WHY THE XWISTEN CROSSED THE RIVER: LITHIC TRANSPORT STRATEGIES ON THE CANADIAN PLATEAU

Michael Todd Wanzenried
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WHY THE XWISTEN CROSSED THE RIVER:

LITHIC TRANSPORT STRATEGIES ON THE CANADIAN PLATEAU

By

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B.A. Anthropology, University of Montana, Missoula, MT, 2003

Thesis

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As has been the case for thousands of years a single kind of stone material, referred to by different researchers as arrowstone, basalt, vitreous trachydacite, and/or dacite, provided the majority (often more than 75%) of many lithic assemblages in the Mid-Fraser region of south-western British Columbia. Most explanations for this have largely been insufficient for explaining the differential transport of lithic materials; no one has addressed why, in a lithic rich environment where a variety of jaspers, chalcedonies, and pisolites can be found in relative close proximity to many winter villages, Mid-Fraser foragers would target resources located much further away.

This thesis addresses and explains lithic material transport in the Mid-Fraser by pairing the logic of diet breadth model with the lithic assemblage recovered during the 2008 excavations at the Bridge River site. My sample consists of those tools, cores, and debitage (detritus from stone tool production and maintenance) recovered from housepits 20, 24, and 54. The lithic assemblages recovered from these houses provide a glimpse into lithic transport over the Bridge River 2 and 3 time periods, which span nearly four hundred years (~1500-1100 cal. B.P.) of human occupation.

This research will provide an alternative framework for considering variability in lithic assemblages other than through the filter of socio-economic explanation typical of previous work. This research will also provide feedback for how suitable human behavioral ecology models are for conceptualizing lithic procurement practices without knowing exact source locations. Finally it will contribute to the larger, ongoing discussion concerning the evolution of complexity by critically examining one of several lines of evidence—the acquisition lithic resources—that has been cited as a potential indicator for control over particular areas on the landscape.
Any project that takes more than a few hours will inevitably accrue a number of debts for the time, patience and energies that others donate to help bring it to a satisfactory conclusion. For this project, I am first and foremost grateful to Lucille Harris whose insight and experience with Mid-Fraser archaeology definitely aided me in ridding this text of extraneous baggage and shaping my ideas into more realistic proportions. Dr. Anna Prentiss provided invaluable insight into human behavioral ecology and whose superb grant writing abilities made all of this possible. Thank you to the Bridge River community and the Stl'atl'imx nation for putting us up and treating us with exceptional hospitality. Although totally oblivious to the content of my thesis, my family and friends provided pleasant distraction and encouraged me through the more difficult aspects of thesis writing, namely keeping my momentum. And thank you to John Zorn, Belle and Sebastian, Juana Molina, the Kranky label, and many other musicians who provided a constant soundtrack to this work.
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CHAPTER 1: INTRODUCTION

The prehistoric Bridge River village was a community located close to the Fraser River in south-central British Columbia (Figure 1.1) where people spent their winters in semi-subterranean lodges located on terraces based at the foot of unstable, steep-sided mountains. Springs, summers, and autumns, people moved across the landscape in small mobile groups, many of their actions linked to the undulating currents of one of the North America’s largest rivers and the cyclic emergence of root crops, berry patches, and deer runs. Today, like then, people continue to live in this area, some of them undoubtedly the descendents of those who lived here hundreds, if not thousands, of years ago; outsiders continue to move here from surrounding towns and from regions further away, becoming part of the local community, modifying the social and physical landscape to better suit their needs and desires. Although highways have replaced footpaths, the Bi-Lo supermarket has become the primary source of food, and provincial law has supplanted the will and rule of First Nation bands, the past has not been entirely left behind. It lives on in the memories and stories of local elders, in the hands and eyes of people trying to recapture the poetry of their ancestral practices, and to a small degree in our archaeological activities as we hopefully try to build accurate representations of the past in our work. Although archaeological research may often be seen as overly erudite and predetermined by disciplinary needs and interests, it is often the hope that despite not knowing who will read our work, the information therein will be of some use to someone down the line.
To those familiar with the Middle-Fraser region, the goal of this paper may seem either self-evident or even trivial. As has been the case for thousands of years a single kind of stone material, referred to by different researchers as arrowstone, basalt, vitreous trachydacite, and/or dacite, provided the majority (often more than 75%) of many lithic assemblages, spanning series of changes in foraging strategies and habitation patterns (Magne 1985; Richards 1987; Rousseau 2004; Sanger 1960). Most explanations for this, like design criteria (Hayden et al. 1996; 2000) and embedded procurement (Alexander 1992), are insufficient. In particular, the near uniform use of materials in the production
of chipped-stone tools suggests the technical requirements for material selection could have been satisfied by a variety of materials (many of them non-dacitic) found in close proximity to the Bridge River village (Bakewell 2000; Crossland and McKetta 2007; Kendall 2010; Rousseau 2000). Likewise, if lithic procurement was an opportunistic practice embedded in daily foraging tasks (sensu Binford 1979) we should imagine that people would invariably utilize non-dacite outcrops, resulting in a more heterogeneous assemblage throughout the village.

**Paper Outline**

The problem that I am addressing is why, in a lithic-rich landscape like the mid-Fraser, would one type of material be selected preferentially. Thus, the ultimate goal of this research project is to explain what factors potentially led to the differential transport of lithic raw materials by prehistoric peoples into a winter housepit village in British Columbia. On the way to that goal, I will provide an anthropological and archaeological overview of work in the Mid-Fraser, which is the focus of the second chapter.

