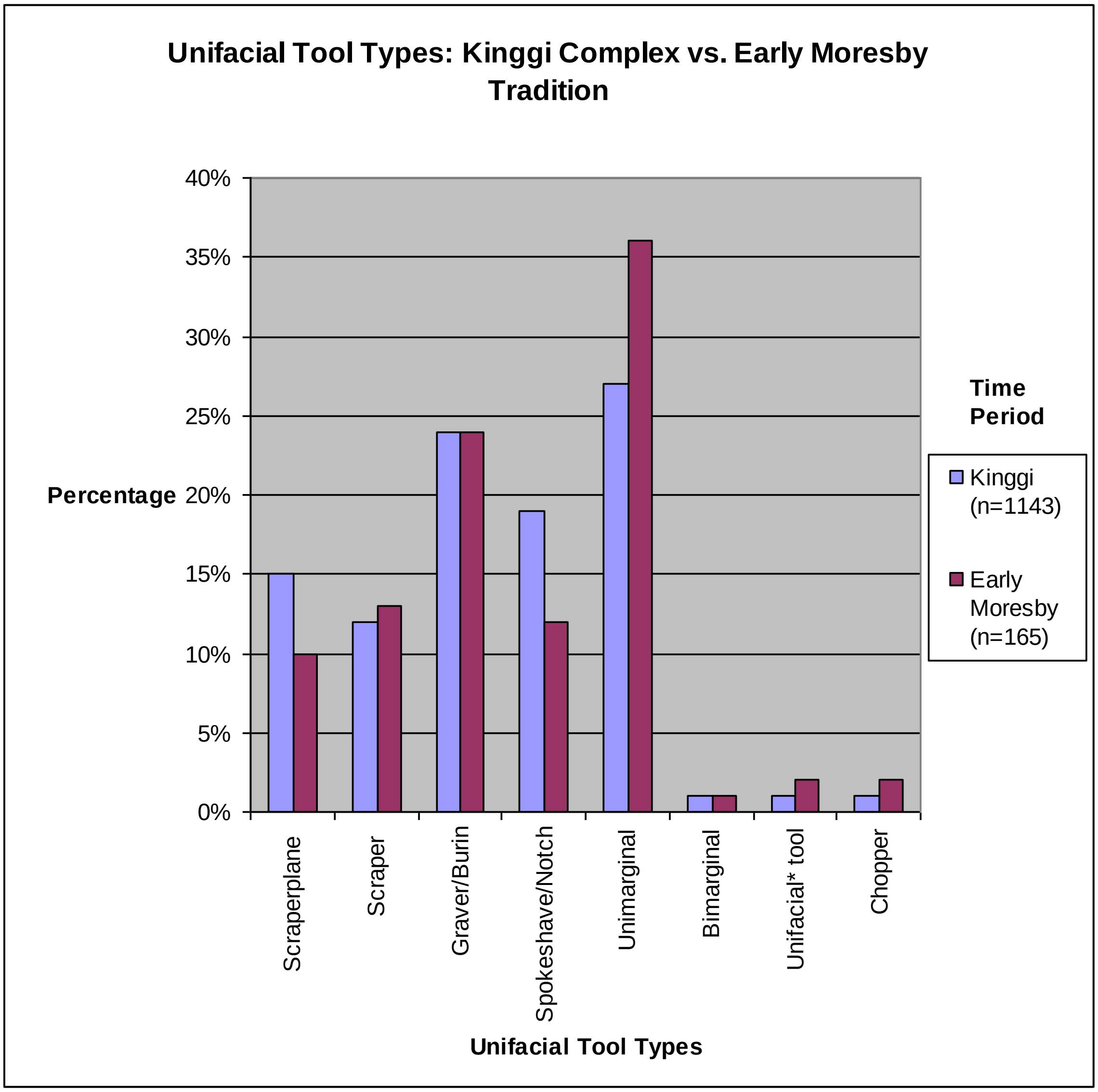


Figure 40: Bar graph of the relative percentages of unifacial tool types in the Kinggi Complex and Early Moresby Tradition.

A chi square test of significance was produced in order to test the relationship between the unifacial tool types for each period. Due to the low numbers of bimarginal, unifacial* tools and choppers, these tool types were not included in the chi square test.

The null hypothesis is that there is no difference between the frequencies of unifacial tools found in the Kinggi Complex vs. the Early Moresby Tradition. I hypothesize that there will not be a significant difference in the amounts of these tool types for each period due to the continuity of tool size, edge angle and multifunctionality.

	Value	df	Significance (*p* value)
Chi Square χ^2	**3.89**	**4**	**0.422**
N of Valid Cases	**1274**		

Table 52: Chi Square test for < 0.05 significance (*p* value).

Results produced from the chi square test support the null hypothesis therefore there is not a significant difference between the unifacial tool types in the Kinggi Complex versus the Early Moresby Tradition. People at the Richardson Island site continued to manufacture the same kinds of tools over time. While the numbers of unifaces in the Early Moresby Tradition does drop dramatically from the Kinggi Complex, the relative proportions of these types do not change significantly.

8.3. Change through Time

8.3.1. Change in Raw Material Selection

While results generated in Figure 37 revealed some of the continuity of raw materials at the site, there were also notable changes between the Kinggi Complex and the Early Moresby period. Specifically, raw material types siliceous argillite and shale/argillite shifted places in their frequencies. Siliceous argillite was more common in the earliest layers at the site and shale/argillite use increased over time. There were also some material types that occurred in low amounts in either the Kinggi Complex or the Early Moresby period. Varvite and rhyolite use at the site also changed through site occupation with varvite dominating in the Kinggi Complex and rhyolite more common in the Early Moresby period. From her analysis of raw material use at the Richardson Island site, Smith (2004) concludes that there was probably experimentation occurring at the site, both for microblade manufacture and for other types of tools.

8.3.2. Change in Blank Form

A final enquiry into blank form was conducted on the Kinggi Complex versus the Early Moresby Tradition unifaces in order to examine temporal trends. What can the blank forms selected during the earliest occupation and extending through time reveal about technological variability, continuity and change? Is there a difference between blank selection in the Kinggi Complex and the Early Moresby Tradition? I hypothesize that there will be a noticeable change in the proportions of tabular slabs and cores to flakes between the two time periods. The decrease in the amounts of siliceous argillite and increase in shale/argillite use through time at the Richardson site will be reflected in blank forms.

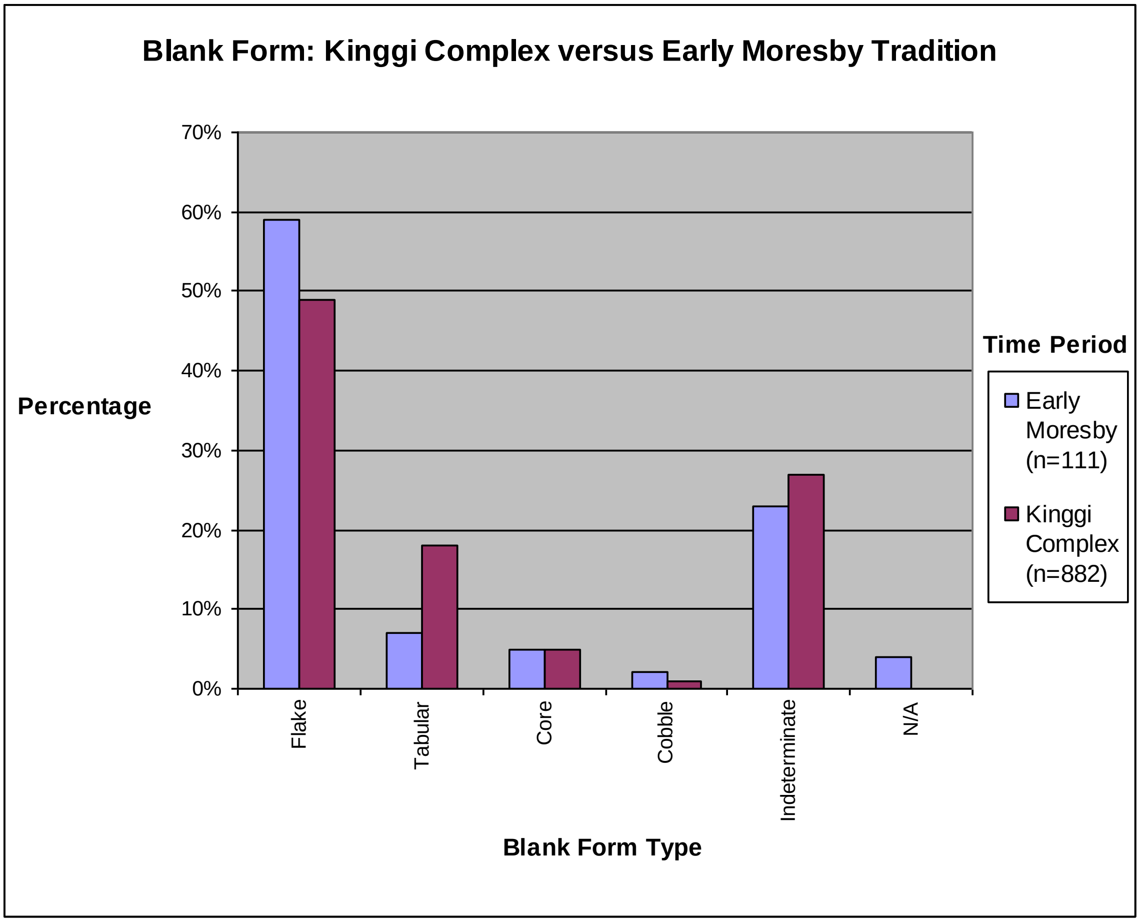


Figure 41: Percentages of blank form types between the Kinggi Complex and Early Moresby.

As Figure 41 indicates, there are some differences in blank forms between the Kinggi Complex and the Early Moresby Tradition. These differences are most evident between the percentages of flakes and tabular forms for the two periods. Unifacial tools manufactured on tabular slabs are more frequent in the Kinggi Complex than in the Early Moresby Tradition while flakes are proportionally more frequent in the Early Moresby Tradition than in the Kinggi Complex. Both time periods have relatively similar proportions of tools made on cores and cobbles. A chi square test for significance was then initiated. This test compared the percentages of flakes, tabular forms and cores from the Kinggi Complex versus those of the Early Moresby Tradition. The null hypothesis is that there is no difference in proportions of blank forms between the two time periods.

	Value	**df**	**Significance (*p* value)**
Chi Square χ^2	**5.76**	**2**	**0.056**
N of Valid Cases	**143**		

Table 53: Chi Square test for < 0.05 significance (*p* value).

The chi square test fails to reject the null hypothesis with a *p* value of 0.056. The *p* value formulated was very close to 0.05 indicating that there may be some level of significance. While some change in blank form is apparent, blank form types are consistent enough to be considered similar between the two time periods.

Discussion

The main point to be drawn from a few temporal aspects of the unifacial tool assemblage is that there is very little change within these variables through a large span of human occupation at the Richardson Island site. The shift in raw material type and blank form does occur in the assemblage but this does not seem to have a significant affect on other aspects of the unifacial tools. The results also indicate that the variability, seen through raw material selection and multi-type tools, extends through the Kinggi Complex and Early Moresby Tradition. All of the unifacial tool types present during the Kinggi Complex are also represented in the Early Moresby Tradition. While scraperplanes and spokeshaves do seem to occur more frequently during the earlier occupation of the site and unimarginal tools are more prevalent in the later site occupation, results produced from a chi square test indicate that these are not significant differences.

8.4. Unifacial technology ca. 8000 to 3000 BP

Throughout the analysis of the temporality of the unifacial tools from Richardson Island, discussions have focused on only the Kinggi Complex (>9500-8900 BP) and the Early Moresby Tradition (ca. 8900-8000 BP). These two periods reflect the most intensive use of the site and most of the artifacts recovered from excavations have dated to this earlier time period in Haida Gwaii. More recent fieldwork conducted at the Richardson Island site in August, 2007 did gather some artifacts that date between ca. 8000 and 3000 BP. As the number of unifaces recovered is quite small (n= 56), an accurate comparison between the latest period of human activity and the earlier time periods could not be conducted. However, the artifacts recovered from the upper most layers at the site are worthy of some discussion, particularly as there is substantially less known about the later period of human occupation. There is a significant gap in the archaeological knowledge for this time span in Gwaii Haanas and yet this is an interesting time in the sea level record. Sea level history documented for the archipelago indicates that falling sea levels had stabilized to present levels by approximately 4000 BP (Fedje and Mackie 2005).

