MICROSCOPIC ANALYSIS UTILIZED IN THE IDENTIFICATION OF CUTTING, SCRAPING AND WHITTLING ACTIVITIES ON FLAKE TOOLS FROM THE QWU?GWES (45TN240), HARTSTENE, AND SUNKEN VILLAGE (35MU4) SITES IN THE CENTRAL NORTHWEST COAST OF NORTH AMERICA

By

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of GERMAN LOFFLER find it satisfactory and recommend that it be accepted.

Chair

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Abstract

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Chair: Robert E. Ackerman

In this thesis, cultural consultation, literature review and lastly experimental archeology via microscopic analysis is utilized in the identification of cutting, scraping and whittling activities on flake tools from the Qwu?gwes (45TN240), Hartstene, and Sunken Village (35MU4) sites in the central northwest coast of North America. Expanding upon earlier more subjective approaches in identification of tool functions, in this study an objective methodology for identifying different activities on lithic flake tools is developed. Utilizing a scanning electron microscope and a regular light microscope, three attributes – striation direction, polish intrusion, and edge morphology are observed on experimental flake tools after cutting, scraping and whittling activities to explain that each activity does leave it's own combination of wear attributes as a form of "activity signature" on the flake tool. As these attributes can be used to determine a flake tools past activities, they are developed into a discriminant function analysis (DFA) used to model possible usage of archaeological flake tools from the Qwu?gwes (45TN240), Hartstene, and Sunken Village (35MU4) sites. Blind test experimentation on flake tool demonstrate that the quantity of wear attributes observed on a flake tool and the accuracy in

which those wear attributes are encoded can effect the correct identification of a particular flakes' past activity. It can be estimated that the DFA applied to identify the activities of flake tools at the sites, correctly identifies a tools activity approximately 67 percent of the time. At Qwu?gwes and at the Sunken Village sites, the flake tools were most likely used in cutting and scraping activities. At the Hartstene site, the flake tools were most likely used in cutting and scraping activities as well, but with the addition of possibly being used for whittling activities. In future work, it would be insightful to move the analysis to sites past the central northwest coast. The approach should also be used to analyze flake tools from older sites. This will hopefully test whether flake tools were used in different ways over time and add to the growing body of literature of Northwest Coast cultural development.

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DEDICATION

I dedicate this thesis to my father and mother.

CHAPTER ONE: INTRODUCTION AND BACKGROUND

PART 1: Introduction

In this study, I will attempt to ascertain what the flake tools from the Qwu?gwes (45TN240), Hartstene, and Sunken Village (35MU4) sites were used for (Figure 1). This thesis consists of five chapters. Chapter one has three major components to it. The first part is a brief outline of the content of each chapter in this thesis; it describes how those chapters are subdivided and organized. The second part is basic background information regarding the Northwest Coast – its' geographic division, temporal division, and human occupation before and after European contact. The third part of this first chapter introduces the history of research that scholars have conducted regarding the function of lithic tools. It outlines a quick overview of microwear analysis and lastly it touts the use of multiple lines of evidence in understanding a tool's function. These multiple lines of evidence include: cultural expert consultation, research from ethnographic literature, and experimental archeology.

In chapter two the three comparative collections from the Qwu?gwes (45TN240) site, the Hartstene site, and the Sunken Village site (35MU4) are described as well as the tools used in this analysis.

In chapter three I have set forth the data to be used in this thesis and it is divided into four sections: (1) how experimental chert flakes were replicated to mimic those found at the Qwu?gwes, Hartstene and Sunken Village site, (2) experimental procedure undertaken with each of the replicated flakes to determine how each of three activities – "cut," "scrape," and "whittle" – occurred, (3) a discussion of the flakes' morphological attributes and how the morphological attributes of the experimental flake tools, the Qwu?gwes flake tools, Hartstene flake tools and the

Sunken Village flake tools were measured and recorded, and (4) the attributes of the archeological flake tools selected for study.

In chapter four I have presented the analysis of the data in five parts. Part one is the analysis of wear attributes on the experimental flakes after they are used in “cutting,” “scraping,” and “whittling” activities as outlined from chapter three. Part two explores the validity of how the data is encoded to make the discriminate function analysis possible. The third part of this chapter deals with the “objective” methodology for assigning flake tools to the categories of “cutting,” “scraping,” and “whittling” activities via discriminant function analysis. In part four the validity of this methodology is tested by applying a discriminant function analysis on blind tests. Lastly, in part five, I have applied a discriminant function analysis on the archeological assemblages themselves.

Chapter five is the summary, discussion and conclusion of the thesis. It is divided into two sections. The first part is a summary of the findings in chapters two, three, and four. The second part contains discussions and conclusions about the study. Based upon my studies I demonstrate that the flake tools at Qwu?gwes, Harstene, and Sunken Village were most likely used in “cutting” and “scraping” of wood and fiber in artifact production.

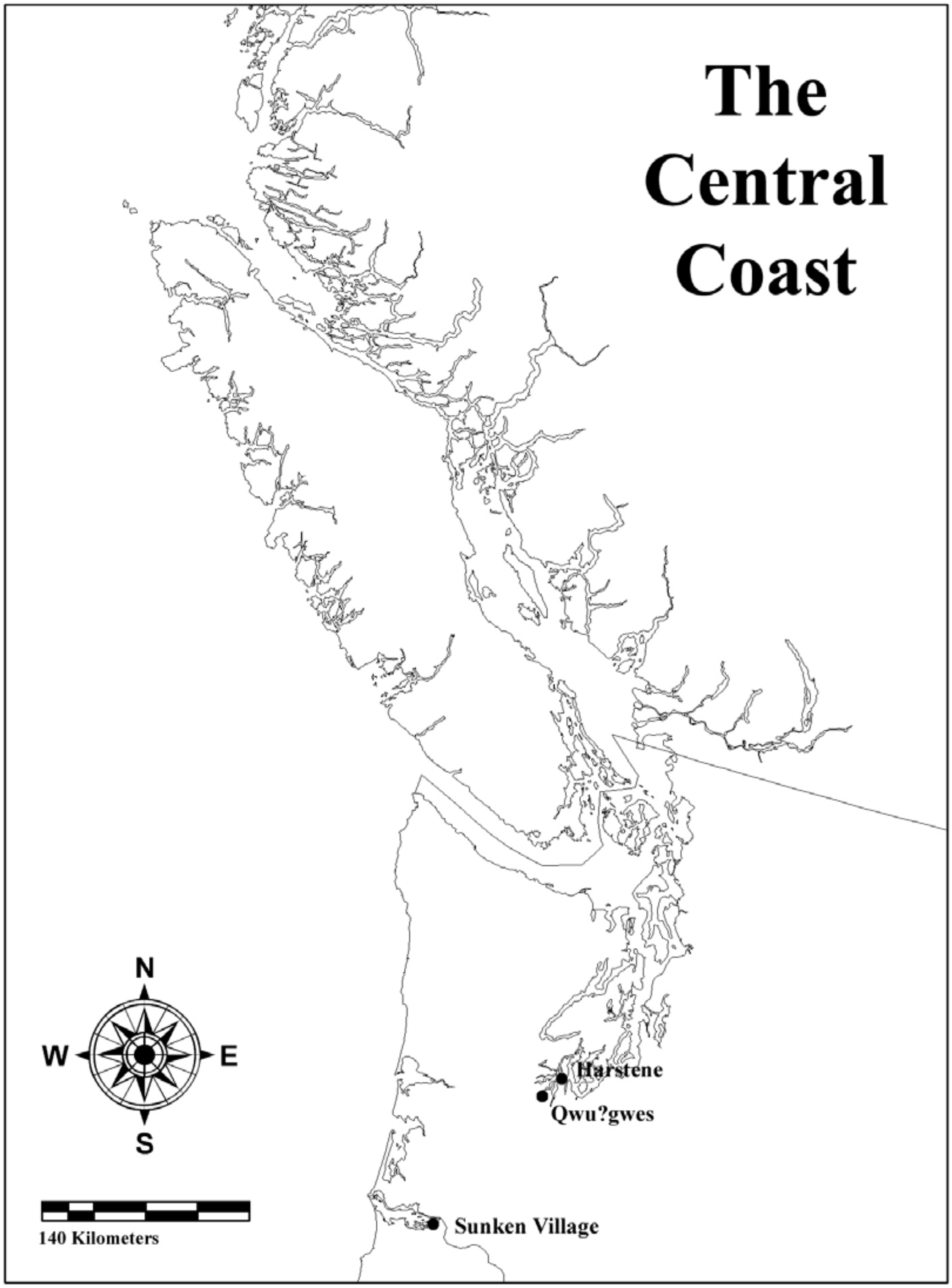

Figure 1. Sites of study in the central coast

PART 2: Northwest Coast Background

Geographic

Different anthropologists have traditionally defined the northwest coast culture area in different ways. Early on, definitions of culture areas were based on environmental and cultural similarities (Boas 1912; Drucker 1955; Kroeber 1923; Wissler 1917). Today, the Northwest Coast culture area is usually meant to encompass the region from the northern California coast to Yakutat Bay in the northern end of the Alaskan Panhandle, and from the coast extending inland to the Chugiak and Saint Elias ranges of Alaska, the Coast mountains to British Columbia, and the Cascade Range of Washington and Oregon (Figure 2) (Matson and Coupland 1995; Suttles 1990). The Northwest Coastal Areas can be subdividing into three regions: 1) The North Coast, from the northern most tip of Vancouver Island to Yakutul Bay; 2) the Central Coast, encompassing Vancouver Island southward to the mouth of the Columbia River at the Washington/Oregon border; and 3) the South Coast – The Columbia River southward to Northern California (Figure 2; Matson and Coupland 1995), with some minor modifications to these generalizations by other scholars (Ames and Maschner 1999). The collections used in this study were obtained from sites on the Central Coast (Figure 1).

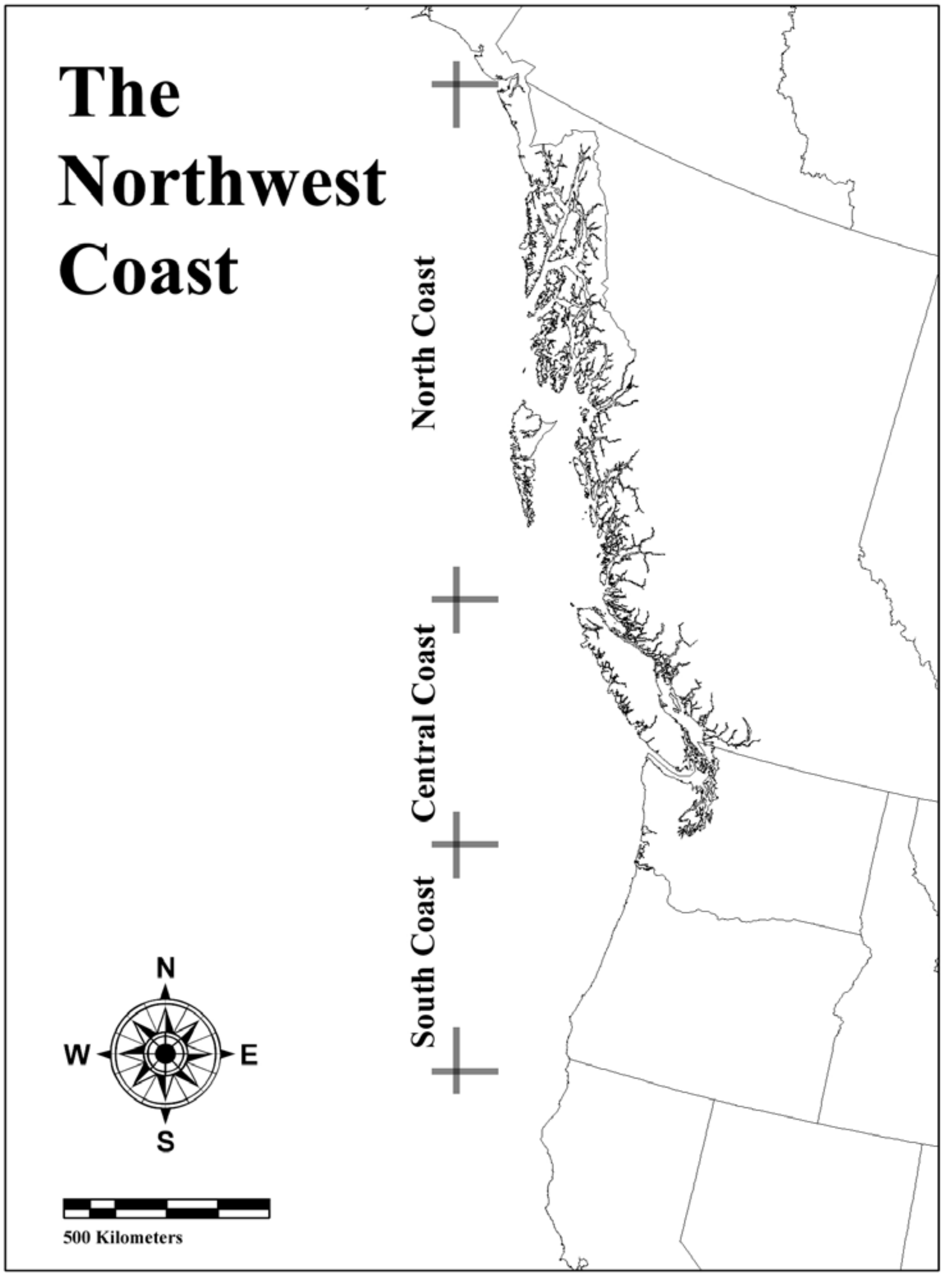

Figure 2. The Southern, Central, and Northern regions of the Northwest coast

Chronology

Several temporal divisions have been proposed for the Northwest Coast, each of which has ample evidence to support it. Perhaps the two best known are those presented here. The sequence presented by Ames and Maschner (1999) begins with the Paleo-Indian period (pre 10,500 BCE), followed by the Archaic period (10,500 BCE - 4,400 BCE), Early Pacific period (4,400 – 1,800 BCE), Middle Pacific period (1,800 BCE – 200/500 ACE), and Late Pacific period (200/500 ACE +) (Figure 3). The chronological sequence by Matson and Coupland (1995) is somewhat different beginning with: the Protowestern Tradition (-9,000 BP), followed by the Old Cordilleran tradition (9,000-4,500 BP), the St. Mungo tradition (4,400 -3,300 BP), the Locarno Beach tradition (3,300 – 2,400 BP), the Marpole tradition (2,400 – 1,500 BP), and the most recent "Gulf of Georgia" tradition (1,500 – present) (Figure 3). I will use the chronological sequence of Ames and Maschner (1999) throughout this thesis.

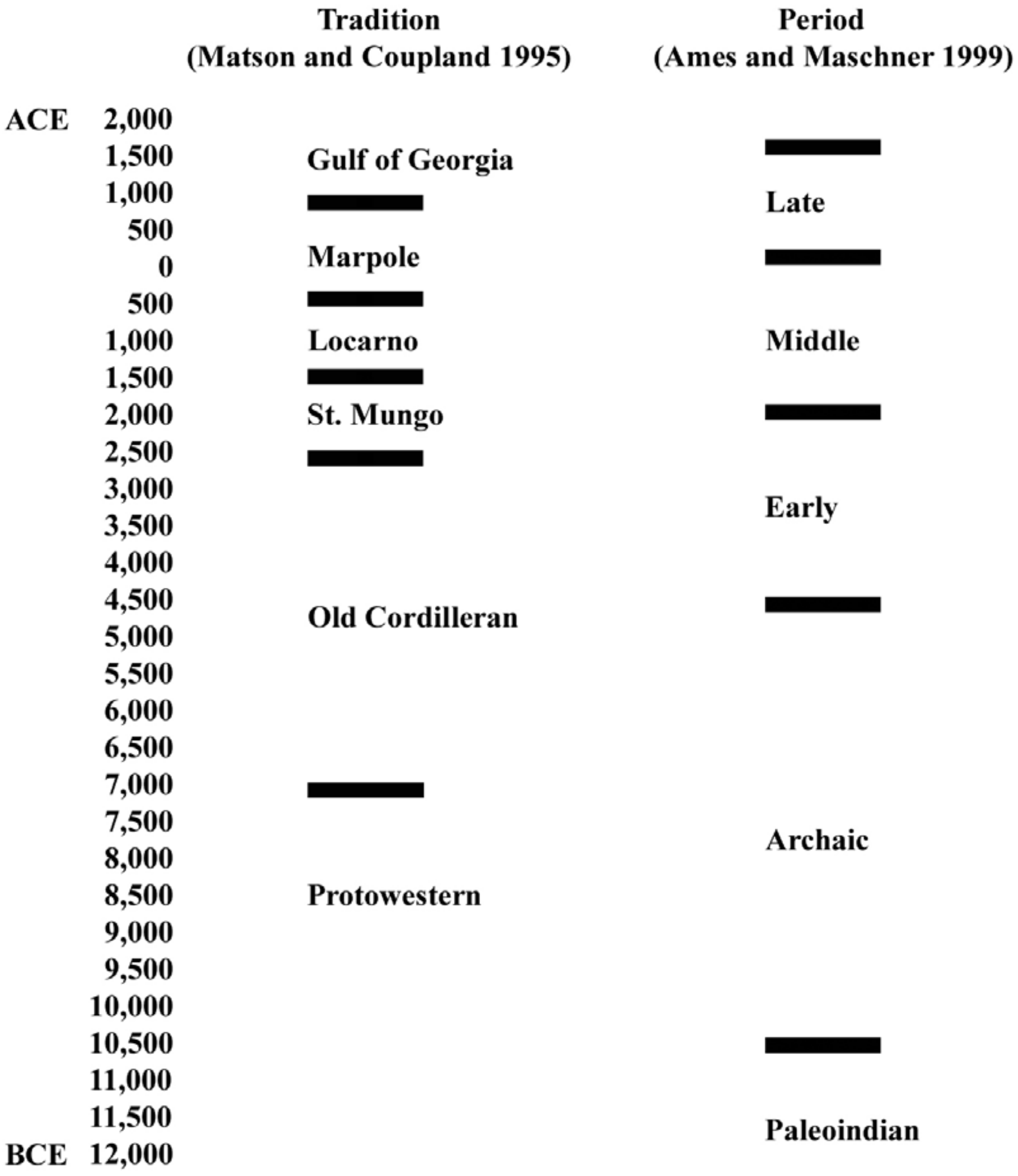

Figure 3. Traditions and Periods of the Northwest Coast

Human history in the Gulf of Georgia, San Juan Islands, and the Puget Sound areas

The notion that people used an intermontaine ice-free corridor as a migration route into the Americas went unchallenged until the early 1960's, when Heusser (1960), Krieger (1961) and then MacGowan and Hester (1962) proposed an alternative to the intercontinental route, a Pacific Coastal migration. It has not been until more recent times that this theory has gained popularity. Recent renewed interest in the possibility of an interior versus coast route during the late Pleistocene has prompted a consideration of the available food resources along either route. It has been estimated that there was not enough bio-mass at that time to support human population in the intermontaine ice-free corridor (Mandryk 1992). Paleoenvironmental and archaeological data suggest that a chain of sea-level refugia around the North Pacific coast could have provided a real alternative to the "ice-free" corridor during the Vashon Stade, the glacial maximum of the Fraser Glaciation, some 14,500 years ago (Fladmark 1979). Whatever the case might be, we know that by 13,000 years ago the Puget Lowland of Washington and south western coastal British Columbia including the lower Fraser Valley became ice free (Borden 1979). It has been argued that sea-level refugia along the North Pacific coast of North America would have been more environmentally suitable for human occupation. With an adequate maritime adaptation marine resources could have provided ample resources for migrants coming into the Americas. (Borden 1979).

The Northwest Coast Ethnographic Pattern

At the time of European contact there was broad similarity between all northwest coastal groups. In generalized broad strokes, the picture emerges that the Northwest Coast peoples made their living by fishing, hunting and gathering of resources found in shores, oceans, rivers and to a lesser extent those from the land. The waters provided rich resources of fish, sea mammals, waterfowl, sea-weed and shellfish (more detail below). The most common mammals exploited from the land were deer (*Odocoileus hemionus* and *Odocoileus virginianus*), elk (*Cervus canadensis*), and occasionally bear (*Ursus americanus*); additionally mountain lion (*Felis* *concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), red fox (*Vulpes fulva*), beaver (*Castor canadensis*), mink (*Mustela vision*), and river otter (*Lutra canadensis*) were exploited from riverine environments. Berries and fern roots were gathered as supplemental foods (Matson and Coupland 1995). There was a heavy reliance and emphasis on marine foreshore and anadromous faunal resources – particularly an emphasis on six species of Pacific salmon (*Oncorhynchus*).

The Northwest Coast cultural pattern (a term coined by Matson and Coupland 1995) at contact times involved a heavy emphasis on bone and antler working and woodworking while flaked stone tool industry seems to have been poorly developed and ceramics were unknown. Metal objects were nearly complexly absent before European contact. Matson and Coupland (1995) note that while woodworking was the greatest achievement of the Northwest Coast technologies, it is almost never recorded in the archeological record as wooden objects are rarely preserved – the most famous exceptions are at the Ozette and Hoko sites. Wood was used for a wide range of activities including as planks for houses, toggle harpoons, fishing hooks, basketry, boxes and probably upward of 90% of everyday commodity artifacts. Plant fibers were utilized in production for clothing, weaving and basketry.

Estimates of Northwest Coastal population at contact range from 100,000 to some 200,000 people (Boyd 1990; Mooney 1928). Many groups from the Northwest Coast pattern lived in large planked houses which were often grouped into large arguably sedentary villages occupied by hundreds of people, particularly during the winter months. The standard household in the Northwest Coast was composed of an extended, multifamily group with roughly some 20-25 individuals. The household acted as the basic economic unit, and owned wooden boxes, baskets and drying racks in which they stored large amounts of food – most often as smoked meat – and goods such as wool blankets which were used as exchange items to acquire social status during potlatches (Ames and Maschner 1999; Matson and Coupland 1995).

The Northwest Coast social status and political system is unique among those groups traditionally considered "hunter-gatherers" as presented by Lee and DeVore (1968). Instead of being "egalitarian" societies, the Northwest Coast was socially stratified into three classes: 1) the "nobles" – senior members of households who controlled most resources of the group and their immediate relatives; 2) "commoners" – those who were freeborn but had less control over households resources; and 3) "slaves" – usually prisoners of war taken as non-status workers (Donald 1990; Suttles and Jonaitis 1990). Accumulation of wealth and status seem to have been the primary preoccupation for the Northwest Coast peoples; the reasons for which and the process of how, have long been debated (Ames 1981; 2001; Suttles 1968; Piddocke 1965; Donald and Mitchell 1975).

The Northwest Coast pattern of a more sedentary lifestyle, involving procurement processing, and storage of large food amounts, an economy based on households, an active manipulation of environment, a complex and sophisticated technology, high population densities, frequent warfare and ascribed social inequality make it stand apart from other ethnographic hunter-gathering patterns seen across the globe.

PART 3: Lithic Technology: The Use of Stone

Archeologists attempt to discover human behavior in the past as inferred from archeological sites. The identification of a site's function is observed by what remains on it – actions imprinted in the artifacts which survive the transformational process at the site. Archeologists infer human behavior at a site by identifying the functions of artifacts found at the site. Unfortunately, the task of correctly identifying artifact function is not as straight forward as one would imagine. The problem is summed up by Andrefsky: "without an accurate interpretation of artifact function, the logic behind site functional interpretations may be flawed" (2005: 201).

Traditionally, artifact functions were inferred from preconceived notions of morphological attributes of the artifact that were thought to imply a particular function. Unfortunately, morphological characteristics do not necessarily correlate on a one to one basis with tool function. Furthermore, artifacts are often multifunctional and used in a variety of activities (Andrefsky 2005). These two principles suggest great difficulties in ascertaining human behavior from the analysis of a single tool.

One method to overcome this complication is to analyze the entire population of tools found at a site to better infer the activities performed at the site. Early approaches were often hampered by the common error of naming of stone tools after preconceived notions of what a tool might have been used for. Most of the time these preconceived notions were spawned by the morphological similarities to modern day tools (e.g. drill, knife, arrow-point, adze, etc.). In naming such artifacts researchers have imposed a function on the artifact rather than determining what that function might have been. In fact, researchers often imposed a single and incorrect action to the tool.

This problem was highlighted by the Binford-Bordes debates in the 1970's regarding Mousterian lithic artifact variability (Binford 1972; Binford and Binford 1966; Bordes 1979; Bordes and de Sonneville-Bordes 1970). Binford argued that variability within the same lithic assemblage was due to functional tool variances. Bordes, on the other hand, proposed that the variability found in the Mousterian assemblage was due to differences in prehistoric cultural groups depositing functionally similar, but stylistically different, tools in the assemblage.

Since these debates archeologists have noted that variation in stone tool types can be attributed to two factors: style and function (Dunnell 1978; Jelinek 1976; Sackett 1977). The argument followed that once "stylistic" variation was accounted for, the remaining difference in artifacts must be "functional." It didn't take long for authors to recognize the difficulty in identifying and defining "style" (Close 1978, 1989; Sackett 1982; 1986; 1990), while other researches proposed that style could be considered as a function as well (Conkey 1978; 1980; Wiessner 1983; Wobst 1977).

Stylistic arguments aside, it was generally agreed that radically different lithic artifact morphologies were associated with different functions. Not all tools are "best" suited for all functions. After all, there are some very realistic limitations to certain activities – say chopping down trees – which are next to impossible with certain tools. Perhaps the best "form equating to function" example of a lithic tool using Andrefsky's morphological typology of artifacts is the "hafted biface" (Andrefsky 2005). Andrefsky notes that these morphologically similar artifacts are often associated with having the function of a projectile – as a spear, dart or arrow. While many studies have supported the notion that hafted bifaces were used as projectile tips (Churchill 1993; Patterson 1985; Peterkin 1993), other studies demonstrate that there were multiple functions – sawing, cutting, scraping, whittling and boring - that a hafted bifaces could have been used for (Ahler 1971; Andrefsky 1997; Goodyear 1974; Greiser 1977; Nance 1971).

It was easy for early archeologist to impose stone tools with morphological similarities to cotemporary tools a (reconceived) functional purpose. The function of tools with no contemporary counterparts posed more of a problem for archeologists to "know" what that tool was used for. Such a disjunction between tool morphology and function is apparent in the microliths found all over the world that had no contemporary counterpart whose function could be compared to modern tools and a hence a function for the tool, by extension, could not be inferred. Lithic flake tools, a tool type morphologically dissimilarity to modern day counterparts – whatever those may be – is another example whose function is relatively unknown. While we can make guesses as to what tools are used for, no one could say for sure what flakes were used for with certainty. Microwear analysis provides a new method for understanding their function

Microwear Analysis

After Semonov's (1964) lifelong work on microwear analysis was translated into English, a new area of analysis was ushered into archeological studies. Archeologists devised new approaches for effectively establishing the function of lithic artifacts (Ahler 1971; Bamforth 1988; Gould et al. 1971; Odell and Odell-Vereecken 1981; Siegel 1984; Vaughan 1985; Yerkes 1987; 1994). More importantly, it provided a method to identify function in those tools with no modern contemporary counterpart – the "meat" of this thesis and the topic of subsequent chapters.

First, a brief understanding of microwear analysis is warranted. Kooyman (2000) outlined three varieties of microscopic use wear analyses to deduce an artifact's particular activity: 1) microchipping; 2) micropolish; and 3) striation analysis. In microchipping studies usewear scar-signatures of particular activities are distinguished from post-depositional chipping, (Flenniken and Haggarty 1979; Shea and Klench 1993), "spontaneous retouch" patterns (Kooyman 2000) and intentional or unintentional retouch patterns (Hayden 1979). Microchipping is a phenomenon that results from the action done, angle of edge of use, pressure per unit area used (Keeley 1980), and hardness of material used (Kooyman 2000).

Micropolishes are produced by abrasion and deposition of silica on a tool's edge (Anderson 1980; Fullagar 1991; Kooyman 2000). Some scholars believe that micropolish analysis is better for defining a particular worked material than microchipping (Odell 1994). Kay (1996) argues that micropolish results from the frictional conditions of the flake and the worked material more so than on the properties of the worked material itself. Micropolish studies in identification of worked material have traditionally relied on polish brightness, texture, contour, morphology and distribution (Kimball et al. 1995; Keeley 1980; Kooyman 2000). These methodologies are not fully accepted by the lithic analysis community as there is controversy as to how accurately polish can distinguish between worked materials, and how accurately it can be quantified and replicated (Grace et al. 1985; Newcomer et al. 1986; Rees et al. 1991).

Striations are observed scratches on the surface of a tool and may be subdivided according to their width and depth (Keeley 1980; Kooyman 2000; Mansur-Franchomme 1983). Keeley (1980) identify two main types of striation. One type is “narrow-deep” (Keeley 1980:20). These striations appear dark and deep under a light microscope. They are usually less than 2 nm wide. Second types of striation are those that Keeley classifies as “broad-shallow” (1980:23). Under a light microscope these striations look light and tend to have a broad width greater than 2 nm. Mansur-Franchomme (1983) suggests that the immediate cause of striation width is the size of the loose particles involved in the contact area between the tool and the worked material. The depth of the striation is believed to be a factor of the material worked and the force used in the action undertaken (Kooyman 2000).

Ethnographic Accounts and Craft Specialists

Microwear analysis of tools is one method to understanding a tool’s function. Consultation with contemporary native tool users, ethnographic accounts, and/or consultation with lithic specialists in the region are other methods to acquire an understanding of a particular tool's function. Coordinated research efforts between Native American groups and archeologists can result in an immense potential benefit for all of the parties involved (Foster and Croes 2002; Foster and Croes 2004; Foster et al. 2007). Coordinated efforts between both parties are particularly beneficiary when one party is lacking in knowledge that the other can supplement.

Ethnographic sources for the Northwest Coast of North America provide an extensive discussion of the periods of early contact of the traditional inhabitants and their European contemporaries. Most European ethnographic sources, in laundry-list fashion, detail what material goods they observed being produced. Wissler (1914) writes: "... boxes and baskets; large rectangular gabled houses of upright cedar plans with carved posts an totem poles; travel chiefly by water in large sea-going dug out canoes some of which had sails; no pottery nor stone vessels, except mortars; baskets in checker... coil basketry not made; mats of cedar bark and soft bags in abundance..." (Wissler 1914:454; see also Drucker 1955; Goddard 1945).

While it is nice to have a list of the material goods early European contact people saw, most ethnographies, unfortunately, have little or no discussion of what tools were used for the preparation of the everyday material goods that were observed and listed. Gunther and Haeberlin (1930) are an exception. In one instance they describe the acquisition of wool: "For sheering, the [wool] dogs' forelegs were tied together and the wool was cut with a stone knife" (1930: 30). Unfortunately there was not much detail provided on the "stone knife." On hide preparation Gunther and Haeberlin (1930:33) note: "Deerskin was soaked in water for three days, then it was hung over an upright pole about six inches in diameter, and scraped with a deer rib". Teit (1928), in an extremely rare exception to the overall lack of specific tool mention in everyday production of material goods, details the tools he observed for procurement of animal skins. Of the middle Columbia Salish peoples Teit (1928: 111) wrote: "skin-scrapers, large and small, for use with one or both hands, were of flaked arrow-stone or of thin pieces broken from boulders." Such detailed observations on the tools used (obviously lacking standardized language of tool names) are extremely rare. These few examples suggest the tools used for animal processing activities are either "knives" (Gunther and Haeberlin 1930) - assumed to be retouched bifaces - or deer ribs. These are tools which should be noted are drastically different from the lithic flake tools analyzed from the collections from Qwu?gwes, Hartstene and the Sunken Village sites.

The few European ethnographic resources which mention specific actions and their accompanying tools most often deal with observed food preparation: Gunther and Haeberlin (1930) note that before butchering a seal, the carcass was rolled over in the fire so as to burn the fur off, the skin was scraped, and then the seal was finally cut open. Unfortunately, they leave out what was used to scrape the skin or to cut the seal open. In one instance where Gunther and Haeberlin (1930) do describe the tool used in some action, we also get a clear picture of the tool's morphology: "For cutting meat and fish a knife of stone with a yew wood handle was used. The blade was sharp on one edge only" (Gunther and Haeberlin 1930:34). Repeating the "knife with one sharpened side" for food procurement theme, Gunther and Haeberlin (1930:36) also note that "the Snohomish used an un-hafted stone knife, sharp on one edge, for food preparation." It seems unlikely that the un-retouched - that is to say "un-sharpened" - flake tools studied in this analysis from Qwu?gwes, Hartstene, and Sunken Village were used in food preparation as seen by Gunther and Haeberlin (1930).

Overall then, the European ethnographic sources are not very helpful in determining the use of flake tools at Qwu?gwes, Hartstene, and Sunken Village sites. There is one tantalizing worded clue. It comes from Elmendorf's (1960:195) careful observation on cordage artifact production: “vegetable fibers, used for cord, were also prepared by chopping and were scraped before twisting, but the details of this process are quite uncertain.” Unfortunately Elmendorf also notes his ignorance of the tool used in cordage production. Where the ethnographers falter, perhaps cultural experts can carry on.

Individuals such as Suquamish master basketry weaver Ed Carrier and Squaxin master wood carver Andrea Wilbur-Sigo are knowledgeable on what tools are needed for basketry production and wood carving respectively. Consultation with Ed Carrier and Andrea Wilbur-Sigo has been extremely helpful as a starting point for the experimental section of this thesis. Ed Carrier and Andrea Wilbur-Sigo visited the excavation at Qwu?gwes on several occasions through the three summer season I participated in its excavation. In addition, Ed Carrier and Andrea Wilbur-Sigo have generously agreed to meet with students in their work studios. Both Ed Carrier and Andrea Wibur-Sigo kindly agreed to experiment with some of the replicated flakes and were happy to share some of their experiences regarding the use of the replicated flake tools.

One of the first steps in basketry production is to gather the raw materials and these are then prepared into manageable components (Figure 4): On one occasion, Ed Carrier visited the Qwu?gwes site for the day, and upon giving a demonstration of modern basketry production he explained that after the limbs and roots of spruce and cedar where collected, they need to be split into strips before they could be managed for basketry production. The split of the gathered tree limb would be halved by hand starting with a split end of the limb and then re-halved. When the limb was manageable, Ed Carrier suggested that a sharp stone [like one of the replicated flake tools he agreed to experiment with] would be utilized in the shaving off of rough spots or thick spots of the soon to be artifact strip (Carrier 2007).

On wood carving, Andrea Wilbur-Sigo explained that the replicated flake tools functioned at the beginning, but that the chert crumbled at the edges. She added that the edge dulled quickly with heavy usage (Figure 5). Andrea Wilbur-Sigo proposed that the replicated flake tools which she was given were most likely not used for big wood working projects, but that instead they might have been used for smaller projects (Wilburn-Sigo 2007). With limited success Andrea Wilbur-Sigo was able to create some small incision and carvings of western red cedar (Wilbur-Sigo 2007). From these interviews, it seems unlikely to me that the flake tools at Qwu?gwes, Hartstene and Sunken Village were used for heavy whittling activities.

This study thus began with the expert witnesses who were able to demonstrate possible uses of the flake tools. Indeed this demonstration of possible uses backed by ethnographic sources in conjunction with experimental archeology, has provided insights into the production of cedar (Thuja plicata) bough artifacts and cherry bark (Prunus emarginata) strips artifacts found at Qwu?gwes, Sunken Village and possibly at Hartstene:

For basketry production, the removal of the bark from the tree, the splitting of the bough, and the necessary modifications by “cutting” “scraping” and “whittling” of unwanted portions of gathered material were probably best done with a lithic flake tool (Carrier personal communication 2007). The likely possibility for the processing of these wood artifacts is flake tools. If the flake tools from Qwu?gwes, Hartstene and Sunken Village were used for “cutting” “scraping” and “whittling” to reduce the mass of wood and fiber artifacts, then, hopefully the flake tools would have a distinguishable – “signature” – wear traces for the three corresponding actions; the subject of the following chapters.