In the third chapter, I outline the theoretical underpinnings to much of my analysis which are related to Darwinian evolutionary theories that, after fifty contentious years in anthropology and archaeology, have emerged as a powerful and versatile tool in the explanation of culture change (Bamforth 2007; Lyman and O’Brien 2005; Spencer and Redmond 2001; Teltser 1995). To help answer my question I decided to use the logic of human behavioral ecology (HBE) to examine some factors that influence foraging behaviors, in particular this will be used to understand lithic procurement strategies at the Bridge River village. The strength inherent to some of these models is that even though
many of the phenomena they address can’t always be modeled mathematically, a researcher can still use them heuristically (Winterhalder and Smith 2000). Many HBE models attribute the selection of unique, patterned behaviors to those that provide the highest economic return to individuals per investment of time and energy, e.g., the net calorie return associated with different foraging practices (Bliege-Bird and Smith 2005; Kaplan et al 2000). However, because lithic procurement strategies will never result in a positive gain of time or energy, I presume from the outset that the best foraging strategy will the one that best conserves calories and time. Simple as this seems, behaviors that allow individuals to maximize returns for time and energy spent provides them with more resources to direct towards other worldly activities like child rearing, gambling, sex, community ritual, and warfare (Chisholm 1993; Winterhalder and Smith 2000).

I use the diet breadth model to understand resource selection on the basis of differences in foraging efficiency associated with particular resources. Resources with returns that can exceed related search and handling costs as well as the returns of other resources will be pursued by foragers and are highly ranked (have high frequency) in the diet. Low ranked resources might not be undesirable as foodstuffs and might be utilized to some degree, but do not contribute significantly to the diet because of their higher costs and/or lower economic returns compared to high ranked resources (Winterhalder and Goland 1997). By extending this same logic to the pursuit of lithic resources, I will be able rank toolstone materials according to which material types could be most efficiently acquired.

Chapter four, is the methodological section where I discuss the procedures that I will follow to develop and support my interpretation of the archaeological record. As
there are few agreed upon ways to establish proxy-values for lithic materials at sites (Minichillo 2006), I found that Knell’s (2004) general nodule analysis (GNA) will allow me to understand toolstone procurement by comparing use-strategies of different lithic materials. I will also be able to address differences in toolstone selection by comparing lithic material patterns during the 2008 excavations to previous research from the Mid-Fraser (Clarke 2005). In particular, as toolstone is thought of being stockpiled at winter housepits those materials that can be procured en mass provide foragers may have been selected due to their high post-foraging returns as a result of significantly lower search and handling costs associated with other resources. To analyze these claims, I will compare the presumed economic costs associated with lithic deposits in the Mid-Fraser using maps and survey information.

The fifth chapter simply consists of employing the methodology to sort and sift the lithic assemblages from the Bridge River site to compare how lithic materials were used at the site. In this chapter, I will establish material rank, which will then be examined through the lens of the diet breadth model to explain why dacite was transported more than other materials.

In the sixth chapter, I discuss these results in light of the expectations of a modified diet breadth model and then recombine this information in light of current archaeological and historical understandings of the Canadian Plateau to see what implications my results may have for current and future interpretations.

All of the data for this research come from excavations at the Bridge River village site during the 2008 field season by the University of Montana. My sample consists of those tools, cores, and debitage (detritus from stone tool production and maintenance)
recovered from housepits 20, 24, and 54 (figure 3). The lithic assemblages recovered from these houses provide a glimpse into lithic transport over the Bridge River 2 and 3 time periods, which span nearly four hundred years (~1500-100 cal. B.P.) of human occupation (Prentiss et al. 2008). Although the lithic assemblage from these housepits had over 20 different raw materials represented, with over half of them used in the production of chipped stone tools, this study concentrates primarily on those raw materials that indigenous knappers used most frequently: dacite, some cryptocrystalline silicates (cherts, chalcedonies, pisolite), and very low frequencies of other materials like quartzite.
obsidian, and mudstone (Prentiss et al. 2009). My decision to analyze housepit assemblages in aggregate rather than individually was based on the fact that the recovered non-dacite materials from housepits 20, 24 and 54 were too low to make meaningful comparisons about individual household utilization of raw materials. Although it may obscure a more fine-grained understanding of lithic transport and use on site for individual occupation sequences, combining roofs, floors, and rim sequences allows me to make general observations about behavioral patterns concerning the selection and use of particular raw materials at the Bridge River village. As the importance of stone tools in these housepits cannot likely be overstated as they provided the means for many activities to be accomplished, understanding the mechanisms of toolstone selection and transport can shed light on the movement of people across the physical and social environments.

This research will provide an alternative framework for considering variability in lithic assemblages other than through the filter of socio-economic explanation typical of previous work (Hayden 2000; Hayden et al 1996). This research will also provide feedback for how suitable HBE models are for conceptualizing lithic procurement practices without knowing exact source locations; and finally it will contribute to the larger, ongoing discussion concerning the evolution of complexity by critically examining one of several lines of evidence—the acquisition lithic resources—that has been cited as a potential indicator for control over particular areas on the landscape (Bakewell 2000; Hayden et al 1996; Prentiss et al. 2008).
CHAPTER 2: BACKGROUND

There is, however, in the interior much undulating lightly wooded land, as well as open prairie of greater or less adaptation to pastoral and agricultural purposes. As a rule the valleys are fertile, and the hill-sides are wooded, while the plateaux are barren. A large level tract between Thompson and Fraser Rivers is wooded. There are places in these highlands of awful, unspeakable grandeur; towering cliffs, yawning chasms; places where granite walls tower a thousand feet and more above foaming waterfalls, which dash down cliffs and thunder through ravines, drowning the wild beasts’ roar, and flinging rainbows through the descending spray upon the sky (Bancroft, 1886: 409).

Although the ultimate goal of my research is to better understand differences in the transport of lithic materials to a winter village in the Mid-Fraser region, I believe my results will also shed light on how lithic materials can potentially help explain how relationships between foraging behaviors and local landscapes in the Mid-Fraser. By considering differences in the frequency and use of lithic materials that have been transported from various sources into a village we can further refine ideas about how and land was used and shared amongst many different neighboring peoples (Carr 1994; Kuhn 2004).