In Table 54, unifacial tools recovered from excavation units (EU) 15 and 16 are shown. Though small in numbers, this table shows the continuation of many of the unifacial tool types through the record of site activity. A statistical summary of the mean lengths, widths, and weights for the unifaces in the two delineated time spans reveals no significant difference between the lengths and widths of the tools however, there does appear to be some larger unifaces in the latest occupation. There are also a small number of multi-type tools; 11 % of the total unifaces from EU 15 and EU16. Although not included in the table, there were also some biface reduction flakes and biface fragments recovered from the Late Moresby Tradition layers and microblades were recovered as late as 3000 BP. These recent findings suggest that there is still much to be learned about the culture history of the area.

Frequencies and Mean Sizes of Unifacial Tools: ca. 8000-5000 BP and ca. 5000-3000 BP		
ca. 5000 - 3000 BP	**Total**	**Mean**
Scraperplane	1	
Scraper	3	
Graver	11	
Spokeshave/Notch	5	
Unimarginal	5	
Bimarginal	0	
Chopper	2	
Unifacial T.	0	
Mean Length (mm)		**48.9**
Mean Width (mm)		**42.4**
Mean Weight (g)		**136.7**
ca. 8000 - 5000 BP	**Total**	**Mean**
Scraperplane	3	
Scraper	3	
Graver	8	
Spokeshave/Notch	4	
Unimarginal	9	
Bimarginal	1	
Chopper	2	
Unifacial T.	0	
Mean Length (mm)		**51.7**
Mean Width (mm)		**39.7**
Mean Weight (g)		**84.5**

Table 54: Frequencies and mean sizes of unifacial tools recovered from EU 15 and EU 16 from ca. 8000-5000 BP and ca. 5000-3000 BP.

8.5. Individual Layers of Occupation at the Richardson Island Site

One of the most unique aspects of the Richardson Island site is the high resolution stratigraphy that allows for the analysis of the unifacial tools on a short-term time scale. Some layers can be divided into time frames that span only 20 or 30 years of site use. From this high resolution, the traces of human behavior normally condensed into a thousand years or more can be seen as the variable actions of people using the site through time. As mentioned in Chapter Three of this thesis, an analysis of hearth features from the Kinggi Complex revealed differences in faunal use from year to year (Steffen 2006).

8.5.1 Hearth features and unifacial tools

During the analysis of hearth features from the Richardson Island site, Steffen (2006) noted that there was variability between the types of artifacts found around hearths and the taxonomic contents within each hearth. Steffen found that tool manufacture and food processing occurred around the hearths that span approximately 200 years in the Kinggi Complex (2006: 210). In an analysis of the frequencies of tool types found adjacent to hearths versus those found in non-hearth layers, Steffen notes a relationship between marginally retouched tools and hearths; she finds that more marginal tools are occurring around hearth features than in non-hearth layers. Steffen also discovers that there are significantly fewer spokeshave/notches and graver/burins within the context of hearth layers (2006). These results are shown in Table 55, based on Table 8.2 from Steffen (2006).

Comparison of artifact types in hearth layers versus those from apparent non-hearth layers: Chi Square results.								
Kinggi Complex "a" Horizon Layers		Marginal tools	Spokeshave/gravers	Scraperplanes/Choppers	Bifacial Tools	Hammerstones	Abraders	Total
With Hearths	Frequency	163	92	68	66	16	37	442
	Percentage	36.90%	20.60%	15.40%	14.90%	3.60%	8.40%	
Without Hearths	Frequency	125	128	60	59	10	65	447
	Percentage	28%	28.60%	13.40%	13.20%	2.20%	14.50%	
Chi Square	<0.05 is significant	0.005	0.007	0.405	0.457	0.221	0.004	

Table 55: Frequencies and percentages of artifact types found in hearth layers versus those found in non-hearth layers. (Table modified from Steffen 2006: Table 8.2)

8.6. Some Implications for the Culture History of Haida Gwaii

An investigation of the unifacial tools from the Richardson Island site has shown that there is a significant amount of variability within these tool types and that this variability continues through time without any distinctive breaks. These tools also make up a substantial portion of the overall stone tool assemblage and suggest that there was more cultural continuity than change throughout the use of the site. The most noticeable change in the unifacial tools appears to relate to differences in the procurement of specific raw materials, specifically siliceous argillite and shale/argillite. As discussed in

Chapter Seven, raw material selection affected all aspects of a tool's use-life and the specific properties of a material were probably a significant factor in the low standardization of tool types. As unifacial tools are more flexible in terms of morphology and the tasks they can be used for, early peoples continued manufacturing these forms, even as other technologies were introduced and raw material use changed.

Based on the unifacial tools manufactured and used at the site, it appears that people's activities were variable on a micro-scale and yet relatively consistent with some patterns on a macro-scale. As shown through the behavioral model in Chapter Seven, unifacial tools exhibited some cohesiveness although any structure in the assemblage was clouded by the more variable tool forms. If the unifacial tools reflect more continuity in practice than distinctive change, how do we choose to divide these artifacts within the established culture historical sequence? As mentioned in previous chapters, the separation of the earliest occupation of the Richardson site into the Kinggi Complex and the Early Moresby Tradition is based on the transition from bifacial to microblade technology. The purpose of a temporal analysis of the unifacial tools was to determine whether or not a change in other tool types occurred simultaneous to the biface/microblade transition.

For the purposes of trying to divide large spans of time into more manageable and workable units, the culture historical sequence for Haida Gwaii can be a useful tool. However, in separating the behavior of early peoples based on cultural change it may be important to ask whether or not more attention should be given to those aspects that exhibit very little change overall. How do the actions of peoples through significantly large time periods remain relatively consistent?

8.6.1. Ethnic Replacement versus In-Situ Development

Returning to the idea of an in-situ development for technological change at the Richardson Island site, the overall continuity in the manufacture of the unifaces supports the gradual transition to new technologies by one cultural group in opposition to the suggestion of ethnic replacement. Results reached through this unifacial tool analysis indicate that the same cultural group revisited the Richardson Island site, procuring many of the same raw materials though in differing proportions, manufacturing their unifacial tools in similar ways and potentially conducting many of the same tasks or activities that were done by their ancestors. As many archaeological sites outside of Haida Gwaii have used ethnic replacement as a guiding explanation for bifacial and microblade technologies (Powers and Hoeffecker 1989; Hoeffecker et al. 1993; Dixon 2001; Goebel et al. 2003) it may be important to examine other types of stone tools recovered from these sites. These more variable, less standardized and arguably "less sexy" artifacts may lead to more robust understandings of these frequently discussed changes in stone tool technology.

Conclusions

In this chapter, several questions were outlined and tested in order to explore any changes or continuities in the unifacial tool assemblage at the Richardson Island site. A distinct trend away from bifacial technology and towards the use of microblade technology at the site has been a central focus for defining the early culture history of Haida Gwaii. Results produced from a temporal analysis of unifacial tools recovered from the Kinggi Complex and the Early Moresby Tradition indicates that unifacial tools showed both technological continuity and change through time. These results are summarized below.

1) Unifacial tool sizes remain relatively consistent through time. The mean sizes for length and width are not significantly different between the Kinggi Complex and the Early Moresby Tradition.

2) Raw material selection for the manufacture of unifacial tools is both continuous and changing at the Richardson site. Most of the material types present in the Kinggi Complex also occur in the Early Moresby Tradition. However, there is some change in the frequencies of material types through time. Specifically, there is a shift from more intensive use of siliceous argillite in the Kinggi Complex to the more frequent use of shale/argillite in the Early Moresby Tradition.

3) The relationship between size and edge angle remains relatively consistent between the two time periods. Steep edged unifacial tools are more frequently large in size and small unifaces have a high number of acute angled working edges.

4) Those unifaces classified as multi-types or multifunctional forms are present through time at the site. The frequencies of multi-types changes very little between the Kinggi Complex and the Early Moresby Tradition. Multi-types tools also extend into the Late Moresby and Early Graham Traditions.

5) Unifacial tool types remain consistent throughout time although some types occur in higher or lower frequencies between the two periods. The most noticeable differences occur with scraperplanes, unimarginals and spokeshave/notches. There appears to be a decline in the number of scraperplanes used at the site in the Early Moresby Tradition while unimarginal tools increase in frequency during this time. Spokeshaves are also found to decline slightly within the later time period. Although some change in unifacial tool type is evident at the site, people are still, for the most part, manufacturing and using the same kinds of tools.

6) Blank form selection at the site does change slightly over time. This change is mainly exhibited through the decline in tabular forms during the Early Moresby Tradition. While tabular pieces, made of materials such as siliceous argillite, are prevalent for unifacial tool manufacture in the earliest occupation of the site, later site use has a proportionally higher number of unifacial tools made on flake blanks. This shift may reflect the changes in raw material use as noted by Smith (2004) and further exemplified in this chapter.

7) Although occurring in very small numbers, those unifacial tools recovered from Late Moresby and Early Graham Tradition layers suggest that people are still manufacturing some of the same tool forms up to 5000 years later.

Discussions of technological change or continuity through time are most often situated from a large scale view of cultural behavior. However, as mentioned in Chapter Four with Ingold (2000), gradual technological change can be as a result of a large amount of small variations over time. These small variations can lead to either continuity in behavior and technologies or in a slow change that occurs through a large span of time. At the Richardson Island site, unifacial tool technologies exhibit a very low level of structure yet this structure remains consistent for a large period of site occupation. The change that is revealed through these tools is both minimal and gradual; there are no distinctively abrupt changes to the assemblage.

In Chapter Seven, the behavioral model was used as a framework for understanding the weak structure of the unifacial tool assemblage. In this chapter, the unifacial assemblage was separated into temporal units in order to trace these technologies through the span of site use.

9 Conclusions

The Typological Structure of the Unifacial Tools

The two main points that can be emphasized after an analysis of the structure of the unifacial tools from Richardson are 1) that there are some differences between these defined tool types that allow for unifacial tools to be separated into distinct categories and 2) that there is also a substantial amount of similarity between some of the defined tool types with many tools situated somewhere in-between categories. These two points will be the focus of discussions below.

During the analysis of the unifacial tool assemblage it became evident that there were distinctive differences between some of the defined tool types. Some of the unifacial tools tended to be predominately small in size i.e., a graver/burin or spokeshave/notch tool, while other tools were all quite large in size i.e., chopper tools. Some tools had very steep working edges i.e., a scraperplane, while other tools had very prominent projections or pointed outlines i.e., a graver/burin. Both of these attributes imply differences in the function or use of these tool types. There were also certain types of tools that were manufactured on one blank form type over another suggesting some sort of preference on the part of the tool maker. For instance, scraperplanes were frequently manufactured on tabular forms while scrapers were more commonly made on flakes. Although there were very few “classic” tools represented in the Richardson assemblage, a couple of end scrapers (n=3) were recovered (Figure 44, Appendix A). It is possible that there were more examples of standardized tool forms but that these artifacts were carried off-site for use at another location or that they were located in areas of the site that were not excavated. In any case, the unifacial tools that are situated closer to being a “scraper” or a “graver” in a more formal sense give reason to separate these artifacts into the defined unifacial types.

At the same time, there were also many tool types that blended into one another, suggesting that, in some instances, there may have been little difference in the use of these tools at the site. Similarities between tool types are reflected in those artifacts that are moderately large to large in size, exhibit denticulate edges or are manufactured on tabular forms, cobbles and cores. Some of the tools classified as scraperplanes share some relationship to both unifacial* tools and choppers in the assemblage. Specifically, scraperplanes and choppers are manufactured using rhyolite, andesite and the variable “others” material category. For blank selection, there are some examples of scraperplanes on cobbles and cores and choppers were manufactured on cobbles, tabular pieces and cores. Although many of the scraperplane tools exhibit regular flaking to create an edge while chopper tools tend to exhibit very rough flaking, there do appear to be some scraperplanes that also exhibit rough flaking to create a steep edge. There may have been some overlap in the function or use of these tool types. Some unifacial* tools may also be grouped with scraperplanes and choppers due to their tendency to be moderately large to large in size with some rough flaking that could suggest use as a cutting or chopping tool.