Figure 4. Ed Carrier using an experimental flake tool on a cedar strip (photo by Dale R. Croes)

Figure 5. Andrea Wilbur-Sigo using replicated flake tools on a piece of cedar (photo by Dale R. Croes)

CHAPTER TWO: THE COMPARATIVE COLLECTIONS

Before diving into the problem of ascertaining the use of flake tools in the central northwest coast, a brief discussion of the comparative collections from Qwu?gwes, Hartstene and the Sunken Village sites is presented below.

Qwu?gwes

Permission to study the flake collection from the Qwu?gwes (45TN240) site was granted by the owners and curators of the Squaxin Island Tribe Cultural Resource Department and the Museum Library and Research Center.

The Squaxin Island Tribe has designated 45TN240 as the "Qwu?gwes" site – commonly translated to mean a "coming together, sharing" (Croes et al. 2005:135). The Qwu?gwes site is located at the southern end of the Puget Sound in Washington State at the head of Eld Inlet, near the city of Olympia. Qwu?gwes is located in the traditional territory of the Lushootseed-speaking Coast Salish People (Suttles and Lane 1990; Thompson and Kinkade 1990). The joint investigation of the Qwu?gwes site at Mud Bay by South Puget Sound Community College and the Sqaxin Island Tribe began during the summer of 1999 and has thus far continued on until the summer of 2007. The results of each summer's investigations are presented as annual reports to the Washington Department of Archaeology and Historic Preservation.

Non-perishable and perishable artifacts of stone, bone and antler are typical of the Late Pacific period (Ames and Mashcner 1999). Two C^{14} dates on wood samples returned dates approximately 710 (+/- 60) and 730 (+/- 60) BP (Croes et al. 2008). However – and more excitingly - the sensitive basketry and cordage styles found at the site show close similarities to basketry styles from sites of Lushootseed speaking Coast Salish peoples extending back some

3,000 years ago (Croes, Kelly & Collard 2005). A geological survey in the south Puget Sound suggests that Qwu?gwes was probably first occupied shortly following an earthquake that occurred around 1000 AD (Sherrod 1998). This earthquake appears to have depressed the shores of Mud Bay nearly three meters forcing people to relocate to higher ground, such as the current site location. All together, the current data suggests that Qwu?gwes was most likely first occupied shortly after 1000 AD, and had a continual occupation at least until the eighteenth century.

The site of Qwu?gwes is divided into three main areas, according to assumed activities: 1) the wet site/shell midden; 2) the food processing area; and 3) the living area. The wet site is approximately 91 meters long (Croes et al. 2005) and is an "artificial (and deliberately) constructed levee of shell midden along the beachfront" protecting the food processing area (Croes, Kelly & Collard 2005:143). There is a fresh water aquifer which carries sands and clay through the densely compacted shells approximately 50 cm below the surface. This buried waterlogged portion in the intertidal zone contains well preserved wood and fiber artifacts. The area immediately adjacent to the wet site is believed to be a food processing area "based on the presence of stone paved steaming ovens that have been found" (Croes, Kelly & Collard 2005:143). This area of the site has a large number of post holes – as might be used for cooking racks—and a large concentration of terrestrial mammal bones not found elsewhere at the site. The living area is north of the food processing area and the shell midden. This area contains house post molds, hearths and house floors (Cores et al. 2005).

Prior to the summer of 2006, approximately 17m^3 of the site has been excavated. Most of the excavation had concentrated on the shell midden portion of Qwu?gwes. The site contained artifacts and components typical of Late Pacific period (Ames and Maschner 1999). Large amounts of perishable artifacts including nets, cordage, two-strand string net made of the twisted inner bark of western red cedar (Thuja plicata), withe pieces, woodchips of various kinds -- the majority of which are western red cedar (*Thuja plicata*), and cherry bark (*Prunus emarginata*) strips and/or basketry were recorded. There were three main types of basketry found at the site: cedar bark checker weave mating, open-twisted cedar splint baskets, and fine twill weave bark basketry (Foster and Croes 2004; Croes et al. 2005). Basketry production debris – or debitage – consists of cedar bark strips, cedar bough – or root – splints (*Thuja plicata*) and cherry bark strips (*Prunus emarginata*). Occasionally these materials were found with discarded lithic flake tools and/or debitage in the same strata.

A distribution of items that are indirect indicators of human activity up to the year 2005 is presented in Figure 6 (Table 1 modified from Croes et al. 2005). The largest category is fire cracked rock that was likely used for steaming butter clams (*Saxidomus giganteus*), horse clams (*Tresus nuttallii* and *Tresus capax*), Olympia oyster (*Ostreola conchaphila*), blue mussel (*Mytilus californianus*) and littleneck clams (*Protothaca staminea*). Seventy-seven percent of the fauna were fish (mostly salmon), while 21.5 % of the fauna were mammal, 1.3 % were birds, and the remaining faunal were snake and frogs. The few macroflora elements recovered include a "handful" of hazelnut shells (*Corylus cornuta*) (Croes et al. 2005:145).

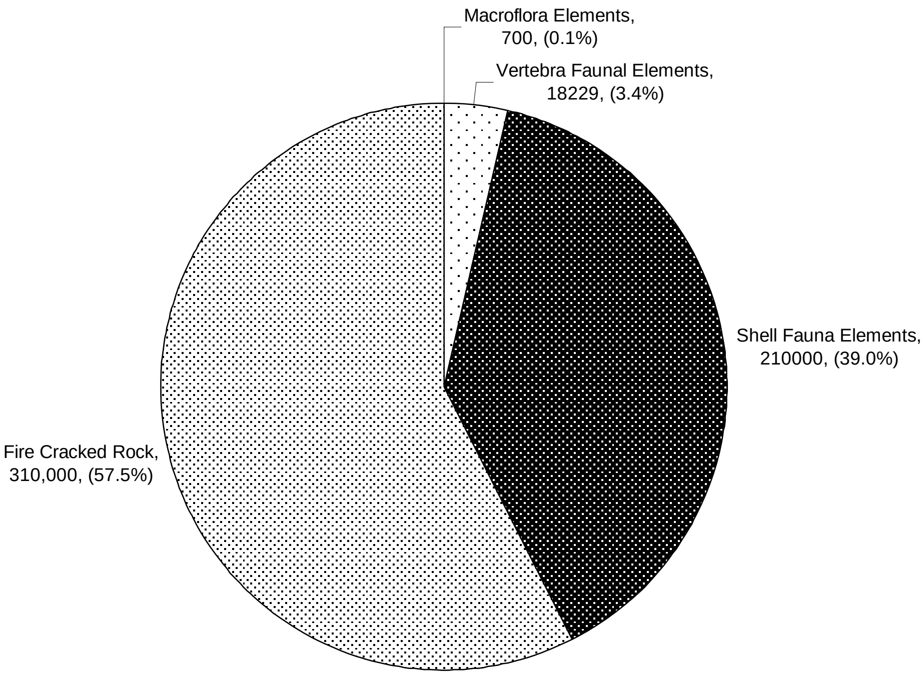

Figure 6. Qwu?gwes items of indirect human activity count

Table 1. Indirect Human Activity Artifacts up to 2005

Indirect Human Activity up to 2005	n =
Shell Fauna Elements	210,000
Vertebra Faunal Elements	18,229
Macroflora Elements	700
Thermally Altered Rock	310,000

The overall distribution of debitage elements recovered up to 2006 can be seen in Figure 7 (Table 2, adapted from Ness et al. 2007, and Hawes 2007). As can be seen there is virtually no split wood debitage elements recovered in seven field seasons (~ 0.1 %). There were however plenty of wood chips (21.7 %) and basketry debitage (38.4 %). Lithic debitage made only a slightly greater contribution (39.8 %) than basketry debitage.

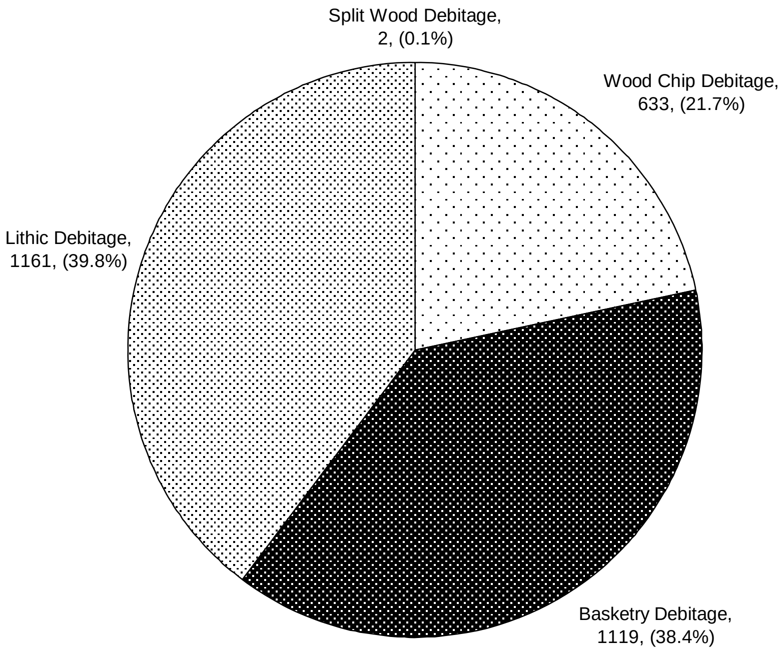

Figure 7. Debitage elements recovered from Qwu?gwes

Table 2. Debitage Elements up to 2006

Debitage Elements up to 2006	n =
Basketry Debitage	1,119
Split Wood Debitage	2
Lithic Debitage	1,161
Wood Chip Debitage	633

Tools recovered from Qwu?gwes include those wood, bone and lithic materials. Unfortunately there is yet no synthesis based upon the number of bone and wood tools recovered at Qwu?gwes. The frequency of the lithic tool types however is illustrated in Figure 8 (Table 3. adapted from Croes et al. 2008). As of 2006 there were a total of 166 lithic tools recovered from Qwu?gwes. These include anvil stones (2.4%), "scrapers" (6.0%), abrader stones (7.2%), hammer stones (13.3%), chipped stone projectile points (15.7%), and flake tools (49.4%). Three multidirectional cores, three nephrite adz bits, two ground slate artifacts, one unidirectional core, and a ground stone bowl make approximately the remaining 10 % of lithic artifacts. From this assemblage, the 82 flake tools collected at Qwu?gwes were selected for microwear analysis.

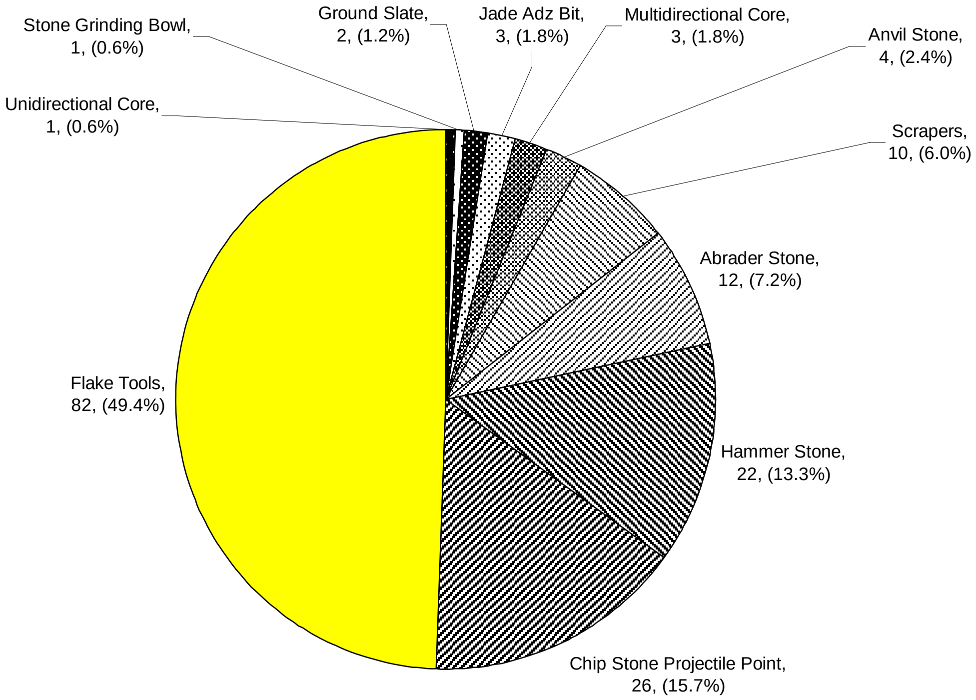

Figure 8. Lithic tools recovered from Qwu?gwes

Table 3. Lithic Tool Distribution up to 2006

Lithic Tools up to 2006	n =
Unidirectional Core	1
Stone Grinding Bowl	1
Ground Slate	2
Nephrite Adz Bit	3
Multidirectional Core	3
Anvil Stone	4
Scrapers	10
Abrader Stone	12
Hammer Stone	22
Chip Stone Projectile Point	26
Flake Tools	82

Hartstene

The Hartstene Island collection is owned and curated by the Squaxin Island Tribe cultural Resource Department and the Museum Library and Research Center. They generously allowed me access to the collection.

The Hartstene Island artifact assemblage consists of a large surface collection obtained from the active tidal zone on the western shore of Hartstene Island. The collection had been gathered by Jack and Carleen Nickels over several years. The Nickles collected not only "pretty points" but also collected other less formalized artifacts (Figure 9; Table 4, adapted from Croes et al. 2008). Although there was a great bias towards the collection of bifaces (86.2% of the collection), the Hartstene collection also contained 40 flake tools that were selected for microwear analysis. Their analysis is discussed in the following chapters.

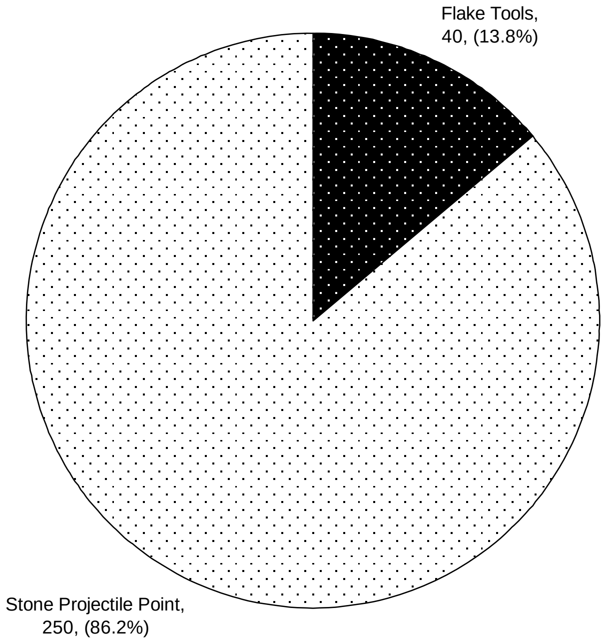

Figure 9. Hartstene tool count

Table 4. Analyzed Tools from Hartstene

Tools up to 2006	n =
Chipped Stone Projectile Point	250
Flake Tools	40

Sunken Village (35-MU-4)

In order to assess the potential effects of a proposed rip-rap on the site and in order to comply with Section 106 of the National Historic Preservations Act, the US Army Corps of Engineers, required the Sauvie Island Drainage Improvement Company Inc. to conduct a field investigation of the National Historic Landmark wet site at “Sunken Village” (35MU4). The Sauvie Island Drainage Improvement Company Inc. contracted with South Puget Sound

Community College and Archaeological Investigations Northwest, Inc. to undertake the field investigation of the site on September 2006. After the investigation, the US Army Corps of Engineers made a finding of "no adverse effect to historic properties" and issued a permit to the Sauvie Island Drainage Improvement Company Inc. to proceed with the proposed rock rip-rap bank extending some 320 meters along the eroding natural earth levee.

The three week limited field investigation resulted in the excavation of four 1x1 meter test units. Three of these units had 10 cm wide drainage trenches dug in 10 cm levels, extending to the edge of the area of potential effect. Five round acorn pit features were cross sectioned, and half of the test units were fully excavated, the sites was surface mapped and cored to a depth of 25 feet across a natural earth levee (Croes, Fagan and Zehendner 2007). The laboratory work of cleaning, labeling, and stabilizing the artifacts recovered from the field extended past the three week field investigation.

Much of the Sunken Village's assemblage consisted of shell, bone, acorns, fire cracked rock, and 5939 pieces of charcoal (72% of all items of indirect human activity recovered). There was a notable emphasis on plant foods (30.5% -- 9% if we include charcoal) in comparison to the smaller amount of bone (18.8% -- 5% if we include charcoal) and shell faunal elements (11.9% -- 3% if we include charcoal) (Figure 10; Table 5, modified from Croes 2007). There were not a lot of faunal remains, and particularly little fish, which suggests that this location was most likely used to process plant food (Croes 2007).

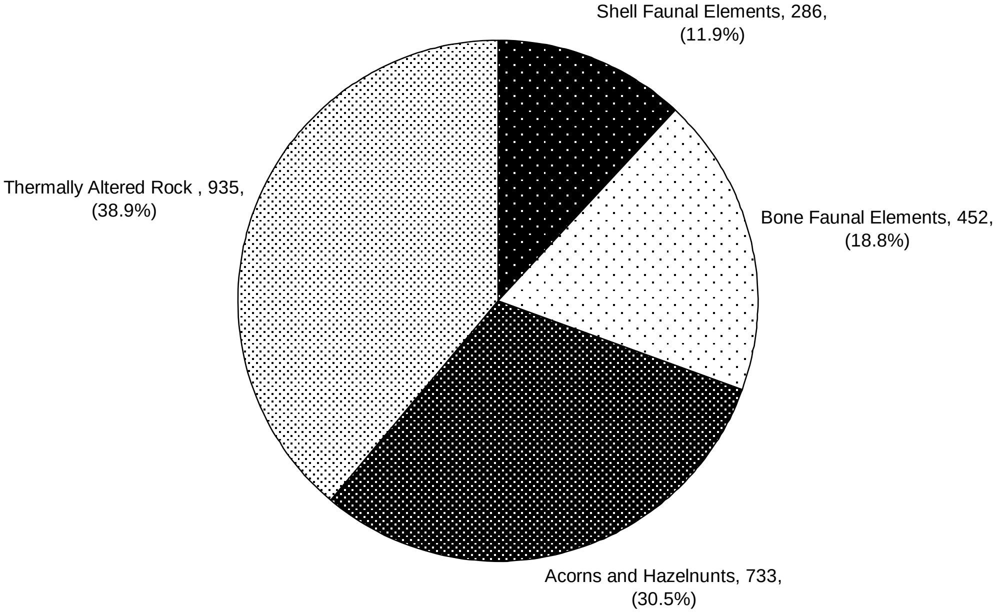

Figure 10. Items of indirect human activities recovered from Sunken Village, excluding 5939 charcoal pieces larger than a finger nail

Table 5. Items of subsistence Activities

Indirect	n =
Acorns and Hazelnuts	733
Bone Faunal Elements	452
Fire Cracked Rock	935
Charcoal	5939
Shell Faunal Elements	286

The distribution of debitage recovered is heavily weighted toward wood and fiber elements (71 % of total), consisting of wood chips (45.2%), split wood (24.2%), and basketry waste (1.6%). Only 29 % of the debitage was of lithic materials (Figure 11; Table 6, modified from Croes 2007).

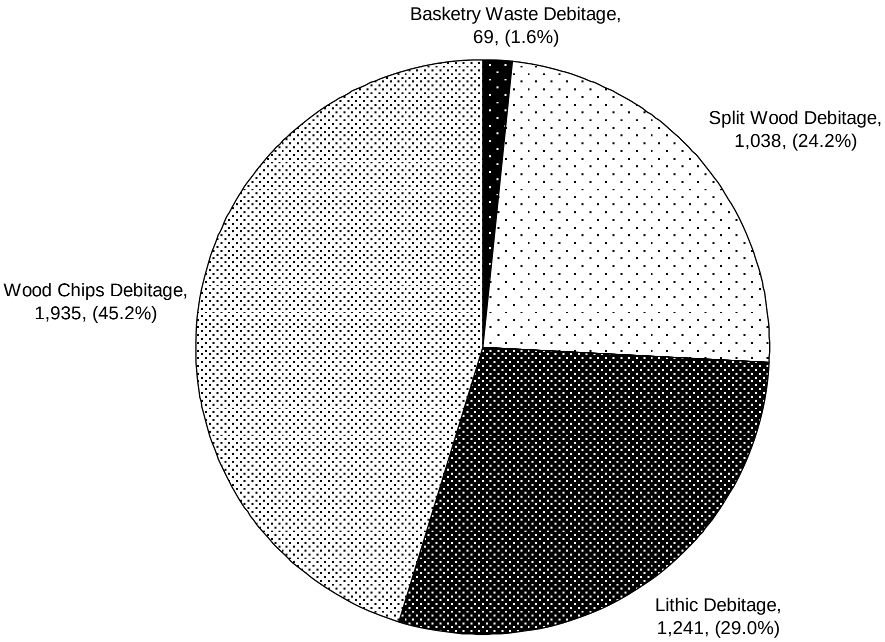

Figure 11. Debitage Elements Recovered from Sunken Village

Table 6. Debitage Elements Recovered from Sunken Village

Debitage	n =
Basketry Waste Debitage	69
Split Wood Debitage	1038
Lithic Debitage*	1241
Wood Chips Debitage	1935

Besides the enumerated items, 115 stone tools were recovered from the excavation of the four 1x1 units. Seventy eight (67.8 %) flake tools were recovered as well as 24 (20.9 %) bifaces, six (5.2 %) scrapers, four (3.5 %) hammer stones, two (1.7 %) abrader stones, and one (0.9 %) multidirectional core (Figure 12; Table 7, modified from Loffler 2007). Of these lithic tools, the 78 flake tools were used in microwear analysis.

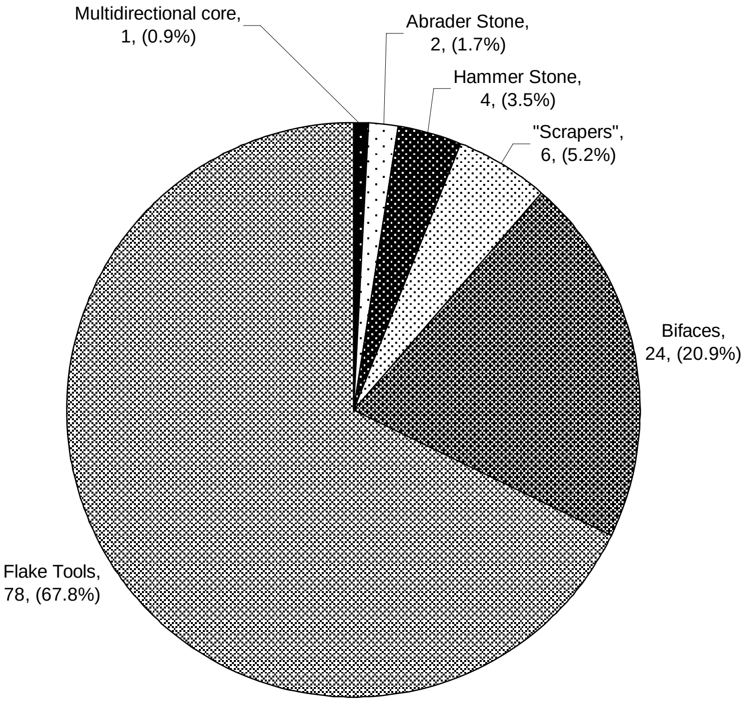

Figure 12. Tools recovered from Sunken Village

Table 7. Lithic Tools Recovered at Sunken Village

Tools	n =
Multidirectional core	1
Abrader stone	2
Hammer Stone	4
“Scrapers”	6
Bifaces	24
Flake Tools	78

The three collections provided a total of 200 flake tools – Qwu?gwes provided 82 flake tools, Hartstene 40 flake tools, and Sunken Village 78 flake tools. The function of these tools was unclear at the beginning of this study.

CHAPTER THREE: DATA

In this chapter the procedures of microscopic analysis to determine whether “cutting” “scraping,” and “whittling” actions leave “signature” wear-patterns on 179 experimental flake tools are discussed. With a scanning electron microscope and a regular light microscope three attributes – striation direction, polish intrusion, and damaged-edge-morphology – were observed to identify the action’s wear pattern on the flake edge after each flake tool was utilized in these activities.

Testing the usefulness of microscopic analysis for cutting, scraping and whittling activities was undertaken in four stages. In the first stage, 179 experimental flake tools were replicated. In the second stage, the replicated flake tools were used for experiments involving cutting, scraping and whittling actions. During the third stage descriptions of the effects of tool use were recorded. Finally the data from the results of experimental usewear were utilized to interpret the use of the flake tools from the Qwu?gwes, Hartstene, and the Sunken Village flake tool collections.

PART 1: Replicating Flakes

One hundred and seventy nine flake tools of Edwards Plateau chert were replicated by direct percussion on a unidirectional core with a hard hammer-stone (Figure 13; Appendix A). Edwards Plateau chert was selected as a “high-quality” (high concentrations of silicate) lithic material used in the experiments because it resembles much of the high quality, heat treated chert and jaspers from the Qwu?gwes site – the main archeological assemblage in my study.

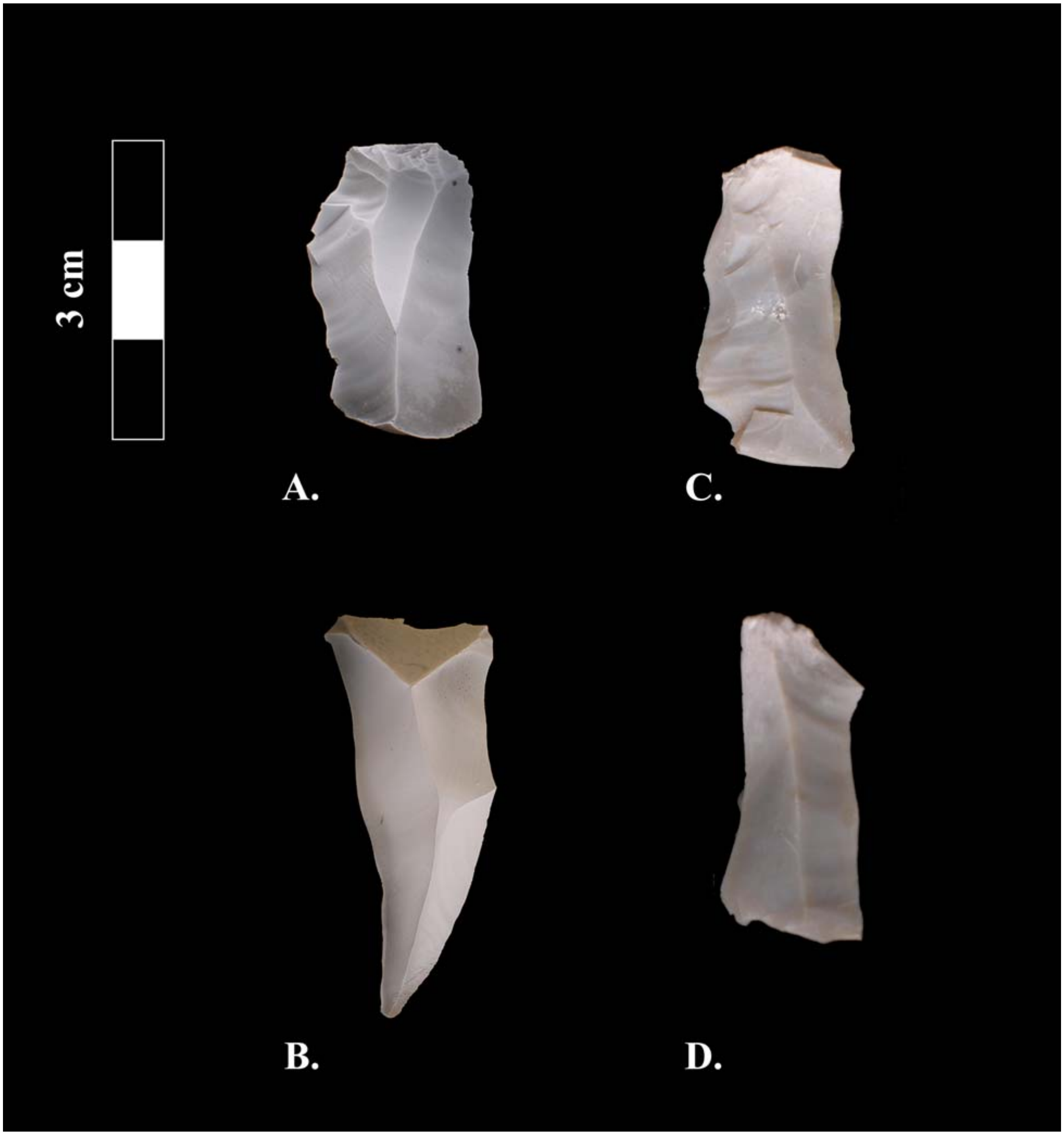

Figure 13. Examples of replicated experimental flake tools

PART 2: Experiments with Flakes

Three actions – cut, scrape and whittle - were undertaken with the replicated flakes. The actions are defined as follows: "Insertion of an edge using bidirectional or unidirectional strokes with the working edge parallel to the direction of use" is termed cutting and slicing (Figure 14 A; after Keeley 1980:18; Odell 1981). Hereafter the terms "cut/cutting" will be used to describe the action performed in this manner. "Scraping" is assigned to the action of a tool being held at a very high angle to the worked surfaces. The edge is held approximately at a right angle from the direction of use with the contact edge being pulled rather than pushed as might be done in "whittling" (Figure 14 B; after Kelley 1980). "Whittling" activities involves the shaving off of material from the parent piece with the working edge of the tool held roughly at a right angle to the direction of use; the contact edge is held at a low angle to the worked material (Figure 14 C; after Keeley 1980; Odell 1981).

In the use experiments flakes were utilized to cut, scrape and whittle cherry wood bark (*Thuja plicata*) and the wood of western red cedar (*Prunus emarginata*). Flakes were considered "used" after 50 cm^2 of fresh bark had been cut away, 50 cm^2 of fresh bark had been scraped off, and 50 cm^2 of fresh wood had been whittled away. The activities were concentrated – to the best of my ability – to a 2 cm portion of each flake edge. This method attempted to standardize "used" edges observed and ensured – or approximated at least – comparable activities' use-wear patterns. From the 179 Edwards Plateau Chert replicated flakes, 112 randomly chosen flakes were utilized for cutting (n = 56), scraping (n = 28), and whittling (n = 28) of cherry wood bark (*Prunus emarginata*) and the wood of western red cedar (*Thuja plicata*). The remaining 67 flakes where set aside for blind test confirmations.

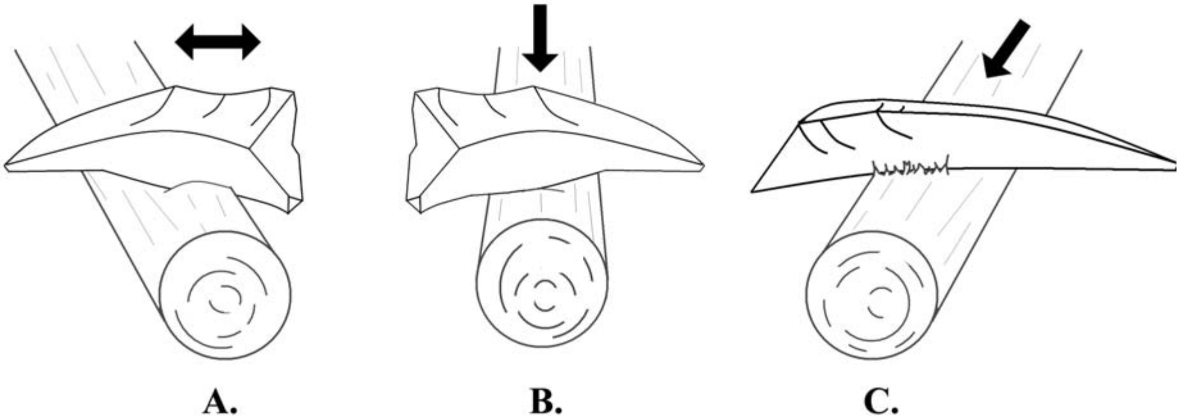

Figure 14. Actions of Flakes A) cut; B) Scrape; and C) Whittle

PART 3: Recording Attributes of Flakes

Flake Morphology

Weight, edge angle, and maximum length, width and thickness attributes were recorded for each of the replicated flake tool (Figure 15; Table 8; Appendix A). An attempt was made to match the morphological attributes of the replicated flake tools to that of the archeological specimens. That is to say, the flakes from Qwu?gwes, Hearstene, and Sunken Village were as closely approximated as could be done at the time. Figures 16, 17, 18, and 19 juxtapose length, width, thickness and edge angle – respectively -- of the comparative collections and the replicated flake tools. The striking platform type is also compared across the collections – following Andrefsky (2005) (Figure 20). Additionally, data on the flake termination – following Andrefsky 2005 – is also compared across the collections where it has been collected (Figure 21).

Lastly, to compare the overall shape of the replicated flake tools to the archeological ones, I charted a scatter plot of the flakes tools ratio of length divided by width attributes compared to each flakes thickness (figure 22). With the exception of two flake tools collected from the sunken village site, all the flake tools are morphologically similar. Disregarding the replicated flake edge's angles, the replicated flake tools closely match the morphological variability from the three archeological collections.

Table 8. Edward Plateau Chert Flake Tools Morphological Attributes

Attribute	N	Minimum	Maximum	Mean	Std. Deviation
Length (mm)	179	14.96	53.37	29.04	8.29
Width (mm)	179	6.34	26.12	13.82	4.01
Thickness (mm)	179	1.48	9.91	4.41	1.61
Weight (g)	179	0.2	7.4	1.8	1.4
Edge Angle	179	10	60	24.5	11.5

Photographs were taken of the experimental flakes before use and after use for comparative analysis. Photographs were taken at 30, 60, 150, and 300 magnification on flake tools with a Hitachi S-570 model Scanning Electron Microscope running at 20 Kilowatts at Washington State University's Electron Microscopy and Imaging Center. Additional close up images were taken under 60-85 magnification with a Nikon C-PS light microscope at Washington State University's Anthropology Department's lithic laboratory. Three attributes were observed on each flake tool after used in cutting, scraping, and whittling actions: 1) striation direction; 2) polish intrusion; and 3) damaged-edge-morphology.