It has been well established from descriptions in their journal entries about copper kettles, iron pieces and other European trade goods that the people of the Mid-Fraser were well aware of whites, even before the expeditions McKenzie’s 1798 and Simon Fraser’s 1808 expeditions. Fraser’s speculation about what eventual impact of European culture may have on indigenous cultures seems all too prescient now—he thought that contact would ultimately benefit the native population by introducing them to civilized ways of living (Lamb 2007). Because Canadian history has often relegated the narratives
of native populations as secondary in importance to the story of explorers and encroaching aspects of civilization, the amount that native communities lost in terms of traditional knowledge, land claims, and identity has been hard to gauge definitively (Turner 1988). However, it is well known that with the first flush of trade goods that were introduced with the fur trade and the steady march of mercantile companies, sawmills, and canneries up the coast and river drainages, the changing social and economic climate of 19th century had many deleterious effects on native populations (Ackerman 2004; Boyd 1994; Lutz 2008). Disease, land grabs, and wage labor made traditional subsistence practices impractical at times to continue and sometimes impossible with the loss of knowledge and changes in the native economies themselves (Lutz 1992; Turner 1988; Teit 1914). And by the time Franz Boas and others working for his Jessup expedition arrived in the Mid-Fraser in the late 19th century with the intent to document indigenous cultures, significant change in cultural practices and social organization had been taking place for nearly a century as Wendy Wickwire (1998) points out, most native people were living [at the time of Teit’s writing] on reserves in single-family dwellings after decades of disease and non-native cultural influences from the waves of immigration during the Gold Rush (1860s) through the railway construction (1880s). Everyone had been instructed in a new religion which emphasized the nuclear family headed by men. In place of the council of family-heads, chiefs were now elected under the Indian Act of 1876 and presided over by missionaries and government agents. These new chiefs administered the affairs of the group.

And it should be stressed that native peoples in the Mid-Fraser were not necessarily innocent victims of an “imperialist march across the continent” but were active participants in changing economic conditions with fur traders and coastal groups (Lutz 1992). Some of the changes led to a dramatic overhaul of traditional economies that were
generally resistant to intrusion from low-ranked members of society, likewise coastal economies that came to depend on the fur trade led to increased interactions between coastal and interior groups, leading to the a relatively late adoption of coastal social traits—including a “noble” class and other similar political and social structures that Teit (1914) was explicit in stating that the origins of these social traits in the Mid-Fraser were extremely recent. Interestingly, similar social structures, particularly the existence of rather deeply stratified societies featuring privileged ‘elite’ classes and commoners have been hypothesized by Hayden (1997) and Prentiss and colleagues (Prentiss and Kuijt 2004; Prentiss et al. 2008) to have existed centuries if not millennia earlier than the historic period. Much work over the last twenty years has attempted to understand the details for such assertions in Mid-Fraser prehistoric cultures.

Analogous to the imperfect recovery of the archaeological record from taphonomic forces, it is through luck and the sheer determination of ethnographers, linguists, and local tribal and band offices that the were able to preserve a record of the stories, languages, and some of the old traditions practiced by people who once lived throughout the Mid-Fraser region. Some of the earliest and best ethnographic work done on these communities in the first decade of the twentieth century was by James Teit. Because he had lived (and summarily worked) in this region for many years, spoke Salish and local dialects fluently, and had married a Thompson woman who helped him access a wide range of cultural features unavailable to many other field workers, many historians, archaeologists, and ethnographers view him as one of the primary ethnographer of the Lillooet, Shuswap, and Thompson (Prentiss et al. 2008; Rohner 1966; Wickwire 1993, 1998). Unlike other ethnographers, Teit wrote a considerable amount about the practices
and lives of women in the region (Wickwire 1993). His posthumously published work in 1930 about basket weaving, body painting and tattooing, plus recording many songs sung by women are prime examples of his ability to represent more than a masculine view of the world. Other researchers working with and around local communities in the Mid-Fraser, like Livingston Farrand (1900), H.I. Smith (1899, 1900), G.M. Dawson (1891), and Charles Hill-Tout (1907) were much more limited in their scope and intent and generally focused on either documenting either oral traditions (Farrand for the Chilcotin), gathering archaeological samples from burial and housepit sites (Smith 1899, 1900), or describing the local geology of the region with some minor work on ethnographic reports (Dawson 1891).

Although ethnographic accounts have come under attack by contemporary anthropologists and sociologists (for example: Clifford and Marcus 1986; Van Maanen 1995) many of those early efforts by Teit and others to document and help native communities have contributed immensely to current understandings of the past and play a pivotal role in the establishment of indigenous identities, land claims, and political activism (Pulla 2008; Wickwire 2006). Interviews with people from native communities over the last century have provided researchers with insight into how people once and continue to try to live their lives (Alexander 2003; Hayden 1992; Kennedy and Bouchard 1970). Stories about root and berry gathering, hunting, and the organization of family groups during salmon runs, for example, have increased our understanding for when and how people would travel to collect roots, visit families, or go to popular trade locations, plus information about how their pithouses were built and used (Alexander 2000).
These pithouses were generally circular in nature, dug into the earth, and (depending on its size) could from a single family to several families, potentially housing up to thirty people at a time (Hayden 1997; Teit 1906). Use of these structures occurred almost exclusively during the coldest winter months where people lived off stores of food (dried salmon, roots, and berries) that they were able to amass over the non-winter months (Teit 1900). Throughout the rest of the year people in different regions of the Mid-Fraser using small, temporary lodges while moving across the landscape, alternated their foraging strategies in accordance with the availability of vital resources (Ackerman 2004; Hayden 1997; Prentiss and Kuijt 2004). In the early spring and late autumn, small family groups likely radiated across the landscape harvesting fresh greens, hunting deer and other small animals. They also supplemented their diet with fish from lakes and streams, collected roots and berries, traded for goods they could not collect locally as well as intentionally altering landscapes (for example: prescribed burns) to increase food production (Lepofsky and Lertzman 2008; Lepofsky and Lyons 2003). However, at other points during the year large groups of people amassed at root harvesting grounds, prime-fishing areas on the Fraser River, or at berry picking locations to harvest, process, and transport large amounts of food to winter villages for use over the winter (Alexander 1992).