Similarly, there may be more of a gradual transition between those tools classified as scrapers and those artifacts grouped as unimarginal tools. While some artifacts do seem to be distinctively “scrapers” or “unimarginals” in the assemblage, there is also some overlap. Both types are manufactured using all of the most commonly procured raw materials at the Richardson Island site and both are predominately manufactured on flake forms. Both tool types are also present in lower frequencies on tabular pieces and cores. Scrapers and unimarginals also occur in all tool size categories from small to large although more scrapers are classified as moderately large while more of the unimarginals are classified as moderate in size. Both of these tool types include several artifacts that have one or more denticulate working edges. As with scraperplanes, choppers and unifacial* tools, there is a range of tools that fall somewhere in between a well-defined scraper and a unimarginal tool.

In Chapter Seven, the analysis of the unifacial tools through a behavioral model emphasized the variability in raw material use as an important factor in differences between tool morphologies. People at Richardson Island made use of the available local materials and it is these materials that may have affected, to some extent, tool design.

Referring back to concepts of design theory from Chapter Four, unifacial tools at Richardson Island can be thought of as produced in varying contexts with various types of constraints. It is from within these contexts that people would have had to continually solve specific problems as they arose. For example, a desired material type for a specific tool form may not have been available at a certain time and a flint knapper may have had to use a less commonly procured material that was picked up at or near to the site. This material type may not flake nicely or predictably but a rough tool form is manufactured and the tool is used for the task at hand. While the flint knapper may have had a specific design in mind, the properties of the material may have resulted in an imperfect form. However, the flint knapper had weighed the costs and benefits of using a more unusual material type and was able to conduct the task at hand. As Rahemtulla (2006) notes, design theory is a concept that focuses on the specific contexts from which tool technologies are created.

At the same time, the creation of tool forms may not always reflect an intentional design on the part of a tool maker as argued by Odell (1996). At this stage, it may be worthy to refer back to Dunnell's (1986) idea of emic types as either a reflection of the intentional act of creating a specific tool type or as an act that, while intentional in the sense of creating a tool, was not produced with a specific design in mind. Dunnell's second emic concept may help explain some of the multi-type tools in the assemblage. While all reflecting some kind of intentionality, some of the artifacts may not reflect a desired tool design. Many of these tools may reflect what Ingold (2000) has referred to as the lived experience of people manufacturing technologies from within particular contexts and structured by the activities of their predecessors.

The purpose of questioning the separation of the unifacial tools into types is not to suggest that the typological structure should be avoided; it is to emphasize the multi-functionality of each tool and the potential relationships between them. It may be more useful to think about the unifacial tools as part of a continuum; tool morphologies that grade into one another and are dynamic. While some tools may represent a well-defined graver or scraper, other tools may be situated on the outskirts. These tools may not fit neatly into one type or another but, instead, are situated somewhere in the middle or change forms throughout their use-lives. Each unifacial tool has a biography that is slightly different from the others. Each tool goes through different stages, serves different functions or tasks and is given a new meaning depending on the context of its use. This notion of tool biographies was discussed in Chapter Four, drawing on the theoretical perspectives of Daniel Miller (1987). While there are some definite patterns present within the Richardson unifacial tool assemblage, there are many tools that are situated somewhere in between two types or seem to represent several types all in one. The presence of multiple forms on a variety of material types and the co-occurrence of different types on one artifact reveal an important aspect of technological practice that is often lost in lithic analysis; the dynamic and variable aspects of human behavior across space and through time. Stone tools can serve many different purposes, can be re-shaped and re-used and may have been given several meanings over their use-lives. The unifacial tools manufactured by the early peoples using the Richardson Island site provide a good example of all of these aspects. A further discussion of each unifacial tool type from the Richardson Island site can be found in Appendix C.

9.1 Final Conclusions

In discussions of technical change, Ingold (2000) emphasizes the dynamic contexts from which artifact forms are created; a rich environment that may include one or several individuals, materials, or other artifact forms. Tool-making practices at Richardson Island and, more broadly, in Haida Gwaii, reflect the dynamic environment that people lived in, traveled through and experienced. As reconstructions of the paleoenvironment, specifically changes in sea levels, paleoclimates and paleoecology, have shown, early peoples of the Late Pleistocene/Early Holocene were living in a fluctuating environment. At this early time in human history, the archipelago remained somewhat isolated, characterized as a unique and diverse environment. Archaeological research has emphasized in-situ development of technologies and has shown that early peoples living in the archipelago had an extensive knowledge of the coastal landscape. Previous research has also emphasized technological change, specifically in the early occupation of Gwaii Haanas or southern portion of the archipelago, as potentially associated to rising and falling sea levels. The site of Richardson Island has played a central role in refining the culture historical sequence as seen through a shift from bifacial to microblade technology. This shift is divided into the Kinggi Complex and the Early Moresby Tradition.

In light of the analysis that has been conducted on the unifacial tool assemblage from Richardson Island, my initial research objectives are reviewed below.

1) **To determine whether or not there is standardization within the unifacial tool assemblage at the Richardson site.**

In Chapter Six, results produced indicated a very low amount of structure present within the unifacial tool assemblage. The application of cluster analysis to the unifacial data set did not serve to produce distinctly meaningful groupings of artifacts. There were some instances where a few similar artifacts would group together but, overall, cluster analysis indicated a very weak underlying structure.

2) **To explore the variability of the unifacial tools from raw material selection to discard in the archaeological record through a behavioral model.**

In order to understand why the unifacial tools appeared to be so different from each other, a behavioral model was created in Chapter Seven. This behavioral model was used as an “operational sequence” for the Richardson unifaces; an analysis between variables began with raw material procurement and ended with tool re-use and discard in the archaeological record. The results of a behavioral analysis revealed both the variable practices of unifacial tool production and a low level of cohesiveness between specific aspects such as raw materials and tool sizes, size and edge angles and the raw materials used for certain tool types. The relationships between these variables provided some indication of structure within a large amount of “noise.” Raw material use, blank form, and the creation of multi-type tools were significant factors affecting the amount of standardization present in the assemblage.

3) **To determine whether or not the unifacial tools reflect technological change or continuity throughout time.**

A temporal analysis of the unifacial tools at the Richardson Island site in Chapter Eight revealed both change and continuity in technological behavior. A shift in raw material selection and subsequently, in blank form types for the unifacial tools provided the main source of distinctive change between the Kinggi Complex and the Early Moresby Tradition. Changes in raw material use at the site were previously noted by Smith (2004). However, there is also continuity as reflected by several aspects of the unifacial tools. Overall, the morphologies of the unifacial tools do not change significantly. Specifically, there is little indication for an abrupt shift in unifacial technological practice as is seen with bifaces and microblades at the site.

4) **To include the results of each objective noted above in a discussion of the established culture history of Haida Gwaii.**

Although the culture historical sequence for Haida Gwaii provides a method for dividing large spans of time into more manageable units, it is based on only a small amount of the overall activities conducted in the past. As emphasized during a temporal analysis of the unifacial tools from the Richardson Island site, there is a significant amount of continuity through time and across the division between the Kinggi Complex and the Early Moresby Tradition. These tools reflect the relative stability of human practices through time. These practices seem to have continued even during rapid sea level change. Though the culture historical sequence tends to emphasize those aspects in the archaeological record that change, it is also very important to discuss the cultural practices that exhibit very minimal or no change through time.

9.2 Future Avenues of Research

There is still a substantial amount of archaeological research to be conducted in Haida Gwaii. At the Richardson Island site, in particular, an analysis of the debitage recovered from excavations to-date would help to expand on the technological behavior over time. As debitage is a very clear reflection of tool production, it would be beneficial for the study of unifacial and bifacial tools as well as microblade technology.
A study of the utilized flakes recovered from the site would be another avenue for conducting future research. In some ways, these tools are just as important for our understanding of site behavior as unifacial, bifacial and microblade use. In many instances, there is a very fine distinction between a utilized flake and a unifacial tool in the assemblage. Similarly, there is also a fine line between a utilized flake and a piece of debitage. Reflecting back to the Behavioral Model from Chapter Seven, these forms, whether retouched or not, are all part of the "operational sequence" that encompasses the total technological behavior at the site. In order to fully understand this behavior, an analysis of all of the material remains from tool production should be conducted.

There is also a need for more archaeological survey and excavation to be conducted in order to better define the culture history in the archipelago. As mentioned in Chapter Two of this thesis, the discovery of early sites in the archipelago has remained limited due to 1) sea level changes that have submerged sites underwater and 2) the high density of the forest obscuring visibility. It is possible that more excavation at some of the known and early archaeological sites would increase the knowledge of the early time in human history.

Archaeological fieldwork conducted in 2007 by Parks Canada, the University of Victoria and the Haida First Nation at the Richardson Island site recovered a small assemblage of stone tools and associated debitage dating to as late as 3000 BP. From this more recent investigation, results indicate that bifacial technology might extend into the Late Moresby Tradition and microblade technology may still be present as late as 3000 BP. The occurrence of these technologies past 8000 BP (for bifacial technology) and

5000 BP (for microblades) adds a new element into the established culture history for the archipelago. Is it possible that these technologies do continue on, at least to some extent, in Haida prehistory? This question can only be answered through more research and analysis.

Finally, more research focused on the paleoenvironment during the early period of human occupation (the Kinggi Complex) would be of benefit to future archaeological studies. At the moment, only a limited amount of research has been conducted for the southern portion of Haida Gwaii with the most detailed paleoenvironmental record coming from the northern coast.

In Haida Gwaii, efforts to better understand the history of the ancestral Haida have relied on a multi-disciplinary approach. Continued research has brought together studies of the paleoshorelines, paleoclimatic conditions, paleoecology and archaeological record; each study adding to a much broader picture of Haida Gwaii as far back as the Late Pleistocene. Studies of the paleoshorelines and sea level histories have guided archaeological surveys and resulted in the discovery of several sites of early human occupation. However, the information conducted to date is far from complete and it will take the continued work of dedicated researchers to provide a more detailed record of life as it was in Haida Gwaii over 3000, 8000 or 10, 000 years ago.

As a final comment in this thesis, I would like to acknowledge the Haida First Nation. I would like to thank them for the opportunity to study the stone tools of their ancestors at the Richardson Island site, part of their traditional territory and an important record of their past. As emphasized in Chapter Eight, the unifacial tools reflect continuity over a large span of time and through several changes in the environment. This long-term continuity is really quite remarkable when we think in terms of hundreds and thousands of years of living in a dynamic landscape such as Haida Gwaii. Though quite limited in some aspects, the study of stone tool technologies reflects the abilities of early ancestral Haida peoples to both exploit and adapt to a continually shifting and changing environment.

10 References Cited

Adams, W.Y. and E.W. Adams.

1991 *Archaeological Typology and Practical Reality: A Dialectical Approach to Artifact Classification and Sorting.* Cambridge University Press, Cambridge.

Acheson, S.R.

1998 *In the Wake of the Ya'áats' Xaatgáay (Iron People): A Study of Changing Settlement Strategies among the Kunghit Haida.* PhD Dissertation, Department of Ethnology and Prehistory, University of Oxford, Oxford.

2005 Gwaii Haanas Settlement Archaeology. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People,* edited by Fedje, D.W. and R.W. Mathewes, pp.154-162. UBC Press, Vancouver.

Ackerman, R.E.

1996a Ground Hog Bay, Site 2. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by Fredrick, H. West. pp. 413-423. The University of Chicago Press, Chicago.

1996b Early Maritime Culture Complexes of the Northern Northwest Coast. In *Early Human Occupation in British Columbia.* Edited by R.L. Carlson and L. Dalla Bona. pp. 123-132. UBC Press, Vancouver.

Aldenderfer, M.S.

1991 The Analytical Engine: Computer, Simulation, and Archaeological Research. In *Archaeological Method and Theory, Vol. 3*. Edited by M.D. Schiffer. Pp. 95-248. University of Arizona Press, Tucson.

Aldenderfer, M.S. and R.K. Blanshfield.

1984 *Cluster Analysis*. Sage University Paper Series on Quantitative Applications in the Social Sciences Series Number 07-044. Sage Publications, Newbury Park.

Andrefsky, W. Jr.

2005 *Lithics: Macroscopic Approaches to Analysis*. Second Edition. Cambridge University Press, UK.

Anoikin, A. and A. Postnov.

2005 Features of Raw Material Use in the Paleolithic Industries of the Mountainous Altai, Siberia, Russia. *Indo-Pacific Prehistory Association Bulletin* 25: 49-56.