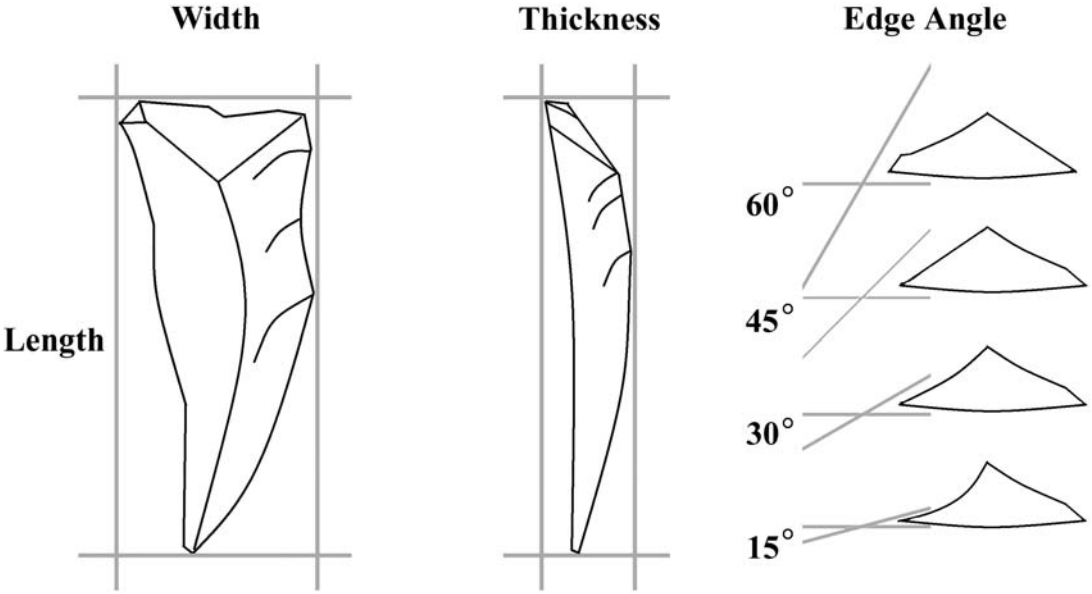

Figure 15. Flake Tools Morphological Attributes Measurements

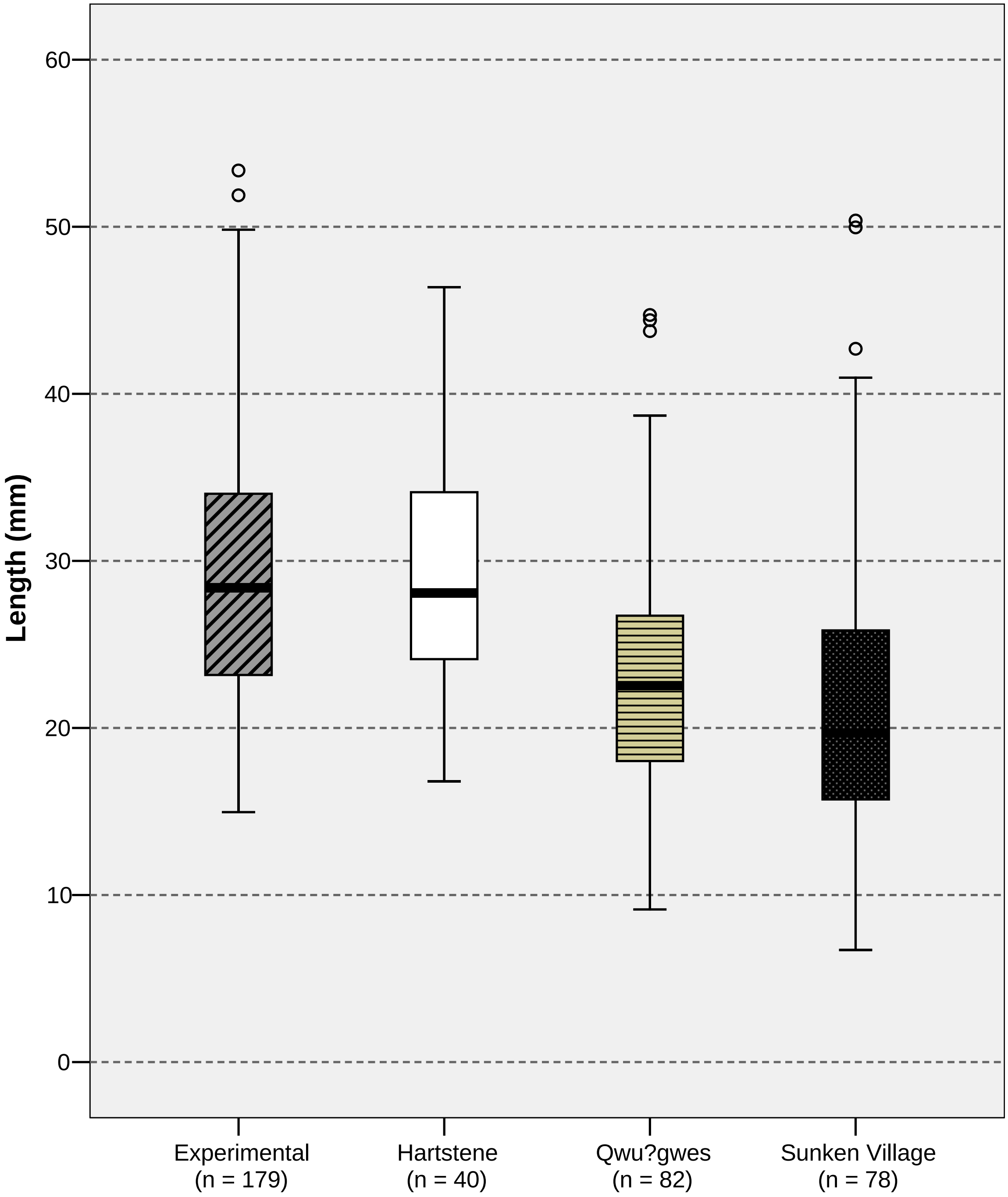

Figure 16. Comparison of flake tool length

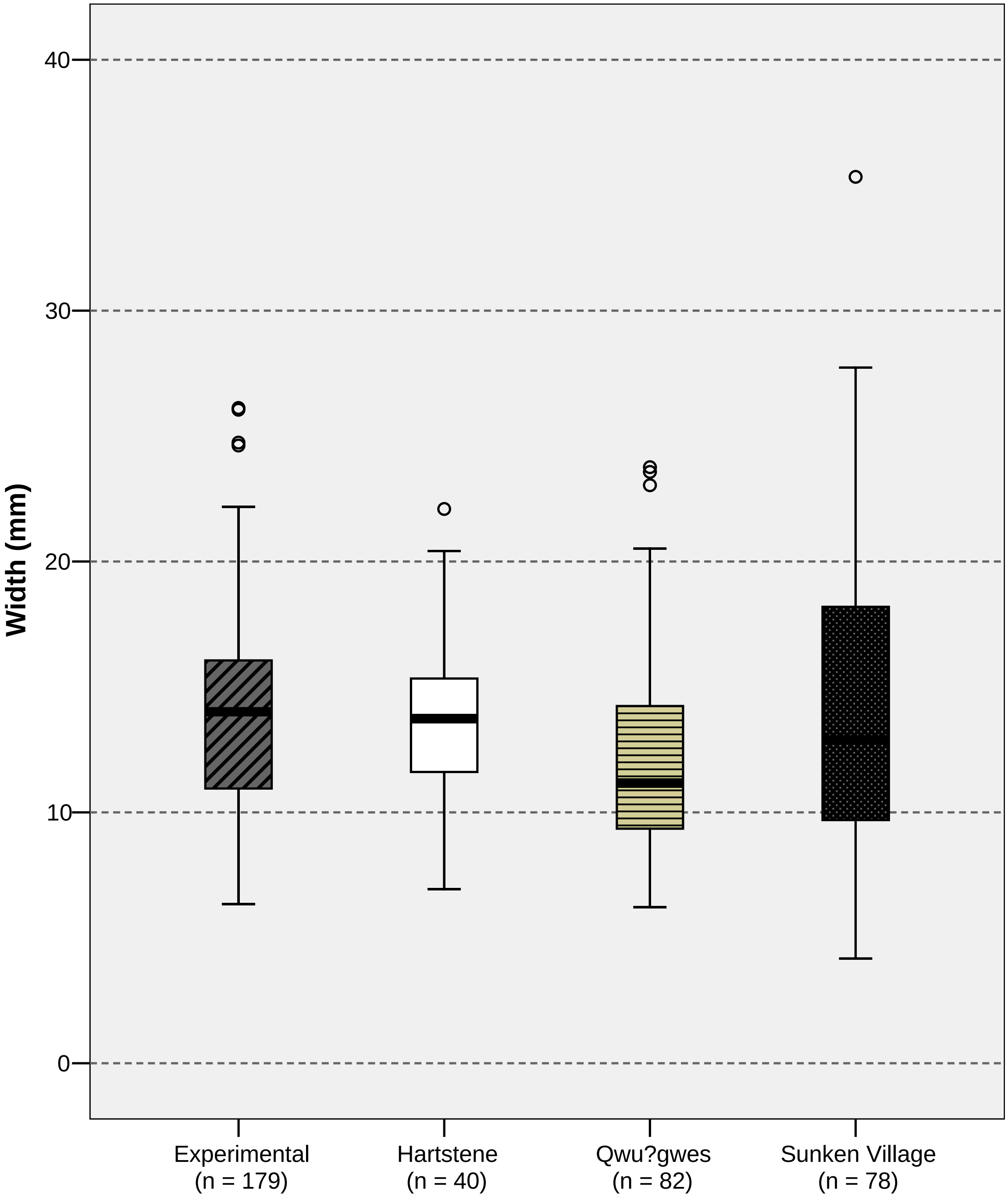

Figure 17. Comparison of flake tool width

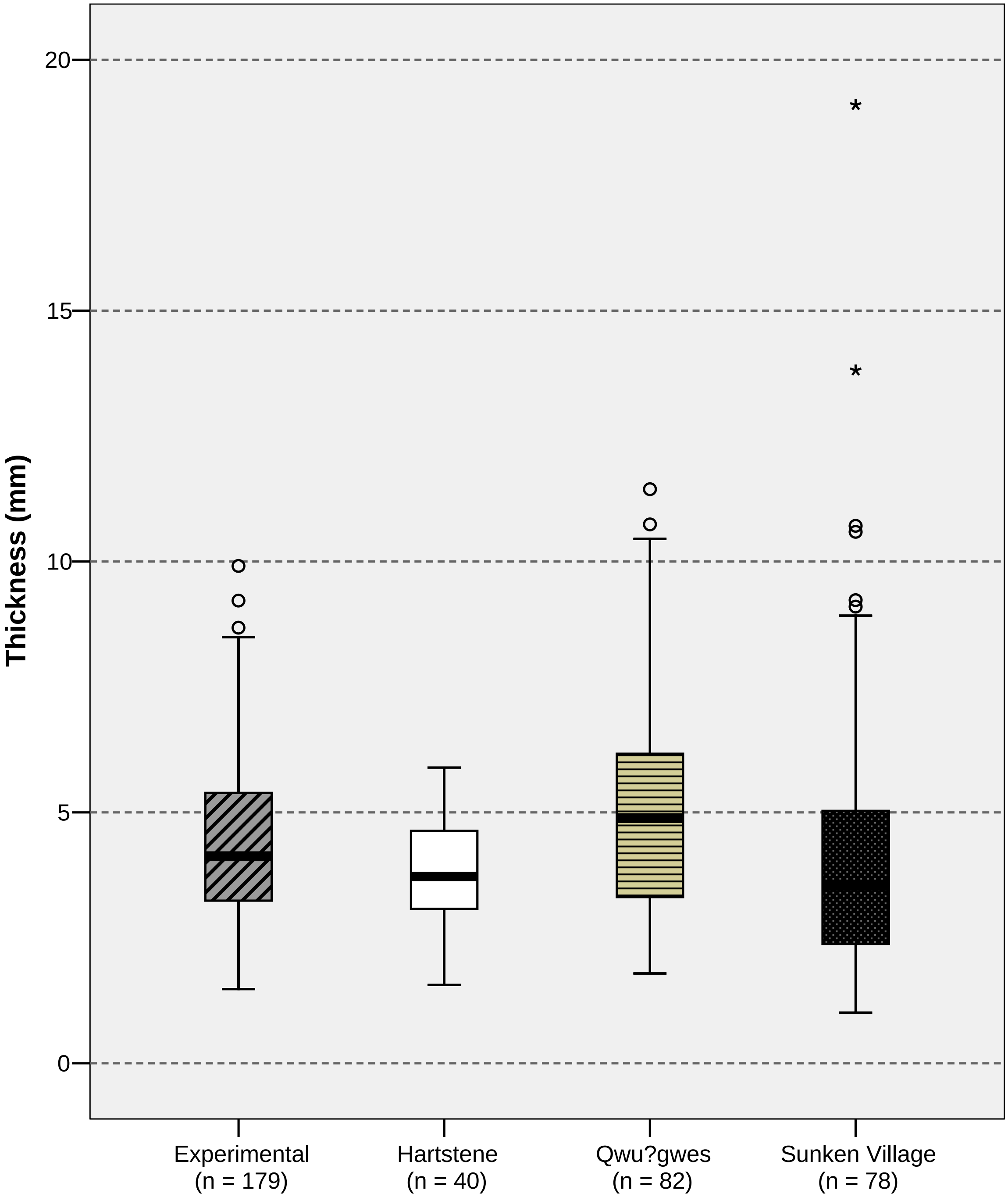

Figure 18. Comparison of flake tool thickness

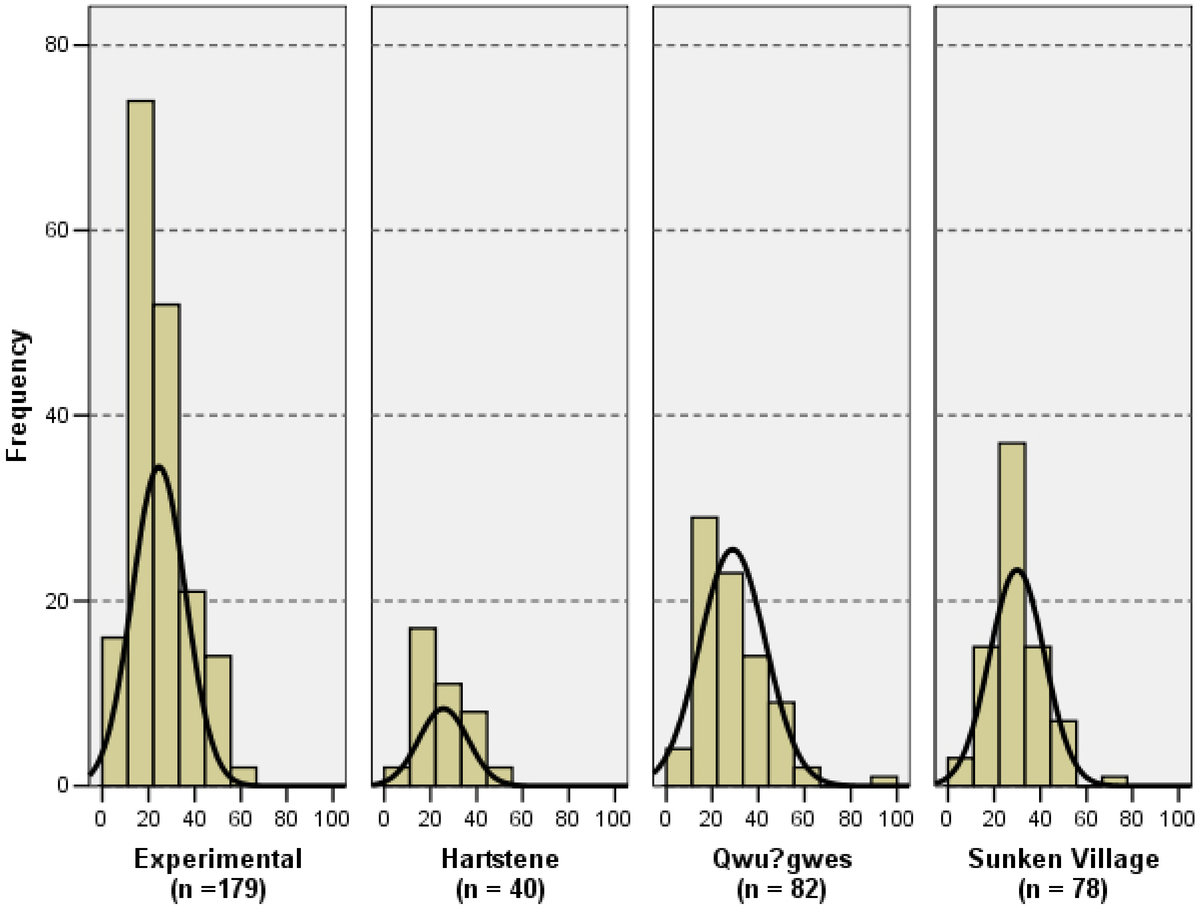

Figure 19. Comparison of edge angles

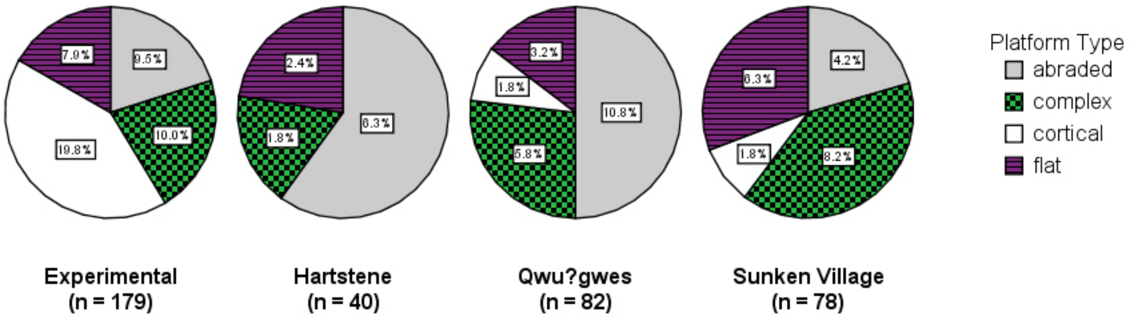

Figure 20. Comparison of flake striking platform types

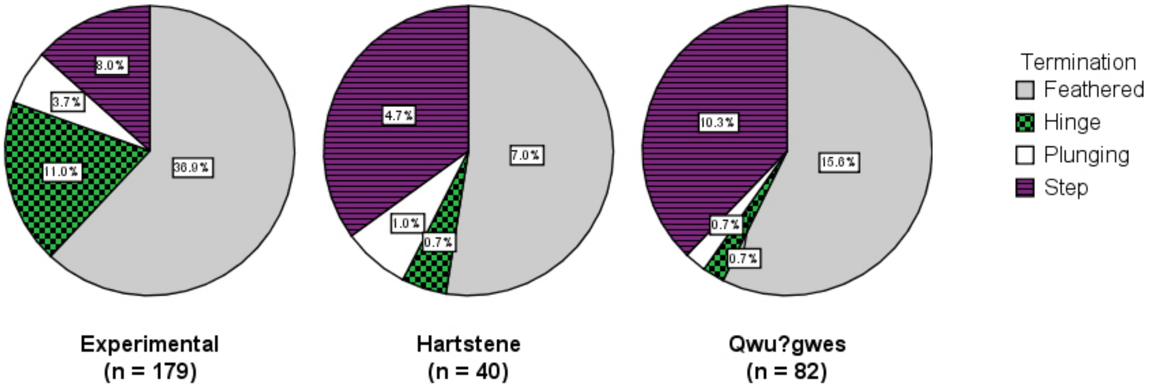

Figure 21. Comparison of flake termination types. Note that Sunken Village flake terminations were not recorded and are not presented here.

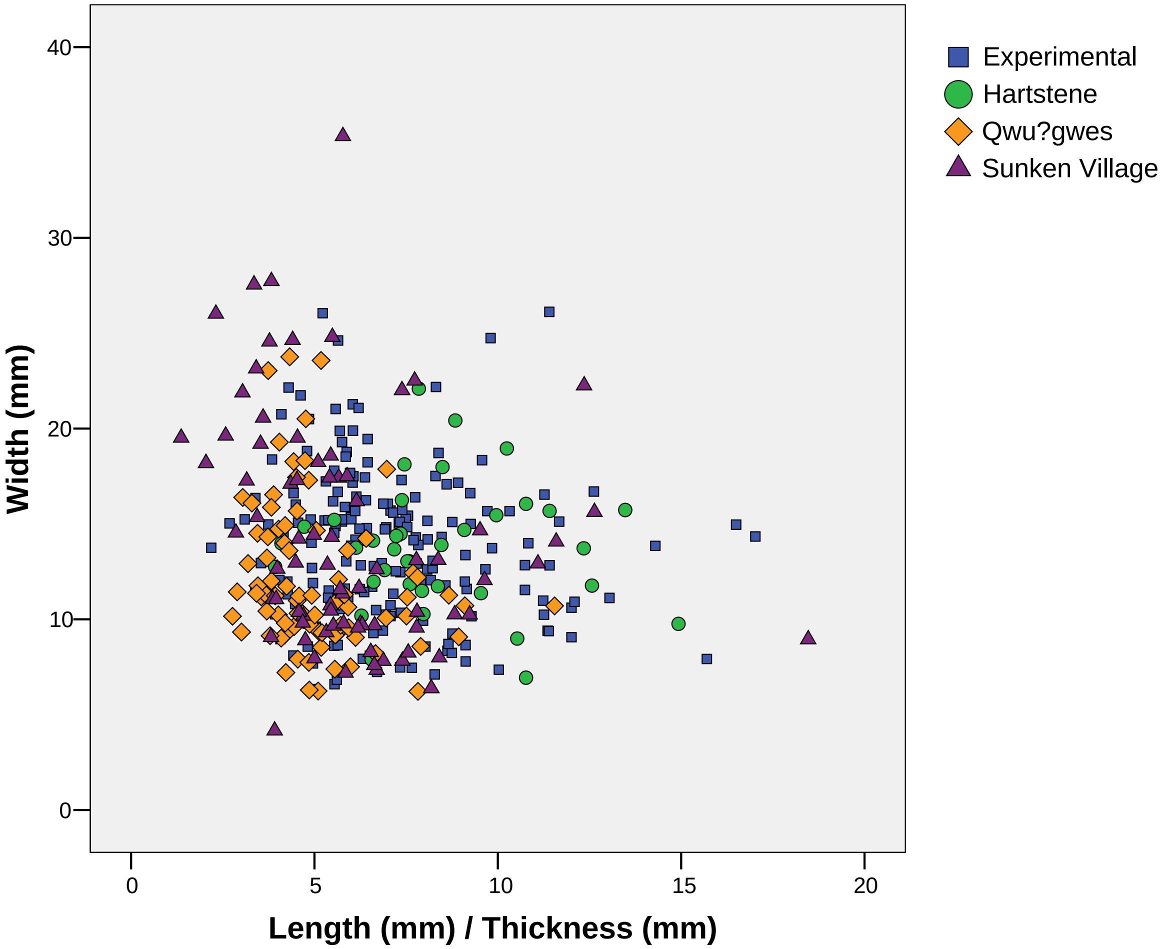

Figure 22. Morphology of lithic tools compared by group.

Striation Ordinal Schema

The first attribute observed after the flake was used, striation direction, was assigned an ordinal measurement with the following schema: Following the striations' closest point to the worked edge an imaginary tangent line on the used edge was used as a base line for a protractor. Following the striation to the furthest distance from the worked flake edge, and connecting the first point to the end point one draws an imaginary line on the flake edge. Superimposing the imaginary line on the protractor, the angle formed is recorded (Figure 23).

Following the striation schema proposed, I assigned the striation direction on each flake to a four point ordinal data set. When the angle formed by the striation and the flake edge fell between 1 and 22.5 degrees it was assigned an ordinal value of "1." When the angle formed was between 22.5 and 45 degrees it was assigned an ordinal value of "2." When the angle formed between the striation and the flake edge was between 45 and 77.5 degrees it was designated a value of "3," while an angle higher than 77.5 degrees was designated a value of "4" (Figure 23).

In practice, there could be up to a 90 point ordinal data set – one point for each of the 90 degrees in the protractor. The four point ordinal striation schema is adopted instead of a "90-point" striation schema because it can safely be assumed that each activity will have a slight variation of striation direction, but will clump around some average angle and at the same time it is hoped that they will be sufficiently different enough that there will be patterning differences when all taken together. The four point striation schema is extremely easy to visually gauge and record when looking at striate on the edge of a flake tool. A "three-point," "six-point" or "nine-point" striation schema could have been developed instead or as well as they are easy to record because they can be divisible by 90 degrees.

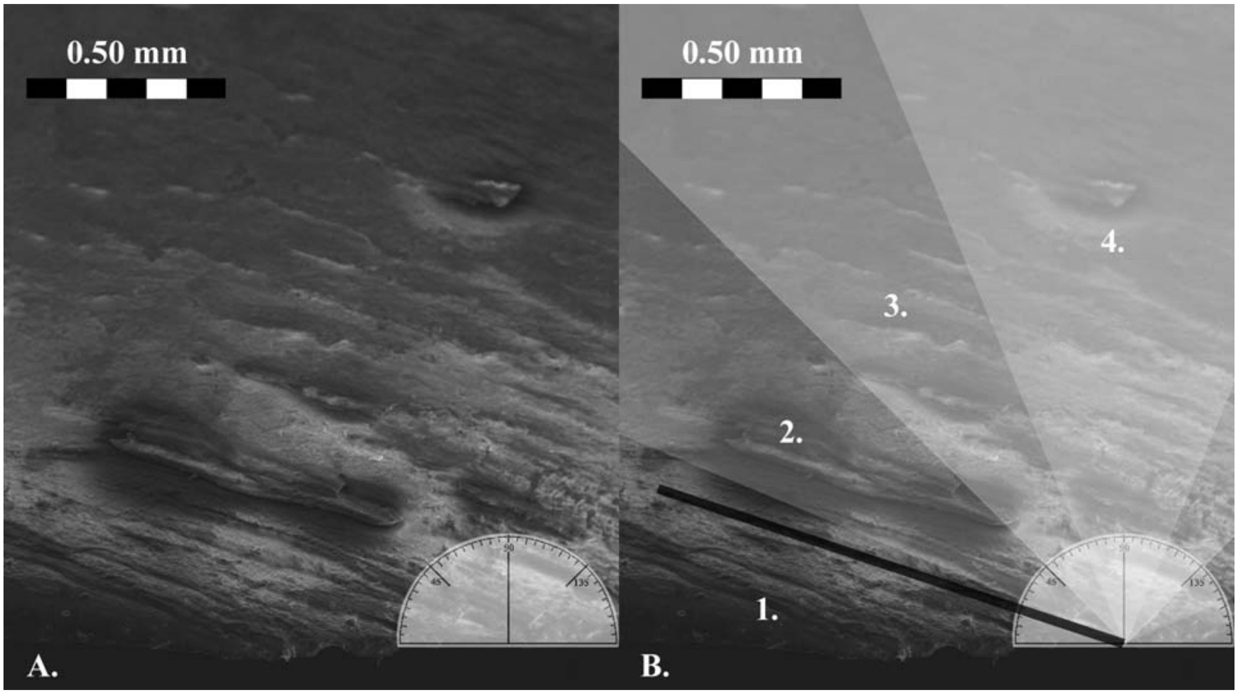

Figure 23. Striation Ordinal Schema

Polish Ratio Schema

Polish intrusion, the second attribute recorded, was measured from the working edge of the flake to its uppermost visible mark (Figure 24). A Nikon C-PS light microscope was used to record this attribute as it facilitated measurement of polish reflections.

To minimize the measurement of non human made polishes on the flake tools, an average polish intrusion can be calculated by taking the polish intrusion on the flake edge at different intervals, then using the calculated average polish intrusion as the flake tools' overall polish intrusion measurement. This works well on experimental flake tools whose edge area of use is known. However, this schema should be exercised with caution on archeological flake tools as the extent of the used edge is unknown.

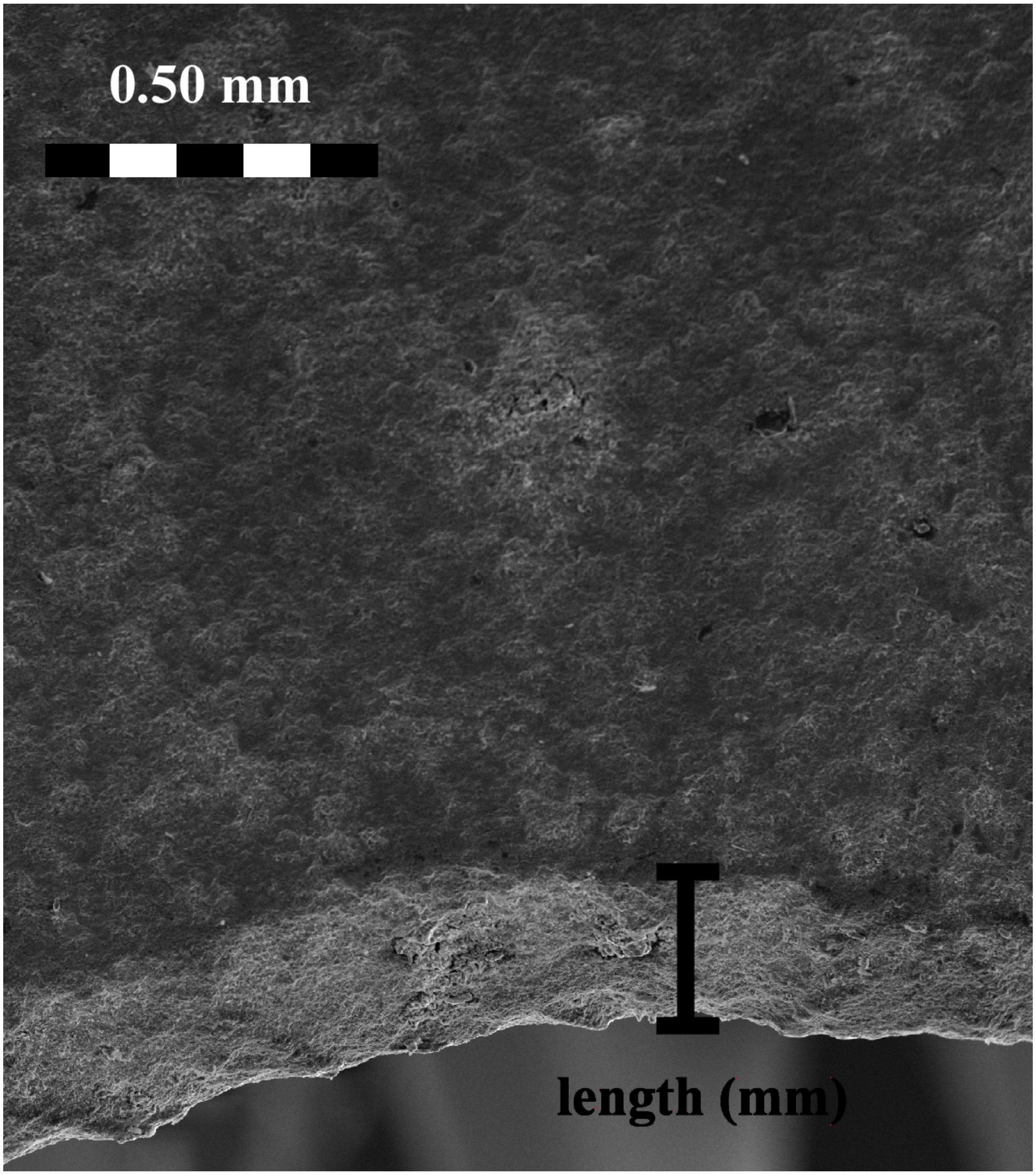

Figure 24. Polish Ratio Schema

Used Edge Morphology Nominal Schema

Edge morphology after tool use was the last attribute used for this analysis. Edge morphology, after the flake had been used, -- hereafter "damaged-edge-morphology" was observed and classified into one of four categories: 1) smooth; 2) lunate; 3) worn; or 4) shattered (Figure 25).

“Smooth” damaged-edge-morphology has little morphological alteration after the flake has been used: microchipping is small (less than 0.2 mm in width) and usually shallow with feathered termination when they do occur – very rarely (Figure 25.A). “Lunate” damaged-edge-morphology has distinct “half-moon” crescent shaped breakages along the edge after use; the edge itself could be snapped off, but the “half-moon” shape is still noticeable (Figure 25.B; after Keeley 1980). “Worn” damaged-edge-morphologies have invasive morphological alteration of the edge after the edge has been used: the flake edge itself could be snapped off or severely crushed, have large microchipping scars (more than 0.2 mm in width) that are deep and most often step terminated (Figure 25.C). “Shattered” damaged-edge-morphologies are distinguished because they rarely have aggressive microchipping like “worn” edges, yet have a noticeably damaged edge (Figure 25.D) which sets them apart from the other three damaged-edge-morphologies.

The length of the edge utilized in the activity was measured (in this case 2 cm) and if a “lunate” or “worn” pattern was present on more than 50 % of the edge (in this case 1 cm) the damaged-edge-morphology fell under that patterns name – “lunate” or “worn;” otherwise it was assigned as “shattered.” If, however, more than 50 % of the edge did not classify as “lunate” or “worn” but was also not noticeably “shattered,” the flakes damaged-edge-morphology defaulted to “smooth.” Only when the flake was completely unmodified was it labeled “blank.” The category “blank” was needed because blanks were used for controlled purposes on the blind test as is explained below.

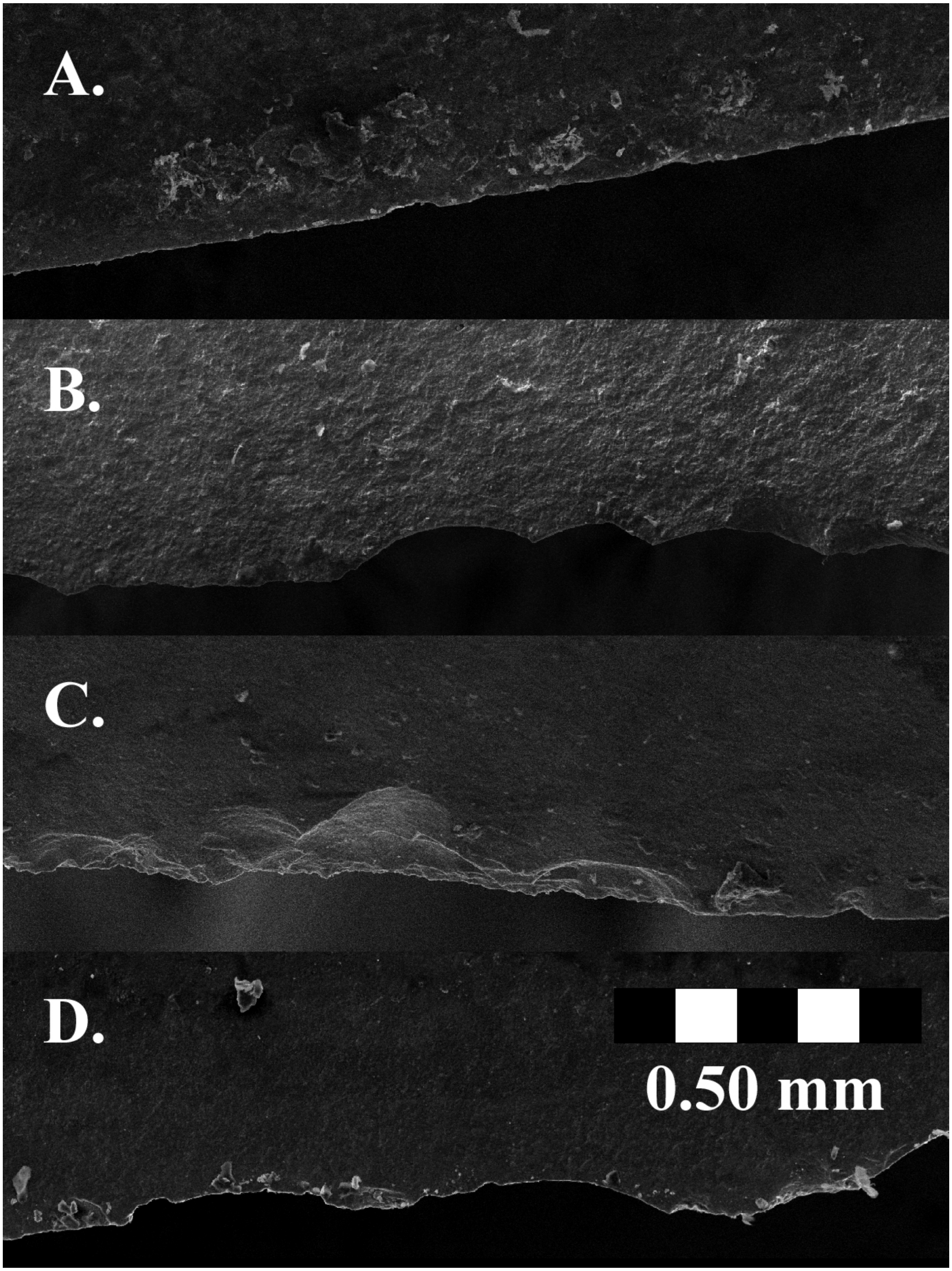

Figure 25. Damage-edge-morphology Nominal Schema. A) Smooth; B) Lunate; C) Worn; and D) Shattered

PART 4: Archeological Record

Three collections provided the flake tools for which the experimental microscopic study and analysis could be applied: 1) the Qwu?gwes (45TN240) collection; 2) the Hartstene collection; and 3) the Sunken Village (35MU4) collection.