One of the simplest expressions of the relationship between people and their environment can be a seasonal calendar that linked different practices with changing seasons, weather patterns, and conditions of available resources (Table 1). Unlike Western calendars that arrange many activities according to fixed months and days, the calendars of the Mid-Fraser were inherently flexible and decisions to do certain activities
seemed to have been decided around factors like the intensity of a winter, when berries ripened, or how long a summer lasted. One of the most important lessons that these maps project is how mobility (literally how people moved during the year) played a significant role for people to acquire resources at different times of the year. Because it was impossible for people in Mid-Fraser to subsist entirely on locally available plant and animal species, they had to travel to neighboring areas to take advantage of salmon runs, root crops, and berry patches as they came into season. Interviews conducted with people who had direct experience or knowledge of contact-era subsistence rounds often saw these frequent moves not as a burdensome hardship but an opportunity to visit friends and families in different areas. Ommer and Turner (2004) relate how once a year Shuswap, Lillooet, and Thompson bands would gather outside of Lytton to take advantage of the great abundance of a number of different "root" vegetables and berries to be found there. Indeed, such sharing was likely not an uncommon practice as people were not bounded strictly to one village but could travel and reside in different villages and households with extended family (Teit 1906).
<table>
<thead>
<tr>
<th>Moon 1 (Nov)</th>
<th>Thompson</th>
<th>Lillooet</th>
<th>Shuswap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer Rut, hunt</td>
<td>Gets cold, enter winter houses.</td>
<td>Deer Rut, some enter winter houses.</td>
<td></td>
</tr>
<tr>
<td>2 (Dec)</td>
<td>Gets cold, some enter winter houses.</td>
<td>Winter solstice</td>
<td>First real cold, remain at home.</td>
</tr>
<tr>
<td>3 (January)</td>
<td>All enter winter houses, bucks shed antlers.</td>
<td>Coldest weather, ice on rivers.</td>
<td>Midwinter</td>
</tr>
<tr>
<td>4 (Feb)</td>
<td>Chinook winds, some leave houses, plants sprout.</td>
<td>Leave winter houses.</td>
<td>Chinook winds, snow goes.</td>
</tr>
<tr>
<td>5 (March)</td>
<td>All leave winter house. Grass grows.</td>
<td>Warm weather, chinook winds, some fish and hunt.</td>
<td>Few roots dug, many leave winter houses.</td>
</tr>
<tr>
<td>7 (May)</td>
<td>Short hunts, dig roots</td>
<td>Small fish, first salmon.</td>
<td>Fish at lakes</td>
</tr>
<tr>
<td>9 (July)</td>
<td>Some salmon, berries ripen, summer solstice.</td>
<td>Pick berries. Warmest weather.</td>
<td>Salmon arrive</td>
</tr>
<tr>
<td>10 (Aug)</td>
<td>Salmon run, cure salmon</td>
<td>Salmon run. Fish.</td>
<td>Fish salmon all month.</td>
</tr>
<tr>
<td>11 (Sep)</td>
<td>Salmon run gets poor, prepare fish oil</td>
<td>Prepare salmon oil.</td>
<td>Cache salmon. Leave rivers to hunt.</td>
</tr>
<tr>
<td>12 (Oct)</td>
<td>Hunt and trap game</td>
<td>Hunt and trap game.</td>
<td>Hunt and trap game.</td>
</tr>
</tbody>
</table>

Table 2.1 An outline of seasonal calendars recorded during the historic period from three, neighboring ethno-linguistic groups of the Mid-Fraser (modified from Alexander 1992).

Teit (1900, 1906, 1909) records that many of the groups in the Mid-Fraser often tolerated the use of local lands for hunting, fishing, and root harvesting by some outside peoples because of the extensive family and trade networks that connected many different band and tribal groups. On a more theoretical level, Kelly (1995: 174) also suggests that in situations where you cannot directly control a resource and/or have need of resources that are not available locally groups of people often tolerate the presence of outsiders on
their land. Although there are exceptions to this, as in the case of some bands or families that would build fishing stations and deer traps (Romanoff 1992), the ethnographic record indicates that there was definitely “reciprocal access to extremely abundant local resources” (Hayden 1992: 518). Teit (1906: 256) reinforces this interpretation of an open-access landscape.

“Hunting and root-digging grounds, trails, and trail-routes, were the common property of the tribe. Members of the Fountain, Fraser River, Lake, and Pemberton bands, sometimes hunted together, or one after another, in the country around the Upper Bridge River, which was more particularly the hunting-grounds of the Lake Lillooet, because they were nearest, and used them the most. This piece of country was noted for its abundance of roots and game; and at a place called "Many-Roots," or "Wealthy-in-Roots," the recognized hunting-grounds of the Lillooet, Chilcotin, and Shuswap, joined. Sometimes parties of Thompson and Shuswap hunted over part of the grounds of the Fraser River band without arousing any feeling of animosity (Teit: 1906, 256).

While I would not want these statements to be misconstrued as a suggestion that indigenous populations existed in a kind of Eden-like idyll free of resource stress and competition, I simply want to underscore the importance of how reciprocal access to land was built into daily practices of those in the Mid-Fraser. Such arrangements made it possible for people to access resources and raw materials that are unavailable in their own regions (Hayden 1992: 518; Turner 1988). Such actions not only help people maintain good relations with neighboring groups who may have beneficial trade contacts with groups outside the region but also helps establish support networks that may be called on for help in times of need (Hayden and Schulting 1997; Teit 1909).