Bamforth, D.B
1986 Technological Efficiency and Tool Curation. *American Antiquity*. 51(1): 38-50.

Barton, M.D., D Olszewski, and N.R. Coinman.
1996 Beyond the Graver: Reconsidering Burin Function. *Journal of Field Archaeology*. 23(1): 111-125.

Bar-Yosef, O. and L. Meignon.
2003 Insights into Levantine Middle Paleolithic Cultural Variability. In *The Middle Paleolithic: Adaptation, Behavior, and Variability*. Edited by H. Dibble. pp. 163-182. UPenn Museum of Archaeology, U.S.A.

Bar-Yosef, O. and B. Vandermeersch, B. Arensburg, A. Belfer-Cohen, P. Goldberg, H. Laville, L. Meignen, Y. Rak, J.D. Speth, E. Tchernov, A.M. Tillier, and S.Weiner.
1992 The Excavations in Kebara Cave, Mt. Carmel. *Current Anthropology* 33(5): 497-550.

Baxter, M.J.
1994 *Exploratory Multivariate Analysis in Archaeology*. Edinburgh University Press, Edinburgh.

Baxter, M.J. and C.C. Beardah.
2008 On Statistical Approaches to the Study of Ceramic Artefacts using Geochemical and Petrographic Data. *Archaeometry*. 50(1): 142-157.

Binford, L.R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity*. 45: 4-20.

Binford, L.R. and S.R. Binford.
1966 A Preliminary Analysis of Functional Variability in the Mousterian of Levallois facies. *American Anthropologist*. 68: 238-95.

Blades, B.S.
2003 End Scraper Reduction and Hunter-Gatherer Mobility. *American Antiquity*. 68(1): 141-156.

Bleed, P.
1986 The Optimal Design of Hunting Weapons: Maintainability or Reliability. *American Antiquity*. 51(4): 737-747.

2001 Trees or Chains, Links or Branches: Conceptual Alternatives for Consideration of Stone Tool Production and Other Sequential Activities. *Journal of Archaeological Method and Theory*. 8(1): 101-127.

Böeda, E.

1995 Levallois: A Volumetric Construction, Methods, a Technique. In *The Definition and Interpretation of Levallois Technology*. Edited by H. Dibble and O. Bar-Yosef. pp. 41-68. Prehistory Press, Madison.

Bordes, F.

1961 Mousterian Culture in France. *Science*, New Series. 134(3482): 803-810.

Breffitt, J.

1993 *The Skoglund's Landing Complex: A Re-examination of the Transitional Complex of Artifacts from Skoglund's Landing, Queen Charlotte Islands, British Columbia*. MA Thesis, Department of Archaeology, Simon Fraser University, Burnaby, B.C.

Carlson, C.

2003 The Bear Cove Fauna and the Subsistence History of Northwest Coast Maritime Culture. In *Archaeology Of Coastal British Columbia: Essays in Honour of Professor Philip M. Hobler*. Edited by R.L. Carlson. pp. 65-86. Archaeology Press, Simon Fraser University, Burnaby, B.C.

Carlson, R.L.

1996 Early Namu. In *Early Human Occupation in British Columbia*. Edited by R.L.Carlson and L. Dalla Bonna. pp. 3-10, 83-102. UBC Press, Vancouver.

Chazan, M.

2001 Bladelet production in the Aurignacian of La Ferrassie (Dordogne, France). *Lithic Technology*. 26: 16-28.

Christensen, T.

1997 *The Gwaii Haanas Archaeological Project*. Raised Beach Survey 1995 Field Report. Report on file, Cultural Resources Services, Parks Canada,Victoria.

Christensen T. and J. Stafford.

2005 Raised Beach Archaeology in Northern Haida Gwaii: Preliminary Results from the Cohoe Creek Site. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by Fedje, D.W. and R.W. Mathewes. pp. 245-273. UBC Press, Vancouver.

Clague, J.J.

1983 Glacio-Isostatic Effects of the Cordilleran Ice Sheet, British Columbia, Canada. In *Shorelines and Isostasy*. Edited by D. Smith and A. Dawson. pp. 321-343. Academic Press, London.

Clague, J.J., R.W. Mathewes, and B.G. Warner.

1982 Late Quaternary Geology of Eastern Graham Island, Queen Charlotte Islands, British Columbia. *Canadian Journal of Earth Sciences*. 19: 1786-1795.

Clague, J.J., R.W. Mathewes and T.A. Ager.
2004 Environments of Northwest North America before the Last Glacial Maximum. In *Entering America: Northeast Asia and Beringia Before the Last Glacial Maximum*. Edited by D.B. Madsen. pp. 63-96. University of Utah Press, Salt Lake City.

Clarkson, C.
2002 An Index of Invasiveness for the Measurement of Unifacial and Bifacial Retouch: A Theoretical, Experimental and Archaeological Verification. *Journal of Archaeological Science*. 29: 65-75.

Close, A.
1991 On the Validity of Middle Paleolithic Tool Types: A Test Case from the Eastern Sahara. News and Short Contributions. *Journal of Field Archaeology*. 18(2): 256-264.

2006 *Finding the people who flaked the stone at English Camp (San Juan Island)*. University of Utah Press, Salt Lake City.

Crabtree, D.E. and E.L. Davis.
1968 Experimental Manufacture of Wooden Implements with Tools of Flake Stone. *Science, New Series*. 159(3813): 426-428.

1977 The Obtuse Angle as a Functional Edge. In *Experimental Archaeology*. Edited by D.Ingersoll, J.E. Yellen, and W. Macdonald. pp. 38-51. Columbia University Press, New York

Dawson, G.M.
1880 *Report on the Queen Charlotte Islands, 1878*. Geological Survey of Canada Report of Progress for 1878-79. 4. Ottawa.

Deans, J.
1895 The Hidery Story of Creation. *American Antiquarian*. 17: 61-67.

Dibble, H.L
1984 Interpreting typological variation of Middle Paleolithic scrapers: function, style, or sequence of reduction? *Journal of Field Archaeology*. 11: 431-436.

1988 Typological Aspects of Reduction and Intensity of Utilization of Lithic Resources in the French Mousterian. In *Upper Pleistocene Prehistory of Western Eurasia*. Edited by Dibble, H.L. and A. Monet-White. pp. 181-197. University Museum Monograph 54. University of Pennsylvania, Philadelphia.

1995a Raw Material Availability, Intensity of Utilization, and Middle Paleolithic Assemblage Variability. In *The Middle Paleolithic Site of Combe- Capelle Bas (France)*. Edited by H.L. Dibble and M.Lenoir. pp. 289-315. University Museum Monograph 91.University of Pennsylvania, Philadelphia.

1995b Middle Paleolithic Scraper Reduction: Background, Clarification, and Review of the Evidence to Date. *Journal of Archaeological Method and Theory*. 2(4): 299-368.

Dibble, H.L. and M.C. Bernard
1980 A comparative study of basic edge angle measurement techniques. *American Antiquity* 45(4): 857-865.

Dikov, Nikolai.
1996 The Ushki Sites, Kamchatka Peninsula. In *American Beginnings: The Prehistory and Paleoecology of Beringia*. Edited by F.H. West. pp. 244-250. The University of Chicago Press, Chicago.

Dillehay, T.D.
1997 *Monte Verde, v.2: The Archaeological Context and Interpretation*. Smithsonian Institution Press: Washington, D.C.

Dixon, J.
1999 *Bones, Boats and Bison: Archeology and the First Colonization of Western North America*. The University of New Mexico Press, Albuquerque.

2001 Human colonization of the Americas: timing, technology and process. *Quaternary Science Reviews*. 20: 277-299.

Dixon, E.J., T.H. Heaton, T.E. Fifield, T.D. Hamilton, D.E. Putnam, and F.Grady.
1997 Late Quaternary regional geoarchaeology of southeast Alaska karst: A progress report. *Geoarchaeology*. 12: 689-712.

Dobres, M.
2000 *Technology and Social Agency*. Blackwell Publishers, Oxford.

Dobres, M. and C.R. Hoffman.
1994 Social Agency and the Dynamics of Prehistoric Technology. *Journal of Archaeological Method and Theory*. 1(3): 211-58.

Duff, W. and M. Kew.
1958 Anthony Island: A Home of the Haidas. In *British Columbia Provincial Museum of Natural History and Anthropology Report for 1957*. 71: 37-64. Victoria.

Dunnell, R.C.

1978 Style and Function: A Fundamental Dichotomy. *American Antiquity*. 43(2): 192-202.

1986 Methodological Issues in Americanist Artifact Classification. *Advances in Archaeological Method and Theory*. 9: 149-207.

Eren, M.E., M. Dominguez-Rodrigo, S.L. Kuhn, D.S. Adler, I. Lee, O. Bar-Yosef.

2005 Defining and Measuring Reduction in Unifacial Stone Tools. *Journal of Archaeological Science*. 32: 239-249.

Erlandson, Jon M.

2001 The Archaeology of Aquatic Adaptations: Paradigms for a new millennium. *J. Archaeol. Res*. 9: 287-350.

2002 Anatomically Modern Humans, Maritime Voyaging, and the Pleistocene Colonization of the Americas. In *The First Americans: The Pleistocene Colonization of the New World*. Edited by Nina G. Jablonski. pp. 59-92. California Academy of Sciences: USA.

Fedje, D.W. and T. Christensen.

1999 Modeling Paleoshorelines and Locating Early Holocene Coastal Sites in Haida Gwaii. *American Antiquity*. 64(4): 635-652.

Fedje, D.W. and H. Josenhans.

2000 Drowned Forests and Archaeology on the Continental Shelf of British Columbia, Canada. *Geology* 28: 99-102.

Fedje, D.W. and Q. Mackie.

2005 Overview of Cultural History. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by Fedje, D.W. and R.W. Mathewes. pp. 154-162. UBC Press, Vancouver.

Fedje, D.W., M. Magne, and T. Christensen.

2005 Test Excavations at Raised Beach Sites in Southern Haida Gwaii and Their Significance to Northwest Coast Archaeology. In *Haida Gwaii: Human History and Environment Since the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 204-244. UBC Press, Vancouver.

Fedje, D.W., Q. Mackie, D. McLaren and M.Magne.

2008 *Function, Visibility, and Interpretation of Archaeological Assemblages at the Pleistocene-Holocene Transition in Haida Gwaii.* Paper presented at the 73rd Annual Meeting for the Society for American Archaeology, March 26-30, 2008.

Fedje, D.W., Q. Mackie, E.J. Dixon, and T.H. Heaton.
2004 Late Wisconsin Environments and Archaeological Visibility on the Northern Northwest Coast. In *Entering America: Northeast Asia and Beringia before the Last Glacial Maximum*. Edited by D.B. Madsen. pp. 97-138. University of Utah Press, Salt Lake City.

Fedje, D.W., A.P. Mackie, J.B. McSporran, and B. Wilson.
1996 Early Period Archaeology in Gwaii Haanas: Results of the 1993 Field Program. In *Early Human Occupation in British Columbia*. Edited by Roy Carlson and Luke Dalla Bona, pp. 133-150. UBC Press, Vancouver.

Fedje, D.W., R.J. Wigen, Q. Mackie, C.R. Lake, and I.D. Sumpter.
2001. Preliminary Results from Excavations at Kilgii Gwaay: An Early Holocene Archaeological Site on Ellen Island, Haida Gwaii, British Columbia. *Canadian Journal of Archaeology* 25: 98-120.

Fedje, D.W., J.M. White, M.C. Wilson, D.E. Nelson, J.S. Vogel, J.R. Southon.
1995 Vermillion Lakes Site: Adaptations and Environments in the Canadian Rockies during the Latest Pleistocene and Early Holocene. *American Antiquity*. 60(1): 81-108.

Fedje, D.W., Heiner Josenhans, John J. Clague, J. Vaughn Barrie, David J. Archer, and John J. Clague.
2005 Hecate Strait Paleoshorelines. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 21-37. UBC Press, Vancouver.

Fladmark, K.R.
1970 A Preliminary Report on the Archaeology of the Queen Charlotte Islands. In *Archaeology in BC, New Discoveries*. Edited by Roy Carlson. BC Studies Special Issue No. 6-7: 18-45.

1971 *Early Microblade Industries on the Queen Charlotte Islands, British Columbia*. Manuscript on file, British Columbia Archaeology Branch, Victoria.