Qwu?gwes

The Qwu?gwes collection contained eighty-two flakes tools recovered over seven summer digs – 1999-2006. The eighty-two flakes were represented in all parts of Qwu?gwes. From the eighty-two flakes recovered 40 (48.8%) were gathered from the shell midden area, 24 (29.3%) were collected from the food processing area, 2 (2.4%) were assembled from the living area, and 16 (19.5%) were surface beach finds (Figure 26).

While there is little spatial patterning to the flake tool distribution recovered at Qwu?gwes it is curious to note that approximately half of the flake tools were found in the shell midden portion of the site; an area with excellent preservation of wood and fiber artifacts as it has good preservation of these materials because of the aquifer which streams from the east, and the daily tide which submerges it under water twice a day from the west. The relatively large number of surface finds of flake tools also along the rest of the intertidal area also suggests that these flake tools were used through the intertidal zone and discarded when the task was finished – presumably to be washed away with other debitage.

The flake tools recovered from the food processing and living areas, suggests that flake tools were also used at other areas of the site. Their lower numbers, however, suggests that perhaps the majority of the activities done with the use of flake tools were preferred to be done in the intertidal area. The lower number of flake tools recovered from living and food processing area could alternatively be explained by a lower volume excavated on this portion of the site.

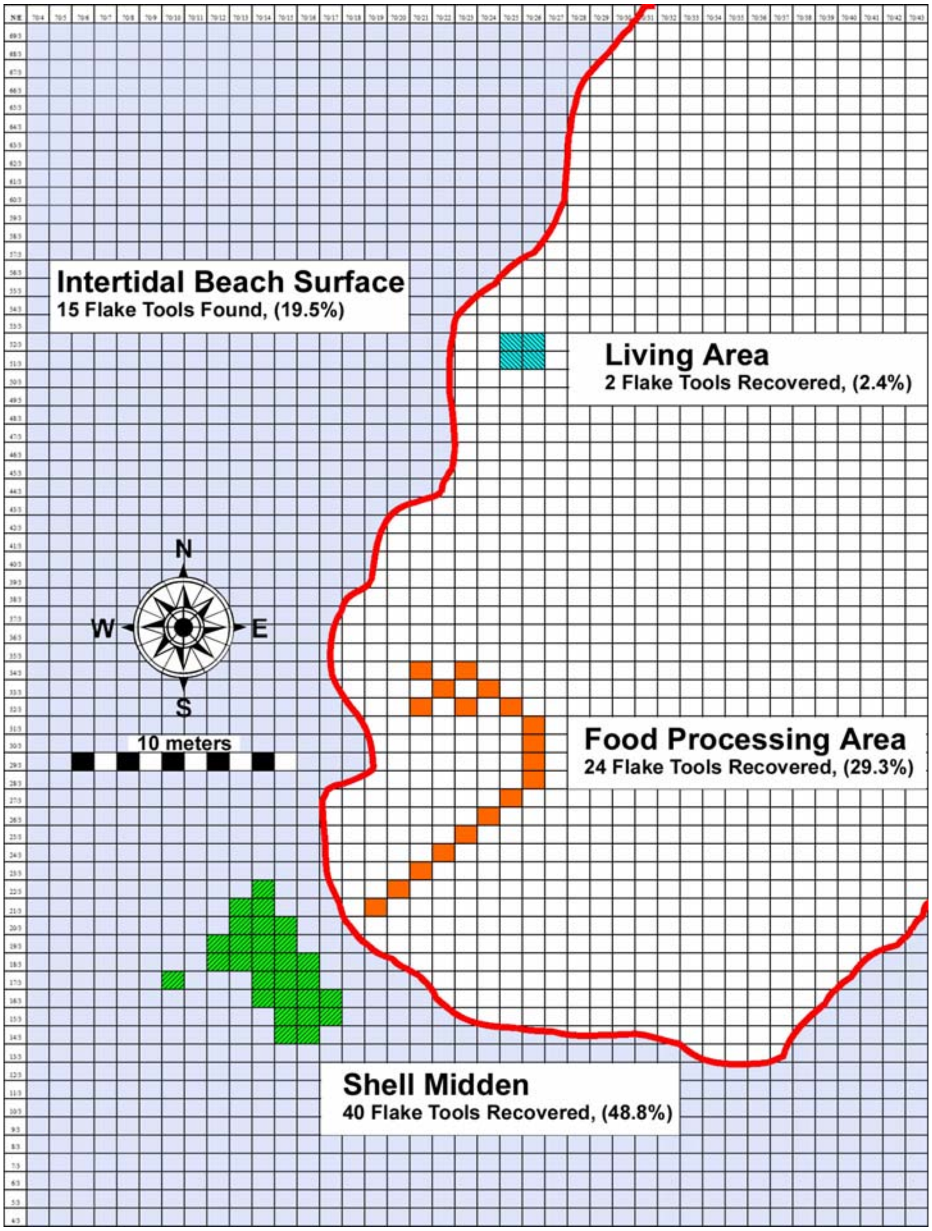

Figure 26. Qwu?gwes flake tool's spatial distribution. The dark area approximated the present day intertidal zone where high tides can reach up to the delineated boundary.

Nevertheless, the distribution of flake tools recovered expands all of the site and is not concentrated in one particular area. Representative specimens are illustrated in Figure 27. Morphological attributes of length, width, thickness, weight, termination and edge angle used were recorded, as well as flake platform type and termination (Figure 16, 17, 18 and 19; Table 9;

Appendix B). The three usewear attributes observed – polish intrusion, striation direction, and edge morphology – were then recorded (Appendix F).

Table 9. Qwu?gwes Flake Tools Morphological Attributes

Attribute	N	Minimum	Maximum	Mean	Std. Deviation
Length (mm)	82	9.13	44.72	23.37	7.13
Width (mm)	82	6.22	23.76	12.05	3.86
Thickness (mm)	82	1.79	11.44	5.00	2.12
Weight (g)	82	0.2	9	1.6	1.7
Edge Angle	82	10	90	28.9	14.2

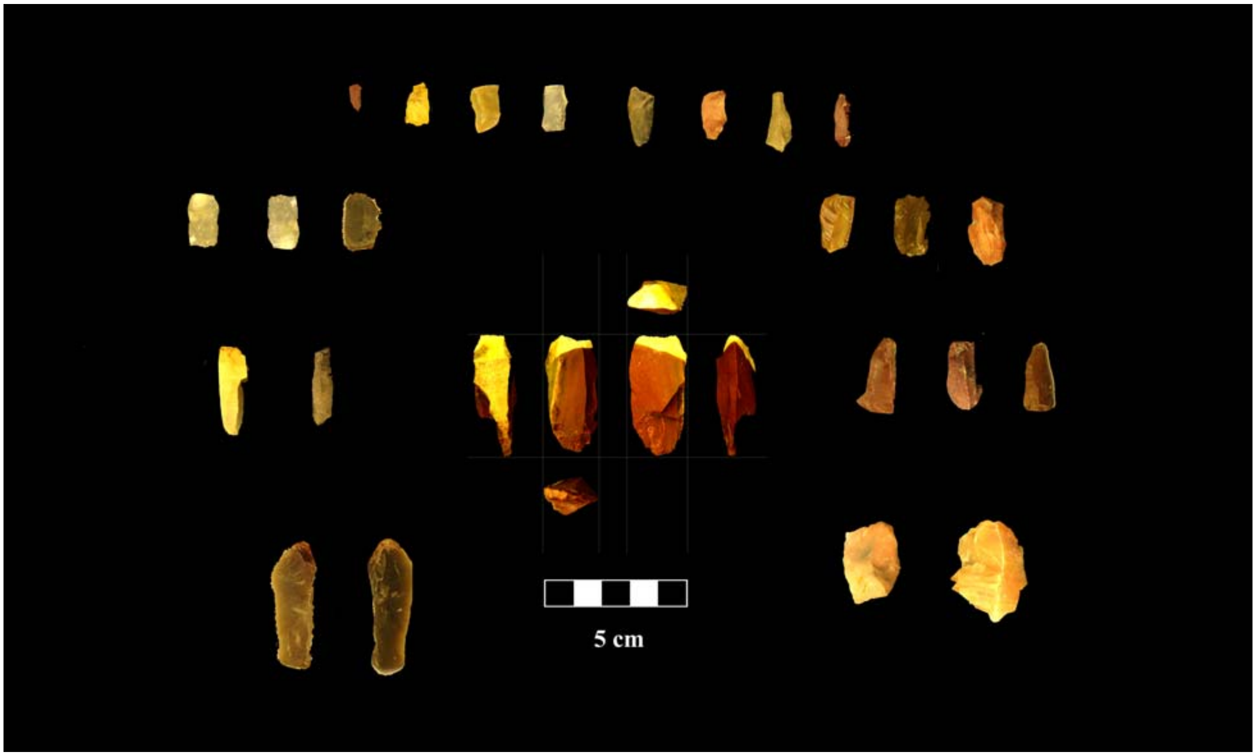

Figure 27. Representative specimens of Flake Tools and a Unidirectional Core from Qwu?gwes

Hartstene

The Hartstene collection provided forty flake tools (Figure 28). Like their Qwu?gwes counterparts, each of the flake tools' morphological attributes of length, width, thickness, weight, termination, angle of edge used, flake termination and platform type were recorded (Figure 16, 17, 18 and 19; Table 10; Appendix C). The three usewear attributes observed – polish intrusion, striation direction, and edge morphology – were also recorded (Appendix G). The Hartstene Island artifact collection consists of a surface collection gathered by Jack and Charleen Nickles from the tidal zone on the western shore of Hartstene Island. Consequently there are no site providences for the artifact distribution analysis.

Table 10. Hartstene Flake Tools Morphological Attributes

Attribute	N	Minimum	Maximum	Mean	Std. Deviation
Length (mm)	40	16.80	46.38	29.32	7.08
Width (mm)	40	6.94	22.09	13.54	3.29
Thickness (mm)	40	1.56	5.89	3.79	1.05
Weight (g)	40	0.1	6.6	1.8	1.2
Edge Angle	40	1	47	25.6	10.6

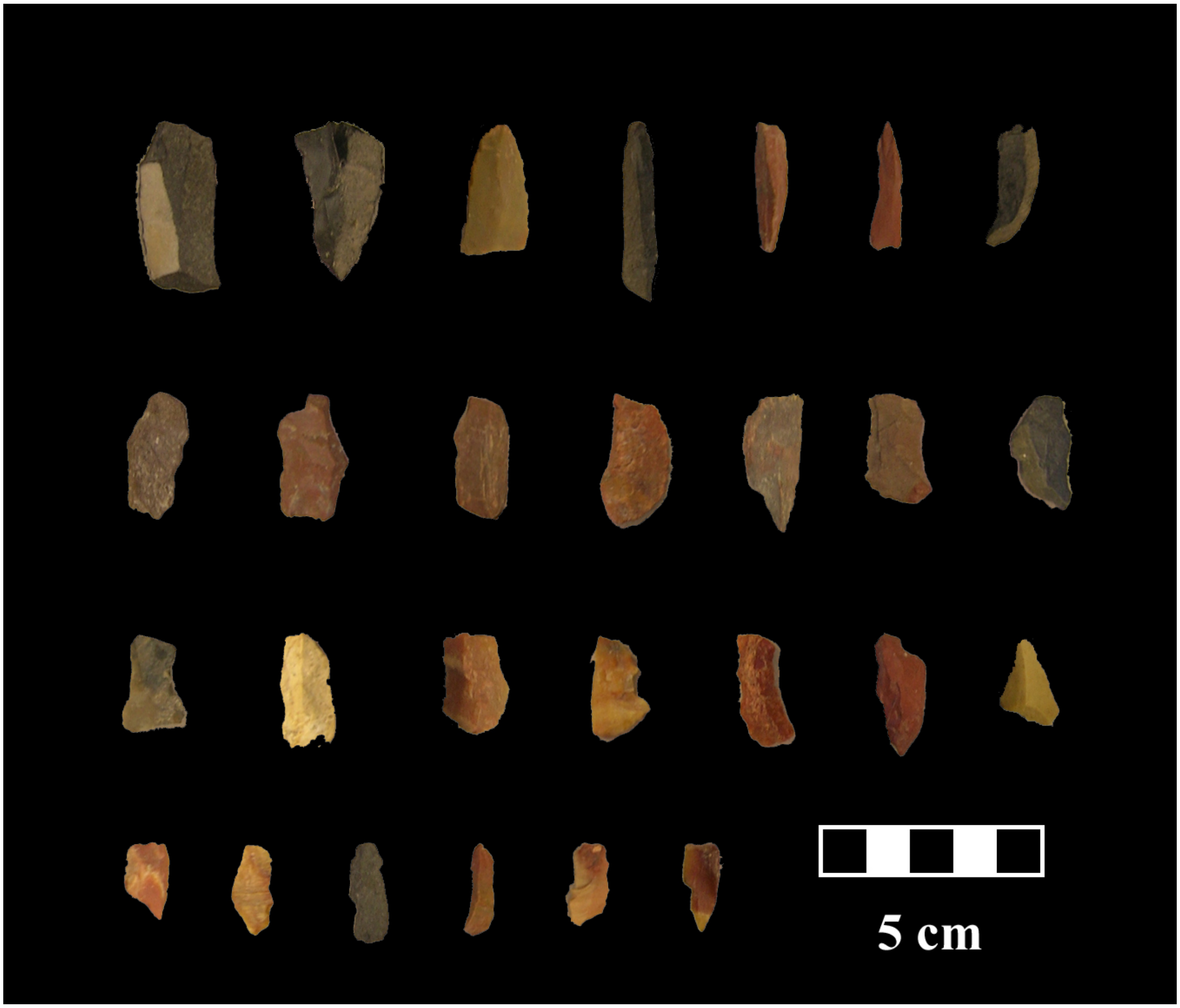

Figure 28. Examples of the Hartstene's Flakes Tools

Sunken Village

The Sunken Village site provided 78 flake tools for analysis (some pictured in Figure 29) whose morphological attributes of length, width, thickness, weight, termination, angle of edge used, flake termination and flake platform type were recorded (Table 11; Appendix D). The three usewear attributes observed – polish intrusion, striation direction, and edge morphology – were also recorded (Appendix H). At the Sunken village site there was no area which contained a concentration of flake tools; the flake tools recovered were collected from all over the site.

Table 11. Sunken Village Flake Tools Morphological Attributes

Attributes	N	Minimum	Maximum	Mean	Std. Deviation
Length (mm)	78	6.71	50.37	21.45	8.86
Width (mm)	78	4.17	35.33	14.35	6.07
Thickness (mm)	78	1.01	19.10	4.34	3.00
Weight (g)	78	0.1	13.6	1.7	2.7
Edge Angle	78	8	75	29.9	11.8

Figure 29. Examples of the Sunken Village's Flakes Tools

CHAPTER FOUR: ANALYSIS AND SYNTHESIS

In the first part of this chapter I describe the attributes observed for each flake tool after it was used. The attributes discussed are striation direction, polish intrusion, and damage-edge-morphology. Analysis of these observable attributes on each flake tool forms the main approach implemented for the microwear analysis section of this thesis. The second part of this chapter deals with new directions in microwear analysis. Here I explore the use of discriminant function analysis as a methodology in developing an objective approach for identifying past actions as seen on flake tools – once a subjective task prone to error from human preconceptions and biases. In the third part, I describe the blind tests developed to assess the strength of this "objective" approach in identifying past actions of flake tools. A brief discussion of discriminant function analysis follows in the forth part of this chapter. Here, I then apply a discriminant function analysis on the replicated experimental flake data and tested the validity of this methodology by testing the discriminant function analysis predictive powers with blind tests. Lastly, in the fifth part, the procedures of discriminate function analysis were applied to the flake tool assemblages from the Qwu?gwes, Hartstene and Sunken village sites.

PART 1: Wear Attributes of Experimental Flake Tools After Use

Striation Ordinal Schema

The four-point ordinal data "striation direction" schema developed in chapter 3 (Figure 23) was applied to the Edwards Plateau chert flake-tools after the actions of cutting, scraping and whittling were completed as defined in that chapter (Appendix E).

Striation direction on the replicated experimental flake tools were observed after the flake tool had been used and the data are graphed by percentages of used-flake tools per task with a clear pattern emerging (Figure 30). Cutting striation directions are mostly less than 45 degrees. That is to say they fall in the ordinal values of "1" and "2". In fact, for cutting, more than 60 % of the striations are at angles less than 22.5 degrees, while approximately 20 % of the striations fall between 22.5 and 45 degrees. This is completely different than the scraping actions which generally left striations higher than 45 degrees.

When we examine striation directions in whittling actions we see that the only striation left are higher than 45 degrees in respect to the working edge. That is to say, only striation direction "3" and "4". In fact, roughly 40 % of the time striations fall between 45 and 77.5 degrees, and another 40 % of the time the striations are higher than 77.5 degrees (Figure 30).

When examining scraping actions we get another pattern. What could be logically expected for scraping actions is striation direction higher than 45 degrees to the worked edge. However, for scraping, roughly 20 % of the striations observed fall under 45 a degree after a flake undergoes scraping activities. I suspect this has come about by the initial insertion of the flake's edge on the worked material which leaves ordinal scale "1" and "2" striations imprinted on the tool.

Nevertheless, scraping and whittling actions produced by far a larger amount of higher than 45 degree striations than less than 45 degree striations. The rare occurrence of striation left at less than 45 degrees for scraping and whittling is not easily explained (Figure 30). One possible scenario that would lead to parallel striation marks is the termination of the action performed by the flake tools. That is to say, as the flake is used to whittle or scrape, the flake might unconsciously or unwittingly be turned "parallel" to the worked surface as the flake exits the worked material to reduce friction forces opposed to the scrapping or whittling action – think of sharpening a pencil with a knife and at what angle the knife forms as it exits from a "whittling" motion. In any event there is a clear pattern that emerges when the striation directions are graphed per action undertaken (Figure 30).

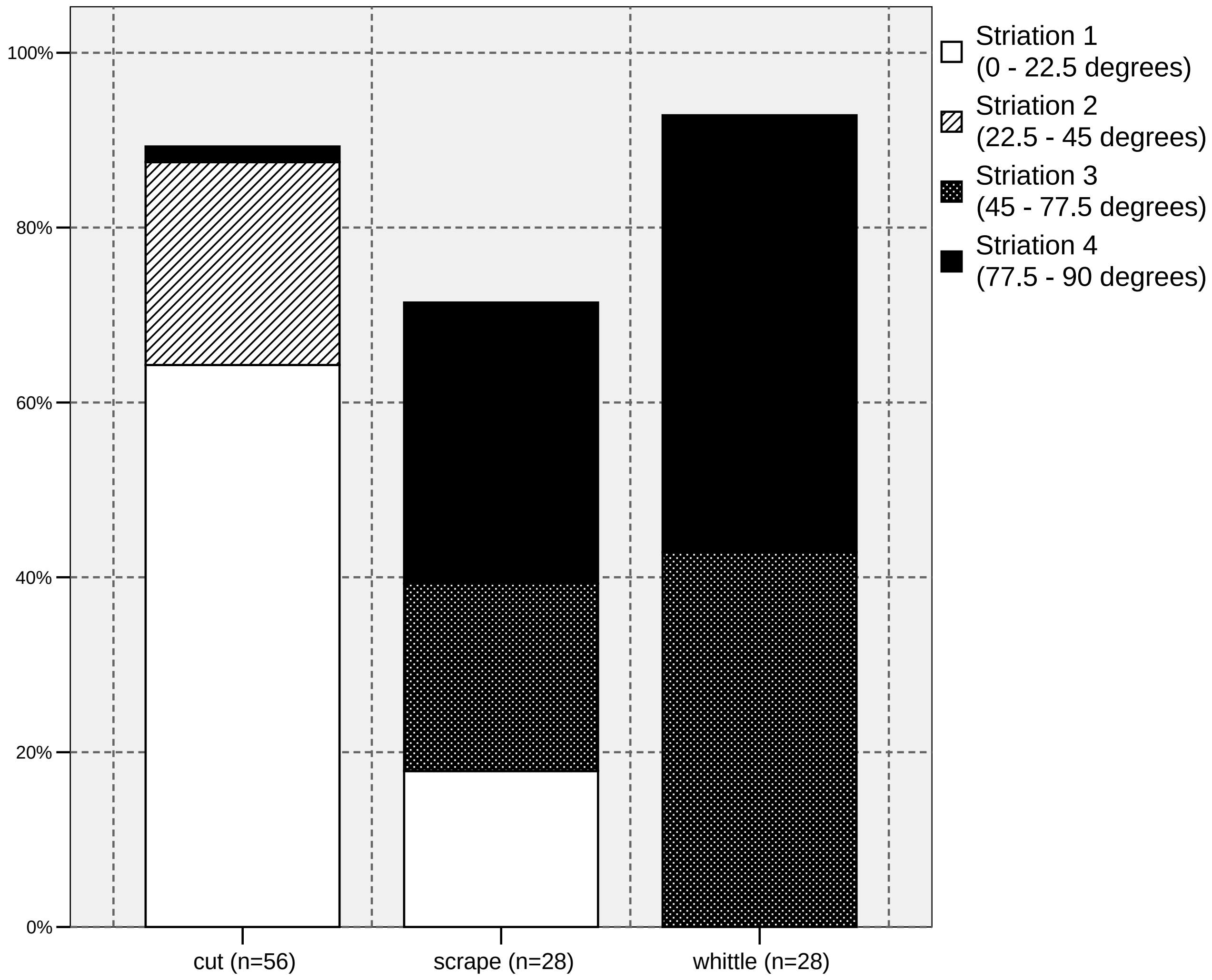

Figure 30. Striation direction per activity

The striation direction per activity pattern – intuitively observed when graphed – is statistically significant. A Chi-squared test on the four point ordinal scheme shows high significance of the data patterning, while a Cramer's' V shows its strong association (Table 12: $X^2 = 78.1499$; df = 6; $p \leq 0.001$; Cramers V = 0.638).

Table 12. Striation direction Chi^2 computation and corresponding percentages

Activity	Striation Direction				Total Flakes with observed striation n (%)
	1 (%)	2 (%)	3 (%)	4 (%)	
Cut (n = 56)	36 (64.3)	13 (23.2)	0 (0)	1 (1.8)	50 (89.3)
Scrape (n = 28)	5 (17.9)	0 (0)	6 (21.4)	9 (32.1)	20 (89.3)
Whittle (n = 28)	0 (0)	0 (0)	12 (42.9)	14 (50.0)	26 (92.9)
Total (n = 112)	41 (36.6)	13 (11.6)	18 (16.1)	24 (21.4)	96 (85.7)

Polish Intrusion Ratio Schema

The ratio data set for the polish intrusion schema developed in chapter three (Figure 24) was applied to the Edwards Plateau chert experimental flake-tools after the actions of cutting, scraping and whittling were completed (Appendix E). It should be stated again that the polish intrusion is measured by the amount of edge polish and is a solid whole number value.

Polish intrusion was graphed by each action undertaken for the experimental flake tools (Figure 31). Mean polish intrusion differences per action can be clearly observed. Cutting mean polish intrusion is 1.623 mm ($\sigma = 0.851$), with a range from 0.0 to 3.8 mm. Scraping has a mean polish intrusion of 0.392 mm ($\sigma = 0.303$) with a range from 0.0 to 1.2 mm. Lastly, whittling has a mean polish intrusion of 5.426 ($\sigma = 2.640$) and a range of 0.0 to 9.0 mm.

Student T-Tests compare the means of cutting, scraping and whittling and demonstrate that polish intrusion is statistically different per action. The students T-Test between cutting and scraping indicates the difference in polish intrusion are not due to chance (t = 7.276; F = 19.526; df = 81; $p \leq 0.001$). The Students T-Test between cutting and whittling also indicates that the difference in polish intrusion are not due to chance (t = -9.828; F = 55.934; df = 81; $p \leq 0.001$). For the last comparison, the Students T-Test between scraping and whittling, also indicates that the difference are not due to chance (t = -9.845; F = 56.265; df = 52; $p \leq 0.001$). The pattern differences observed between different polish intrusion depending on action done by each flake tool is statistically supported and evident in Figure 31.

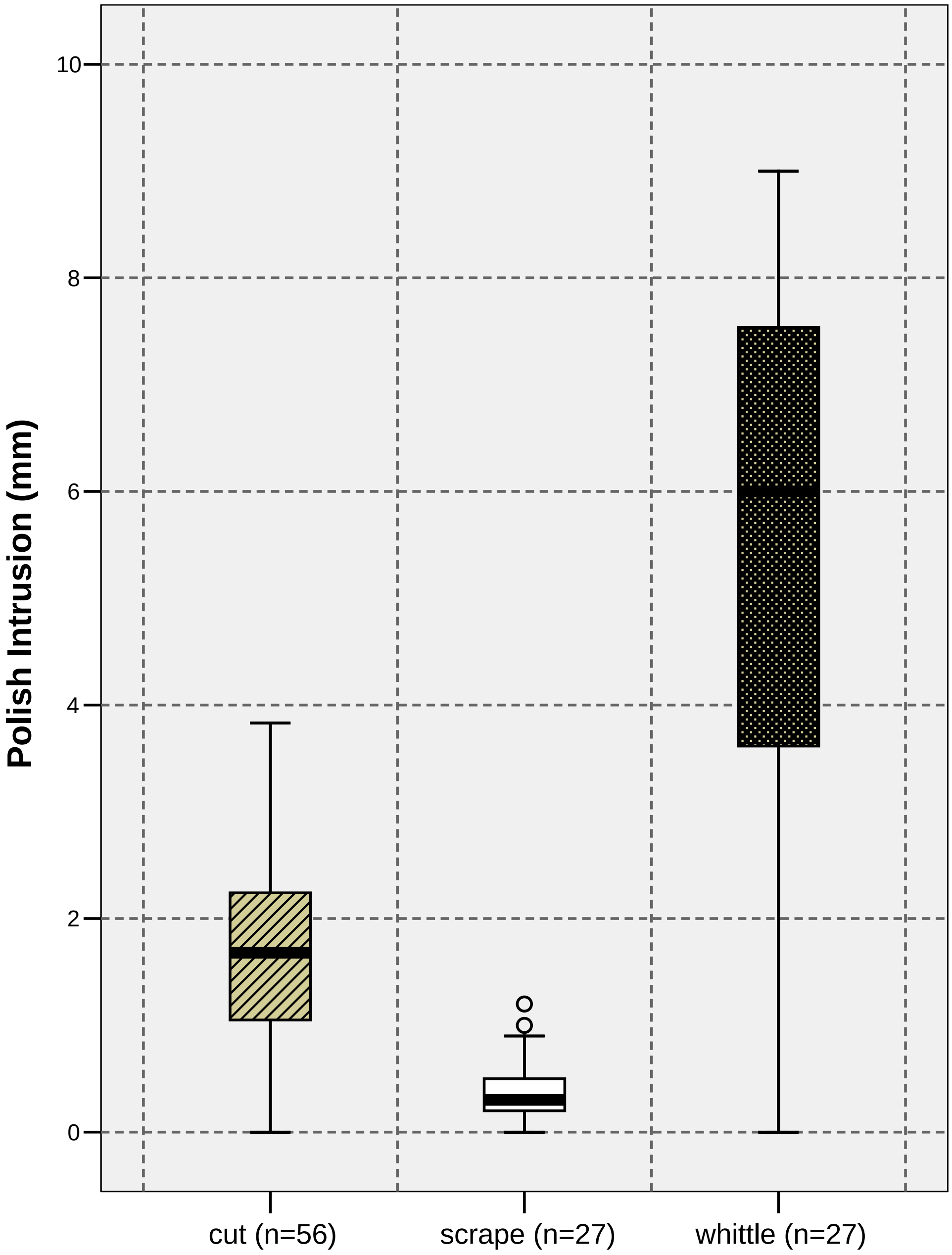

Figure 31. Polish intrusion per activity

Damage-edge-morphology Nominal Schema

The “damage-edge-morphology” nominal schema developed in chapter three (Figure 25) was applied to the Edwards Plateau Chert flake-tools (Appendix E). The experimental flake tools were divided into the four edge type categories: 1) smooth; 2) lunate; 3) worn; and 4) shattered. Graphing the percentage of each activity with its resulting damaged-edge-morphology reveals a pattern of edge-morphology after particular actions undertaken (Figure 32):

Cutting actions produced the largest category of “smooth” (42.9 %) used edge morphology; followed by “shattered” (32.1 %), “lunate” (14.3 %), and “worn” (10.7 %) edge morphologies. Scraping actions produce a drastically different edge type patterns than cutting actions: the vast majority of edge types after use were classified as “lunate” (64.3 %) followed by “smooth” (21.4 %), “worn” (7.1 %) and “shattered” (7.1 %) respectively in diminishing quantities. Whittling actions produced the most amounts of [surprisingly] “smooth” edges (35.7 %) running somewhat in the same quantity as “worn” (32.1 %) edge morphology. “Lunate” (21.4 %) and “shattered” (10.7 %) edge morphology were observed in diminishing numbers.

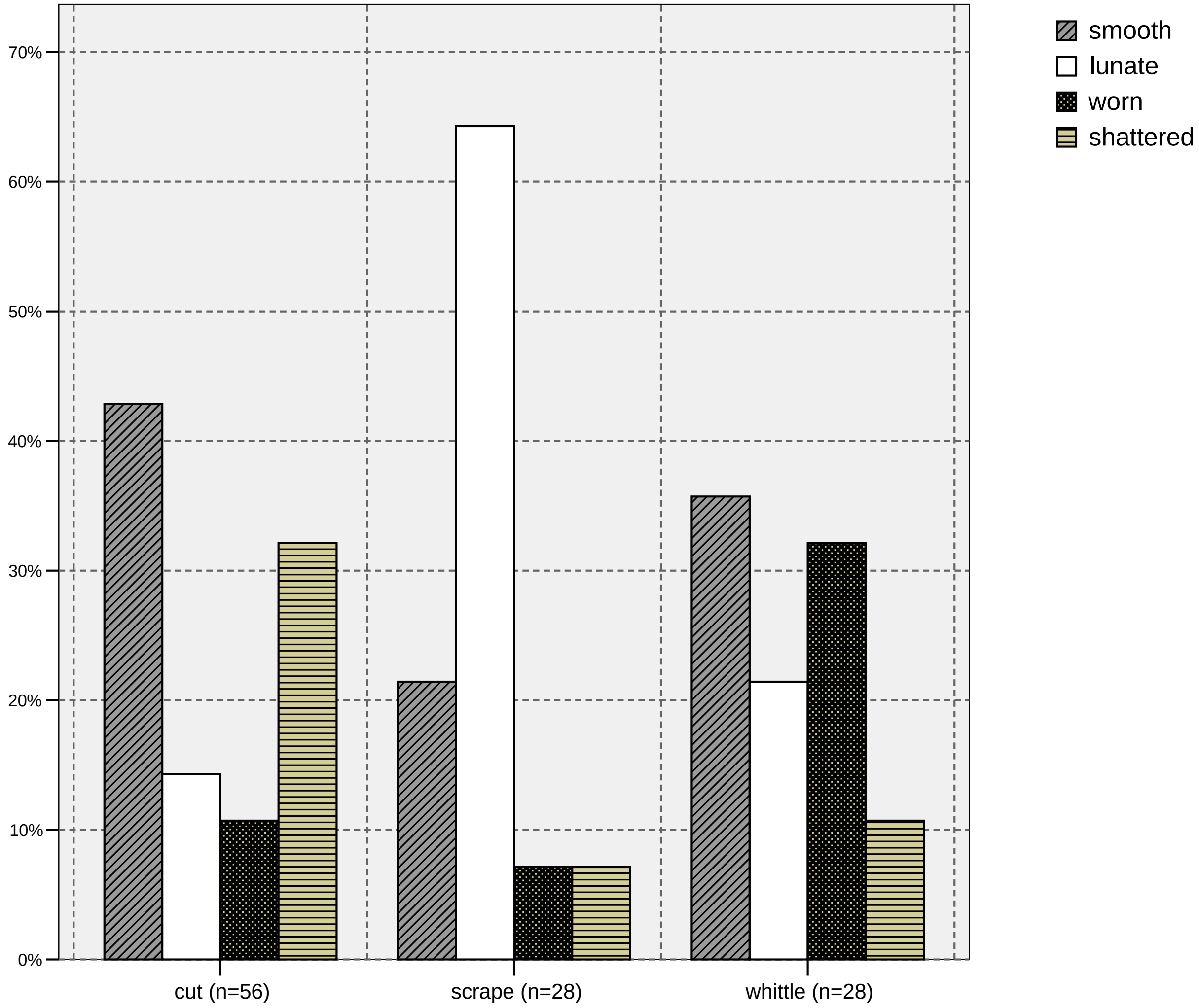

Figure 32. Damage-edge-morphology per Activity

A Chi-squared test on the data reveal the pattern are highly significant and a Crammers' V measures it's' association (Table 13; $X^2 = 34.0701$; df = 6; $p \leq 0.001$; Cramers V = 0.389). Said differently, the edge morphology of a flake-tool after a particular activity does leave statistically significant morphological traces on the tools edge. In sum: "smooth" damaged-edge-morphology most often occurred when the edge angle of the flake was used in a parallel direction to worked surface, as done by cutting actions. “Lunate” damaged-edge-morphology usually occurred with flake tools which had small angled edges (30° or less) were worked in a lateral motion to the worked surface, as done by “scraping” actions. “Worn” damaged-edge-morphology most often occurred after the edge of the tool was used in “whittling” actions, although “whittling” actions also has a large percentage of edge morphology as “smooth.”

Table 13. Damage-edge-morphology Chi^2 Computation and Corresponding Percentage

Activity	Damage-edge-morphology				Total flakes with observed edge morphology n (%)
	Smooth n (%)	Lunate n (%)	Worn n (%)	Shattered n (%)	
Cut (n = 56)	24 (42.9)	8 (14.3)	6 (10.7)	18 (32.1)	*56 (100)*
Scrape (n = 28)	6 (21.4)	18 (64.3)	2 (7.1)	2 (7.1)	*28 (100)*
Whittle (n = 28)	10 (35.7)	6 (21.4)	9 (32.1)	3 (10.7)	*28 (100)*
Total (n = 112)	*40 (35.7)*	*32 (28.6)*	*17 (15.2)*	*23 (20.5)*	*112 (100)*

PART 2: Discriminant function analysis: A Test on Experimental Flake Tools

A discriminant function analysis procedure generates a function based on linear combinations of the predictor variables – in this case: striation direction, polish intrusion and damaged-edge-morphology - which provide the best discrimination between the groups. The functions for the analysis are generated from a sample of cases for which group membership is known – the experimental flakes – and then are applied to new cases with measurements for the predictor variables but whose group membership is unknown – the three archaeological flake tools assemblages (Baxter 1994; Drennan 1996; Shennan 1997).