Beside the collection of fish, berries, and meat, another activity that was important to life in winter housepits was the stockpiling of suitable lithic materials for the production of chipped stone tools (Rousseau 2004). While the ethnographies are largely
silent about how lithic materials were acquired, it is obvious from archaeological excavations and conjecture that household economies depended heavily on lithic tools during the winter (Clarke 2005). And while having enough food over the course of a winter may be substantially different than having enough usable stone, winters are seen as times when people could build and repair tools, prepare hides, cook food, and other tasks like basket making and net weaving—all activities for which stone tools were an essential component (Teit 1900: 182-186; 1909: 203-204).

Early ethnographers document a large variety of different stone materials that were commonly used to produce stone tools, like red-stone (likely jasper), white-stone (quartz or perhaps chalcedony) black-stone (obsidian? Dacite?) and a smooth greenish-colored stone (serpentine or nephrite), plus a variety of multi-colored cherts were used, and the perennial importance of arrowstone (dacite) in housepit contexts (Armstrong 2008; Dawson 1891; Teit 1900). Exact deposit or outcrop locations for all of these raw materials have been hard, if not impossible, to determine since there are no bedrock sources for lithic materials in this region, only secondary deposits like glacial till. However, dacite source locations have been positively linked to a large region that includes the Upper Hat Creek, Medicine Creek, and Cache Creek drainage areas and some areas where non-dacite materials like cherts, chalcedonies, and jaspers can be located have also been identified (Bakewell 2000; Greenough et al 2004; Rousseau 2000, 2004). As for the social and symbolic value of these raw materials, few accounts exist other than a few mythological accounts by early ethnographers on the creation of dacite (Dawson 1891: 35; Teit 1900: 241) and interviews that describe some dacite locations in
the Maiden Creek area as being kept secret due to its value as a trade item (Alexander 1992: 147).

It is not hard to imagine, as archaeologists in the region have speculated for years, that the procurement of lithic raw materials was likely an important part of the foraging cycle (Hayden 2000; Magne 1985). However, while archaeologists assert that Mid-Fraser foragers could logistically plan for a variety of shortages expected to occur during the winter by targeting high abundance resources like salmon, roots, and berries it is sometimes overlooked that foragers would utilize lithic resources in a similar fashion. Hayden et al. (2000: 189) treat lithic procurement as an activity of limited importance.

“The introduction of raw materials into the site should have been limited because of the need to transport food and gear from mountain sources….Without travel aids prehistorically, the addition of lithic raw material to food and gear would have been very burdensome, and we thus expect minimal amounts to have been transported….”

The underlying rationale of this argument suggests that lithic procurement was more of an afterthought each year when people were already returning to their villages. This is a strange claim for a variety of reasons. The first is that as lithic materials played a significant role in the day-to-day activities for basketry, hide processing, butchery, making clothes, and manufacturing and repairing tools the acquisition of a toolstone was likely not of minimal importance. The second problem with this description and approach to understanding lithic transport is that it almost denies the possibility that people would invest significant amount of time and energy to harvest suitable lithic resources. This flies in the face of the majority of archaeological conclusions regarding lithic transport where significant costs accrued in the acquisition of suitable material seemed to be offset by the need to have reliable tool making material (Andrefsky 2009; Beck et al. 2002; Beck and
Jones 1990; Gould and Saggers 1985). However, the primary focus on foraging activities for roots, salmon, and berries for winter use has led to the impression that lithic procurement is of secondary importance, a position that has been influenced by Binford’s (1979, 1980) description of lithic acquisition as an activity embedded that would be of secondary importance to food acquisition activities.

One way to navigate the archaeologically complex products of embedded from direct procurement has been offered by Kuhn (2006) who proposes that archaeologists take into consideration that different mobility strategies present at different times during the year would result in different lithic procurement strategies. Although I will go into this more later in the paper, Kuhn suggests that archaeologists explore the possibility that foraging needs fluctuate between supplying individuals, places, and activities—the requirements of each would necessarily be different in terms of how materials were pursued, resulting in the use of different acquisition and transport behaviors at a site.

Mid-Fraser Archaeological Overview

Contemporary archaeological evidence of the Mid-Fraser demonstrates that people have been either occasionally using the Mid-Fraser or residing there and exploiting its resources for thousands of years (Sanger 1967, 1970; Prentiss et al 2006; Stryd and Rousseau 1996). The age of the Mid-Fraser cultures was even suspected by some of the earliest archaeologists who, by comparing lithic artifacts found in obviously prehistoric burials with relatively recent ones and through observation of then-contemporary uses of stone artifacts that Indigenous peoples had been present in the Mid-Fraser for a long period of time (Smith 1899, 1900). Archaeologists in subsequent
decades working with the luxury of larger comparative artifact assemblages from many sites in the region and carbon-14 dating have been able to reconstruct habitation patterns with a fair amount accuracy (Morin et al 2008; Prentiss et al 2005, 2008; Richards and Rousseau 1987; Sanger 1970; Stryd 1970).

One of the most widely used chronologies was proposed by Richards and Rousseau (1987) in which, after 3500 BP, they proposed using the term the Plateau Pithouse Tradition to describe the cultural patterns that spanned the years between 3500 and 200 BP. This tradition was divided into three cultural horizons that were similar in gross detail but gradually showed dramatic changes both in subsistence strategies, social complexity, and to some degree lithic technology (Stryd and Rousseau 1996).