1975 *A Paleoecological Model for Northwest Coast Prehistory*. National Museums of Canada, Ottawa.

1979 Routes: Alternative Migration Corridors for Early Man in North America. *American Antiquity*. 44: 55-69.

1986 Lawn Point and Kasta: Early Microblade Sites on the Queen Charlotte Islands, British Columbia. *Canadian Journal of Archaeology* 10: 39-58.

1989 The Native Culture History of the Queen Charlotte Islands. In *The Outer Shores*. Edited by G.G.E. Scudder and N. Gessler. pp. 199-222. Queen Charlotte Islands Museum Press, Skidegate.

1990 Possible Early Human Occupation of the Queen Charlotte Islands, British Columbia. *Canadian Journal of Archaeology* 14: 183-197.

Fladmark, K.R., K.M. Ames, and P.D. Sutherland.
1990 Prehistory of the Northern Coast of British Columbia. In *Handbook of North American Indians Vol 7: The Northwest Coast*, Edited by W. Suttles. pp. 229-239. Smithsonian Institution, Washington D.C.

Ford, J.A.
1954 On the Concept of Types. *American Anthropologist*. 56(1): 42-54.

Gessler, N. and L. Watney.
1976 *Archaeological Reconnaissance from Rennel Sound to Tian Head, Queen Charlotte Islands, British Columbia*. Report on file, British Columbia Archaeology Branch, Victoria.

Goebel, T. and S.B. Slobodin.
1999 Colonization of Western Beringia: Technology, Ecology, and Adaptations. In *Ice Age People of North America: Environments, Origins, and Adaptations*. Edited by R. Bonnichsen and K.L. Turnmire. pp. 104-155. Oregon State University Press, Corvallis.

Goebel, T., M.R. Waters, M. Dikova.
2003 The Archaeology of Ushki Lake, Kamchatka, and the Pleistocene Peopling of the Americas. *Science*. 301: 501-505.

Goodyear, A.C.
1988 On the Study of Technological Change. Current Anthropology. 29(2): 320-323.

Gould, R.A., D.A. Koster and A. Sontz.
1971 The lithic assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 43: 86-88.

Gower, J.C.
1971 A general coefficient of similarity and some of its properties. *Biometrics*. 27: 857-874.

Greiser, S.T.
1977 Micro-analysis of Wear Patterns on Projectile Points and Knives from the Jurgens Site, Kersey, Colorado. *Plains Anthropologist*. 22: 107-116.

Ham, L.C.

1988 *An Archaeological Impact Assessment of the Cohoe Creek Site, FjUb 10, Port Clements, Queen Charlotte Islands, British Columbia*. Report on file, British Columbia Archaeology Branch, Victoria.

1990 The Cohoe Creek Site: A Late Moresby Tradition Shell Midden. *Canadian Journal of Archaeology* 14: 199-221.

Hamilton, T.D. and T. Goebel.

1999 Late Pleistocene Peopling of Alaska. In *Ice Age People of North America: Environments, Origins, and Adaptations*. Edited by R. Bonnichsen and K. L. Turnmire. pp. 156-199. Oregon State University Press, Oregon.

Harper, J.R., W.T. Austin, M. Morris, P.D. Reimer and R. Reitmeier.

1994 *A Biophysical Inventory of the Coastal Resources in Gwaii Haanas*. Coastal & Ocean Resources Inc. Sidney, B.C.

Hayden, B.

1979 Snap, Shatter, and Superfractures: Usewear of Stone Skin Scrapers. In *Lithic Usewear Analysis*. Edited by B. Hayden. pp. 207-230. Academic Press, New York.

Hayden, B., N. Franco, J. Spafford.

1996 Evaluating Lithic Strategies and Design Criteria. In *Stone Tools: Theoretical Insights into Human Prehistory*. Edited by G.H. Odell. pp. 9-50. Plenum Press, New York.

Hays, M. and G. Lucas.

2000 A technological and functional analysis of carinates from Le Flageolet I, Dordogne, France. *Journal of Field Archaeology*. 27: 455-465.

Hetherington, R. and R.G. Reid.

2003 Malacological Insights into the Marine Ecology Changing Climate of the Late Pleistocene: Early Holocene Queen Charlotte Islands Archipelago, Western Canada, and Implications for Early Peoples. *Canadian Journal of Zoology*. 81: 626-661.

Heusser, C.J., L.E. Heusser, and D.M. Peteet.

1985. Late-Quaternary Climatic Change on the American North Pacific Coast. *Nature*. 315: 485-487.

Hiscock, P.

2007 Looking the Other Way: A Materialist/Technological Approach to Classifying Tools and Implements, Cores and Retouched Flakes. In *Tools versus Cores? Alternative Approaches to Stone Tool Analysis*. Edited by S. McPherron. pp. 198-222. Cambridge Scholars Publishing, Cambridge.

Hiscock, P. and V. Attenbrow.

2003 Early Australian Implement Variation: A Reduction Model. *Journal of Archaeological Science*. 30: 239-249.

Hiscock, P. and C. Clarkson.

2005 Experimental Evaluation of Kuhn's Geometric Index of Reduction and the Flat-Flake Problem. *Journal of Archaeological Science*. 32(7): 1015-1022.

Hobler, P.M.

1976 *Archaeological Sites on Moresby Island, Queen Charlotte Islands*. Report on file, British Columbia Archaeology Branch, Victoria.

1978 The Relationship of Archaeological Sites to Sea Levels on Moresby Island, Queen Charlotte Islands. *Canadian Journal of Archaeology* 2: 1-14.

Hoffecker, J.F., W.R. Powers, and T. Goebel.

1993 The Colonization of Beringia and the Peopling of the New World. *Science*. 259: 46-53.

Holdaway, S., S. Mcpherron, and B.Roth.

1996 Notched Tool Reuse and Raw Material Availability in French Middle Paleolithic Sites. *American Antiquity*. 61(2): 377-387.

Ingold, T.

2000 *The Perception of the Environment: Essays in livelihood, dwelling and skill*. Routledge, London.

Jackson, B.J.

1977 *Plane Sense: A Technological and Functional Analysis of a Stone Tool Category*. Unpublished M.A. Thesis, Washington State University, Pullman.

Kaufman, L. and P.J. Rousseeuw.

1990 *Finding Groups in Data*. Wiley, New York.

Kooyman, B.P.

2000 *Understanding Stone Tools and Archaeological Sites*. University of Calgary Press, Alberta.

Kuhn, S. L.
1990. A Geometric Index of Reduction for Unifacial Stone Tools. *Journal of Archaeological Science*. 17: 583-593.

1992 Blank Form and Reduction as Determinants of Mousterian Scraper Morphology. *American Antiquity*. 57(1): 115-128.

Kuhn, S.L. and M.C. Stiner.
1992 Subsistence, Technology, and Adaptive Variation in Middle Paleolithic Italy. *American Anthropologist*, *New Series*. 94 (2): 306-339.

Lacourse, Terri and Rolf W. Mathewes.
2005 Terrestrial Paleoecology of Haida Gwaii and the Continental Shelf: Vegetation, Climate, and Plant Resources of the Coastal Migration Route. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 38-58. UBC Press, Vancouver.

Mackie, Q.
1995 *The Taxonomy of Ground Stone Woodworking Tools*. BAR International Series 613. Archaeological and Historical Associates Ltd, Oxford.

Mackie, A.P. and B. Wilson.
1994 *Archaeological Inventory of Gwaii Haanas 1993*. Manuscript on file, Cultural Resources Services, Parks Canada, Victoria.

1995 *Archaeological Inventory of Gwaii Haanas 1994*. Manuscript on file, Cultural Resources Services, Parks Canada, Victoria.

Mackie, Q. and S. Acheson.
2005 The Graham Tradition. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 274-302. UBC Press, Vancouver.

Mackie, Q. and I. Sumpter.
2005 Shoreline Settlement Patterns in Gwaii Haanas during the Early and Late Holocene. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 274-302. UBC Press, Vancouver.

Mackie, Q., D. Fedje, D. McLaren, and N. Smith.
2008 Early Holocene technological transitions at the multicomponent Richardson Island archaeological site, Haida Gwaii, B.C. Paper presented at the 73rd Annual Meeting for the Society for American Archaeology, March 26-30, 2008, Vancouver, British Columbia.

Magne, M.P.R.

1985 *Lithics and Livelihood: Stone Tool Technologies of Central and Southern Interior British Columbia.* National Museum of Man, Mercury Series Archaeological Survey of Canada Paper No. 133, Ottawa.

1996 Comparative Analysis of Microblade Cores from Haida Gwaii. In *Early Human Occupation in British Columbia*. Edited by R.L. Carlson and L. Dalla Bona. pp. 83-102. UBC Press, Vancouver.

2004 Technological Correlates of Gwaii Haanas Microblades. *Lithic Technology* 29(2): 91-118.

Mathews, D.

2006 *Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point, British Columbia.* M.A. Thesis, Department of Anthropology, University of Victoria.

Mathewes, R.W.

1989 The Queen Charlotte Islands Refugium: A Paleoecological Perspective. In *Quaternary Geology of Canada and Greenland*. Edited by R.J. Fulton. Geological Survey of Canada. 1: 486-491.

Mathewes, R.W., L.E. Heusser, and R.T. Patterson.

1993 Evidence for a Younger Dryas- like Cooling Event on the British Columbia Coast. *Geology* 21: 101-104.

Matson, R.G.

1996 The Old Cordilleran Component at the Glenrose Cannery Site. In *Early Human Occupation in British Columbia.* Edited by R.L. Carlson and L. Dalla Bona. pp.111-122. UBC Press, Vancouver.

McLaren, D.

2008 *Sea Level Change and Archaeological Site Locations on the Dundas Island Archipelago of North Coastal British Columbia*. PhD dissertation, University of Victoria.

Miller, Daniel.

1987 *Material Culture and Mass Consumption*. Basil Blackwell Ltd: Oxford.

Mitchell, D. and D.L. Pokotylo.

1996 Early Period Components at the Milliken Site. In *Early Human Occupation in British Columbia*. Edited by R.L. Carlson and L. Dalla Bona. pp. 65-81. UBC Press, Vancouver.

Morris, J.

2004 ‘Agency’ theory applied: a study of later prehistoric lithic assemblages from northwest Pakistan. In *Agency Uncovered: Archaeological Perspectives on Social Agency, Power, and Being Human.* Edited by A. Gardner. pp. 51-64. UCL Press, Great Britain.

Nash, S. E.

1996 Is Curation a Useful Heuristic? In *Stone Tools: Theoretical Insights into Human Prehistory*. Edited by G.H. Odell. pp. 81-99. Plenum Press, New York.

Nelson, M.C.

1991 The Study of Technological Organization. In *Advances in Methodological Theory*. 3. Edited by M.B. Schiffer. pp. 57-100. University of Arizona Press, Arizona.

Odell, G.H.

1981 The Morphological Express at Function Junction: Searching for Meaning in Lithic Tool Types. *Journal of Anthropological Research*. 37(4): 311-342.

1996 Stone Tools: Theoretical Insights into Human Prehistory. Edited by G.H. Odell. Plenum Press, New York.

Orchard, T.J.

2007 *Otters and Urchins: Continuity and Change in Haida Economy during the Late Holocene and Maritime Fur Trade Periods*. PhD thesis. Department of Anthropology, University of Toronto.

Pellatt, M.G. and R.W. Mathewes.

1997 Holocene Tree Line and Climate Change on the Queen Charlotte Islands, Canada. *Quaternary Research*. 48: 88-99.

Powers, W.R. and T.D. Hamilton.

1978 Dry Creek: A Late Pleistocene Human Occupation in Central Alaska. In *Early Man in America from a Circum-Pacific Perspective*. Edited by A.L. Bryan. pp. 72-77. Occasional Papers No. 1, Department of Anthropology, University of Alberta, Edmonton.

Powers, W.R. and J.F. Hoffecker.

1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity*. 54: 263-287.

Rahemtulla, F.

2006 Design of Stone Tool Technology during the Early Period (CA. 10,000-5,000) at Namu, Central Coast of British Columbia. PhD Dissertation. Department of Archaeology, Simon Fraser University.

Ramsey, C.L., P.A. Griffiths, D.W. Fedje, R.J. Wigen, and Q. Mackie.
2004 K1 Preliminary Investigation of a late Wisconsinan Fauna from K1 Cave, Queen Charlotte Islands (Haida Gwaii), Canada. *Quaternary Research* 62: 105-109.