A discriminant function analysis was applied to model the chert experimental flake tools set. A one-way ANOVA for chert’s independent variables of the experimental flake tools as a factor indicate that variables, polish intrusion and striation direction, in the model significantly contribute to the discriminate model, while damage-edge-morphology doesn't statistically significantly contribute to it at the arbitrary $p \leq 0.05$ level – yet it can be used to discriminate between activity groups (Table 14: Polish Intrusion: F = 71.002; df 2,92; $p \leq 0.001$; Striation Direction: F = 84.892; df 2,92; $p \leq 0.001$; Damage-edge-morphology: F = 0.966; df; 2,92; p = 0.384). Measurements of Wilks' lambda indicate that striation direction is the best variable at discriminating between groups; Polish intrusion and damaged-edge-morphology follow with diminishing discriminatory power (Table 14; Polish Intrusion: Wilks' Λ = 0.351; Striation Direction: Wilks' Λ = 0.393; Damage-edge-morphology: Wilks' Λ = 0.979). The discriminant function analysis on Chert is visually displayed in Figure 33.

Table 14. Tests of Equality of Group Means

Variable	Wilks' Lambda	F	df1	df2	Sig.
Polish Intrusion	0.393	71.002	2	92	0.001
Striation Direction	0.351	84.892	2	92	0.001
Edge Morphology	0.979	0.966	2	92	0.384

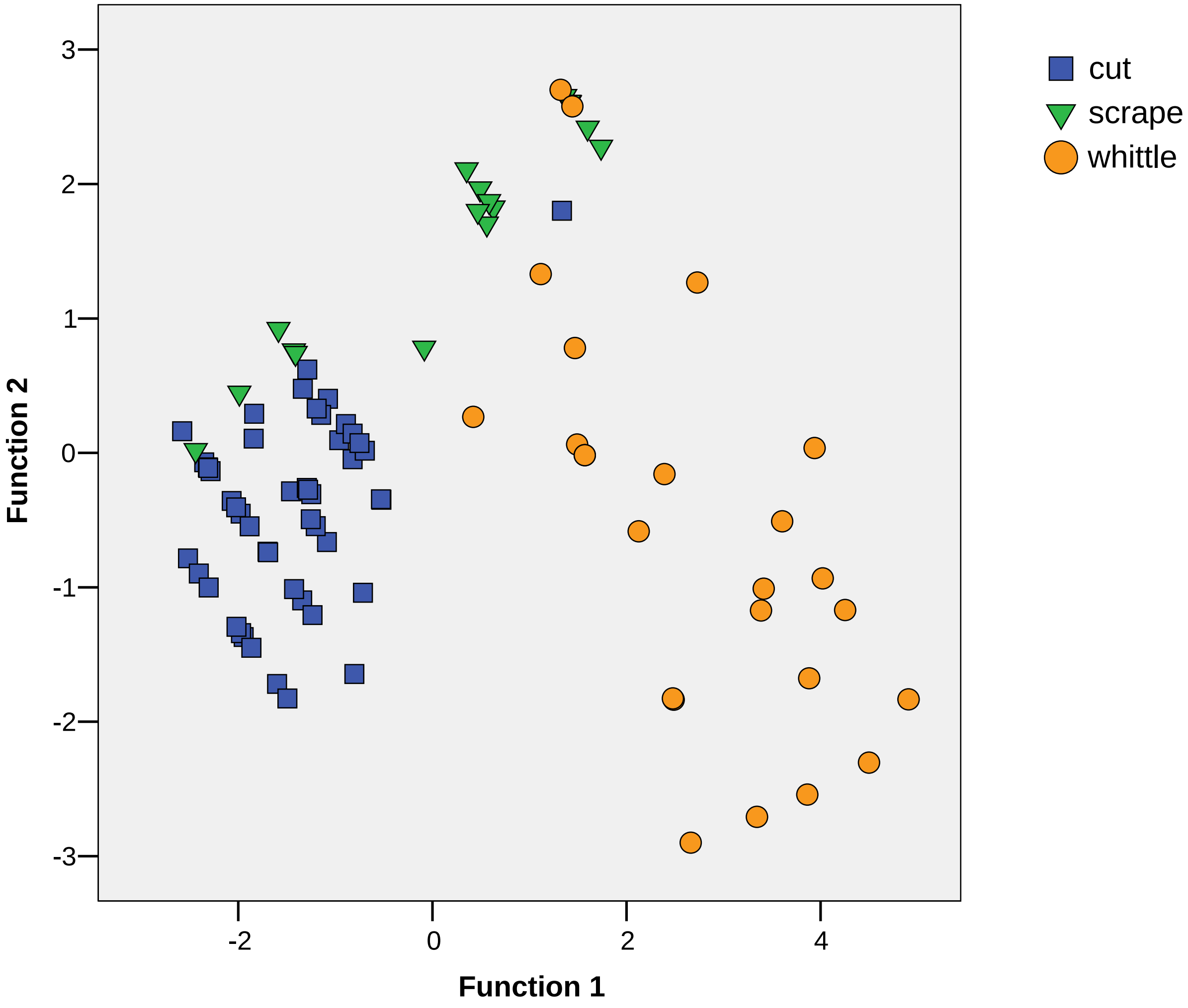

Figure 33. DFA of experimental flake tools

The correct reclassifications per activity on experimental flakes by the discriminant function analysis are presented in Table 15. Cutting actions are correctly classified 96 % of the time. Scraping actions are correctly classified 75 % of the time, while whittling action were correctly classified 84 % of the time (Table 15). Overall, 88.4 % of cases from known activities were classified correctly.

Table 15. DFA on Chert Experimental Flake Tools

		Predicted Group Membership (%)		
	Action	Cut	Scrape	Whittle
TOOL	Cut (n = 50)	96.0	4.0	0.0
	Scrape (n = 20)	25.0	75.0	0.0
	Whittle (n = 25)	0.0	16.0	84.0

Cutting actions have such a high correct reclassification rate because of their overwhelming quantity of striation direction at angles less than 45 degrees, and their low polish intrusion. The reason they incorrectly are identified as scraping-flake-tools is most likely due to cutting and scraping activities result in overlapping polish intrusion measurements and their damage-edge-morphology. The same is true for the scraping-flake-tools being miss-classified as cutting-flake-tools (and not whittling-flake-tools) as the result of similar overlapping polish intrusion left after each action (Figure 31). Polish intrusion is in fact what nicely separates the recognition of whittling-actions. Whittling action, eighty-four percent correct reclassification rates are due in fact to it's highly unique polish intrusions (whittling mean: 5.426 mm, σ = 2.6395; Figure 31). Whittling-flakes were only incorrectly classified as scraping-flakes about sixteen percent of the time, a byproduct of both actions having highly similar striation direction patterns after use (Figure 30). Scraping-flakes, on the other hand, only incorrectly classified some twenty-five percent of the time as cutting-flakes – not whittling-flakes; an artifact of whittling-flakes having drastically different mean polish intrusion (5.426 mm, σ = 2.6395) as compared to the more closely mean similar polish intrusion of cutting-flakes' (1.623 mm, σ = 0.8509) to scraping-flake's mean polish intrusion (0.392 mm, σ = 0.3030) which overlaps, somewhat, with each other (Figure 31).

PART 3: Blind Tests

Blind tests were undertaken to confirm the methodological validity of the analysis. The blind tests were performed with the help of two fellow graduate students. Each of the 67 flakes set aside for blind test confirmation was randomly designated an action to be undertaken to cut, scrape or whittle. There is a potential for bias in the form of preconceived notions for which flake should be used for what activity afflicts both the blind-testers – the two fellow graduate helpers – and the analyst German Loffler. Each flake tools' action, therefore, was randomly designated to reduce biases in assigning a use for each flake.

In addition, approximately 5 % of the blind test flakes for each test were randomly left "blank" (unused) for further cross validation of the analysis. In other words, from the flakes for each blind test, 5 % were randomly chosen not to be utilized while the remaining flakes were randomly assigned for 50 cm^2 of fresh wood to be whittled away, 50 cm^2 of fresh bark to be scraped off, and 50 cm of fresh bark to be cut. The new category added made the categories for the blind test flakes: 1) cut; 2) scrape; 3) whittle; and 4) blank.

The flake tools' action was recorded by the blind-testers. While the action of each flake remained unknown to the analysts, the three attributes – striation direction, polish intrusion and damage-edge-morphology - were recorded and utilized to generate possible past activities (Appendix E). The blind test flake's actions were also guessed by the analyst. The correct activities of the blind test flakes would later be compared to the activity inferred by the analyst; and eventually compared to a computed prediction computed by a discriminant function analysis.

Using discriminnt function analysis, it appeared that the blind test flakes overlay those of the experimental flake tools (Figure 34); they are within an estimated range of what might be expected for the identification of four actions activities based on three attributes (Table 16).

Averaging the correct reclassification of the blind test flake's to each action as before, we can get the overall correct reclassification calculated by the discrimant function analysis. Overall, there was approximately 88 % correct classification of the original flake tools, and only approximately 70 % of the blind test flakes were correctly classified to their corresponding activities (Table 16; Table 17). The results for the blind test portion of these experiments are discussed below.

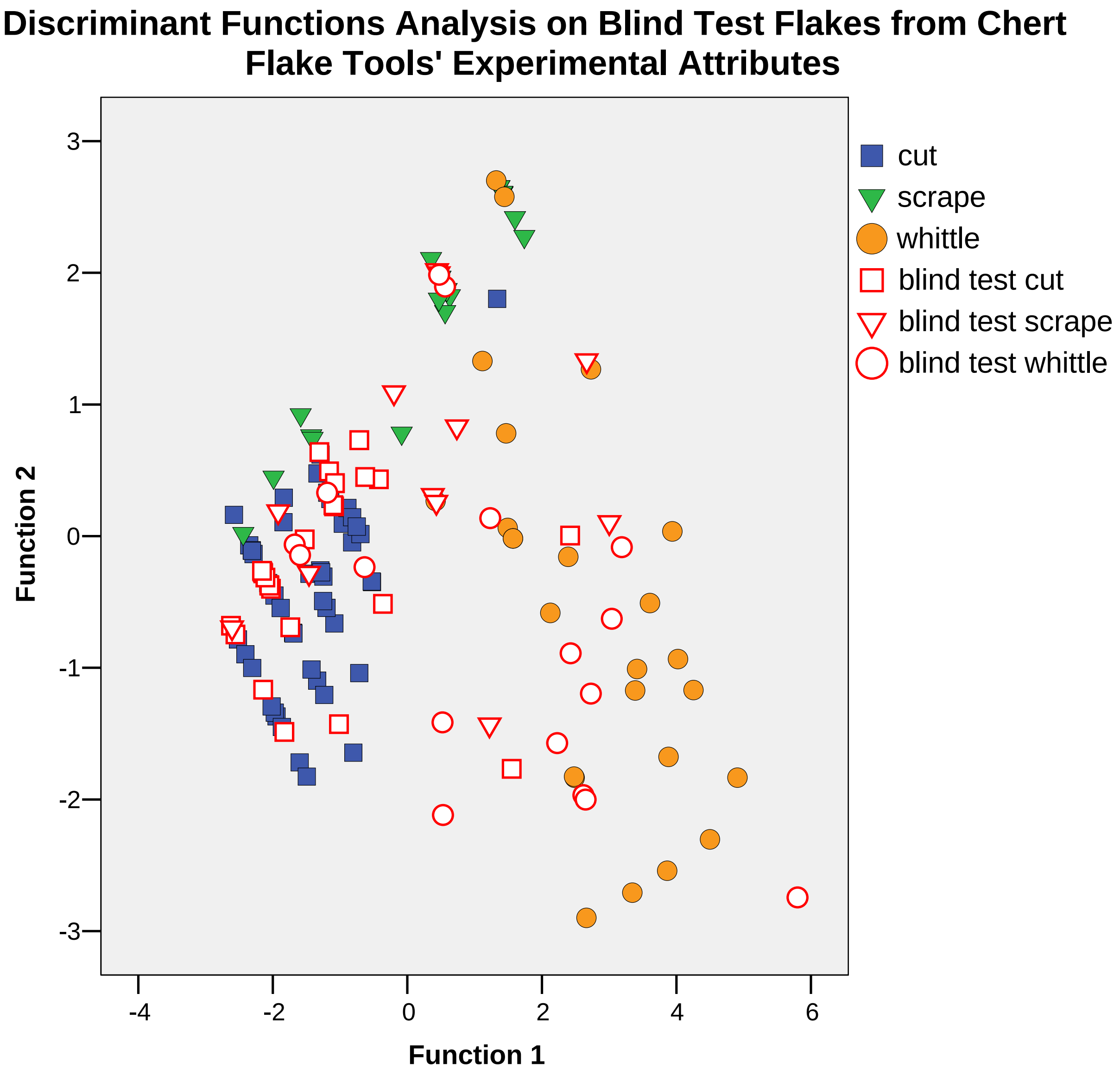

Figure 34. Chert attributes projected by discriminant function analysis

Table 16. Discriminant function analysis on Blind Test Flake Tools

DFA on BT		Predicted Group Membership (%)		
	Action	Cut	Scrape	Whittle
Flake Tools	Cut (n = 50)	96.0	4.0	*0.0*
	Scrape (n = 20)	25.0	75.0	*0.0*
	Whittle (n = 25)	0.0	16.0	*84.0*
Blind Test	Cut (n = 25)	92	0	8
	Scrape (n = 12)	25	50	25
	Whittle (n = 17)	35	12	53

The model's overall successful evaluation compared to the experimental data has its genesis in two key factors: The first is that only one raw material – Edward Plateau Chert – was used for the experimental analysis which eliminates complications and factors that murk up clear results projected onto the archeological record. Second, and more important, is the fact that the preoccupation of this analysis was in distinguishing signatures of only three activities: cutting, scraping and whittling. That is to say, additional activities carried out by the flake tools would reduce the success rates of evaluation. While multifunctional flake tools could possibly skew results or overlap wear patterns on flake tools, it is believed that these patterns record the signature of the last activity done with the flake before it was discarded. In other words, the analysis doesn't portray the entire flake tools active life – most likely it reveals only its last use although this remains to be tested.

For the blind test flakes then, for the four total options of what the flake tool might have been used for – cutting, scraping, whittling, or blank – I could only correctly identify about 75 % of the actions reflect on the blind test flake tools (Table 17; Appendix E). The discriminant function analysis could correctly identify each blind test flake to its corresponding action approximately 70 % of the time (Table 17). The low percentage of correct classification by the discriminant function analysis can be partially explained by the high number of errors in identifying “whittling” as “cutting,” and the misclassification of “scraping” as “cutting” (Table 16; Appendix E).

Table 17. Activity Correct Reclassification for Blind Tests per Lithic Material

	n	% Correct from 4 Activities	
		Guessed by GL	Computed by DFA
Chert (Appendix I)	68	75.0	70.4

PART 4: Discriminant function analysis: A Simplified Ideal DFA Data Set (64-bit & 8-bit)

This section explores how different numbers of variable inputs and different numbers of attribute inputs alter the predictive powers of the discriminant function analysis. In other words how that affects the confidence in predicting group membership in a flake tool’s function whose uses are unknown. Two explorations were undertaken. The first is termed a “64-bit” resolution discriminant function analysis while the second is termed an “8-bit” resolution discriminant function analysis. They are described below.

64-bit

The “64-bit” resolution exploration is so termed because each of three attributes observed can be classified into four ordinal or nominal categories each (4 x 4 x 4 = 64). The discriminant function analysis generated by temporarily transforming the amount of polish intrusion by three categories of use from chapter three into a four category ordinal data set, combined with the four category striation ordinal schema, and the four category damage-edge-morphology will be referred to as a“64-bit” resolution data set (Appendix I).

To arrive at the “64-bit” data set the three values are transformed to four ordinal and nominal data categories. Edge-morphology was kept as either “smooth,” “lunate,’ “worn” or “shattered” – four categories. Striation direction remained its ordinal “1,” “2,” “3,” or “4” direction – again four categories. Polish intrusion was the only greatly modified data as it was reduced from a scalar set to ordinal by taking the aggregated average of each activity and adding to it one standard deviation of polish intrusion (Table 18) and naming everything less than that which doesn’t overlap with another activity a “1,” “2,” “3,” or “4.” In effect, if we recall that cutting has a mean polish intrusion of 1.623 mm (σ = 0.8509), with a range from 0.0 to 3.8 mm. Scraping has a mean polish intrusion of 0.392 mm (σ = 0.3030) with a range from 0.0 to 1.2 mm. Lastly, whittling has a mean polish intrusion of 5.426 (σ = 2.6395) and a range of 0.0 to 9.0 mm. So if polish intrusion falls between 0 - 0.695 mm it is relabeled as “1.” If the polish intrusion falls between 0.695 - 2.4739 mm is relabeled as “2.” If however, the polish intrusion falls in the range of 2.4739 - 8.0655 mm it is classified as “3,” while anything higher than 8.0655 mm is classified as “4” (Table 18; Appendix I).

Table 18. Aggregated Polish Intrusion Values transformed into categories for "64-bit”

Polish Intrusion (mm)	*“64-bit” polish intrusion Schema*
$0.000 < X < 0.695$	*“1”*
$0.695 < X < 2.474$	*“2”*
$2.474 < X < 8.065$	*“3”*
$8.065 < X$	“4”

A discriminant function analysis based on this idealized “64-bit” data set is computed and illustrated for the three actions undertaken with the chert experimental flakes (Figure 35). The

“64-bit” classifications in this ideal model emerge from the graph. It should be immediately noted that there is much overlap in the discriminant function analysis’s 2-D coordinate projection. It should be kept in mind that the discriminant function analysis actually produced three functions for a 3D graph. However, as the first two functions explain the majority of the data variation and consequently only the first two functions are graphed.

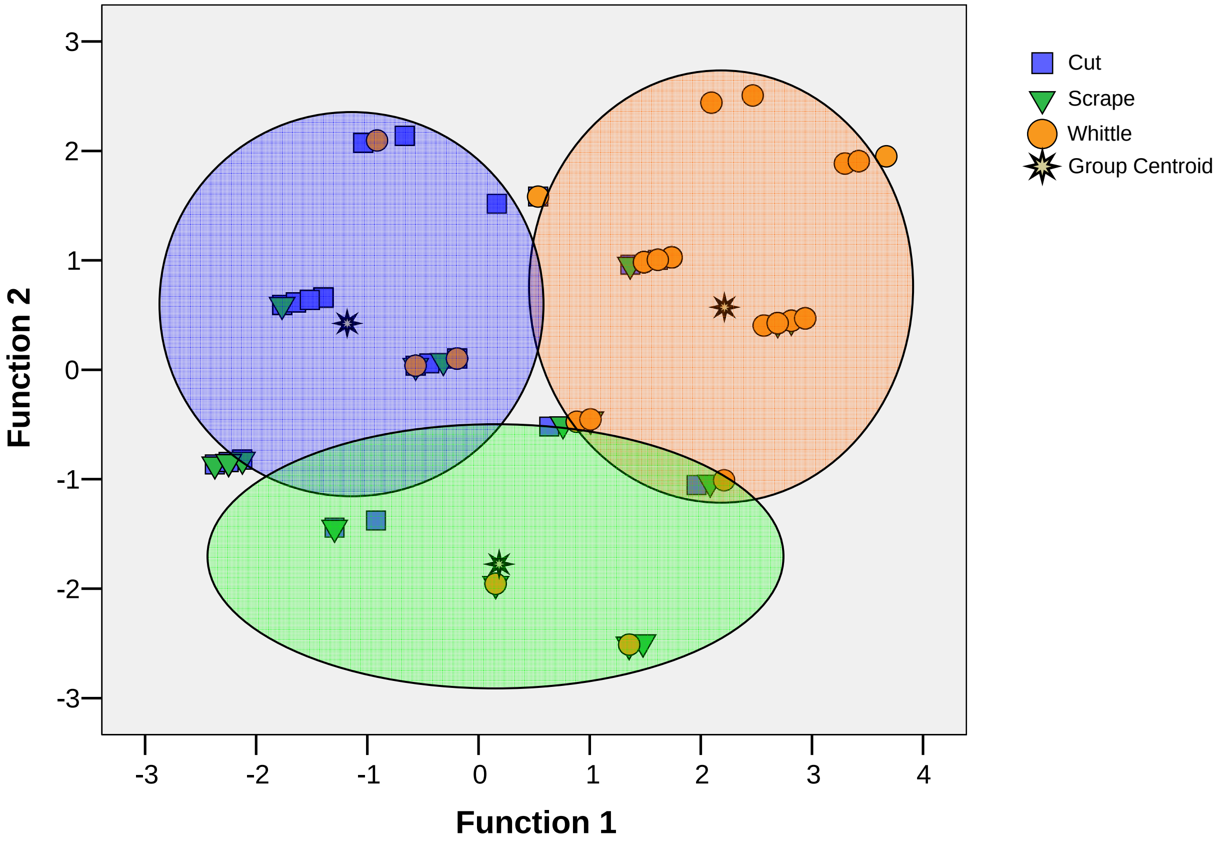

Figure 35. Ideal 64-bit discriminant function analysis of experimental flakes. Note the group centroid for each activity. The group centroid is calculated by taking the mean of each activity along its perspective Function 1 and Function 2 axis. The group centroid is plotted for visual representation of the average placement of a particular activity from its combined wear attributes. Ideally these centroids would be as far

from each other as possible. Whittling activities cluster on the upper right side of the plot. Cutting activities cluster on the left upper side of the plot. Scrapping actions are widely distributed along Function 1, but seem to cluster on the lower half of the graph along Function 2. Note the overlap of activities to single points – an artifact of projecting a three-dimensional graph into two dimensions.

The correct reclassifications per actions are outlined in Table 19. They are calculated by taking the correct percent of reclassification per activity and averaging them. So for example for the experimental tools, flakes used for cutting were correctly reclassified into cutting categories 94 % of the time. Flakes used for scraping were correctly reclassified 70 % of the time. Flakes used for whittling on the other hand were correctly reclassified 84 % of the time. This average percentage of correct reclassification is used as the overall correct reclassification. It follows that overall the correct classification via discriminant function analysis was 86.3 % of the experimental flakes (94 % +70 % + 84 % / 3), with only 68.5 % of blind test flakes being correctly classified (84 % + 50 % +58.8 % / 3) – a point I will tackle in the "blind test" section, the fourth part of this chapter.

Table 19. Correct Reclassification of Flake Tools at a "64-bit" Resolution

		64 bit DFA 3 actions 3 variables			Total (%)
		% correct of action guessed			
	Action	Cut	Scrape	Whittle	
Experimental Flake Tools	Cut (n = 50)	94	4	2	100
	Scrape (n = 20)	25	70	5	100
	Whittle (n = 25)	0	16	84	100
Blind Test Flake tools	Cut (n = 25)	84	4	12	100
	Scrape (n = 14)	25	50	25	100
	Whittle (n = 17)	29.4	11.8	58.8	100

8-bit

The experimental data set was not only simplified to a “64-bit” resolution, it was also simplified to an “8-bit” resolution data set. The four point ordinal striation schema was further reduced to a two point striation schema by aggregating striation directions of “1” and “2” to a new “A” category. The original ordinal category of “3” and “4” were converted to the new category “B”. The four point polish intrusion schema was also reduced to a two point schema by aggregating the 64-bit “1” and “2” categories into a new “A” category. The 64 bit “3” and “4” categories for polish intrusion were aggregated into the newfound “B” category (Table 20). Likewise was the four category schema for edge-morphology reduced to a two category schema by aggregating “smooth” and “lunate” into an “A” category, while “shattered” and “worn” into a new “B” category (Appendix I). The emerging data set with two categories of striation direction, two category polish intrusion, and two point edge-morphology, will be referred to as an “8-bit” resolution (2 x 2 x 2 = 8) data set (Appendix I).

Table 20. Aggregated Polish Intrusion Values transformed into categories for "64-bit" and "8-bit" Idealized Data Set

Polish Intrusion (mm)	“64-bit” polish intrusion Schema	“8-bit” polish intrusion Schema
0.000 < X < 0.695	“1”	“A”
0.695 < X < 2.474	“2”	“A”
2.474 < X < 8.065	“3”	“B”
8.065 < X	“4”	“B”

In the same manner as the “64 bit” data set, a discriminant function analysis on the “8-bit” data set was computed (Figure 36). The overall correct classifications per actions computed by the discriminant function analysis are outlined in Table 21. Averaging the correct reclassification per activity as done in the “64-bit” resolution analysis we get an over correct reclassification at the "8-bit" resolution analysis. The overall correct classification via discriminant function analysis was 88.4 % of the experimental flakes, with only 66.7 % of blind test flakes being correctly classified.

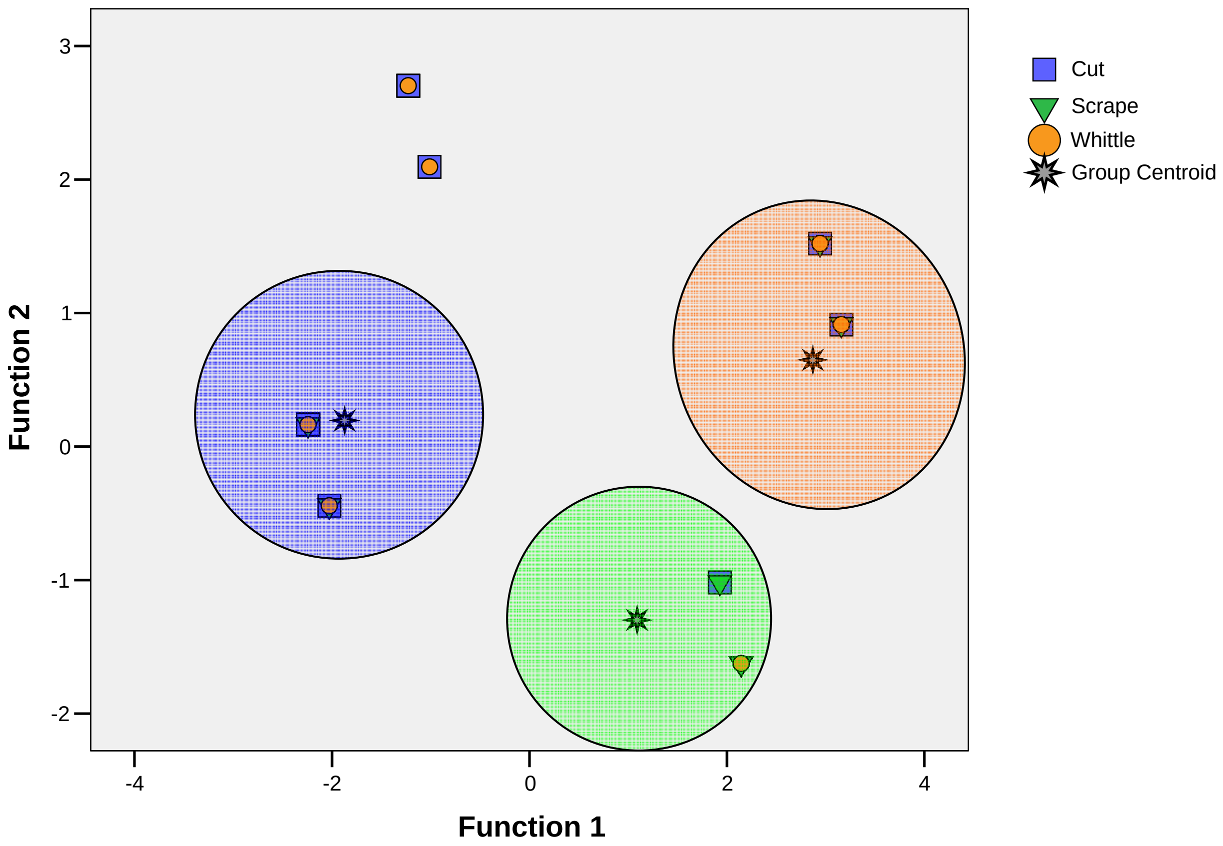

Figure 36. Ideal 8 bit discriminant function analysis of experimental flakes. Note that there is clumping or overlap of several activities to single points – an artifact of projecting a three-dimensional graph into two dimensions.

What should be noted for the moment is that the "lower" the resolution – as seen in a decrease of correct reclassification when reducing the analysis from "64-bit" to "8-bit" – the lower the identification potential of the discriminant function analysis on the experimental flake tools.

Table 21. Correct Reclassification of Flake Tools at a "8-bit" Resolution

		8 bit DFA 3 actions 3 variables			Total (%)
		% correct of action guessed			
	Action	Cut	Scrape	Whittle	
Experimental Flake Tools	Cut (n = 50)	98	2	0	100
	Scrape (n = 20)	25	75	0	100
	Whittle (n = 25)	0	20	80	100
Blind Test Flake tools	Cut (n = 25)	88	4	8	100
	Scrape (n = 14)	33.3	41.7	25	100
	Whittle (n = 17)	35.3	11.8	52.9	100

Discriminant function analysis: Influence of number of wear attributes observed and number of actions

The question that emerged was how the number of attributes observed – three, two or one attribute,– and at what resolution – “64-bit” or “8-bit” – affects the correct reclassification of the discriminant function analysis with increasing number of activities undertaken?

To tackle this question, several discriminant function analysis were set up to account for variation of actions in data set – 3 actions, 2 actions, or 1 action,-- and to account for variables observed – 3 variables, 2 variables, or 1 variable. Different activities have different correct reclassification returns based on different attributes observed. For example, using the variable of striation direction it is difficult to distinguishing between scraping and whittling actions, but easy to distinguish between cutting and whittling actions (Figure 30). The net effect unfortunately is that no pattern emerges from single trial runs of discriminant function analysis.

To overcome this, a discriminant function analysis had to be applied for every possible combination of actions (3 to 1) with every possible combination of variables (3 to 1) at a “64-bit” resolution. With the three actions of cutting, scraping and whittling the possible combinations for a three-action-tool-set is: “cut/scrape/whittle.” For two-action-tool-sets the possible combinations are: “cut/scrape,” “cut/whittle,” and “scrape/whittle.” For one-action-tool-set they are: “cut,” scrape” and “whittle.” Similarly, with the three variables observed of striation-direction, polish intrusion and edge-morphology the possible combinations for a three-variable-tool-set is: “striation/polish/edge.” For two-variable-tool-sets the possible combinations are: “striation/polish,” “striation/edge,” and “polish/edge.” For one-variable-tool-set they are: “striation,” “polish” and “edge.” Therefore with these possible combinations twenty-eight discriminant function analysis were run with each possible combination of tools and variables. The discriminant function analyses were run against the blind tests and the percentage of correct reclassification of the blind-tests flakes were aggregated in Table 22.

The combination of actions and the combination of attributes observed for those actions, can dramatically influence the correct percentage of reclassification. For example, if we take a set of “cut/scrape” flakes (2 actions) and analyze them with “striation direction/polish intrusion” (2 variables) the correct reclassification rate of the known blind test flake tools is 81.1% at the 64-bit resolution (Table 22). Alternatively a two-action-tool-set of “scraping/whittling” flakes observed with the two-variables of “striation direction/edge-morphology” we correctly reclassify 43.3% of the blind test flake tools at a 64-bit resolution (Table 22). When observing Table 22 it should be noted that sometimes some attributes dominate the correct reclassification percentage of the blind test flake tools. For example, if by analyzing an assemblage with three known activities with all three attributes we might get a correct reclassification rate of 68.5 % of the blind test flake tools (Table 22). Analyzing that same assemblage of three known activities with the two attributes of striation direction and polish intrusion we would have the same correct reclassification rate of 68.5 % of the blind test flake tools (Table 22). however, if we were to analysis that same assemblage of three known activities with a different two attributes, - striation direction and edge morphology – we would notice that the correct reclassification rate of the blind test flakes would drop to 54.5 % (Table 22). We can therefore deduce that polish intrusion contributes a more important role in distinguishing some activities than do the flake's attributes of striation direction and/or edge morphology. Therefore, the last step was to average the correct percent reclassification on the blind test flake tools with respect to the number of activities undertaken in the assemblage (3, 2 or 1) and the variable observed (3, 2 or 1) (Table 23).

Table 22. "64-bit" DFA Correct Reclassification Results for possible Variables and Action Combinations projected by experimental flakes on the blind test flakes

		3 act	2 act			1 act								
	Variables (64-bit)	Cut Scrape Whittle	Cut Scrape	Cut Whittle	Scrape Whittle	Cut			Scrape			whittle		
3	Striation Polish Edge	68.5	81.1	78.1	62.1	96	88	58.3	50	64.7	64.7	68.5	81.1	78.1
2	Striation Polish	68.5	81.1	78.6	69	96	88	75	50	64.7	64.7	68.5	81.1	78.6
2	Striation Edge	54.5	73.7	78.6	43.3	76	88	61.5	69.2	29.4	64.7	54.5	73.7	78.6
2	Polish Edge	59	69.8	73.9	66.7	89.3	82.1	60	33.3	72.2	61.1	59	69.8	73.9
1	Striation	58.2	81.6	78.6	46.7	88	88	84.6	69.2	17.6	64.7	58.2	81.6	78.6
1	Polish	59	69.8	73.9	66.7	88.3	82.1	73.3	33.3	61.1	61.1	59	69.8	73.9
1	Edge	29	40.4	43.5	47.1	35.7	35.7	50	50	44.4	55.6	29	40.4	43.5

Table 22 deserves some explanation. The "1-act" categories have three values for a single variable because they are the individual blind test flakes correct reclassification of "cutting", "scraping", and "whittling" actions of each test taken at the "3-act" combinations and the "2-act" combinations. One complication that confuses the three values on a single variable for the blind test flake tools are the "blank" blind test flakes which are correctly identified but cannot be categorized into one of the three (cut, scrape or whittle) categories which the DFA forces each blind test flake into. The outcome is a lower correct reclassification percentage returned by the DFA than the summation of the flakes into their corresponding categories. This can be seen when noticing that the fist value for the cut, scrape and whittle variables – individual values contributed from the "3-act, 3-variable" DFA – averages out to a higher number (96 + 50 + 68.5 = 71.5) than is reported on the "3-act, 3-variable" DFA category (68.5). This small difference is attributed to the those extra "blank-blind-test-flakes" which need to be incorrectly forced into a cutting, scraping, or whittling categories and when taken all together lower the average correct reclassification reported by the number of activity categories.

Table 23. Correct Percent Reclassification with Increasing Number of Activities and Variable Numbers at "64-bit" resolution

64-bit		variables		
		1	2	3
act	1	60.2	68.1	70.3
	2	60.9	70.5	73.8
	3	48.7	60.7	68.5

Then the discriminant function analysis had to be reapplied all over again to every possible combination of action with every combination of attributes at the "8-bit" resolution (Table 24). Much like at the 64-bit resolution discriminant function analysis data sets, no clear correlations of correct percent reclassification to number of actions and/or variables stand out until the average of the correct percent reclassification of the action numbers and variable numbers are taken (Table 25).

Exactly like its 64-bit resolution counter part, the combination of actions and the combination of attributes observed for those actions at the 8-bit resolution, can dramatically influence the correct percentage of reclassification. However, a point of interest is that any one combination of actions or attributes can be different at the 8-bit level than at its 64-bit counterpart – however this does not need to always be the case. If we look at the same example as before and take the set of "cut/scrape" flakes (2 actions) and analyze them with "striation direction/polish intrusion" (2 variables) the correct reclassification rate is 81.1% at the 8-bit resolution – the same as at 64-bit resolution (Table 24). Alternatively a two-action-tool-set of "scraping/whittling" flakes observed with the two-variables of "striation direction/edge-morphology" we correctly reclassify 46.7% of the time at the new 8-bit resolution – an improvement to the 64-bit counterpart but not by much as other values are rather similar (Table 24). When observing Table 24, much like when observing Table 22, it is noted that some attributes dominate the correct reclassification percentage of the blind test flake tools. In fact, some attributes when used alone do not reclassify one single flake tool to its corresponding activity – an artifact of how the variables and categories were grouped.