The first, called the Shuswap Horizon (3500-2400 B.P), is characterized by small-scale winter settlements, ranging from three to ten pithouses. As is the case with all pithouse villages, it is unclear how many houses at a locality were occupied simultaneously, though it is believed that most if not all of pithouses dating to this time period were single occupations, seeing little to no reuse of the structures (Rousseau 2004). House size during this period ranged from 7.5 to 16 m in diameter. Storage pits occurred only inside the houses, and though salmon bones are relatively common in houses from this time period, mammalian resources appear to have played a substantial, if not a dominant role, in the diet (Richards and Rousseau 1987; Rousseau 2004). Artifacts that have been attributed to possible status differentiation are relatively rare during this period and are limited to a handful of nephrite adzes and the occasional unmodified *Dentalium* shell from the coast (Richards and Rousseau 1987).
The second part of the Plateau Pithouse Tradition was the Plateau Horizon (2400-1200 B.P). During this time period populations appear to have increased, as indicated by the number of dated sites and the overall size of village communities, some of which during this period reached upwards of 100 structures (Rousseau 2004; Wilson 1980). The Plateau Horizon witnessed a clear shift away from heavy reliance on terrestrial mammals to a much greater emphasis on salmon (Rousseau 2004). This shift in subsistence focus coincides with evidence for the first systematic intensive exploitation of upland root resources, where large numbers of earth ovens greater than 5 m in diameter appear (Lepofsky and Peacock 2004; Pokotylo and Froese 1983). Storage pits increased in both size and frequency during this period and begin to be constructed outside of houses as well as inside. Several regional scale studies have demonstrated an increase in the number of wealth, prestige, and exotic trade items circulating on the Plateau after 2000 B.P (Erickson 1990; Galm 1994, Hayden and Schulting 1997).

The final part of the Plateau Pithouse Tradition, called the Kamloops Horizon (1200-800 cal B.P), represents a continuation of the settlement trends begun during the Plateau Horizon with village populations likely reaching peak density during this period. While house size distributions indicate a drop off in the number of small sized housepits during this time in the Mid-Fraser region, storage pits continue to occur both inside and outside the housepits (Lenert 2001). And while salmon continued to supply the bulk of the winter diet there is evidence that populations began to depend more heavily on terrestrial mammalian resources compared to the preceding Plateau Horizon (Prentiss et al 2007). Participation in long-distance trade networks appears to have intensified based on an increase in the number and variety of exotic trade goods encountered in household
contexts (Hayden 1997; Rousseau 2004; Prentiss et al. 2007). Around 800 cal B.P the large villages of the Mid-Fraser region were abandoned, giving the impression not just of the dissolution of large settlements but an actual depopulation of the area for 200-300 years. Evidence strongly suggests that abandonment of the Mid-Fraser villages was not tied to a local environmental disaster as suggested by Hayden and Ryder (1991), but rather was an expression of much larger scale changes in culture and environment (Kuijt 2001; Kuijt and Prentiss 2004).

Although the aggregated village pattern provides a general outline for cultural sequences, villages themselves had unique occupation histories and every effort should, when possible, be made to outline those histories. For the Bridge River site, a particular dating sequence has been developed after extensive testing of each housepit that provided over 110 radiocarbon dates that has been used for a site specific chronology (Prentiss et al 2008). The first and second defined occupations of the Bridge River village (Bridge River 1 and Bridge River 2 or BR 1 and BR2) appear to occur initially halfway through the Plateau horizon between at 1797-1614 and 1552-1326 cal B.P. The third sequence identified, BR3, occurred near the end of the Plateau Horizon around 1200 cal B.P. when social complexity is thought to have peaked (Prentiss et al 2008). The village seems to have been abandoned after BR3 for several centuries until it was reoccupied around 610 B.P. until just before the contact period, at 145 B.P. This time period is referred to as Bridge River 4 (BR4).

The technological organization of the Mid-Fraser pithouse villages has been well documented (Hayden et al 1996; Magne 1985; Prentiss 2000; Prentiss et al 2005; Richards and Rousseau 1987; Stryd and Rousseau 1996; Stryd 1973). The most recent
synthesis of regional information by Prentiss et al. (2006) provides a comprehensive overview and I will only summarily cover some of the largest shifts and most important aspects of technological organization and development in the Mid-Fraser according to different time periods. Before the transition to a predominately collector subsistence pattern in the Mid-Fraser around 3200 BP, there is evidence of a more formalized quality to lithic technology with the production of microblades, large bifacial points and cores, as well as multiple forms of formalized scrapers—all evidence of a more mobile pattern of existence referred to as the Nesikep tradition (Sanger 1970). However, with the emergence of the PPT the lithic technology, except for the decrease in projectile point size with the advent of the bow and arrow, is extremely stable in terms of both tools and the use of raw materials (Austin 2007; Clarke 2005; Hayden 1996, 1997).

In housepit contexts, an informal core and flake technology was the most common technological expression throughout the PPT (Prentiss 1998, 2000). One explanation for why such high frequencies of expedient tools occurs in contexts like housepit villages, is that when people have ready access to lithic materials, like those stockpiled stores in winter villages, the need to conserve raw materials through more formal, conservative tool designs is reduced (Kelly 1988; Nelson 1991). The use of expedient tools can be thought of as occurring when And while expedient flake tools constitutes the bulk of housepit lithic assemblages, there are also a number of more formally made tool types like projectile points and bifaces that were likely used for off-site activities, like hunting, during the winter. These tools also likely entered the housepit with the completion of foraging activities and may reflect an accidental inclusion of tools into the winter housepits without direct intent for their use over the winter.
Ostensibly, such lack of conservation allows people to use expedient flake tool technologies with the increase in the number of activities performed in one area, will result in a wide range of (Kelly 1988; Nelson 1991). While groundstone and bifacial technologies were present and fluctuated in importance, their numbers were overwhelmed by the preponderance of the more informal and less taxing flake and core technology.