Reimchen, Tom and Ashley Byun.
2005 The Evolution of Endemic Species in Haida Gwaii. *In Haida Gwaii: Human History and Environment from the Time of Loon to the Time of the Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 77-95. UBC Press, Vancouver.

Rice, P.M. and M.E. Saffer.
1989 Cluster analysis of mixed-level data: pottery provenience as an example. *Journal of Archaeological Science*. 9: 395-409.

Rogers, M.J.
1939 Early Lithic Industries of the Lower Colorado River and Adjacent Desert Areas. *San Diego Museum Paper* 3: 49-51.

Rolland, N.
1981 The Interpretation of Middle Paleolithic Variability. *Man* 16: 15- 42.

Rolland, N. and H.L. Dibble.
1990 A New Synthesis of Middle Paleolithic Variability. *American Antiquity*. 55(3): 480-499.

Salls, R.A.
1985 The Scraper Plane: A Functional Interpretation. *Journal of Field Archaeology*. 12: 99-106.

Semenov, Sergei A.
1964 *Prehistoric Technology*, trans. M.W. Thompson. Cory, Adams and Mackay, London.

Schiffer, M.B.
1995 *Behavioral Archaeology: First Principles*. University of Utah Press, Salt Lake City.

Schiffer, M.B. and J.M. Skibo.
1987 Theory and Experiment in the Study of Technological Change. *Current Anthropology*. 28(5): 595-622.

Schiffer, M.B. and J.M. Skibo.
1997 The Explanation of Artifact Variability. *Society for American Archaeology*. 66 (1): 27-50.

Sellet, F.
1993 Chaîne Opératoire: The Concept and its Application. *Lithic Technology*. 18: 106-12

Severs, P.D.
1974 Archaeological Investigations at Blue Jackets Creek, FlUa-4, Queen Charlotte Islands, British Columbia. *Bulletin of the Canadian Archaeological Association* 6: 163-205.

Shennan, S.
1997 *Quantifying Archaeology, 2nd edition*. Edinburgh University Press, UK.

Shott, M.
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. *Journal of Anthropological Research*. 42(1):15-51.

1989 On Tool-Class Use-Lives and the Formation of Archaeological Assemblages. *American Antiquity*. 54(1): 9-30.

Slobodin, S.B. and M.L. King.
1996 Uptar and Kheta: Upper Paleolithic Sites of the Upper Kolyma Region. In *American Beginnings: The Prehistory and Paleoecology of Beringia*. Edited by F.H. West. pp. 236-244. The University of Chicago Press, Chicago.

Smith, H.I.
1929 Kitchen-Middens of the Pacific Coast of Canada. National Museums of Canada, Annual Report for 1927. *Bulletin* 56: 42-46.

Smith, N. F.
2004 *A Geochemical Approach to Understanding Stone Tool Production at the Richardson Island Archaeological Site, Haida Gwaii, British Columbia*. M.A. Thesis. Department of Anthropology, University of Victoria.

Sneath, P. and R. Sokal.
1973 *Numerical Taxonomy: The Principles and Practice of Numerical Classification*. W.H. Freeman and Company, San Francisco.

Spaulding, A.C.
1953 Statistical Tests for the Discovery of Artifact Types. *American Antiquity*. 18(4): 305-313.

Stafford, J. and T. Christensen.
2000 *Naden Harbour Archaeological Inventory Survey*. Report on file, British Columbia Archaeology Branch, Victoria.

Steffen, M.L.
2006 *Early Holocene Hearth Features and Burnt Faunal Assemblages at the Richardson Island Archaeological Site, Haida Gwaii, British Columbia*. MA Thesis. Department of Anthropology, University of Victoria.

Strathern, M.
1969 Stone Axes and Flake Tools: Evaluations from Two New Guinea Highlands Societies. In *The Prehistoric Society*.13: 311-329.

Tomášková, S.
2005 What is a Burin? Typology, Technology, and Interregional Comparison. *Journal of Archaeological Method and Theory*. 12(2): 79-115.

Tomenchuk, J., and P.L. Storck.
1997 Two Newly Recognized Paleoindian Tool Types: Single- and Double-Scribe Compass Gravers and Coring Gravers. *American Antiquity*. 62(3): 508-522.

Torrence, R.
1983 Time Budgeting and Hunter-Gatherer Technology. In *Hunter-Gatherer Economy in Prehistory: A European Perspective*. Edited by G. Bailey. pp.11-22. Cambridge University Press, New York.

White, J.P.
1967 Ethno-Archaeology in New Guinea: Two Examples. *Mankind*. 6(9): 409-416.

Wigen, Rebecca J.
2003 Identification of Fauna from Richardson Island. Report submitted to Quentin Mackie, University of Victoria.

2005 History of the Vertebrate Fauna in Haida Gwaii. In *Haida Gwaii: Human History and Environment from the Time of Loon to the Time of Iron People*. Edited by D.W. Fedje and R.W. Mathewes. pp. 96-115. UBC Press, Vancouver.

Wishart, D.
1987. *Clustan User Manual*. University of St. Andrews, St. Andrews.

1999 *Clustan Graphics Primer: A Guide to Cluster Analysis*. 4th Edition. Clustan Limited, Edinburgh.

Wylie, H.G.
1975 Tool microwear and functional types from Hogup Cave, Utah. *Tebiwa*. 72(2): 1-31.

Appendix A: Photos of Unifacial tool types

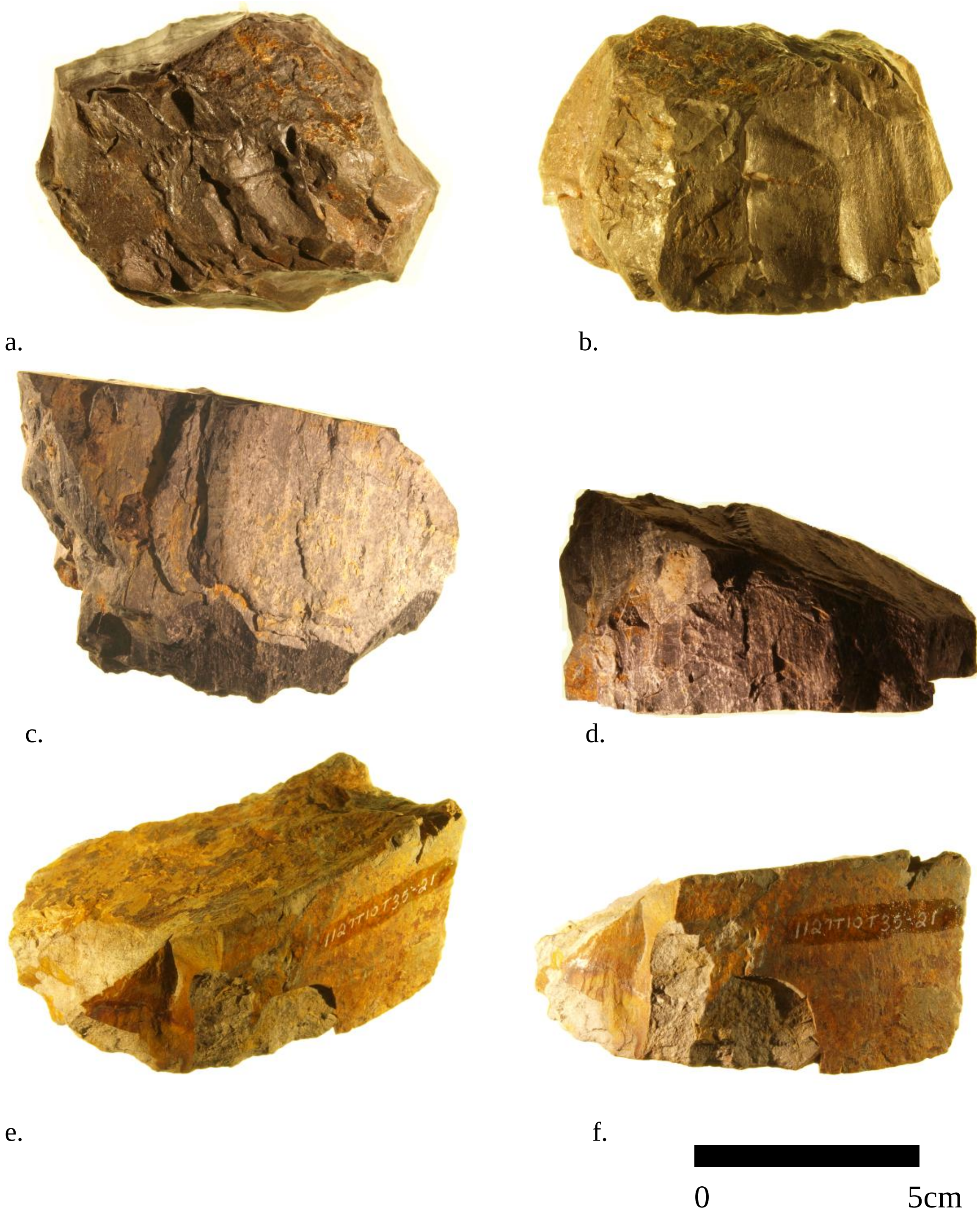


Figure 42: a-b, 1127T12H5-43, Scraperplane top down and side view; c-d, 1127T12M14-24, Scraperplane, top down and side view; e-f, 1127T10T35-21, Scraperplane, top down and side view.

Figure 43: a-b, 1127T10S35-22 and 1127T13S7-4 Scraperplanes; c, 1127T13N14/14b-2, side view of Scraperplane; d-e, 1127T12A20-30 and 1127T12G12-41 Scraperplanes; f, 1127T12G12-41, side view of artifact.

Figure 44: Scrapers; a, 1127T10R35-74, b, 1127T13B9-9, c, 1127T13E26-1, d, 1127T10R41-32, e, 1127T13D6-17, f, 1127T13T14-1. Endscrapers; g, 1127T13U10-7, h, 1127T13K6-1, i, 1127T12K20-6.

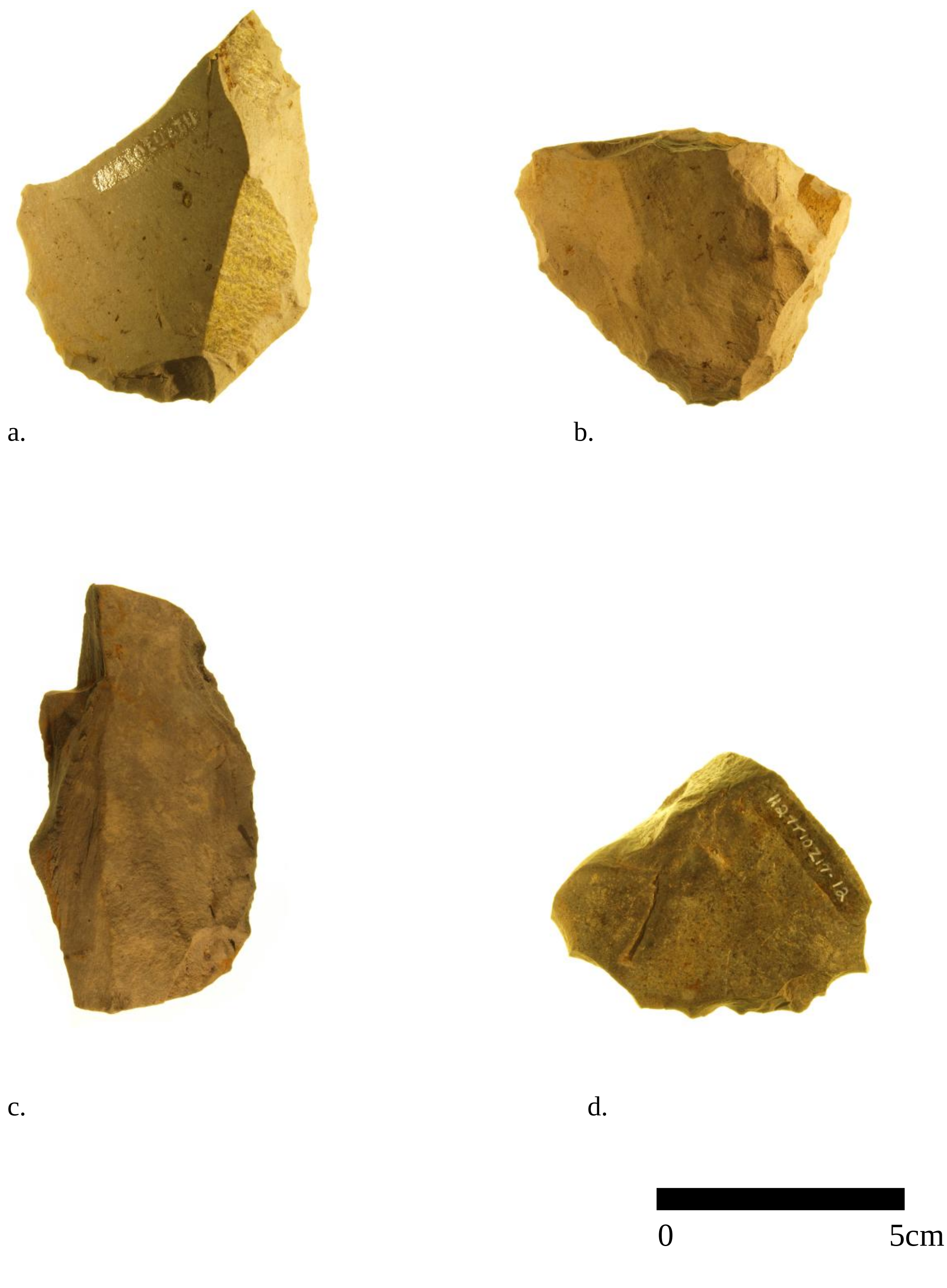


Figure 45: Scrapers; a, 1127T13U24-1, b, 1127T10R40-15, c, 1127T13I24-3, d, 1127T10Z17-12.