Table 24. "8-bit" DFA Correct Reclassification Results for possible Variables and Action Combinations projected by experimental flakes on the blind test flakes

		3 act	2 act			1 act								
	Variables (64-bit)	Cut Scrape Whittle	Cut Scrape	Cut Whittle	Scrape Whittle	Cut			Scrape			whittle		
3	Striation Polish Edge	66.7	81.1	78.6	69	88	88	75	66.7	64.7	64.7	66.7	81.1	78.6

2	Striation Polish	66.7	81.1	78.6	69	88	88	75	66.7	64.7	64.7	66.7	81.1	78.6
2	Striation Edge	60	81.6	78.6	46.7	88	88	69.2	69.2	29.4	64.7	60	81.6	78.6
2	Polish Edge	41	44.2	73.9	66.7	46.4	82.1	73.3	40	61.1	61.1	41	44.2	73.9
1	Striation	60	81.6	78.6	50	88	88	30.8	69.2	64.7	64.7	60	81.6	78.6
1	Polish	36.1	37.2	73.9	66.7	17.9	82.1	73.3	73.3	61.1	61.1	36.1	37.2	73.9
1	Edge	29	40.9	0	47.1	35.7	0	50	50	44	0	29	40.9	0

*** see table 17 for explanations of this table**

Table 25. Correct Percent Reclassification with Increasing Number of Activities and Variable Numbers at "8-bit" resolution

8-bit		variables		
		1	2	3
act	1	59.6	67.8	74.5
	2	59.5	68.9	76.2
	3	41.7	55.9	66.7

The diminishing correct reclassification averages with increasing number of activities can then be graphed at both a "64-bit" resolution and at an "8-bit" resolution level (Figure 37). While recognizing that this is an idealized data set, whose flakes actions where known at the time of attribute recording which biases the data for high success rate, some general trends can be made:

In the best case scenario, with a 64-bit resolution discriminant function analysis, utilizing three variables to identify a single action yielded a correct reclassification rate of 70 % (Table 23). When we decrease the variables to one, we loose 10 % of the correct reclassification rates; they drop from 70 to 60 percent. Correct reclassification is also lost with increasing number of actions in the tool set. It is curious that when three variables are observed, or when one variable is observed, but the number of activities increases from one to three, the correct percent reclassification rates decrease roughly 10 % -- 70 to 68 % decrease and 60 to 49 % decrease respectively (Table 23). Utilizing one variable only has the highest rate of declining correct reclassification of blind test flake tools as the number of activities in the blind test assemblage increases.

The diminishing correct reclassification averages with increasing number of activities pattern in paralleled at the 8-bit resolution level (Figure 37). The only difference is that it seems more of a drastic change. For example when both when 3 variables are observed and the number of activities increases from one to three, the correct percent reclassification rates drop roughly 8 % - 75 to 67 %. However, when 1 variable is observed and there is an increase of number of actions from 1 to 3, then the correct reclassification drops 18 % from 60 to 42% (Table 25). Nevertheless, overall, when the resolution is dropped from 64-bit to 8-bit the correct reclassification does lower, but not greatly (Figure 37). These observations should be kept in mind as the exploration of un-idealized data sets for the discriminant function analysis is explored. Maximum resolution would be archived if all the variables could be recorded and analyzed as ratio variables.

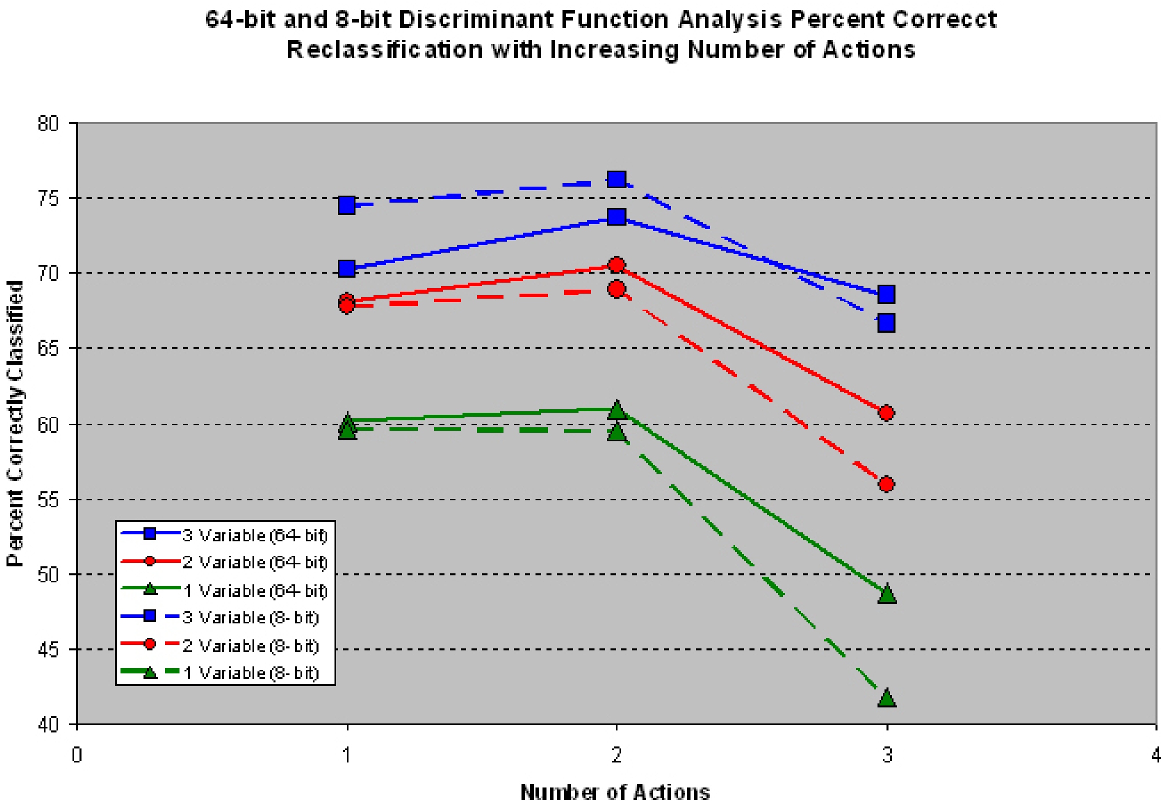

Figure 37. Diminishing reclassification rates with increasing number of activities in regard to the blind test flake tool assemblage.

PART 5: DFA to determine flake tool use from the Archeological Record

Lastly, a discriminate function analysis was used to model the possible use of flake tools from the Qwu?gwes, Hartstene and the Sunken Village sites.

Qwu?gwes

The Qwu?gwes site provided eighty-two flake tools to determine use by the discriminant function analysis. The experimental flake tools are graphed by the functions produced by the discriminant function analysis based on the attributes produced by each flake's use and are compared with the Qwu?gwes flake tools (Figure 38). It should be noted that there is overlap of many flake tools to a single point in this graph; the graph, therefore, can be visually misleading about its representation of the flake tools within its' 2-D spatial projection. The overall pattern does seem apparent nevertheless, and it suggest that the flakes from Qwu?gwes were used in cutting and scraping activities.

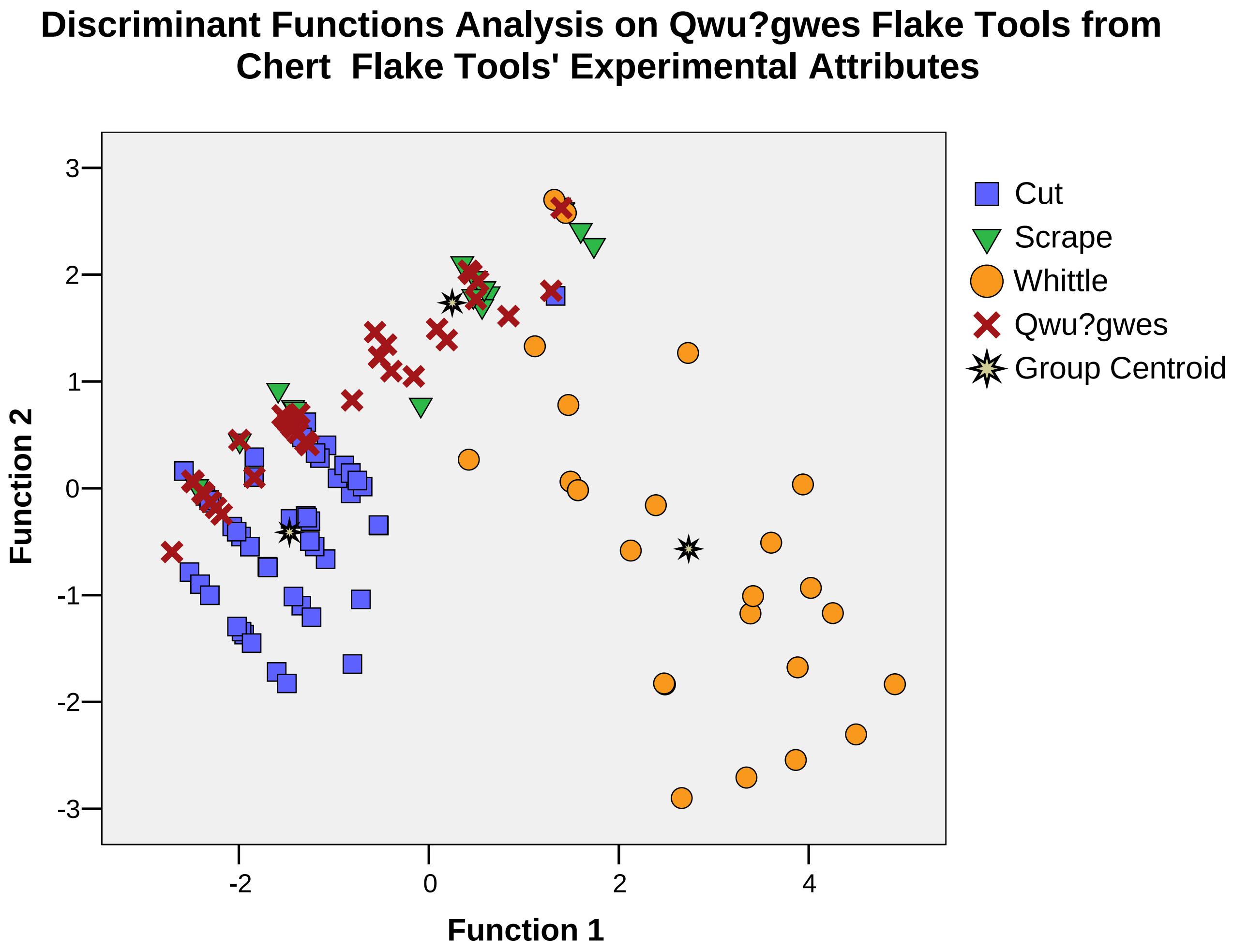

Figure 38. Chert Attributes Projected by discriminant function analysis

Unfortunately, many of the flake tools from Qwu?gwes have enough water-worn damage for the model to successfully delegate possible flake actions to each flake (Appendix F). From the Qwu?gwes flake tools that are not too water-worn (n = 44), the majority are grouped around the cutting group centroid (n = 27). The remaining 17 mapped around the scraping group's centroid (n = 17). This suggests the flake tools were most likely used for cutting and scraping. Such tools could have been used by the Squaxin to procure and produce some of the wood artifacts found at the site. Whittling activities to procure and finish the wood artifacts is not likely a use for the Qwu?gwes flake tools as suggested in the discriminant function analysis.

Hartstene

The Hartstene collection provided forty flake tools to be modeled by the discriminant function analysis. The Hartstene flakes experimental flakes tools were plotted by the functions produced by the discriminant function analysis based on the attributes produced by each flake's actions and are contrasted against the experimental flake tools (Figure 39). It should be noted that, again, there is overlap of many flake tools to a single point in this graph, and that the plot, can be misleading about the representation of the flake tools within its' 2-D spatial projection. The overall pattern seem apparent and is in much agreement with the patterns seen by the Qwu?gwes flake tools. That is to say, the patterns for the Hartstene flake tools suggest that they were used in cutting and scraping activities.

Unfortunately, many of the flake tools from Hartstene also have considerable water-worn damage for the model to successfully designate possible flake activities (Appendix G). Hartstene was, however, did contain eleven flake-tools that were not too water worn. From the Hartstene flake tools that were not too water-worn (n = 11), the discriminant function analysis grouped the majority around the cutting group centroid (n = 7) followed by scraping group's centroid (n = 3), and whittling (n = 1). This suggests the flake tools were most likely used for cutting ans scarping activities, with the possibility of some minor whittling activities at Hartstene as done with the flake tools found there. The general patterns very much mirrors the conclusions modeled for the Qwu?gwes flakes and is suggestive of similar activities carried out at both sites, the cutting and scraping of possibly wood materials with the flake tools.

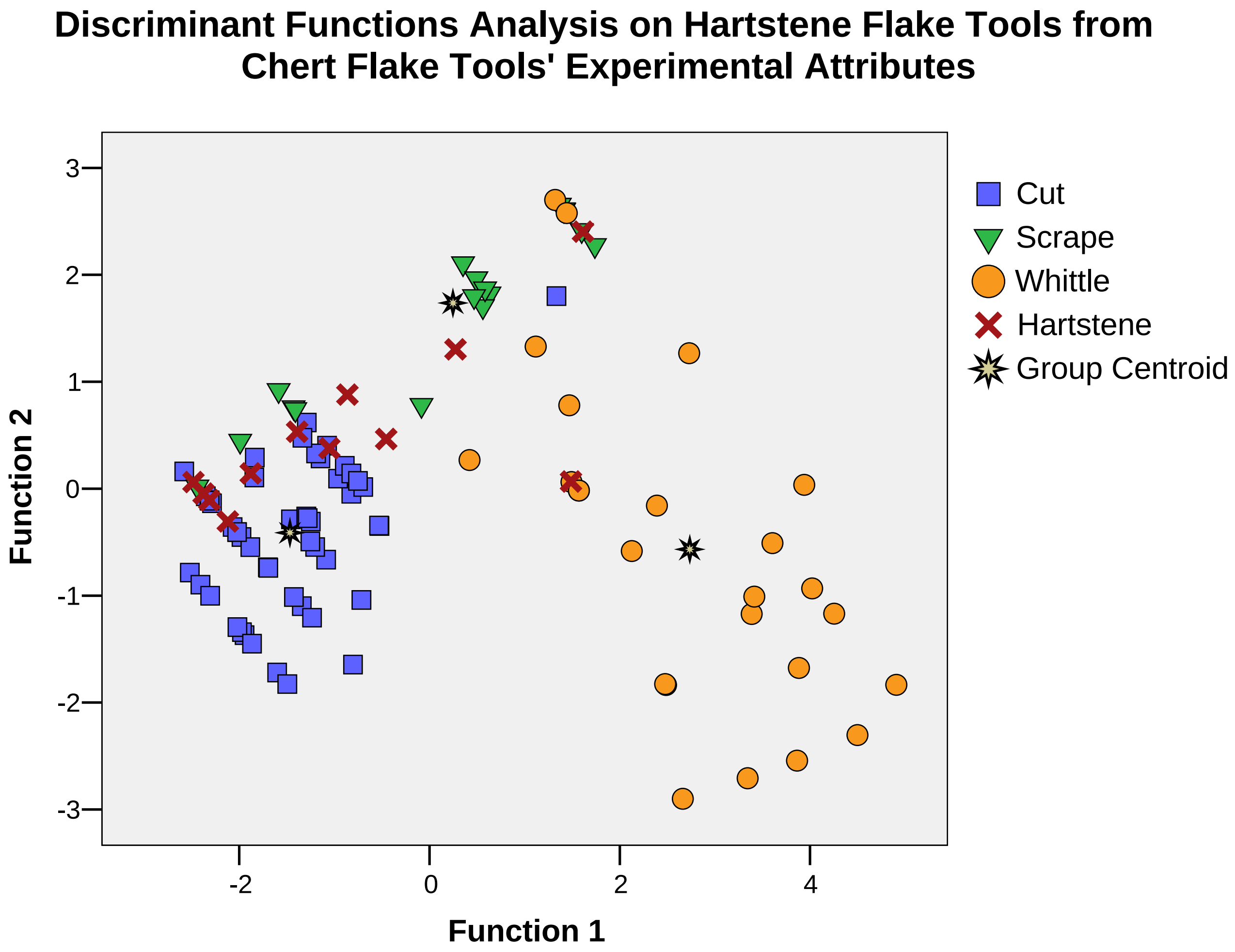

Figure 39. Chert Attributes Projected by discriminant function analysis

Sunken Village

The two week excavation at Sunken Village provided 78 flake-tools for analysis. The Sunken Village flakes tools are plotted by the functions produced by the discriminant function analysis based on the attributes produced by each flake's actions (Figure 40). Like the previous collections' discriminant function analysis, there is much overlap of many flake tools to a single point in the graph, and therefore the plot, can be misleading in its' 2-D spatial projection. The overall pattern seems apparent and is in much agreement with the patterns seen before: this time around, all flakes tools apparently were used in scraping and slicing activities.

Twenty-two of the flake tools from the Sunken Village collection have too much water-worn damage for the model to successfully delegate possible flake activities. This left 56 flake tools available for analysis (Appendix H). From the flake tools that were not too water-worn, the discriminant function analysis grouped the flakes around two activities, suggesting these flakes were used for cutting (n = 33) and scraping (n = 23) – a pattern parallel to that modeled for Qwu?gwes and Hartstene flake tools.

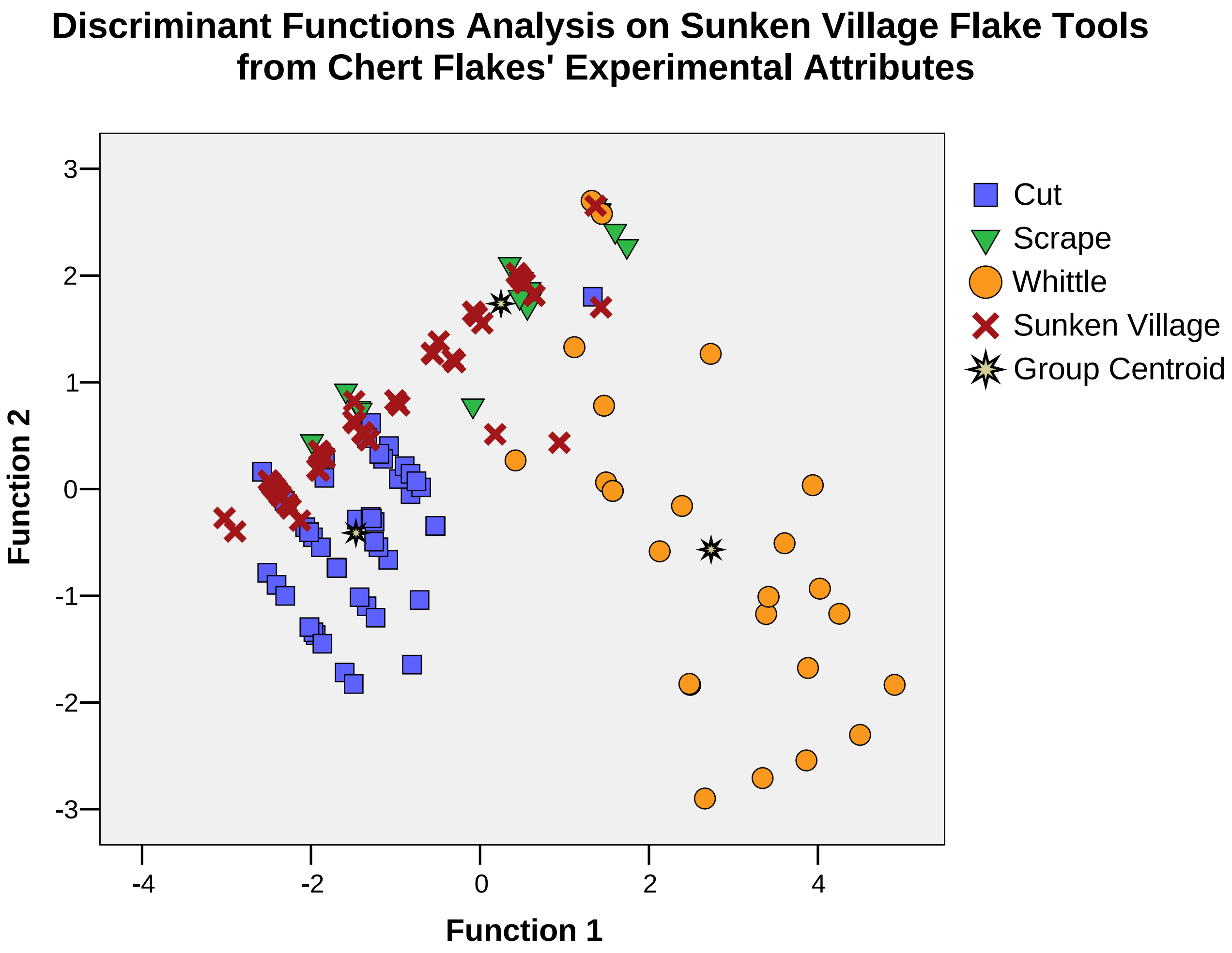

Figure 40. Chert Attributes Projected by discriminant function analysis

CHAPTER 5: SUMMARY, DISCUSSION AND CONCLUSION

PART 1: Summary

The temporal, geographic and cultural background to the northwest Coast was presented in chapter one. In this chapter, I acknowledge the great benefit derived from working with native craftsmen and craftswomen – cultural experts – and archeologists on joint research undertakings. It was also acknowledged utilizing information derived from both ethnographic accounts and experimental archeology in tackling a particular question can be of great benefit. In that same chapter, Squaxin and Suquamish cultural experts – Andrea Wilbur-Sigo and Ed Carrier respectively – suggested that cutting, scraping and whittling actions probably helped shape the cedar (*Thuja plicata*) artifacts and cherry bark (*Prunus emarginata*) strip lashings found at Qwu?gwes. It is very likely that the same sort of flake tools found at Hartstene and Sunken Village had similar functions. From experimental studies, it was rediscovered that the actions of cutting and scraping wood artifacts can be done with a flake tool. The information on tool use provided a great "jumping off" point in this attempt in identifying those actions as imprinted on the Qwu?gwes, Hartstene and Sunken Village flake tools.

The Qwu?gwes, Hartstene and the Sunken Village sites were introduced in a brief outline in the second chapter. In the third chapter the actions of cutting, scraping and whittling were defined. Additionally, it was demonstrated how the morphological attributes of both the experimental flake tools and the archeological flake tools were to be measured. The morphological attributes replicated in the experimental data set were length, width, thickness, and edge angle. The three attributes (striation direction, polish intrusion and edge-morphology) observed on the experimental flake tools after "cutting," "scraping," and "whittling" actions were introduced with detailed statements on how each artifacts wear attributes were encoded. This proved to be helpful in identifying different actions performed by each flake, the subject of chapter four.

The three wear attributes – striation direction, polish intrusion and edge-morphology – are not only helpful when looked at individually (Figure 30, 4.2, 4.3), but become much stronger when viewed collectively (Table 22). As noted in chapter four striation-direction was effective in distinguishing and identifying gross tool movements of the tools edge relative to a worked material. These results proved to be statically valid (Figure 30; Table 12). Polish intrusion was helpful in revealing how the tool was held in contact with the worked material – be it only slightly near the edge as by scraping, or across the width of a face of the tool as in whittling. These results are also statistically sound (Figure 31). Damaged-edge-morphology, overall, produces strong patterns in frequency due to the three different actions of cutting, scraping and whittling. Damage-edge-morphology has a lot of overlap in worn edge types and action performed by a flake, nevertheless, the patterning results too are statistically valid (Figure 32; Table 13). While damage edge-morphology is the weakest link (that is to say has the least predictive powers in identifying any one activity undertaken with a flake tool) , in combination, all three attributes make a good foundation for identifying cutting, scraping, and whittling activities on flake tools.

A lengthy discussion and analysis on notion of an “idealized” discrimiant function analysis data set was presented in chapter four. It explored the predictive powers of the analysis at different “resolutions” (more or less encoding of the observed characteristics on the flake tools) – were explored at both “64-bit” and “8 bit” resolution. The conclusion of that analysis was what would be expected intuitively, the higher the resolution (either from more observed characteristics, or more detailed encoding of the observed characteristics) the better chance one has to correctly identify a particular tools past function. It was also concluded that on average the greater the number of action uses undertaken by an artifact assemblage the less likely one is to correctly reclassify each flake to its corresponding action (Figure 34). While Figure 34 does seem to suggest that sometimes less resolution (“8-bit”) has higher correct reclassification than its higher resolution (“64-bit”) counterpart, it should be remembered that this was only an artifact produced by how the observed characteristics were reduced. Overall, the higher the resolution, and the more wear characteristics the analyst observes the better chance there is for correctly predicting the tool’s function.

A strong benefit in using the two morphological attributes of edge damage and striation direction and the one observed attribute of polish intrusion aforementioned is that, with the exception of “damaged-edge-morphology” all data at the moment are based on a ratio or ordinal data set. This gives “polish intrusion’ and “striation direction” more replicable results as they are less subjective in the opinion of an analyst. “Damaged-edge-morphology,” given enough thought and ingenuity could possibly become more than a nominal data set perhaps even an ordinal data set. It should be noted, that the damaged-edge-morphology categories must therefore be applied with the analyst’s best judgment, as it is more prone to human error than the other measured attributes. From my own experience I can vouch that the more practice one has in observing the damaged-edge-morphologies of used flake tools the easier, more accurate, and more consistent it becomes to correctly recognize and categorize each flake’s edge morphology according to the particular activity with which it is used. As noted, the best possibility for correct reclassification would come with “maximum” resolution – a feat only hypothetically accomplishable if all variables are encoded in a ratio data format.

PART 2: Discussion and Conclusion

In this thesis, I have proposed a method to "objectively" identify a flake tools past use. To achieve this, a discriminant function analysis was applied to 112 flake tools forming an experimental data set. Each of the flake tool's wear attributes were recorded and associated with specifications. Knowing which attributes were indicative of which activity, the experimental flakes' attribute could be applied to the archeological record – whose flake actions were unknown. To ensure some success, the discriminant function analyses from experimental flakes were applied to a set of 67 blind test flake tools. The discriminant function analysis correctly identified the action of roughly 69 % of these flake tools.

During the blind test, one of the model's weaknesses – mirroring my own difficulties – was in the correct reclassification of scraping actions to the scraping action group centroid (Figure 36). The plot of the flake tools with their group centroid as projected from the discriminant function analysis plot showed that whittling flake tools patterns protrude into scraping and/or cutting flake pattern territories, but these latter are classified with much more consistency (Figure 36). The correct reclassification results are good because of the need to only classify only three activities: cutting, scraping and whittling.

The discriminant function analysis model was applied to the flake tools at Qwu?gwes, Hartstene and Sunken Village to determine their likely use, the methodologies greatest weakness because evident. The discriminant function analysis can only be applied to those tools with clearly visible and recordable attributes. So for example, out of the 82 flake tools from Qwu?gwes to be analyzed, roughly half of the flake tools were too "water-worn" for successful classification. That is to say, the discriminant function analysis could not predict where each of the unknown flake tools should be grouped where much of the required attributes were missing.

This is the model's biggest draw back, because even if a "subjective" observer can only distinguish "edge shape morphology" and "polish intrusion" attributes they can make a best guess suggestion of what that flake tool was used for; the discriminant function analysis can not.

Despite this limitation, the discriminate function analysis was used to model possible flake tool activities at Qwu?gwes, Hartstene and Sunken Village. The discriminant function analysis model supports the notion that Qwu?gwes flake tools were most likely used for cutting and scraping of wood. This has been verified by Indian craftsmen and craftswomen and demonstrated through experimental feasibility (Figure 37). The discriminant function analysis was also applied to the Hartstene's flake tool collection where again the flake tools were projected to be used in cutting and scrapping activities (Figure 38). A single specimen fell into "whittling" territory in the plot (Figure 38), most of the flake tools were clustered in the area of scraping and cutting. This is curious as the Harstene flake tool assemblage seems to be somewhat larger than its Qwu?gwes and Sunken Village counterparts (Figure 16, 3.5, and 3.6). This would further validate Andrea Wilbur-Sigo's assessment on the replicated flake tools ability to be used for whittling (Wilbur-Sigo 2007). Lastly the discriminant function analysis was applied to the Sunken Village flake tool collection. They too were projected as cutting and scraping tools (Figure 40). The overall consensus then, from craftsmen and craftswomen cultural experts, experimental feasibility, and an "objective" discriminant function analysis on the flake from the three sites seems to be that flake tools were largely used for cutting and scraping of wood to produce artifacts.

In sum, the use of a scanning electron microscope and a light microscope in observing attributes can be successful in identifying a flake action's wear pattern on its' edge after use with some activities discerned more easily than others. Whittling and cutting are fairly easy to distinguish apart, while scraping actions proved to be the most difficult to identify correctly with major consistency.

Future work, using this "objective" methodology – and expanding on it – will be to apply this type of tool activity modeling on similar flake-tool collections – particularly from sites associated with similar (Lushootseed) cultural affiliations first, then with dissimilar cultural affiliations. That is to say, it would be insightful to move the analysis to sites past the central northwest coast. The approach should also be used to analyze flake tools from older sites. This will hopefully test whether flake tools were used in different ways over time. Should there be a temporal aspect to how flake tools were used, these studies would further add to the accumulating body of knowledge dealing with culture change on the Northwest coast.

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APPENDICES

Appendix A. Edward Plateau Chert Experimental Flake Tools Morphological Attributes

Flake Name	Material	Platform	Termination	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Edge Angle
EPC-001	Chert	Complex	Feathered	34.96	17.23	6.58	2.9	30
EPC-002	Chert	Cortical	Feathered	29.15	15.7	4.12	1.7	30
EPC-003	Chert	Flat	Step	18.94	8.57	2.36	0.2	15
EPC-004	Chert	Abraded	Feathered	23.49	18.38	6.11	1.5	30
EPC-005	Chert	Complex	Hinge	45.81	21.74	9.91	7.4	15
EPC-006	Chert	Cortical	Feathered	24.69	16.68	4.38	1.7	15
EPC-007	Chert	Complex	Feathered	44.97	24.62	7.97	6.2	30
EPC-008	Chert	Abraded	Feathered	49.82	13.04	8.49	4.8	45
EPC-009	Chert	Flat	Feathered	23.32	15.03	8.68	1.5	15
EPC-010	Chert	Complex	Feathered	23.13	16.36	6.82	2.3	60
EPC-011	Chert	Cortical	Feathered	18.33	11.51	3.4	0.4	15
EPC-012	Chert	Abraded	Feathered	38.1	18.77	6.48	3.4	15
EPC-013	Chert	Cortical	Feathered	20.22	7.93	3.2	0.5	15
EPC-014	Chert	Flat	Feathered	26.07	10.25	3.75	0.8	15
EPC-015	Chert	Abraded	Step	33.49	12.47	4.56	2.2	45
EPC-016	Chert	Abraded	Plunging	23.65	9.93	2.97	1.4	15
EPC-017	Chert	Cortical	Feathered	51.88	22.18	6.24	6.1	30
EPC-018	Chert	Abraded	Plunging	26.62	13.37	2.92	1	15
EPC-019	Chert	Cortical	Hinge	24.77	12.79	3.74	0.7	15
EPC-020	Chert	Abraded	Feathered	20.05	11.3	5.51	1.2	15
EPC-021	Chert	Cortical	Hinge	32.1	15.67	3.11	1.3	15
EPC-022	Chert	Cortical	Feathered	26.39	14.57	6.35	1.8	30
EPC-023	Chert	Cortical	Feathered	21.86	15.06	4.8	1.4	15
EPC-024	Chert	Cortical	Hinge	23.6	10.98	2.1	0.4	15
EPC-025	Chert	Abraded	Feathered	22.16	12.52	3.07	1.4	15
EPC-026	Chert	Flat	Step	26.17	15.13	4.55	1.8	15
EPC-027	Chert	Cortical	Hinge	23.29	12.95	6.58	1.6	45
EPC-028	Chert	Cortical	Plunging	35.53	13.99	3.28	1.2	30
EPC-029	Chert	Complex	Feathered	23.21	10.17	3.28	0.8	35
EPC-030	Chert	Abraded	Feathered	19.72	9.25	2.25	0.5	24
EPC-031	Chert	Complex	Hinge	32.67	14.96	1.98	1	49
EPC-032	Chert	Cortical	Step	28.39	14.01	5.77	1.3	51
EPC-033	Chert	Cortical	Feathered	28.18	12.61	3.49	1	25
EPC-034	Chert	Abraded	Feathered	26.24	10.24	2.33	0.5	20
EPC-035	Chert	Cortical	Feathered	29.12	15.35	4.86	2.2	17
EPC-036	Chert	Abraded	Feathered	16.44	11.13	3.06	0.5	42
EPC-037	Chert	Abraded	Plunging	22.47	14.89	4.03	1.1	23
EPC-038	Chert	Abraded	Feathered	29.45	18.53	5.03	2.4	20
EPC-039	Chert	Complex	Step	16.62	8.57	3.45	0.4	31
EPC-040	Chert	Cortical	Feathered	22.7	9.06	1.89	0.3	11
EPC-041	Chert	Cortical	Feathered	32.42	15.89	5.56	1.9	41
EPC-042	Chert	Cortical	Feathered	18.42	6.6	3.32	0.5	33
EPC-043	Chert	Abraded	Feathered	28.23	12.94	4.13	1.7	35

EPC-044	Chert	Abraded	Feathered	17.61	7.79	1.93	0.4	23
EPC-045	Chert	Cortical	Feathered	29.57	17.55	4.95	2.9	26
EPC-046	Chert	Flat	Feathered	21.32	8.61	3.85	0.7	38
EPC-047	Chert	Abraded	Hinge	24.56	14.32	2.9	0.9	25
EPC-048	Chert	Cortical	Feathered	34.27	14.36	4.73	3.8	26
EPC-049	Chert	Cortical	Feathered	27.92	11.12	2.14	0.5	36
EPC-050	Chert	Cortical	Feathered	25.09	11.34	3.51	0.9	34
EPC-051	Chert	Abraded	Feathered	16.81	9.4	1.48	0.3	11
EPC-052	Chert	Cortical	Step	29.51	15.24	5.1	2.1	50
EPC-053	Chert	Flat	Step	34.86	7.92	2.22	0.4	31
EPC-054	Chert	Cortical	Hinge	24.85	9.41	3.62	0.8	44
EPC-055	Chert	Cortical	Feathered	17.21	14.97	4.6	1.1	28
EPC-056	Chert	Flat	Feathered	27.02	14.29	3.48	1	24
EPC-057	Chert	Complex	Feathered	37.45	17.79	6.76	3.9	15
EPC-058	Chert	Complex	Feathered	39.42	16.05	5.63	3.2	15
EPC-059	Chert	Complex	Hinge	24.26	14.19	3	0.8	15
EPC-060	Chert	Cortical	Feathered	18.79	8.65	2.06	0.4	30
EPC-061	Chert	Abraded	Step	24.46	6.34	4.9	0.6	15
EPC-062	Chert	Cortical	Step	19.05	12.83	3.04	0.5	15
EPC-063	Chert	Flat	Hinge	25.09	12.05	3.07	0.5	15
EPC-064	Chert	Complex	Hinge	31.67	9.38	2.78	0.8	15
EPC-065	Chert	Cortical	Feathered	17.71	8.96	4.35	0.5	15
EPC-066	Chert	Complex	Feathered	30.97	22.15	7.21	4.8	45
EPC-067	Chert	Complex	Hinge	31.76	17.44	4.98	2.2	15
EPC-068	Chert	Complex	Hinge	35.41	18.23	5.49	2.3	30
EPC-069	Chert	Complex	Hinge	19.63	9.28	2.97	0.3	15
EPC-070	Chert	Flat	Feathered	27.83	14.82	4	0.9	15
EPC-071	Chert	Flat	Step	31.14	10.74	4.4	0.9	60
EPC-072	Chert	Flat	Feathered	53.37	16.61	5.77	4.5	15
EPC-073	Chert	Abraded	Feathered	44.6	26.12	3.91	4	15
EPC-074	Chert	Complex	Feathered	28.78	20.75	7.02	3.9	30
EPC-075	Chert	Complex	Hinge	16.73	10.8	3.74	0.5	30
EPC-076	Chert	Complex	Feathered	30.58	15.43	4.05	1.9	15
EPC-077	Chert	Flat	Feathered	45.02	15.1	5.14	1.4	15
EPC-078	Chert	Abraded	Feathered	23.3	10.61	1.94	0.4	15
EPC-079	Chert	Abraded	Step	30.96	10.92	2.56	0.6	30
EPC-080	Chert	Cortical	Step	19.36	6.83	3.45	0.3	30
EPC-081	Chert	Abraded	Feathered	19.39	7.69	3.91	0.4	15
EPC-082	Chert	Cortical	Feathered	19.91	7.46	2.6	0.4	30
EPC-083	Chert	Abraded	Step	19.74	7.48	2.69	0.2	15
EPC-084	Chert	Cortical	Hinge	19.54	7.11	2.36	0.3	30
EPC-085	Chert	Complex	Step	41.75	26.05	7.99	5.4	30
EPC-086	Chert	Complex	Feathered	30.72	13.9	3.92	1.9	15
EPC-087	Chert	Abraded	Feathered	30	15.12	2.57	0.6	15
EPC-088	Chert	Flat	Feathered	29.03	16.61	6.55	2.2	30
EPC-089	Chert	Cortical	Hinge	44.92	19.88	7.89	4.8	15
EPC-090	Chert	Complex	Feathered	33.94	15.25	5.65	2.2	15
EPC-091	Chert	Cortical	Hinge	29.48	16.19	5.35	1.4	15