The tool typologies that have been used in the Mid-Plateau to designate tool forms and, presumably, tool functions consist of more than 50 different types of tools. However, the flake and core technology that has been subsumed under a light duty, woodworking technology focus in which they could be used for scraping and cutting purposes forms the largest amount of these tools, followed by some of the considerably more formalized tools like drills, key-shaped and end scrapers, as well as bifacial technologies that have been interpreted as being the backbone to heavier duty woodworking and butchery tasks (Clarke 2005; Rousseau 1992). Fluctuations in general tool classes, light duty versus heavy duty, have been said to correlate with the intensity in which certain kinds of activities. Heavy duty assemblages have been more commonly associated with salmon fishing since these tools were used to work wood, antler, bone, common elements of fishing gear, whereas lighter duty assemblages have been associated more with other activities like hide working and basketry production. Bifacial and more formally made tools are commonly associated with hunting due to the need for reliable and maintainable tools while traveling far from village sites and lithic sources. Despite the kind of tool used or produced, and all the different raw materials that were used in the production of not only the lithic assemblage at Bridge River but throughout the entire
Mid-Fraser region the high frequency of dacite is notable—particularly because it is located further away than other more local sources of toolstone from many village sites in the Mid-Fraser (Hayden et al. 2000: 189).

Stone materials played a crucial role in the production of tools used throughout the Mid-Fraser. Dip nets, salmon traps, fish weirs, and projectile shafts were produced using stone materials, as were clothing, baskets, blankets, root diggings tools, “art” artifacts and in the important tasks of butchery during hunting and fishing seasons. It is also presumed that some lithic raw materials like obsidian were possibly integrated into other social networks including-long distance trade networks. And while there is ethnographic evidence of a significant bone and wood industry, unequal rates of preservation leave archaeologists to only speculate how those technologies were organized or how significant those technologies were in the course of daily life. Teit’s ethnographies from the Shuswap, Thompson, and Lilooet describe the use of bone tools with the same functional purposes—scraping, piercing, and wood working—as stone tools, though the extent to which these bone tools were used alongside stone ones remains a source of conjecture. In particular, there is substantial disconnect between the Keatley Creek and Bell sites. As there are few bone tools from the former and substantially more from the latter, it is apparent that either bone preservation at Keatley Creek was a serious problem or that the people from both sites engaged with their material culture in significant ways (Hayden 2000; Stryd 1973).

The earliest investigations of stone tools followed the culture-history approach and generally attempted to identify functions and create names for recovered tools, often based on comparisons with already accepted tool types like arrowheads, axes, or celts
(Smith 1891). This formed the basis for much of the archaeological work and was successful in that chronological sequences detailing changes in cultural patterns were developed. Slowly, other approaches to lithic analysis have been used to identify household organization including activity areas and potentially social ranking in housepits (Prentiss 2000; Spafford 1991; Schulting 1995). Recently archaeologists have started using aspects of dual inheritance theory and are examining lithic artifacts from the Mid-Fraser for elements of cultural transmission, how stone tools may convey semiotic messages of identity or prestige (Darwent 1998; Matson and Magne 2007), and the first inklings of (hopefully) larger scale sourcing projects (Greenough et al 2004; Mallory-Greenough et al 2002). And it may be that the careful and explicit examination of individual lithic material types in the Mid-Fraser may become a most crucial aspect to understanding land use patterns—especially in light of poor faunal and floral preservation at several key sites in the Mid-Fraser. As Odell notes, “[lithic] Technology is dependent on the procurement of resources appropriate for making the technology work. If those resources are not readily available, procurement becomes a scheduling problem (Odell 2001).” Based on results from preliminary analyses of the Bridge River assemblage the exceptionally high frequency of dacite artifacts and debitage over hundreds of years (and very likely longer) strongly suggest that the collection of lithic materials is not so easily explained. This research will be a first step in better understanding some of the more fundamental aspects (selection and transport) to the actual production of stone tools.
Since the late 1970’s archaeologists have increasingly used theoretical structures modeled after Darwinian principles to analyze aspects of human behavior and cultural evolution. Over these decades, archaeologists have pursued these research interests by investigating the relationships between culture and biology, using cultural material histories to reconstruct potential relationships between human populations, as well as using economic optimality models to predict what types of behavior should emerge given change to social or physical environments (Lyman and O’Brien 2000; Shennan 2003; Ugan et al 2003). As Darwinian archaeologists modify biological concepts to better fit anthropological and archaeological models, many of these share, despite perceived differences in research goals, common underlying principles (natural selection, transmission of heritable traits, and drift) and focus on the economizing benefits of certain behaviors over others (Leonard 2001; O’Brien 2002; Winterhalder and Smith 2005). Because of this, I use the insight from a Darwinian-based foraging model to analyze and understand raw material transport strategies in terms of economic decisions, much like other models that have been used to investigate transport strategies of animal, plant, and lithic resources (Beck et al 2003; Bird and Bliege Bird 1997; Gremillion 2002; Thomas 2002).

Although Darwinian based archaeological theories are of recent origin, North American archaeology has a long history of using evolutionary models and explanations to interpret the archaeological record (Carneiro 1971; Lyman 1997; O’Brien et al 2006). Despite their mutual use of the word “evolution” Darwinian archaeologists have been
attempting to clearly define the difference between the Darwinian evolution and the cultural evolutionism that originated with the work of Herbert Spencer, and later resonated in the works of anthropologists like Tylor and Morgan (Trigger 2006). Those models often perceived cultural evolution as a ladder in which different cultural types were thought to exist during a specific time—stone age, bronze age, industrial age—and are eventually replaced by other more technologically advanced people (Dunnell 1980). Often, the cultural attributes that identified specific time periods were built on fragmented knowledge and qualitative assertions of superiority and inferiority based on Victorian notions of cultural propriety (Kehoe 1991).