Figure 46: Gravers/Burins; a, 1127T13F24-3, b, 1127T13S7-1, c, 1127T13C9-23, d, 1127T13C9-11, e, 1127T13E21-14, f, 1127T13H9-16, g, 1127T13D4-18, h, 1127T13U5a-4, i, 1127T13F9-11.

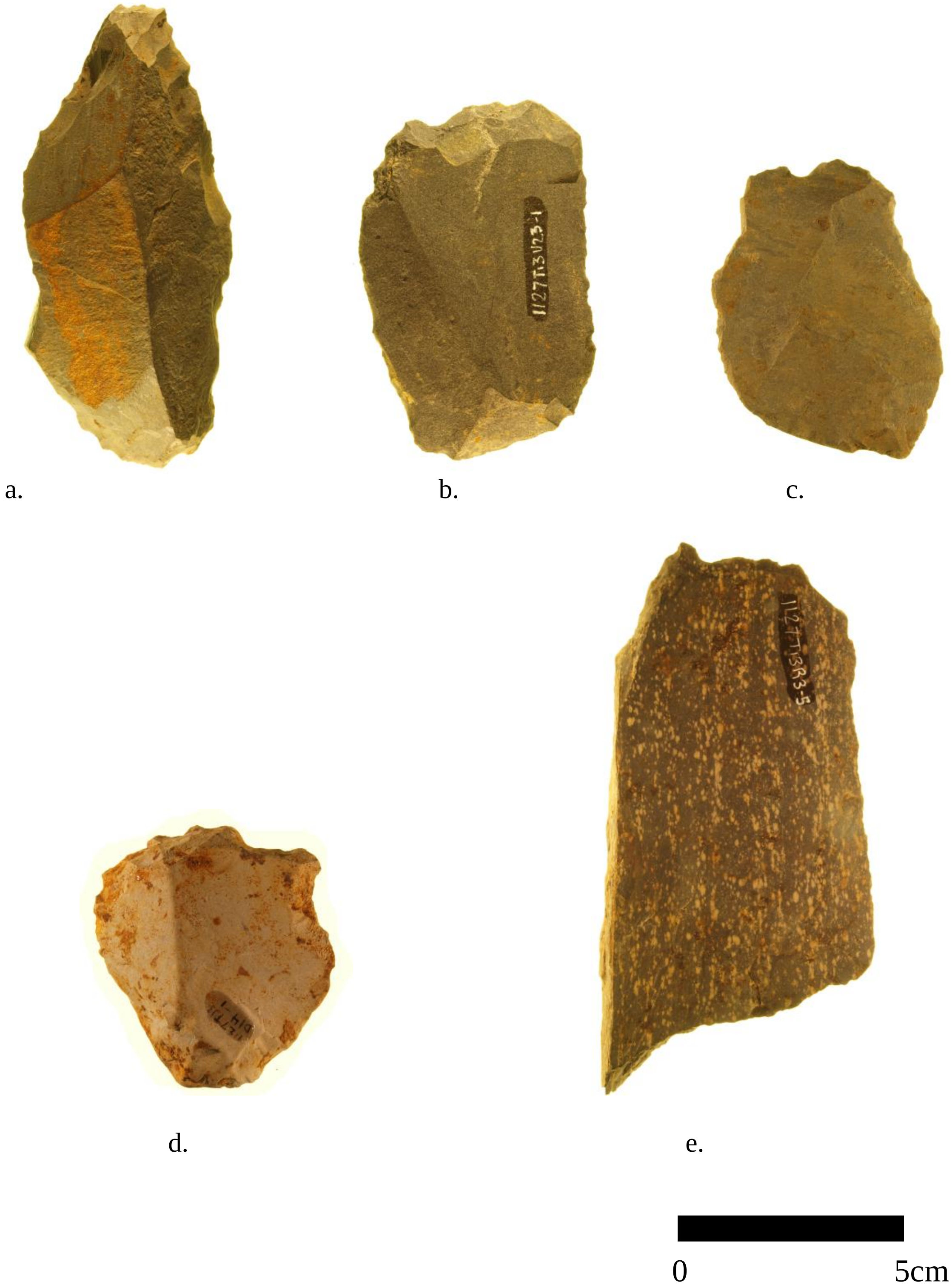


Figure 47: Multi-type tools; a, 1127T10X40-28 Scraper/ Graver/ Biface; b, 1127T13U23-1 Scraper/ Spokeshave/ Unimarginal tool; c, 1127T13F9-5 Graver/ Spokeshave/ Unimarginal; d, 1127T13D14-1 Scraper/ Graver/ Spokeshave; e, 1127T13R3-5 Scraper/Graver.

Figure 48: Spokeshave/Notches; a, 1127T13T4-7, b, 1127T10V28-14, c, 1127T13P3-1, d, 1127T10X33-4, e, 1127T13K22-6, f, 1127T10DD31-7, g, 1127T13A9-49, h, 1127T13Q14a-3.

Figure 49: Waterworn unifaces; a, 1127T13S24-2 Scraper; b, 1127T10S31-7 Scraper; c, 1127T13D24-2 Waterworn flake retouched into Scraper; d, 1127T13S106-3 Scraper/ Graver/ Spokeshave; e, 1127T13U105-4 Scraper, waterworn artifact with non-waterworn retouch.

Figure 50: Denticulate Unifaces; a, 1127T10W35-13 Unimarginal tool; b, 1127T13D11-1 Scraper; c, 1127T13I27-1 Scraper; d, 1127T13D9-8 Scraper; e, 1127T13D14-1 Scraper/ Graver/ Spokeshave; f, 1127T13D11-6 Unimarginal tool.

Figure 51: Unimarginal tools; a, 1127T12M15-26, b, 1127T13P12-2, c, 1127T13S21-2, d, 1127T13U24-10, e, 1127T13S7-10, f, 1127T10DD35-31, g, 1127T10R15-7.

a.

b.

0 5cm

Figure 52: a, 1127T12L3-1 Unifacial* tool; b, 1127T13M108-1 Chopper.

a.

b.

Figure 53: a, 1127T10Z19-12 Unifacial* tool, b, 1127T13U7-2 Chopper.

Appendix B: Radiocarbon Calibration Table

Radiocarbon Calibration Table	
Radiocarbon years	Calibrated age
1000 BP	930 cal yrs ago
2000 BP	1,940 cal yrs ago
3000 BP	3,180 cal yrs ago
4000 BP	4, 490 cal yrs ago
5000 BP	5, 730 cal yrs ago
6000 BP	6,820 cal yrs ago
7000 BP	7,810 cal yrs ago
8000 BP	8,870 cal yrs ago
9000 BP	10,190 cal yrs ago
10,000 BP	11,400 cal yrs ago
12,000 BP	14,060 cal yrs ago
13,000 BP	15, 630 cal yrs ago
14,000 BP	16, 790 cal yrs ago

Table 56: Radiocarbon calibration table
(Based on table from Fedje and Mathewes 2005).

Appendix C: Revisiting the Parks Canada Typology for the Unifacial Tools

In the following section, each unifacial tool type from the Richardson Island site will be discussed within the framework of the behavioral model from Chapter Seven. This framework will take each unifacial tool type through its life history from raw material procurement to discard in the archaeological record. Please refer to Appendix A for photo plates of each unifacial tool type.

Scraperplanes (n=194[11])

At the Richardson Island site, siliceous argillite is most frequently procured for the manufacture of scraperplane tools. People were most often selecting large tabular slabs and transporting these pieces to the site for use. However, people also made use of cores, flakes and, in a few instances, cobbles, as blank forms. The moderate percentage of cores (24%) used for scraperplanes indicates that people used these forms as they were available at the site. A core used to produce flake blanks at the site could just as easily be picked up and used as a tool in itself. Hiscock (2000) discusses the dichotomy between cores and “core tools” in typological systems, emphasizing the ambiguity present in creating such oppositions. Many of the cores at the Richardson Island site may have been used without exhibiting any evidence of retouch. Only those core tools exhibiting steep edged retouch were specifically classified as scraperplanes in the assemblage.

Other raw materials were also used, in smaller amounts for the scraperplanes; shale/argillite, rhyolite and “others” were often selected. Varvite, wacke, dacite, andesite and tuff are also associated with this tool type in small numbers. It is interesting to note that “others” had a relatively high frequency amongst the scraperplanes suggesting that people used what was available to them. Scraperplanes could be manufactured on many different kinds of materials even though materials such as siliceous argillite may have been preferred. In terms of size (62%) of scraperplane tools are large in length or

[11] For counts of unifacial tool types, the total number will be higher than the total artifact count (n=1097) for the assemblage due to the occurrence of multi-types tools. In many instances, one artifact could count for two or three tools. The total count of unifacial types was 1,365.

moderately large (32%) suggesting that people tended to select large blank forms. The selection of large blanks may indicate a need for scraperplanes to serve specific functions or tasks that required more heavy-duty tools.

During tool production processes, those scraperplanes manufactured from flake blanks show an overall pattern of either intensive tool reduction or the selection of flake blanks in late stages of reduction. It is possible that scraperplanes made on flakes dulled or broke more quickly than scraperplanes on tabular forms; these flake tools may reflect multiple episodes of rejuvenation until they are exhausted and discarded in the archaeological record.

During manufacture, scraperplane tools are predominately large in size with steep working edges and many of them exhibit denticulate edges. Of all denticulate edged tools recorded in the unifacial assemblage, 41% were comprised of scraperplane tools. It is maybe not surprising then that denticulate edges are most frequently associated with siliceous argillite; the preferred material type for scraperplane manufacture. Although making inferences into tool function can be problematic as discussed in Chapter Four of this thesis, it is possible that the large sizes of these tools along with their steep working edges suggests their use for heavy-duty scraping, planning or chopping tasks. In chapter four, a broad synthesis of scraperplanes from varying archaeological contexts found that, interpretations of tool function vary even in their terminology. For example, these tools are referred to as “core scrapers” (Carlson 1996) in some instances, and a “scraper-like adze” in another case (Goebel and Slobodin 1999). Ethnographic sources from New Guinea indicate that a flake tool resembling scraperplanes from the Richardson Island site had been used to plane wood. In a different context, ethnographic data from the Diegueno peoples in Southern California associated a scraperplane tool with the processing of the agave plant; the tool was used as a plane to pulp or shred plant fibers (Rogers 1939).

Scraperplane tools were also re-used, re-sharpened and re-shaped at the Richardson Island site. Forty of the unifacial tools classified as scraperplanes in the assemblage were also grouped as multi-type tools. It is possible that these multi-type tools were manufactured to be multi-functional or that these tools represent the re-use of a tool. Scraperplanes designated as multi-type tools were classified as many different combinations of types. The most common of these types were scraperplane/spokeshaves (n=17) and scraperplane/gravers (n= 5). Overall, scraperplane tools could often be re-used to serve a new function or purpose. Many of these tools, specifically those manufactured from flakes, may have changed forms through time or may have only been used once or twice before being discarded in the archaeological record.