EPC-092	Chert	Abraded	Feathered	28.41	14.53	5.13	1.4	30
EPC-093	Chert	Cortical	Feathered	28.51	17.17	4.72	2.6	15
EPC-094	Chert	Flat	Feathered	31.59	17.5	5.21	2.7	15
EPC-095	Chert	Flat	Feathered	29.92	15	3.23	1.2	15
EPC-096	Chert	Abraded	Feathered	39.82	19.29	6.92	5.2	15
EPC-097	Chert	Cortical	Plunging	35.76	21.03	6.41	4.1	30
EPC-098	Chert	Abraded	Step	24.61	16.01	5.48	1.7	15
EPC-099	Chert	Complex	Feathered	26.69	17.67	4.47	1.2	15
EPC-100	Chert	Flat	Step	26.02	12.83	2.28	0.5	30
EPC-101	Chert	Flat	Hinge	22.83	14.78	3.55	0.8	15
EPC-102	Chert	Flat	Feathered	24.53	16.24	3.83	1	15
EPC-103	Chert	Cortical	Feathered	34.16	21.27	5.65	3.7	15
EPC-104	Chert	Cortical	Feathered	18.96	11.58	3.04	0.6	30
EPC-105	Chert	Abraded	Feathered	39.97	18.82	8.33	4.2	15
EPC-106	Chert	Flat	Feathered	18.4	11.6	5.43	1	30
EPC-107	Chert	Complex	Feathered	24.33	16.43	3.96	1.4	15
EPC-108	Chert	Flat	Feathered	22.16	11.7	3.37	0.6	30
EPC-109	Chert	Complex	Feathered	25.01	15.18	4.74	2	15
EPC-110	Chert	Flat	Hinge	20.45	11.98	4.8	1.5	15
EPC-111	Chert	Cortical	Hinge	18.36	11.31	4.3	0.9	30
EPC-112	Chert	Cortical	Step	14.96	9.61	2.97	0.6	30
EPC-BT-01	Chert	Cortical	Feathered	26.11	12.06	6.46	2.4	10
EPC-BT-02	Chert	Flat	Feathered	25.64	11.9	5.17	2.2	30
EPC-BT-03	Chert	Cortical	Feathered	35.34	13.73	3.59	2.3	20
EPC-BT-04	Chert	Cortical	Feathered	31.76	14.75	5.1	2.1	10
EPC-BT-05	Chert	Flat	Feathered	22.93	15.24	7.4	2.3	15
EPC-BT-06	Chert	Complex	Feathered	24.04	14.15	3.12	0.7	10
EPC-BT-07	Chert	Complex	Feathered	26.63	14.17	4.35	0.8	10
EPC-BT-08	Chert	Cortical	Feathered	35.05	15.02	4.8	2.2	20
EPC-BT-09	Chert	Cortical	Feathered	47.24	17.08	5.49	3.9	30
EPC-BT-10	Chert	Cortical	Step	28.48	10.34	3.87	0.7	15
EPC-BT-11	Chert	Abraded	Feathered	23.01	10.36	2.93	0.5	15
EPC-BT-12	Chert	Cortical	Plunging	44.75	16.54	3.97	4	30
EPC-BT-13	Chert	Cortical	Hinge	28.82	9.42	6.67	2.4	35
EPC-BT-14	Chert	Cortical	Feathered	30.07	10.26	7.65	2.7	20
EPC-BT-15	Chert	Cortical	Feathered	38.95	15.67	4.01	3.2	30
EPC-BT-16	Chert	Cortical	Feathered	28.82	15.59	4.03	2.6	30
EPC-BT-17	Chert	Cortical	Feathered	29.78	16.7	2.36	0.6	10
EPC-BT-18	Chert	Cortical	Plunging	44.27	15.26	5.91	2.7	30
EPC-BT-19	Chert	Cortical	Feathered	20.16	13.75	9.22	1.5	45
EPC-BT-20	Chert	Cortical	Feathered	18.32	8.65	3.25	0.4	15
EPC-BT-21	Chert	Cortical	Plunging	48.52	18.34	5.07	4.5	20
EPC-BT-22	Chert	Complex	Step	22.93	16.4	2.96	2.7	30
EPC-BT-23	Chert	Cortical	Plunging	42.07	15.74	5.69	3.4	30
EPC-BT-24	Chert	Cortical	Feathered	40.67	15.11	5.55	4	40
EPC-BT-25	Chert	Cortical	Hinge	36.26	19.45	5.62	4.1	35
EPC-BT-26	Chert	Cortical	Feathered	24.9	18.72	2.97	1.8	35
EPC-BT-27	Chert	Cortical	Plunging	43.14	24.74	4.4	5.1	45

EPC-BT-28	Chert	Abraded	Feathered	38.16	21.08	6.15	3.3	45
EPC-BT-29	Chert	Flat	Feathered	24.8	19.89	4.1	3.4	35
EPC-BT-30	Chert	Complex	Feathered	19.35	11.61	3.32	0.9	30
EPC-BT-31	Chert	Complex	Feathered	20.84	11.54	1.94	0.4	10
EPC-BT-32	Chert	Flat	Feathered	38.17	13.86	6.36	3	35
EPC-BT-33	Chert	Flat	Feathered	46.63	17.3	6.32	3.4	35
EPC-BT-34	Chert	Flat	Step	29.44	7.24	4.39	1.1	45
EPC-BT-35	Chert	Cortical	Plunging	35.15	11.43	5.53	3.1	45
EPC-BT-36	Chert	Flat	Hinge	39.18	17.51	4.72	2.7	50
EPC-BT-37	Chert	Flat	Step	39.52	14.84	5.25	2.9	40
EPC-BT-38	Chert	Complex	Hinge	24.05	15.2	4.47	1.6	40
EPC-BT-39	Chert	Abraded	Feathered	31.19	10.16	3.36	1.9	20
EPC-BT-40	Chert	Abraded	Feathered	29.21	12.69	5.92	2	20
EPC-BT-41	Chert	Abraded	Hinge	21.01	15.23	4.29	2.1	35
EPC-BT-42	Chert	Complex	Feathered	24.34	11.17	4.11	1.4	10
EPC-BT-43	Chert	Abraded	Hinge	31.44	12.02	3.98	1.8	15
EPC-BT-44	Chert	Abraded	Hinge	37.36	17.16	4.19	1.9	25
EPC-BT-45	Chert	Complex	Feathered	29.21	14.72	4.22	1.6	15
EPC-BT-46	Chert	Cortical	Feathered	44.09	14.34	2.59	1.3	10
EPC-BT-47	Chert	Abraded	Feathered	34.1	15.16	4.22	2.4	40
EPC-BT-48	Chert	Cortical	Step	39.95	11.77	4.66	1.6	25
EPC-BT-49	Chert	Complex	Hinge	18.81	8.35	2.18	0.4	30
EPC-BT-50	Chert	Complex	Hinge	36.6	13.85	2.56	1.1	10
EPC-BT-51	Chert	Complex	Feathered	18.72	8.24	2.14	0.3	10
EPC-BT-52	Chert	Cortical	Feathered	38.17	12.62	3.95	1.6	15
EPC-BT-53	Chert	Cortical	Hinge	28.53	10.54	5.01	1.7	30
EPC-BT-54	Chert	Cortical	Feathered	33.78	11.59	3.69	1.4	35
EPC-BT-55	Chert	Cortical	Feathered	16.33	8.1	3.69	0.5	10
EPC-BT-56	Chert	Cortical	Feathered	29.18	8.09	4.48	0.4	45
EPC-BT-57	Chert	Complex	Feathered	29.67	11.98	3.26	1.1	30
EPC-BT-58	Chert	Cortical	Feathered	25.97	7.36	2.59	0.7	15
EPC-BT-59	Chert	Cortical	Feathered	29.02	15.68	4.75	1.3	10
EPC-BT-60	Chert	Cortical	Hinge	27.59	16.06	4.01	1.3	20
EPC-BT-61	Chert	Cortical	Feathered	42.75	12.84	3.98	1.9	40
EPC-BT-62	Chert	Cortical	Step	31.75	10.48	4.75	1.3	10
EPC-BT-63	Chert	Complex	Feathered	27.52	8.71	3.18	0.7	10
EPC-BT-64	Chert	Cortical	Feathered	32.72	12.68	3.98	1.6	30
EPC-BT-65	Chert	Complex	Hinge	26.81	13.07	3.26	1	15
EPC-BT-66	Chert	Flat	Step	33.72	12.92	4.33	2.2	20
EPC-BT-67	Chert	Cortical	Feathered	25.23	20.5	5.2	3.1	15

* “BT” is designated for “blind-test” flake tools.

Appendix B. Qwu?gwes Flake Tools Morphological Attributes

Flake Name	Material	Platform	Termination	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Edge Angle
Q-01	Jasper	Complex	Feathered	20.3	10.98	4.48	1	46
Q-02	Chert	Abraded	Feathered	25.19	16.53	6.48	2	45
Q-03	Chert	Flat	Plunging	28.41	8.2	4.26	0.5	22
Q-04	Petrified Wood	Flat	Step	24.33	8.58	3.08	0.8	35
Q-05	Chert	Abraded	Step	31.19	14.66	6.17	3.1	38
Q-06	Chert	Abraded	Feathered	21.61	12.43	2.81	0.7	14
Q-07	Chert	Abraded	Feathered	24.18	11.26	2.79	0.8	23
Q-08	CCS	Complex	Step	23.52	7.51	3.93	0.7	45
Q-09	Chert	Abraded	Hinge	15.87	10.29	3.39	0.5	22
Q-10	Jasper	Abraded	Feathered	23.91	14.24	3.73	1.1	24
Q-11	Chert	Flat	Step	26.78	23.76	6.19	3.7	23
Q-12	Jasper	Complex	Feathered	27.38	17.29	5.65	2.8	15
Q-13	Chalcedony	Abraded	Feathered	22.98	13.99	5.49	1.8	17
Q-14	Chalcedony	Abraded	Feathered	19.39	9.08	2.17	0.3	15
Q-15	Jasper	Abraded	Step	19.67	11.18	5.54	1.1	28
Q-16	Chalcedony	Complex	Step	18.02	12.01	4.71	1.1	14
Q-17	Jasper	Abraded	Feathered	22.69	10.23	5.65	1.1	90
Q-18	Jasper	Complex	Feathered	16.28	7.39	2.93	0.3	21
Q-19	Chalcedony	Abraded	Feathered	25.79	7.91	5.67	0.9	37
Q-20	Jasper	Abraded	Feathered	9.13	6.24	1.79	0.2	10
Q-21	Jasper	Flat	Step	24.21	8.53	4.67	1	18
Q-22	Chert	Complex	Feathered	24.96	9.2	5.95	1.2	37
Q-23	Jasper	Complex	Step	22.55	10.93	3.97	0.9	22
Q-24	CCS	Complex	Step	18.12	12.92	5.68	1	29
Q-25	Chalcedony	Abraded	Feathered	18.23	11.22	3.98	0.8	24
Q-26	Chalcedony	Abraded	Step	44.41	15.68	9.81	5.9	24
Q-27	Chert	Abraded	Feathered	17.48	9.35	3.41	0.4	28
Q-28	Jasper	Abraded	Feathered	20.71	9.01	5.06	0.7	33
Q-29	Chert	Complex	Feathered	17.87	10.84	3.22	0.6	21
Q-30	Jasper	Abraded	Feathered	20.71	10.64	3.5	0.5	19
Q-31	Jasper	Abraded	Step	11.27	7.21	2.67	0.2	16
Q-32	Jasper	Abraded	Step	24.9	17.44	5.52	2.1	17
Q-33	Jasper	Complex	Step	20.38	10.16	7.37	1.2	33
Q-34	Chert	Abraded	Feathered	24.21	14.51	7.02	2.1	26
Q-35	Chalcedony	Cortical	Feathered	38.7	23.04	10.35	6	22
Q-36	Jasper	Abraded	Step	32.7	16.39	10.74	4.1	27
Q-37	Chalcedony	Complex	Step	16.19	7.74	3.34	0.4	21
Q-38	Petrified Wood	Flat	Step	22.51	11.25	4.57	1.5	18
Q-39	Jasper	Flat	Feathered	22.45	17.87	3.22	1.7	10
Q-40	Chalcedony	Abraded	Step	19.25	11.29	3.31	0.7	18
Q-41	Basalt	Cortical	Feathered	34.53	10.7	2.99	1.3	46
Q-42	Chalcedony	Abraded	Feathered	22.6	13.22	6.1	1.7	41
Q-43	CCS	Complex	Feathered	44.72	23.57	8.63	9	35
Q-44	Chalcedony	Abraded	Feathered	17.55	9.24	3.13	0.5	16
Q-45	Chalcedony	Flat	Step	21	9.14	5.54	0.6	36

Q-46	Jasper	Abraded	Feathered	19.93	11.35	5.47	0.8	14
Q-47	Chalcedony	Complex	Step	28.85	14.73	7.17	2.2	32
Q-48	Jasper	Abraded	Feathered	31.02	20.51	6.51	3.4	25
Q-49	Chalcedony	Flat	Step	20.72	11.76	5.99	1.5	43
Q-50	CCS	Cortical	Feathered	43.75	15.87	11.44	7.5	33
Q-51	CCS	Cortical	Feathered	30.67	9.63	6.89	2.3	44
Q-52	Agate	Abraded	Step	16.04	9.18	2.88	0.6	47
Q-53	Agate	Abraded	Feathered	21.76	11.73	5.13	1.2	32
Q-54	Agate	Abraded	Feathered	16.89	9.74	3.47	0.5	16
Q-55	Agate	Abraded	Feathered	26.09	14.92	6.21	2.7	48
Q-56	Petrified Wood	Abraded	Feathered	30.59	9.69	5.35	1.5	42
Q-57	Basalt	Abraded	Feathered	25.94	12.2	3.32	1.4	16
Q-58	Agate	Abraded	Feathered	30.34	13.61	5.14	2.4	46
Q-59	Agate	Abraded	Feathered	26.72	11.36	7.81	1.6	26
Q-60	Basalt	Complex	Step	22.28	9.05	3.64	0.6	16
Q-61	Basalt	Abraded	Feathered	16.67	10.17	2.22	0.4	15
Q-62	Chalcedony	Complex	Step	15.72	11.44	5.43	0.8	63
Q-63	CCS	Flat	Step	27.26	10.22	5.44	1.1	32
Q-64	Jasper	Complex	Feathered	15.11	6.29	3.11	0.2	40
Q-65	Chert	Abraded	Feathered	22.39	10.07	3.22	0.5	25
Q-66	Jasper	Abraded	Step	25.76	19.29	6.37	3.5	19
Q-67	Jasper	Flat	Feathered	15.77	9.3	3.03	0.4	17
Q-68	CCS	Complex	Step	18.8	13.6	4.36	0.9	18
Q-69	Chert	Complex	Feathered	28.57	10.43	7.72	1.2	28
Q-70	Chert	Complex	Plunging	35.82	12.09	6.33	3.8	41
Q-71	Chalcedony	Flat	Feathered	17.04	9.33	5.66	0.7	12
Q-72	Jasper	Abraded	Step	23.12	11.16	3.07	0.8	51
Q-73	Jasper	Flat	Feathered	23.59	18.27	5.32	2	25
Q-74	Chert	Cortical	Step	17.67	10.31	3.88	0.6	63
Q-75	Basalt	Abraded	Step	23.27	14.32	6.24	2.7	44
Q-76	CCS	Abraded	Hinge	15.22	11.23	3.87	0.5	26
Q-77	Chert	Complex	Feathered	15.26	9.8	3.63	0.6	41
Q-78	Chalcedony	Abraded	Feathered	14.55	6.22	1.86	0.2	11
Q-79	Chalcedony	Complex	Feathered	15.79	9.56	2.66	0.3	14
Q-80	Chert	Cortical	Step	34.46	16.09	10.45	6.4	45
Q-81	Chalcedony	Complex	Feathered	19.48	10.71	2.14	0.4	10
Q-82	Chert	Cortical	Step	34.51	18.32	7.28	5.2	26

Appendix C. Hartstene Flake Tools Morphological Attributes

Flake Name	Material	Platform	Termination	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Edge Angle
H-01	Basalt	Flat	Plunging	45.45	20.42	5.14	6.6	21
H-02	Jasper	Abraded	Feathered	28.51	16.25	3.86	1.9	21
H-03	Basalt	Abraded	Feathered	46.38	11.77	3.69	2.2	17
H-04	CCS	Abraded	Step	28.24	11.49	3.56	1.1	42
H-05	CCS	Abraded	Plunging	26.26	11.97	3.97	1.3	25
H-06	Jasper	Abraded	Step	16.8	6.94	1.56	0.1	22
H-07	Jasper	Complex	Step	37.42	14.49	5.09	2.7	33
H-08	Jasper	Complex	Step	29.65	12.58	4.29	1.9	30
H-09	Petrified Wood	Abraded	Step	31.73	13.9	3.75	2.3	15
H-10	Chert	Abraded	Feathered	27.85	14.12	4.22	1.7	32
H-11	Jasper	Flat	Step	21.85	10.27	2.74	0.7	17
H-12	CCS	Abraded	Feathered	24.18	11.73	2.89	0.5	15
H-13	Jasper	Flat	Plunging	25.2	8.24	3.81	0.7	25
H-14	Jasper	Abraded	Step	26.3	11.84	3.46	1.4	19
H-15	Basalt	Abraded	Feathered	33.08	14.69	3.64	1.4	35
H-16	Jasper	Abraded	Feathered	41.96	17.98	4.94	3.7	16
H-17	Jasper	Flat	Hinge	27.34	14.37	3.78	2	20
H-18	Jasper	Abraded	Feathered	23.83	15.21	4.3	1.6	37
H-19	CCS	Abraded	Feathered	22.39	9.86	4.71	0.9	27
H-20	Chert	Abraded	Feathered	27.92	13.75	4.55	1.7	27
H-21	Jasper	Abraded	Feathered	21.65	12.75	5.51	1.4	40
H-22	Jasper	Flat	Feathered	23.46	13.98	5.72	1.2	47
H-23	Jasper	Abraded	Step	28.43	16.05	2.64	1.5	14
H-24	Chert	Abraded	Feathered	33.15	15.73	2.46	1.7	37
H-25	Jasper	Flat	Step	18.35	10.19	2.92	0.6	24
H-26	Basalt	Complex	Step	26.42	9.76	1.77	0.6	15
H-27	Jasper	Complex	Feathered	34.22	13.67	4.77	2.1	35
H-28	Chalcedony	Flat	Step	24.81	13.72	2.01	1	8
H-29	Basalt	Abraded	Feathered	34.25	11.37	3.59	1.5	32
H-30	Petrified Wood	Complex	Feathered	38.35	15.68	3.36	2.6	27
H-31	Basalt	Complex	Feathered	40.09	22.09	5.11	4.3	17
H-32	Petrified Wood	Flat	Hinge	24.06	13.04	3.17	1.4	19
H-33	Jasper	Abraded	Step	35.19	18.12	4.72	3.2	17
H-34	Jasper	Flat	Step	35.76	15.46	3.59	2.3	1
H-35	CCS	Abraded	Feathered	29.1	18.96	2.84	2	22
H-36	Chalcedony	Abraded	Feathered	27.82	14.85	5.89	2.9	44
H-37	Petrified Wood	Abraded	Feathered	21.15	14.21	3.31	1.4	45
H-38	Jasper	Abraded	Feathered	19.55	7.89	2.98	0.4	18
H-39	CCS	Abraded	Feathered	30.59	13.04	4.06	1.2	27
H-40	Jasper	Complex	Step	34.01	8.99	3.23	1.1	37

Appendix D. Sauvie Island Flake Tools Morphological Attributes

Flake Name	Material	Platform	Termination	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Edge Angle
SV-01	Quartz	Flat	-	28.19	18.19	13.81	8.7	75
SV-02	CCS	Complex	-	30.22	22.01	4.09	2.6	43
SV-03	CCS	Complex	-	17.25	12.86	3.22	0.6	16
SV-04	CCS	Flat	-	25.38	20.57	7.05	3.8	32
SV-05	CCS	Complex	-	16.66	11.35	2.89	0.4	23
SV-06	CCS	Flat	-	36.39	15.62	2.88	1.7	22
SV-07	CCS	Complex	-	20.05	9.69	3.02	0.5	10
SV-08	CCS	Flat	-	40.97	27.73	10.71	10.4	33
SV-09	CCS	Complex	-	12.48	13.11	1.49	0.2	15
SV-10	Quartzite	Complex	-	18.8	26.02	8.13	4	29
SV-11	CCS	Flat	-	17.84	19.52	3.93	1.6	25
SV-12	CCS	Flat	-	18.82	11.05	4.87	1.1	35
SV-13	CCS	Complex	-	50.37	35.33	8.72	13.6	24
SV-14	CCS	Abraded	-	23.81	7.82	3.46	0.6	19
SV-15	Basalt	Complex	-	20.53	11.57	3.6	0.6	28
SV-16	CCS	Abraded	-	20.64	11.64	3.32	1	16
SV-17	Basalt	Flat	-	49.96	24.8	9.1	10.9	32
SV-18	CCS	Flat	-	28.28	23.15	8.29	4	52
SV-19	Quartz	Flat	-	39.99	24.56	10.59	11.4	50
SV-20	CCS	Cortical	-	26.1	19.52	19.1	5.6	55
SV-21	CCS	Flat	-	26.73	18.24	5.24	1.7	37
SV-22	CCS	Complex	-	19.95	14.54	6.98	1.8	54
SV-23	CCS	Complex	-	13.36	17.1	3.07	0.5	30
SV-24	CCS	Cortical	-	16.67	27.55	4.97	1.8	25
SV-25	CCS	Abraded	-	6.71	19.2	1.9	0.3	41
SV-26	CCS	Cortical	-	19.77	17.42	3.49	1.1	36
SV-27	Agate	Complex	-	18.65	8.95	1.01	0.1	8
SV-28	CCS	Complex	-	13.28	8	1.58	0.5	12
SV-29	CCS	Complex	-	12.88	9.32	2.42	0.2	31
SV-30	Agate	Cortical	-	12.7	11.05	3.21	0.3	24
SV-31	CCS	Flat	-	29.28	17.43	5.41	2.8	37
SV-32	CCS	Abraded	-	10.52	10.18	2.24	0.3	23
SV-33	CCS	Complex	-	20.08	12.92	1.81	0.4	20
SV-34	Rhyolite	Abraded	-	14.19	10.38	3.1	0.4	25
SV-35	Agate	Abraded	-	21.24	12.62	3.17	0.7	32
SV-36	CCS	Flat	-	11.09	9.66	2.01	0.1	22
SV-37	CCS	Complex	-	13.45	7.19	2.3	0.2	24
SV-38	CCS	Cortical	-	18.59	9.77	2.97	0.4	26
SV-39	Agate	Flat	-	23.35	17.3	5.16	2.1	27
SV-40	CCS	Complex	-	12.05	7.95	2.41	0.3	30
SV-41	Obsidian	Cortical	-	14.41	6.38	1.76	0.1	22
SV-42	Basalt	Abraded	-	18.18	12.65	4.56	0.8	24
SV-43	CCS	Complex	-	42.69	22.51	5.52	5.4	43
SV-44	CCS	Abraded	-	25.84	9.07	6.77	1.2	31
SV-45	CCS	Complex	-	22.65	14.66	2.38	0.6	18
SV-46	Rhyolite	Abraded	-	27.55	22.26	2.23	1.3	12

SV-47	CCS	Complex	-	17.47	14.23	3.82	0.5	33
SV-48	CCS	Flat	-	18.89	12.05	1.96	0.5	27
SV-49	Quartzite	Cortical	-	32.69	14.07	2.82	1.3	18
SV-50	CCS	Flat	-	20.56	4.17	5.25	1.4	28
SV-51	CCS	Abraded	-	19.92	9.69	3.16	0.5	31
SV-52	Quartzite	Flat	-	17.29	15.36	5.03	1.2	55
SV-53	CCS	Complex	-	17.62	10.39	2.26	0.4	23
SV-54	Basalt	Flat	-	16.95	9.82	3.62	0.4	35
SV-55	Basalt	Flat	-	18.01	12.97	4.01	0.9	47
SV-56	CCS	Complex	-	18.35	10.26	2.08	0.3	36
SV-57	CCS	Abraded	-	13.91	7.83	1.88	0.3	30
SV-58	Quartzite	Abraded	-	20.2	18.58	3.71	1.1	35
SV-59	Chert	Complex	-	19.63	10.73	3.61	0.5	23
SV-60	Agate	Abraded	-	25.28	16.19	4.11	1.7	33
SV-61	Quartzite	Flat	-	18.06	24.64	4.1	1.4	28
SV-62	CCS	Complex	-	25.01	14.32	4.57	1.1	32
SV-63	CCS	Flat	-	13.53	8.25	1.79	0.1	41
SV-64	CCS	Abraded	-	11.37	8.28	1.74	0.3	19
SV-65	CCS	Complex	-	11.31	8.9	2.38	0.1	26
SV-66	CCS	Abraded	-	23	19.63	8.92	2.5	36
SV-67	CCS	Flat	-	22.2	17.5	3.77	1.3	26
SV-68	CCS	Complex	-	29.65	9.56	4.79	1	27
SV-69	CCS	Complex	-	32.63	9.56	4.19	1.3	39
SV-70	CCS	Complex	-	9.11	7.35	1.36	0.3	8
SV-71	CCS	Complex	-	15.72	7.6	2.37	0.3	26
SV-72	CCS	Complex	-	17.06	10.45	3.13	0.1	30
SV-73	Quartzite	Flat	-	33.84	9.78	5.84	1.4	40
SV-74	CCS	Flat	-	29.1	17.27	9.23	2.9	47
SV-75	CCS	Complex	-	15.14	10.25	1.64	0.3	41
SV-76	Agate	Flat	-	9.94	21.89	3.27	0.3	27
SV-77	CCS	Complex	-	29.56	13.1	3.8	0.4	16
SV-78	Siltstone	Abraded	-	21.63	14.43	4.34	0.4	20

Appendix E. Edward Plateau Chert Experimental Flake Tools Microwear Morphological Attributes, Activity and Predicted Activity

Flake Name	Striation Direction (ordinal)	Polish Intrusion (mm)	Edge-Morphology (nominal)	Activity	Guessed by German	DFA Predicted Activity	DFA Function 1	DFA Function 2
EPC-001	1	1.1	Lunate	Cut	-	Cut	-1.08	0.40
EPC-002	2	1.7	Smooth	Cut	-	Cut	-0.82	-0.05
EPC-003	4	1.1	Worn	Cut	-	Scrape	1.34	1.80
EPC-004	2	1.4	Smooth	Cut	-	Cut	-0.96	0.09
EPC-005	2	1.4	Shattered	Cut	-	Cut	-1.46	-0.29
EPC-006	-	0.9	Shattered	Cut	-	-	-	-
EPC-007	1	1.9	Smooth	Cut	-	Cut	-1.70	-0.73
EPC-008	1	1.2	Smooth	Cut	-	Cut	-2.02	-0.40
EPC-009	1	1.5	Lunate	Cut	-	Cut	-0.89	0.21
EPC-010	1	1.7	Worn	Cut	-	Cut	-1.29	-0.26
EPC-011	1	1.8	Worn	Cut	-	Cut	-1.25	-0.31
EPC-012	1	1.1	Smooth	Cut	-	Cut	-2.07	-0.36
EPC-013	1	1.2	Shattered	Cut	-	Cut	-2.52	-0.78
EPC-014	1	1.3	Smooth	Cut	-	Cut	-1.98	-0.45
EPC-015	2	1	Smooth	Cut	-	Cut	-1.15	0.28
EPC-016	1	1.5	Smooth	Cut	-	Cut	-1.88	-0.55
EPC-017	2	0.9	Smooth	Cut	-	Cut	-1.19	0.33
EPC-018	1	1.2	Smooth	Cut	-	Cut	-2.02	-0.40
EPC-019	1	0.53	Worn	Cut	-	Cut	-1.84	0.29
EPC-020	1	0.49	Smooth	Cut	-	Cut	-2.35	-0.07
EPC-021	-	0.43	Lunate	Cut	-	-	-	-
EPC-022	1	0.63	Smooth	Cut	-	Cut	-2.29	-0.14
EPC-023	2	0.57	Shattered	Cut	-	Cut	-1.84	0.11
EPC-024	1	0.64	Lunate	Cut	-	Cut	-1.29	0.62
EPC-025	1	0	Smooth	Cut	-	Cut	-2.58	0.16
EPC-026	-	0	Lunate	Cut	-	-	-	-
EPC-027	1	0.57	Smooth	Cut	-	Cut	-2.31	-0.11
EPC-028	1	0.58	Smooth	Cut	-	Cut	-2.31	-0.11
EPC-029	1	2.44	Shattered	Cut	-	Cut	-1.94	-1.37
EPC-030	1	1.44	Shattered	Cut	-	Cut	-2.41	-0.90
EPC-031	1	1.92	Lunate	Cut	-	Cut	-0.70	0.02
EPC-032	-	2.04	Smooth	Cut	-	-	-	-
EPC-033	2	2.2	Shattered	Cut	-	Cut	-1.09	-0.66
EPC-034	1	1.7	Worn	Cut	-	Cut	-1.29	-0.26
EPC-035	-	1.78	Shattered	Cut	-	-	-	-
EPC-036	1	1.66	Shattered	Cut	-	Cut	-2.31	-1.00
EPC-037	-	2.47	Shattered	Cut	-	-	-	-
EPC-038	1	1.73	Worn	Cut	-	Cut	-1.28	-0.27
EPC-039	2	2.34	Smooth	Cut	-	Cut	-0.53	-0.35
EPC-040	1	1.65	Lunate	Cut	-	Cut	-0.82	0.14
EPC-041	1	2.67	Smooth	Cut	-	Cut	-1.34	-1.10
EPC-042	2	2.33	Smooth	Cut	-	Cut	-0.53	-0.34
EPC-043	1	2.38	Shattered	Cut	-	Cut	-1.97	-1.34
EPC-044	1	2.28	Shattered	Cut	-	Cut	-2.02	-1.29

EPC-045	1	3.18	Shattered	Cut	-	Cut	-1.60	-1.72
EPC-046	1	2.61	Shattered	Cut	-	Cut	-1.87	-1.45
EPC-047	1	2.49	Smooth	Cut	-	Cut	-1.43	-1.01
EPC-048	1	1.91	Smooth	Cut	-	Cut	-1.69	-0.74
EPC-049	2	1.95	Shattered	Cut	-	Cut	-1.20	-0.55
EPC-050	2	1.84	Shattered	Cut	-	Cut	-1.25	-0.49
EPC-051	2	0.59	Smooth	Cut	-	Cut	-1.34	0.48
EPC-052	1	2.9	Smooth	Cut	-	Cut	-1.24	-1.21
EPC-053	2	3	Shattered	Cut	-	Cut	-0.72	-1.04
EPC-054	1	3.83	Smooth	Cut	-	Cut	-0.80	-1.64
EPC-055	1	3.41	Shattered	Cut	-	Cut	-1.50	-1.83
EPC-056	1	1.8	Lunate	Cut	-	Cut	-0.75	0.07
EPC-057	-	0.9	Lunate	Scrape	-	-	-	-
EPC-058	4	0.2	Lunate	Scrape	-	Scrape	1.41	2.61
EPC-059	-	1	Lunate	Scrape	-	-	-	-
EPC-060	3	1.2	Smooth	Scrape	-	Scrape	-0.08	0.78
EPC-061	1	0.2	Worn	Scrape	-	Cut	-1.99	0.45
EPC-062	1	0.3	Smooth	Scrape	-	Cut	-2.44	0.02
EPC-063	-	0.3	Worn	Scrape	-	-	-	-
EPC-064	3	0	Lunate	Scrape	-	Scrape	0.35	2.11
EPC-065	1	0	Lunate	Scrape	-	Cut	-1.59	0.92
EPC-066	3	0.3	Lunate	Scrape	-	Scrape	0.49	1.97
EPC-067	4	0.2	Lunate	Scrape	-	Scrape	1.41	2.61
EPC-068	4	0.1	Lunate	Scrape	-	Scrape	1.37	2.65
EPC-069	3	0.6	Lunate	Scrape	-	Scrape	0.63	1.82
EPC-070	4	0.9	Lunate	Scrape	-	Scrape	1.74	2.28
EPC-071	4	0.6	Lunate	Scrape	-	Scrape	1.60	2.42
EPC-072	4	0.5	Smooth	Scrape	-	Scrape	0.56	1.70
EPC-073	3	0.3	Lunate	Scrape	-	Scrape	0.49	1.97
EPC-074	3	0.5	Lunate	Scrape	-	Scrape	0.58	1.87
EPC-075	4	0.1	Lunate	Scrape	-	Scrape	1.37	2.65
EPC-076	-	0.33	Shattered	Scrape	-	-	-	-
EPC-077	4	0.19	Lunate	Scrape	-	Scrape	1.41	2.61
EPC-078	1	0.34	Lunate	Scrape	-	Cut	-1.43	0.76
EPC-079	1	0.38	Lunate	Scrape	-	Cut	-1.41	0.74
EPC-080	4	0.3	Smooth	Scrape	-	Scrape	0.47	1.80
EPC-081	-	-	Lunate	Scrape	-	-	-	-
EPC-082	-	0.17	Smooth	Scrape	-	-	-	-
EPC-083	-	0.29	Smooth	Scrape	-	-	-	-
EPC-084	-	0.39	Shattered	Scrape	-	-	-	-
EPC-085	3	8.2	Shattered	Whittle	-	Whittle	2.66	-2.90
EPC-086	3	8.6	Smooth	Whittle	-	Whittle	3.34	-2.71
EPC-087	3	4.9	Worn	Whittle	-	Whittle	2.13	-0.58
EPC-088	-	7.7	Worn	Whittle	-	-	-	-
EPC-089	-	5.2	Shattered	Whittle	-	-	-	-
EPC-090	4	9	Smooth	Whittle	-	Whittle	4.50	-2.30
EPC-091	4	6	Worn	Whittle	-	Whittle	3.61	-0.51
EPC-092	4	7.4	Worn	Whittle	-	Whittle	4.25	-1.17

EPC-093	4	8.7	Shattered	Whittle	-	Whittle	3.86	-2.54
EPC-094	4	6.9	Worn	Whittle	-	Whittle	4.02	-0.93
EPC-095	4	6.6	Smooth	Whittle	-	Whittle	3.39	-1.17
EPC-096	3	6.75	Smooth	Whittle	-	Whittle	2.49	-1.84
EPC-097	4	7.67	Smooth	Whittle	-	Whittle	3.88	-1.68
EPC-098	3	3.53	Worn	Whittle	-	Whittle	1.49	0.06
EPC-099	3	-	Smooth	Whittle	-	-	-	-
EPC-100	3	1.65	Lunate	Whittle	-	Scrape	1.12	1.33
EPC-101	4	0	Lunate	Whittle	-	Scrape	1.32	2.70
EPC-102	4	3.04	Lunate	Whittle	-	Whittle	2.73	1.27
EPC-103	4	8.81	Worn	Whittle	-	Whittle	4.91	-1.83
EPC-104	3	6.73	Smooth	Whittle	-	Whittle	2.48	-1.83
EPC-105	4	5.65	Lunate	Whittle	-	Whittle	3.94	0.04
EPC-106	4	4.45	Smooth	Whittle	-	Whittle	2.39	-0.16
EPC-107	4	2.46	Smooth	Whittle	-	Scrape	1.47	0.78
EPC-108	3	3.7	Worn	Whittle	-	Whittle	1.57	-0.02
EPC-109	4	0.26	Lunate	Whittle	-	Scrape	1.44	2.58
EPC-110	3	3.7	Worn	Whittle	-	Whittle	1.57	-0.02
EPC-111	3	6.61	Lunate	Whittle	-	Whittle	3.42	-1.01
EPC-112	3	2.29	Smooth	Whittle	-	Scrape	0.42	0.27
EPC-BT-01	1	5.64	Worn	Whittle	Whittle	Cut	0.53	-2.12
EPC-BT-02	1	0.94	Smooth	Cut	Cut	Cut	-2.14	-0.28
EPC-BT-03	2	1.12	Smooth	Cut	Cut	Cut	-1.09	0.23
EPC-BT-04	-	0.44	Worn	Scrape	Scrape	-	-	-
EPC-BT-05	1	1.01	Shattered	Scrape	Cut	Cut	-2.61	-0.69
EPC-BT-06	3	0.19	Lunate	Scrape	Scrape	Scrape	0.44	2.02
EPC-BT-07	3	0.24	Lunate	Scrape	Scrape	Scrape	0.46	1.99
EPC-BT-08	1	0.98	Shattered	Cut	Cut	Cut	-2.62	-0.68
EPC-BT-09	1	0.6	Lunate	Cut	Cut	Cut	-1.31	0.64
EPC-BT-10	-	0.94	Shattered	Cut	Cut	-	-	-
EPC-BT-11	2	0.93	Shattered	Whittle	Cut	Cut	-1.67	-0.06
EPC-BT-12	3	0.45	Lunate	Whittle	Scrape	Scrape	0.56	1.90
EPC-BT-13	1	0.92	Smooth	Cut	Cut	Cut	-2.15	-0.27
EPC-BT-14	-	0.31	Lunate	Cut	Scrape	-	-	-
EPC-BT-15	2	0.86	Worn	Cut	Cut	Cut	-0.71	0.73
EPC-BT-16	-	-	Smooth	Blank	Blank	-	-	-
EPC-BT-17	3	2.2	Smooth	Scrape	Scrape	Scrape	0.38	0.31
EPC-BT-18	2	1.49	Worn	Cut	Cut	Cut	-0.42	0.43
EPC-BT-19	3	5.09	Shattered	Scrape	Whittle	Whittle	1.22	-1.43
EPC-BT-20	3	4.46	Lunate	Cut	Whittle	Whittle	2.42	0.00
EPC-BT-21	2	1.39	Shattered	Scrape	Cut	Cut	-1.46	-0.28
EPC-BT-22	1	1.13	Smooth	Cut	Cut	Cut	-2.06	-0.37
EPC-BT-23	4	10.74	Worn	Whittle	Whittle	Whittle	5.80	-2.74
EPC-BT-24	3	2.31	Smooth	Scrape	Whittle	Scrape	0.43	0.26
EPC-BT-25	1	2.01	Shattered	Cut	Cut	Cut	-2.14	-1.17
EPC-BT-26	1	0.91	Lunate	Cut	Cut	Cut	-1.16	0.49
EPC-BT-27	1	1.12	Shattered	Cut	Cut	Cut	-2.56	-0.75
EPC-BT-28	3	7.03	Smooth	Whittle	Whittle	Whittle	2.62	-1.97

EPC-BT-29	1	1.19	Smooth	Cut	Cut	Cut	-2.03	-0.40
EPC-BT-30	3	5.55	Worn	Whittle	Whittle	Whittle	2.43	-0.89
EPC-BT-31	3	0.26	Lunate	Whittle	Scrape	Scrape	0.47	1.98
EPC-BT-32	1	1.14	Smooth	Cut	Cut	Cut	-2.05	-0.38
EPC-BT-33	1	1.81	Smooth	Cut	Cut	Cut	-1.74	-0.69
EPC-BT-34	3	1.9	Worn	Scrape	Whittle	Scrape	0.74	0.83
EPC-BT-35	2	2.69	Smooth	Cut	Cut	Cut	-0.36	-0.51
EPC-BT-36	3	6.19	Smooth	Whittle	Whittle	Whittle	2.23	-1.57
EPC-BT-37	1	3.37	Smooth	Cut	Cut	Cut	-1.02	-1.43
EPC-BT-38	4	3.02	Shattered	Whittle	Whittle	Whittle	1.23	0.14
EPC-BT-39	1	2.69	Shattered	Cut	Cut	Cut	-1.83	-1.49
EPC-BT-40	-	0.32	Lunate	Whittle	Scrape	-	-	-
EPC-BT-41	1	1.01	Smooth	Cut	Cut	Cut	-2.11	-0.31
EPC-BT-42	2	-	Smooth	Blank	Blank	-	-	-
EPC-BT-43	2	1.1	Smooth	Cut	Cut	Cut	-1.10	0.24
EPC-BT-44	4	4.7	Worn	Scrape	Whittle	Whittle	3.00	0.10
EPC-BT-45	3	6.2	Worn	Whittle	Whittle	Whittle	2.73	-1.20
EPC-BT-46	3	1.1	Shattered	Cut	Cut	Cut	-0.63	0.45
EPC-BT-47	3	7.1	Smooth	Whittle	Whittle	Whittle	2.65	-2.00
EPC-BT-48	3	5.8	Lunate	Whittle	Whittle	Whittle	3.04	-0.63
EPC-BT-49	4	5.1	Worn	Whittle	Whittle	Whittle	3.19	-0.08
EPC-BT-50	3	5.8	Shattered	Cut	Whittle	Whittle	1.55	-1.77
EPC-BT-51	-	0.1	Lunate	Cut	Scrape	-	-	-
EPC-BT-52	4	2.9	Lunate	Scrape	Scrape	Whittle	2.67	1.33
EPC-BT-53	2	0.9	Lunate	Scrape	Cut	Scrape	-0.20	1.09
EPC-BT-54	-	-	Smooth	Blank	Blank	-	-	-
EPC-BT-55	1	0.9	Smooth	Cut	Cut	Cut	-2.16	-0.26
EPC-BT-56	-	-	Smooth	Blank	Blank	-	-	-
EPC-BT-57	-	4.1	Smooth	Scrape	Scrape	-	-	-
EPC-BT-58	2	1.1	Shattered	Whittle	Cut	Cut	-1.60	-0.14
EPC-BT-59	1	1.2	Worn	Cut	Cut	Cut	-1.53	-0.02
EPC-BT-60	3	-	Shattered	Scrape	Scrape	-	-	-
EPC-BT-61	2	4.6	Smooth	Whittle	Whittle	Cut	0.52	-1.41
EPC-BT-62	1	1.1	Lunate	Cut	Cut	Cut	-1.08	0.40
EPC-BT-63	-	-	Smooth	Blank	Blank	-	-	-
EPC-BT-64	2	0.4	Shattered	Scrape	Scrape	Cut	-1.92	0.19
EPC-BT-65	2	0.9	Smooth	Whittle	Cut	Cut	-1.19	0.33
EPC-BT-66	2	2.1	Smooth	Whittle	Cut	Cut	-0.64	-0.24
EPC-BT-67	-	0.2	Smooth	Scrape	Scrape	-	-	-

* “BT” is designated for “blind-test” flake tools.

Appendix F. Qwu?gwes Flake Tools Microwear Morphological Attributes, Activity and Predicted Activity

Flake Name	Striation Direction (ordinal)	Polish Intrusion (mm)	Edge-Morphology (nominal)	Activity	Guessed by German	DFA Predicted Activity	DFA Function 1	DFA Function 2
Q-01	4	-	Lunate	?	-	-	-	-
Q-02	-	-	Lunate	?	-	-	-	-
Q-03	1	-	Worn	?	-	-	-	-
Q-04	1	0.61	Smooth	?	-	Cut	-2.30	-0.13
Q-05	-	0.54	Smooth	?	-	-	-	-
Q-06	-	0.26	Lunate	?	-	-	-	-
Q-07	2	0.99	Lunate	?	-	Scrape	-0.16	1.05
Q-08	2	-	Worn	?	-	-	-	-
Q-09	1	-	Smooth	?	-	-	-	-
Q-10	2	0.4	Smooth	?	-	Cut	-1.42	0.57
Q-11	2	0.58	Shattered	?	-	Cut	-1.84	0.10
Q-12	4	1	Worn	?	-	Scrape	1.29	1.85
Q-13	-	-	Worn	?	-	-	-	-
Q-14	2	-	Smooth	?	-	-	-	-
Q-15	-	0.97	Smooth	?	-	-	-	-
Q-16	4	-	Worn	?	-	-	-	-
Q-17	2	0.21	Smooth	?	-	Cut	-1.51	0.66
Q-18	3	-	Smooth	?	-	-	-	-
Q-19	4	-	Worn	?	-	-	-	-
Q-20	-	0.13	Worn	?	-	-	-	-
Q-21	3	0.5	Worn	?	-	Scrape	0.09	1.49
Q-22	-	-	Worn	?	-	-	-	-
Q-23	3	0.72	Worn	?	-	Scrape	0.19	1.39
Q-24	-	-	Lunate	?	-	-	-	-
Q-25	1	0.19	Worn	?	-	Cut	-1.99	0.45
Q-26	1	0.48	Lunate	?	-	Cut	-1.36	0.69
Q-27	1	0.73	Smooth	?	-	Cut	-2.24	-0.18
Q-28	-	0.64	Shattered	?	-	-	-	-
Q-29	2	-	Smooth	?	-	-	-	-
Q-30	2	0.39	Smooth	?	-	Cut	-1.43	0.57
Q-31	-	0.58	Smooth	?	-	-	-	-
Q-32	1	0.8	Shattered	?	-	Cut	-2.70	-0.60
Q-33	-	0.45	Smooth	?	-	-	-	-
Q-34	2	0.36	Lunate	?	-	Scrape	-0.45	1.34
Q-35	3	0.36	Lunate	?	-	Scrape	0.52	1.94
Q-36	-	0.24	Smooth	?	-	-	-	-
Q-37	4	0.36	Smooth	?	-	Scrape	0.50	1.77
Q-38	1	0.42	Smooth	?	-	Cut	-2.38	-0.04
Q-39	1	0.46	Smooth	?	-	Cut	-2.37	-0.06
Q-40	-	-	Smooth	?	-	-	-	-
Q-41	1	0.86	Smooth	?	-	Cut	-2.18	-0.24
Q-42	1	0.61	Smooth	?	-	Cut	-2.30	-0.13
Q-43	-	-	Worn	?	-	-	-	-
Q-44	3	-	Lunate	?	-	-	-	-
Q-45	2	0.74	Smooth	?	-	Cut	-1.27	0.41

Q-46	-	0.27	Lunate	?	-	-	-	-
Q-47	2	-	Worn	?	-	-	-	-
Q-48	3	0.21	Lunate	?	-	Scrape	0.45	2.01
Q-49	3	-	Worn	?	-	-	-	-
Q-50	2	0.66	Worn	?	-	Scrape	-0.81	0.82
Q-51	2	0.15	Smooth	?	-	Cut	-1.54	0.68
Q-52	2	-	Smooth	?	-	-	-	-
Q-53	3	-	Worn	?	-	-	-	-
Q-54	-	0.05	Lunate	?	-	-	-	-
Q-55	3	-	Worn	?	-	-	-	-
Q-56	-	0.61	Smooth	?	-	-	-	-
Q-57	-	0.44	Worn	?	-	-	-	-
Q-58	2	0.67	Smooth	?	-	Cut	-1.30	0.44
Q-59	3	0.25	Smooth	?	-	Scrape	-0.52	1.23
Q-60	4	0.16	Lunate	?	-	Scrape	1.40	2.63
Q-61	2	0.11	Lunate	?	-	Scrape	-0.57	1.46
Q-62	-	-	Lunate	?	-	-	-	-
Q-63	-	-	Worn	?	-	-	-	-
Q-64	3	0.26	Smooth	?	-	Scrape	-0.52	1.22
Q-65	2	-	Lunate	?	-	-	-	-
Q-66	-	-	Smooth	?	-	-	-	-
Q-67	-	-	Lunate	?	-	-	-	-
Q-68	1	0.22	Smooth	?	-	Cut	-2.48	0.06
Q-69	1	0.19	Smooth	?	-	Cut	-2.49	0.07
Q-70	2	0.5	Smooth	?	-	Cut	-1.38	0.52
Q-71	3	1.05	Lunate	?	-	Scrape	0.84	1.61
Q-72	-	0.24	Smooth	?	-	-	-	-
Q-73	-	0.1	Worn	?	-	-	-	-
Q-74	2	0.28	Smooth	?	-	Cut	-1.48	0.62
Q-75	2	0.4	Smooth	?	-	Cut	-1.42	0.57
Q-76	-	0.24	Lunate	?	-	-	-	-
Q-77	-	0.37	Lunate	?	-	-	-	-
Q-78	3	0.15	Lunate	?	-	Scrape	0.42	2.04
Q-79	-	0.33	Smooth	?	-	-	-	-
Q-80	3	0.53	Smooth	?	-	Scrape	-0.39	1.10
Q-81	3	-	Worn	?	-	-	-	-
Q-82	2	0.35	Smooth	?	-	Cut	-1.45	0.59

Appendix G. Hartstene Flake Tools Microwear Morphological Attributes, Activity and Predicted Activity

Flake Name	Striation Direction (ordinal)	Polish Intrusion (mm)	Edge-Morphology (nominal)	Activity	Guessed by German	DFA Predicted Activity	DFA Function 1	DFA Function 2
H-01	2	0.47	Smooth	?	-	Cut	-1.39	0.53
H-02	1	0.57	Smooth	?	-	Cut	-2.31	-0.11
H-03	1	-	Smooth	?	-	-	-	-
H-04	4	-	Worn	?	-	-	-	-
H-05	-	-	Worn	?	-	-	-	-
H-06	3	-	Lunate	?	-	-	-	-
H-07	3	-	Worn	?	-	-	-	-
H-08	-	-	Worn	?	-	-	-	-
H-09	1	0.99	Smooth	?	-	Cut	-2.12	-0.31
H-10	1	-	Shattered	?	-	-	-	-
H-11	4	-	Worn	?	-	-	-	-
H-12	4	-	Worn	?	-	-	-	-
H-13	-	-	Worn	?	-	-	-	-
H-14	-	-	Worn	?	-	-	-	-
H-15	-	0.23	Lunate	?	-	-	-	-
H-16	4	-	Worn	?	-	-	-	-
H-17	-	-	Worn	?	-	-	-	-
H-18	-	-	Shattered	?	-	-	-	-
H-19	1	1.15	Lunate	?	-	Cut	-1.05	0.38
H-20	3	3.52	Worn	?	-	Whittle	1.49	0.07
H-21	3	-	Shattered	?	-	-	-	-
H-22	4	-	Worn	?	-	-	-	-
H-23	4	-	Lunate	?	-	-	-	-
H-24	3	-	Smooth	?	-	-	-	-
H-25	2	-	Smooth	?	-	-	-	-
H-26	-	-	Lunate	?	-	-	-	-
H-27	2	0.49	Shattered	?	-	Cut	-1.88	0.14
H-28	1	0.44	Smooth	?	-	Cut	-2.37	-0.05
H-29	-	1.21	Smooth	?	-	-	-	-
H-30	2	0.54	Worn	?	-	Scrape	-0.86	0.88
H-31	-	-	Worn	?	-	-	-	-
H-32	-	-	Worn	?	-	-	-	-
H-33	2	-	Worn	?	-	-	-	-
H-34	1	0.21	Smooth	?	-	Cut	-2.48	0.06
H-35	-	-	Worn	?	-	-	-	-
H-36	3	0.9	Worn	?	-	Scrape	0.27	1.30
H-37	4	0.63	Lunate	?	-	Scrape	1.61	2.40
H-38	3	-	Lunate	?	-	-	-	-
H-39	2	1.42	Worn	?	-	Cut	-0.46	0.46
H-40	-	-	Worn	?	-	-	-	-

Appendix H. Sauvie Island Flake Tools Microwear Morphological Attributes, Activity and Predicted Activity

Flake Name	Striation Direction (ordinal)	Polish Intrusion (mm)	Edge-Morphology (nominal)	Activity	Guessed by German	DFA Predicted Activity	DFA Function 1	DFA Function 2
SV-01	-	-	Shattered	?	-	-	-	-
SV-02	1	0.27	Smooth	?	-	Cut	-2.45	0.03
SV-03	-	0.16	Smooth	?	-	-	-	-
SV-04	3	1.77	Smooth	?	-	Scrape	0.18	0.51
SV-05	4	2.39	Shattered	?	-	Scrape	0.94	0.43
SV-06	1	0.17	Smooth	?	-	Cut	-2.50	0.08
SV-07	1	0.39	Worn	?	-	Cut	-1.90	0.36
SV-08	2	0.29	Smooth	?	-	Cut	-1.48	0.62
SV-09	3	0.39	Shattered	?	-	Cut	-0.96	0.78
SV-10	1	0.64	Smooth	?	-	Cut	-2.28	-0.14
SV-11	1	0.31	Smooth	?	-	Cut	-2.44	0.02
SV-12	1	0.73	Smooth	?	-	Cut	-2.24	-0.18
SV-13	3	0.29	Shattered	?	-	Cut	-1.00	0.83
SV-14	1	0.53	Worn	?	-	Cut	-1.84	0.29
SV-15	3	-	Shattered	?	-	-	-	-
SV-16	1	0.21	Smooth	?	-	Cut	-2.48	0.06
SV-17	-	-	Shattered	?	-	-	-	-
SV-18	4	-	Worn	?	-	-	-	-
SV-19	1	0.97	Smooth	?	-	Cut	-2.13	-0.30
SV-20	4	-	Worn	?	-	-	-	-
SV-21	1	0.38	Shattered	?	-	Cut	-2.90	-0.40
SV-22	-	0.98	Lunate	?	-	-	-	-
SV-23	3	0.18	Lunate	?	-	Scrape	0.44	2.02
SV-24	3	-	Worn	?	-	-	-	-
SV-25	2	0.63	Lunate	?	-	Scrape	-0.32	1.22
SV-26	1	0.5	Smooth	?	-	Cut	-2.35	-0.07
SV-27	1	0.4	Worn	?	-	Cut	-1.90	0.35
SV-28	3	0.29	Lunate	?	-	Scrape	0.49	1.97
SV-29	3	0.18	Smooth	?	-	Scrape	-0.56	1.26
SV-30	2	0.5	Smooth	?	-	Cut	-1.38	0.52
SV-31	2	0.62	Smooth	?	-	Cut	-1.32	0.46
SV-32	3	0.14	Worn	?	-	Scrape	-0.08	1.66
SV-33	-	-	Lunate	?	-	-	-	-
SV-34	1	0.47	Worn	?	-	Cut	-1.86	0.32
SV-35	3	0.63	Lunate	?	-	Scrape	0.64	1.81
SV-36	3	0.24	Lunate	?	-	Scrape	0.46	1.99
SV-37	3	0.38	Lunate	?	-	Scrape	0.53	1.93
SV-38	3	0.14	Worn	?	-	Scrape	-0.08	1.66
SV-39	4	-	Worn	?	-	-	-	-
SV-40	2	0.24	Smooth	?	-	Cut	-1.50	0.64
SV-41	3	-	Worn	?	-	-	-	-
SV-42	4	1.31	Worn	?	-	Scrape	1.43	1.70
SV-43	3	0.23	Worn	?	-	Scrape	-0.04	1.62
SV-44	1	0.27	Smooth	?	-	Cut	-2.45	0.03
SV-45	2	0.43	Shattered	?	-	Cut	-1.91	0.17

SV-46	3	-	Worn	?	-	-	-	-	-
SV-47	1	0.37	Smooth	?	-	Cut	-2.41	-0.01
SV-48	1	-	Smooth	?	-	-	-	-
SV-49	2	0.47	Smooth	?	-	Cut	-1.39	0.53
SV-50	1	0.22	Smooth	?	-	Cut	-2.48	0.06
SV-51	1	0.63	Smooth	?	-	Cut	-2.29	-0.14
SV-52	1	0.11	Shattered	?	-	Cut	-3.02	-0.27
SV-53	4	0.1	Lunate	?	-	Scrape	1.37	2.65
SV-54	2	0.63	Smooth	?	-	Cut	-1.32	0.46
SV-55	-	0.19	Smooth	?	-	-	-	-
SV-56	3	0.15	Smooth	?	-	Scrape	-0.57	1.28
SV-57	1	0.26	Smooth	?	-	Cut	-2.46	0.04
SV-58	2	0.39	Shattered	?	-	Cut	-1.93	0.19
SV-59	3	0.37	Worn	?	-	Scrape	0.03	1.55
SV-60	3	-	Worn	?	-	-	-	-
SV-61	1	0.21	Lunate	?	-	Cut	-1.49	0.82
SV-62	2	0.69	Lunate	?	-	Scrape	-0.30	1.19
SV-63	1	0.45	Smooth	?	-	Cut	-2.37	-0.05
SV-64	-	0.17	Worn	?	-	-	-	-
SV-65	3	0.61	Lunate	?	-	Scrape	0.64	1.82
SV-66	-	0.25	Smooth	?	-	-	-	-
SV-67	-	0.3	Lunate	?	-	-	-	-
SV-68	2	0.51	Smooth	?	-	Cut	-1.37	0.51
SV-69	2	0.28	Lunate	?	-	Scrape	-0.49	1.38
SV-70	3	0.37	Lunate	?	-	Scrape	0.52	1.93
SV-71	1	0.45	Smooth	?	-	Cut	-2.37	-0.05
SV-72	3	-	Worn	?	-	-	-	-
SV-73	1	-	Smooth	?	-	-	-	-
SV-74	-	0.3	Worn	?	-	-	-	-
SV-75	1	0.32	Smooth	?	-	Cut	-2.43	0.01
SV-76	-	0.14	Shattered	?	-	-	-	-
SV-77	3	0.21	Lunate	?	-	Scrape	0.45	2.01
SV-78	1	0.32	Smooth	?	-	Cut	-2.43	0.01

Appendix I. Flake encoding at 64-bit and 8-bit resolution

Flake Name	Polish Intrusion (64-bit)	Polish Intrusion (8-bit)	Striation Direction (64-bit)	Striation Direction (8-bit)	Edge Morphology	Edge Morphology (64-bit)	Edge Morphology (8-bit)	Activity	Projected Action Computed by DFA (64-bit)	Projected Action Computed by DFA (8-bit)
EPC-001	2	A	1	A	lunate	2	A	cut	cut	cut
EPC-002	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-003	2	A	4	B	worn	3	B	cut	whittle	scrape
EPC-004	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-005	2	A	2	A	shattered	4	B	cut	cut	cut
EPC-006	2	A	-	-	shattered	4	B	cut	-	-
EPC-007	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-008	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-009	2	A	1	A	lunate	2	A	cut	cut	cut
EPC-010	2	A	1	A	worn	3	B	cut	cut	cut
EPC-011	2	A	1	A	worn	3	B	cut	cut	cut
EPC-012	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-013	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-014	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-015	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-016	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-017	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-018	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-019	1	A	1	A	worn	3	B	cut	cut	cut
EPC-020	1	A	1	A	smooth	1	A	cut	cut	cut
EPC-021	1	A	-	-	lunate	2	A	cut	-	-
EPC-022	1	A	1	A	smooth	1	A	cut	cut	cut
EPC-023	1	A	2	A	shattered	4	B	cut	scrape	cut
EPC-024	1	A	1	A	lunate	2	A	cut	cut	cut
EPC-025	1	A	1	A	smooth	1	A	cut	cut	cut
EPC-026	1	A	-	-	lunate	2	A	cut	-	-
EPC-027	1	A	1	A	smooth	1	A	cut	cut	cut
EPC-028	1	A	1	A	smooth	1	A	cut	cut	cut
EPC-029	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-030	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-031	2	A	1	A	lunate	2	A	cut	cut	cut
EPC-032	2	A	-	-	smooth	1	A	cut	-	-
EPC-033	2	A	2	A	shattered	4	B	cut	cut	cut
EPC-034	2	A	1	A	worn	3	B	cut	cut	cut
EPC-035	2	A	-	-	shattered	4	B	cut	-	-

EPC-036	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-037	3	B	-	-	shattered	4	B	cut	-	-
EPC-038	2	A	1	A	worn	3	B	cut	cut	cut
EPC-039	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-040	2	A	1	A	lunate	2	A	cut	cut	cut
EPC-041	3	B	1	A	smooth	1	A	cut	cut	cut
EPC-042	2	A	2	A	smooth	1	A	cut	cut	cut
EPC-043	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-044	2	A	1	A	shattered	4	B	cut	cut	cut
EPC-045	3	B	1	A	shattered	4	B	cut	cut	cut
EPC-046	3	B	1	A	shattered	4	B	cut	cut	cut
EPC-047	3	B	1	A	smooth	1	A	cut	cut	cut
EPC-048	2	A	1	A	smooth	1	A	cut	cut	cut
EPC-049	2	A	2	A	shattered	4	B	cut	cut	cut
EPC-050	2	A	2	A	shattered	4	B	cut	cut	cut
EPC-051	1	A	2	A	smooth	1	A	cut	scrape	cut
EPC-052	3	B	1	A	smooth	1	A	cut	cut	cut
EPC-053	3	B	2	A	shattered	4	B	cut	cut	cut
EPC-054	3	B	1	A	smooth	1	A	cut	cut	cut
EPC-055	3	B	1	A	shattered	4	B	cut	cut	cut
EPC-056	2	A	1	A	Lunate	2	A	cut	cut	cut
EPC-057	2	A	-	-	Lunate	2	A	scrape	-	-
EPC-058	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-059	2	A	-	-	lunate	2	A	scrape	-	-
EPC-060	2	A	3	B	smooth	1	A	scrape	scrape	scrape
EPC-061	1	A	1	A	worn	3	B	scrape	cut	cut
EPC-062	1	A	1	A	smooth	1	A	scrape	cut	cut
EPC-063	1	A	-	-	worn	3	B	scrape	-	-
EPC-064	1	A	3	B	lunate	2	A	scrape	scrape	scrape
EPC-065	1	A	1	A	lunate	2	A	scrape	cut	cut
EPC-066	1	A	3	B	lunate	2	A	scrape	scrape	scrape
EPC-067	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-068	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-069	1	A	3	B	lunate	2	A	scrape	scrape	scrape
EPC-070	2	A	4	B	lunate	2	A	scrape	whittle	scrape
EPC-071	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-072	1	A	4	B	smooth	1	A	scrape	scrape	scrape
EPC-073	1	A	3	B	lunate	2	A	scrape	scrape	scrape
EPC-074	1	A	3	B	lunate	2	A	scrape	scrape	scrape

EPC-075	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-076	1	A	-	-	shattered	4	B	scrape	-	-
EPC-077	1	A	4	B	lunate	2	A	scrape	scrape	scrape
EPC-078	1	A	1	A	lunate	2	A	scrape	cut	cut
EPC-079	1	A	1	A	lunate	2	A	scrape	cut	cut
EPC-080	1	A	4	B	smooth	1	A	scrape	scrape	scrape
EPC-081	-	-	-	-	lunate	2	A	scrape	-	-
EPC-082	1	A	-	-	smooth	1	A	scrape	-	-
EPC-083	1	A	-	-	smooth	1	A	scrape	-	-
EPC-084	1	A	-	-	shattered	4	B	scrape	-	-
EPC-085	4	B	3	B	shattered	4	B	whittle	whittle	whittle
EPC-086	4	B	3	B	smooth	1	A	whittle	whittle	whittle
EPC-087	3	B	3	B	worn	3	B	whittle	whittle	whittle
EPC-088	3	B	-	-	worn	3	B	whittle	-	-
EPC-089	3	B	-	-	shattered	4	B	whittle	-	-
EPC-090	4	B	4	B	smooth	1	A	whittle	whittle	whittle
EPC-091	3	B	4	B	worn	3	B	whittle	whittle	whittle
EPC-092	3	B	4	B	worn	3	B	whittle	whittle	whittle
EPC-093	4	B	4	B	shattered	4	B	whittle	whittle	whittle
EPC-094	3	B	4	B	worn	3	B	whittle	whittle	whittle
EPC-095	3	B	4	B	smooth	1	A	whittle	whittle	whittle
EPC-096	3	B	3	B	smooth	1	A	whittle	whittle	whittle
EPC-097	3	B	4	B	smooth	1	A	whittle	whittle	whittle
EPC-098	3	B	3	B	worn	3	B	whittle	whittle	whittle
EPC-099	-	-	3	B	smooth	1	A	whittle	-	-
EPC-100	2	A	3	B	lunate	2	A	whittle	scrape	scrape
EPC-101	1	A	4	B	lunate	2	A	whittle	scrape	scrape
EPC-102	3	B	4	B	lunate	2	A	whittle	whittle	whittle
EPC-103	4	B	4	B	worn	3	B	whittle	whittle	whittle
EPC-104	3	B	3	B	smooth	1	A	whittle	whittle	whittle
EPC-105	3	B	4	B	lunate	2	A	whittle	whittle	whittle
EPC-106	3	B	4	B	smooth	1	A	whittle	whittle	whittle
EPC-107	2	A	4	B	smooth	1	A	whittle	whittle	scrape
EPC-108	3	B	3	B	worn	3	B	whittle	whittle	whittle
EPC-109	1	A	4	B	lunate	2	A	whittle	scrape	scrape
EPC-110	3	B	3	B	worn	3	B	whittle	whittle	whittle
EPC-111	3	B	3	B	lunate	2	A	whittle	whittle	whittle
EPC-112	2	A	3	B	smooth	1	A	whittle	scrape	scrape
epc-bt-01	3	B	1	A	worn	3	B	whittle	cut	cut

epc-bt-02	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-03	2	A	2	A	smooth	1	A	cut	cut	cut
epc-bt-04	1	A	-	-	worn	3	B	scrape	-	-
epc-bt-05	2	A	1	A	shattered	4	B	scrape	cut	cut
epc-bt-06	1	A	3	B	lunate	2	A	scrape	scrape	scrape
epc-bt-07	1	A	3	B	lunate	2	A	scrape	scrape	scrape
epc-bt-08	2	A	1	A	shattered	4	B	cut	cut	cut
epc-bt-09	1	A	1	A	lunate	2	A	cut	cut	cut
epc-bt-10	2	A	-	-	shattered	4	B	cut	-	-
epc-bt-11	2	A	2	A	shattered	4	B	whittle	cut	cut
epc-bt-12	1	A	3	B	lunate	2	A	whittle	scrape	scrape
epc-bt-13	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-14	1	A	-	-	lunate	2	A	cut	-	-
epc-bt-15	2	A	2	A	worn	3	B	cut	cut	cut
epc-bt-16	-	-	-	-	-	-	-	blank	-	-
epc-bt-17	2	A	3	B	smooth	1	A	scrape	scrape	scrape
epc-bt-18	2	A	2	A	worn	3	B	cut	cut	cut
epc-bt-19	3	B	3	B	shattered	4	B	scrape	whittle	whittle
epc-bt-20	3	B	3	B	lunate	2	A	cut	whittle	whittle
epc-bt-21	2	A	2	A	shattered	4	B	scrape	cut	cut
epc-bt-22	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-23	4	B	4	B	worn	3	B	whittle	whittle	whittle
epc-bt-24	2	A	3	B	smooth	1	A	scrape	scrape	scrape
epc-bt-25	2	A	1	A	shattered	4	B	cut	cut	cut
epc-bt-26	2	A	1	A	lunate	2	A	cut	cut	cut
epc-bt-27	2	A	1	A	shattered	4	B	cut	cut	cut
epc-bt-28	3	B	3	B	smooth	1	A	whittle	whittle	whittle
epc-bt-29	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-30	3	B	3	B	worn	3	B	whittle	whittle	whittle
epc-bt-31	1	A	3	B	lunate	2	A	whittle	scrape	scrape
epc-bt-32	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-33	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-34	2	A	3	B	worn	3	B	scrape	scrape	scrape
epc-bt-35	3	B	2	A	smooth	1	A	cut	whittle	cut
epc-bt-36	3	B	3	B	smooth	1	A	whittle	whittle	whittle
epc-bt-37	3	B	1	A	smooth	1	A	cut	cut	cut
epc-bt-38	3	B	4	B	shattered	4	B	whittle	whittle	whittle
epc-bt-39	3	B	1	A	shattered	4	B	cut	cut	cut
epc-bt-40	1	A	-	-	lunate	2	A	whittle	-	-

epc-bt-41	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-42	-	-	2	A	smooth	1	A	blank	-	-
epc-bt-43	2	A	2	A	smooth	1	A	cut	cut	cut
epc-bt-44	3	B	4	B	worn	3	B	scrape	whittle	whittle
epc-bt-45	3	B	3	B	worn	3	B	whittle	whittle	whittle
epc-bt-46	2	A	3	B	shattered	4	B	cut	scrape	scrape
epc-bt-47	3	B	3	B	smooth	1	A	whittle	whittle	whittle
epc-bt-48	3	B	3	B	lunate	2	A	whittle	whittle	whittle
epc-bt-49	3	B	4	B	worn	3	B	whittle	whittle	whittle
epc-bt-50	3	B	3	B	shattered	4	B	cut	whittle	whittle
epc-bt-51	1	A	-	-	lunate	2	A	cut	-	-
epc-bt-52	3	B	4	B	lunate	2	A	scrape	whittle	whittle
epc-bt-53	2	A	2	A	lunate	2	A	scrape	cut	cut
epc-bt-54	-	-	-	-	-	-	-	blank	-	-
epc-bt-55	2	A	1	A	smooth	1	A	cut	cut	cut
epc-bt-56	-	-	-	-	smooth	1	A	blank	-	-
epc-bt-57	3	B	-	-	smooth	1	A	scrape	-	-
epc-bt-58	2	A	2	A	shattered	4	B	whittle	cut	cut
epc-bt-59	2	A	1	A	worn	3	B	cut	cut	cut
epc-bt-60	-	-	3	B	shattered	4	B	scrape	-	-
epc-bt-61	3	B	2	A	smooth	1	A	whittle	whittle	cut
epc-bt-62	2	A	1	A	lunate	2	A	cut	cut	cut
epc-bt-63	-	-	-	-	smooth	1	A	blank	-	-
epc-bt-64	1	A	2	A	shattered	4	B	scrape	scrape	cut
epc-bt-65	2	A	2	A	smooth	1	A	whittle	cut	cut
epc-bt-66	2	A	2	A	smooth	1	A	whittle	cut	cut
epc-bt-67	1	A	-	-	smooth	1	A	scrape	-	-