Temporally, the scraperplane tools at the Richardson site appear to decline during the Early Moresby Tradition (8750-8000 BP) along with the use of siliceous argillite and tabular forms. It is possible that the decline in the use of siliceous argillite had an affect on the manufacture of this tool type through time. However, scraperplane tools do not disappear but simply decline in relative frequency, suggesting that there is still continuity in the manufacture of this tool form.

Scrapers (n=170)

For the manufacture of scrapers at the Richardson Island site, people most commonly procured shale/argillite, bringing the material from off-site and probably from off-island (Smith 2004). Siliceous argillite was also a preferred material for these tools and was used almost as frequently as shale/argillite. The third most frequently used material category is “others” indicating that people picked up more variable material types as they needed them and could use these materials for scraper manufacture. Scrapers made on these less common material types may reflect more expedient tool manufacture; for example, an immediate task requires a tool for scraping and a somewhat suitable stone of some kind happens to be nearby. Rhyolite, wacke, varvite, tuff, andesite and dacite are also used for scraper manufacture in lesser and varying amounts. For the selection and manufacture of blank forms, people tend to select flakes taken off of some nodule of raw material in order to make a scraper tool. However, people sometimes selected tabular pieces for scraper manufacture and in a few instances both cores and cobbles were used.

For the manufacturing process, people tended to select flake blanks that were moderately large (40 %) to large (24%) in length although some scrapers are found in the 2nd quartile for length or the moderately sized category. In many cases, scrapers found in the archaeological record may not reflect the initial size of the blank form or tool accurately due to repeated resharpening and reduction of these tools.

It is likely that many of these scraper tools were manufactured for specific purposes or tasks based on their edge angles. Many of these tools tend to have moderately steep working edges (those classified between 45-60º in angle). Some scraper tools in the assemblage also exhibit one or more denticulate edges. 27% of the unifacial tools classified as denticulate are scrapers. These denticulate tools may have been used to serve a different purpose than those without the serrated edges.

A visual analysis of these scraper tools indicates that many of them were probably re-used through time. As mentioned in chapter seven, measures of reduction or invasiveness (Kuhn 1992; Clarkson 2002; Hiscock and Attenbrow 2005) have been developed for unifacial tools including scrapers. At Richardson Island, measuring the amounts of reduction for scraper tools is inhibited by both the variability in scraper morphology i.e. the lack of “classic” endscrapers or sidescrapers, and differential weathering processes that obscure tool characteristics. However, of the 41 waterworn unifaces exhibiting non-waterworn retouch, 12 of these artifacts are scrapers (29%) and all are quite small (1st and 2nd quartiles) suggesting intensive reduction of these tools until they were exhausted.

Many of the scrapers are also classified as multi-type tools (n=73). These multi-type tools are found in numerous combinations. Most frequently, these multi-types occur as scraper/gravers (n=9) and as scraper/unimarginals (n=7).

Temporally, there is little change in the frequencies of scraper tools between the Kinggi Complex and the Early Moresby Tradition at the Richardson site. People continue to manufacture this tool type relatively consistently through the period of intensive site use.

Graver/Burin[12] (n=330)

The most frequently selected raw materials for the manufacture of graver/burin tools were siliceous argillite followed by shale/argillite. Rhyolite, varvite, “others”, and wacke were also often used. A small number of graver tools also occurred on dacite, andesite and tuff. People manufactured graver/burin tools on all types of available materials. For the selection and manufacture of blank forms, people at the Richardson site predominately used flake blanks for graving tools although some graver/burins were also found on tabular forms and, in a few cases, on cores. These flake blanks were knapped from cores during early, mid and late stages of reduction although there are more late stage reduction flake blanks associated with graver/burins than other stages of tool production.

For size, graver/burin tools were most frequently represented in the 1st quartile or smallest unifaces followed by moderate (2nd quartile), moderately large (3rd quartile) and finally, large tools (4th quartile). People at Richardson Island may have preferred graver tools to be relatively small in order to serve more delicate tasks. Many of these tools exhibit minimal retouch, often accenting a natural projection or sharp broken edge of a flake.

Interestingly, graver/burins are the unifacial tool type most frequently classified as a multi-type tool (n=184). The most prevalent combinations of these multi-types include graver/spokeshaves (n=57), graver/unimarginals (n=39), graver / spokeshave / unimarginals (n=10) and scraper/gravers (n=9).

A temporal analysis of graver/burins at the site reveals that there is very little change in the frequencies of these tools through the Kinggi and Early Moresby Tradition.

---

[12] As a large number of the gravers and burins were included in the tool type “graver/burin” during initial classification and data collection, these types were subsumed under one type for analysis.

Graver/burins remained the most consistent of all of the unifacial tools as indicated by a tally of their relative frequencies and percentages in Chapter Eight.

Spokeshave/Notch (n=241)

At the Richardson Island site, people used all available raw material types for the manufacture of spokeshave/notches. Similar to graver/burins, spokeshave/notches were most frequently made on siliceous argillite followed by shale/argillite. Rhyolite, “others”, varvite and wacke are represented by these tools in moderate numbers and andesite, dacite and tuff occur in a few cases.

The predominant blank forms selected for spokeshave/notch tools are flakes. However, tabular forms are also used and, in some instances, these tools occur on cores. Flakes reflecting all stages of tool production were manufactured to have one or more steep edged concavities. These concavities may have served as a rounded working edge. Spokeshave/notches are found relatively consistently across all unifacial tool sizes from small to large. Unlike graver/burins or scrapers, spokeshave/notches occur most frequently in the moderately sized category (2^{nd} quartile).

It is possible that some spokeshave/notch tools were rejuvenated more than once during their use-lives although evidence for this can only be speculation. People may have enlarged notches or created a new notch on the same tool form. Spokeshave/notch tools are the second unifacial tool type most frequently classified as a multi-type after graver/burins. These spokeshave/notched tools occur in multiple combinations although they are most commonly found as graver/spokeshaves (n=69), spokeshave/unimarginals (n=20), scraperplane/spokeshaves (n=17) and graver/spokeshave/unimarginals (n=10).

Temporally, there is some change in the frequencies of spokeshave/notch tools through time. As noted in Chapter Eight, there is a higher frequency of this artifact type in the Kinggi Complex than in the Early Moresby Tradition suggesting a decrease in the use of these tools through time. However, similarly to the scraperplanes, this change in the frequencies of spokeshave/notches may not represent a significant shift in technological practice as these types of tools are still present in the Early Moresby and into the Late Moresby Tradition.

Unimarginal tools (n=381)

When people at the Richardson site needed a unimarginal tool, they tended to use siliceous argillite as a material type however shale/argillite was also quite commonly selected. All of the other material types used for unimarginal tool manufacture were used in much smaller quantities. As with many of the other tool types, people at Richardson appeared to have used what was available; material that was left behind after the manufacture of other tools or blank nodules and cores that could be flint knapped to obtain a flake. Flake forms were the preferred blank type for the manufacture of unimarginal tools, most commonly in early stages of reduction in contrast to many of the other unifacial flake tool types. Although dominated by flake forms, some unimarginal tools also occurred on tabular pieces and in a few instances, on cores. Unimarginal tools reflect all sizes of unifacial tools from small to large, occurring most frequently in the moderately sized category (2nd quartile). Most of these tools have acute edge angles (0-45º) and some have one or more denticulate edges. 31% of all denticulate unifaces are unimarginal tools.

Many of these unimarginal tools appear to have very minimal amounts of retouch suggesting they were manufactured expediently for a task as it arose at the site. However, 24% of the waterworn unifaces exhibiting non-waterworn retouch are unimarginal tools; a small glimpse into the reduction or re-use of these artifacts through time. Unimarginal tools also co-occur with all of the other tool types. After both graver/burins and spokeshave/notches, unimarginals are the most common tool type represented in multi-type forms. The most prevalent combinations of multi-types are graver/unimarginals (n=39), spokeshave/unimarginals (n=20), graver/spokeshave/unimarginals (n=10) and scraper/unimarginals (n=9).

On a temporal scale, the frequencies of unimarginal tools change through time; there is a higher relative frequency of this tool type in the Early Moresby Tradition than in the Kinggi Complex. However, unimarginal tools in both time periods are the most frequently manufactured unifacial tool type, representing 27% of all tools in the Kinggi Complex and 36% of all tools in the Early Moresby Tradition.

Bimarginal tools (n=15)

Bimarginal tools were not manufactured very frequently at the Richardson Island site. Of those tools that are recorded in the unifacial assemblage, many are manufactured on siliceous argillite (60%). Unlike most of the other unifacial tools at the site, there are no examples of the use of shale/argillite for manufacture. Other materials were selected in low numbers including rhyolite, varvite and andesite. Preferred blank forms for these tools were flakes that were either manufactured from cores specifically for the creation of a bimarginal tool or collected from tool production waste flakes or debitage already available. People did not seem to use tabular pieces, cores or cobbles as blank forms for bimarginal tools.

For the manufacture of bimarginal tools, there was a range of sizes represented from small to large, similarly to unimarginal tools. There were also a few examples of denticulate edged bimarginals in the assemblage. Some bimarginals were also classified as multi-type tools in the assemblage (n=11). All of these multi-types occurred in the “others” category representing those combinations of tool types that occurred only once or twice in the assemblage.

Temporally, there is little change in the frequencies of bimarginal tools through time. There is an almost equal but minimal occurrence of this tool type in the Kinggi Complex and the Early Moresby Tradition.

Unifacial* tool (n=18)

Unifacial* tools at the Richardson Island site occur in very small numbers. The predominant raw materials used for the manufacture of unifacial* tools are siliceous argillite and shale/argillite. For blank selection and/or manufacture, people predominantly used flake forms for unifacial* tools however there were a few examples of these tools on tabular pieces, cobbles and, in one instance, on a core. Most flake forms used were manufactured in late stages of tool reduction.

All of the unifacial* tools are moderately large to large in size. There are also a small amount of these artifacts that have been classified as multi-types (n=5). These multi-types occur in a variety of combinations. Most of these tools do not show any evidence of extensive reduction. Picked up from the beach or surrounding area at the Richardson site, people seem to have needed large forms and the general shape of the tool may not have been an important factor. Unifacial* tools were either discarded or set aside at the site. They may have been used on several different occasions as they were needed for specific tasks.

An analysis of the temporality of unifacial* tools indicates that this tool form did not change through time. There may be a minimal trend towards a higher frequency of unifacial* tools within the Early Moresby Tradition however, this result is hard to assess due to low numbers of this type within the assemblage as a whole.

Choppers (n=16)

The dominate raw material type used for the manufacture of choppers was rhyolite followed by andesite and “others” with only one example of shale/argillite. There are very few examples of choppers at the Richardson Island site and results indicate that people tended to pick up any large pieces of raw materials in the form of tabular slabs, cobbles or cores. These comparatively large forms could then be expediently reduced with a few large flakes removed from one surface to create an appropriate working edge. Chopper tools are all large in size suggesting their use for heavy-duty tasks. There are also a few examples of choppers with denticulate edges in the assemblage.

Although these tools may be expedient in manufacture and may not have had any significant reduction, there are a few multi-types associated with chopper tools. Specifically, a few of the artifacts have been classified as both a chopper and a Unifacial Tool or a chopper and a scraperplane. Interestingly, the association of choppers, scraperplanes and unifacial* tools leads to an important question: Is there any significant difference between these defined tool types? In a comparison of results from chapter seven, the raw materials selected for each one of these tool types appear to be different. Chopper tools also appear to be relatively larger in size than both scraperplanes and unifacial* tools. However, the low occurrence of both choppers and unifacial* tools in the Richardson assemblage does inhibit comparisons. For both choppers and unifacial* tool types specifically, flaking tends to be somewhat rough ad expedient however, there are some scraperplanes that also exhibit relatively rough flake scars. These tool forms could potentially have all been used for chopping and cutting tasks. While there are some distinct differences between scraperplanes, unifacial* tools and choppers, there are also some examples in the assemblage that fall somewhere between these three types and suggest that there may not always be a lot of difference between these tools overall.

Temporally, there is a slightly higher frequency of choppers recorded for the Early Moresby Tradition but, overall, there is little change through time. As discussed with the unifacial* tools, the low occurrence of chopper tools in the assemblage may skew the temporal interpretation of these defined types.