The neo-evolutionary approaches of Leslie White and Julian Steward and much of the New Archaeology re-conceptualized culture as a regulatory mechanism that kept humans populations in balance with their physical environment (Trigger 2006). Their explanations for evolving cultures and behaviors were deterministic and saw new technologies as intentional solutions to specific problems (usually environmental); e.g. the invention of agriculture to reduce food shortages (O’Brien and Lyman 2000). This often led archaeologists to focus almost exclusively on aspects of the archaeological record like tool technologies and food production behaviors they felt most easily explained how people and cultures remained in balance with their environments (Winterhalder 2007). However, their view of cultures was largely ahistorical, and subsequent research has shown that more often than not technologies (like agriculture) gradually developed alongside others over long periods of time and only gradually did their utility over other options become “selected for” by people when environmental or social conditions changed (Rindos 1984; Lyman and O’Brien 1998).
In the last few decades archaeological notions of cultural evolution have changed dramatically (Shennan 2008). The most vocal of early approaches, often referred to as the selectionists, tried to radically reorient archaeological practice by (a) making archaeology an exclusively materialistic based discipline; (b) insisting that humans and culture were not outside of evolutionary processes of natural selection; (c) reasserting the need for a diachronic understanding of cultural change rather than a synchronic approach to culture; (d) locating the engine of cultural evolution in the economic tradeoffs between different technologies with those that provided the highest return being selected or having “replicative success” (Leonard and Jones 1987; Lyman et al 1997). However, despite some insightful applications of Darwinian theory to explain cultural evolution through natural selection (for example, Braun 1983; Rindos 1984 and Neiman 1995), and significant contributions to archaeology in discussions of style and function (Dunnell 1978; Lyman and O’Brien 1998), plus the extension of cladistic and phylogenic models to the representation of cultural lineages (O’Brien et al 2001, 2008), the selectionist approach to explain cultural evolution was hindered by their attachment to biological models that explained evolution as a very gradual process, beginning with changes made at the smallest unit, analogous to the gene. This led to an overly broad use of natural selection that viewed the emergence of new or improved technological forms not only as a strictly undirected process, effectively preventing humans from being seen as potential agents in the selection of new, beneficial behaviors (Boone and Smith 1998; Degeratu et al 2000; Leonard and Jones 1987; Loney 2000; Pauketat 2001).

The lack of adequate interpretive structures that allow researchers to explain what factors lead to the dissemination of new behaviors has been explored by other Darwinian

Of those, processual evolutionary studies and dual inheritance theories provide explanatory structures that approach the evolution of human behaviors by examining factors beyond the level of the artifact, especially in the examination of the production, dissemination, and survival of novel behaviors of people—the very agents who engage in foraging behaviors and tool manufacture. And while genetic evolution retains its importance as a factor in human evolution, cultural evolution is driven primarily by the process in which human agents interact with each other in relation to their social and physical environments (Alvard 2003; Rosenberg 1994; Shennan 2008). Key to these processes are the recognition that humans can initiate and experiment with novel behaviors that, like Lamarckian qualities in biology, may allow non-genetic skills, attributes, or changes in behavior to be continually transmitted to others throughout a population regardless of age or familial relation and that behaviors can be influenced by entities larger than the individual (Bettinger and Eerkens 1997; Boyd and Richerson 1992, 2005; Lyman 2008). Such cultural traits are particularly important to recognize since it is the codification and dissemination of information within a population that leads to changes in behaviors which are then reflected in archaeological assemblages by shifting frequencies in artifacts (Shennan 2002).

One of the most prevalent approaches that has focused on such biology and culture interfaces, dual inheritance theory, has used mathematical modeling to disentangle the numerous factors that condition the decisions humans make under certain environmental and social conditions, especially in acquiring information to guide their behavior (Bettinger 2008; Boyd and Richerson 2003). Criticism of these, and other
predictive or agent-based models, has focused on the intangible aspects of DIT, particularly its use of game theory and optimization models to explain the transmission of information behavioral traits in prehistoric settings (Bamforth 2002). The use of these or any model can be problematic since they require the presence of certain, unchanging rules to control the exchange of information and resources; however, the use of such models have consistently demonstrated their explanatory value, by allowing researchers to systematically test variables they suspect are responsible for forming, maintaining, or changing behaviors (Winterhalder 2002).

One approach that makes use of explanatory models extensively is human behavioral ecology (HBE). Similar to the behavioral ecology that began in 1970’s and examined the range of animal behaviors, the principle guiding human behavioral analyses is that humans will respond flexibly to environmental conditions in ways that enhance their fitness (Mulder 2003). Ignoring the problematic use of the word fitness (see Barton 2008) such a statement means that in its broadest application, HBE elects to focus on the tension between humans (how they behave) and their social and physical environments as they try to maximize their use of time and energy in pursuit of food, resources, wealth, social prestige, mates, among other things (Broughton and O’Connell 1999; Kaplan and Hill 1992).

Although HBE’s utility and overall application of evolutionary thoery has been questioned (Lyman and O’Brien 1998), it remains one of the most widely used theoretical paradigms for any of the Darwinian evolutionary theories used in anthropology or archaeology (Marwick 2008; Sheehan 2004). Part of its popularity is due to the fact that while DIT and selectionism are primarily focused on deciphering the processes through
which different cultural traits are selected and transmitted, HBE simply assumes that even though humans constantly employ a wide variety of behaviors, natural selection has favored a behavioral flexibility that can track changes in the environment, resulting in so-called optimal behaviors (O’Connell and Smith 2000). As Shennan (2002: 4) notes, the reason for taking this view is that...the history of evolution by natural selection has produced in us psychological capacities and propensities, not least our emotions, which predispose us to act in ways which lead to this end. Even though most of the variation we observe in people's behaviour arises through learning, by trial-and-error and from other people, the behavioural ecology expectation is that our inherited propensities will tend to make us 'opt for' fitness-enhancing behaviour.

And while such fitness-enhancing behaviors are certainly affected by the transmission processes identified by DIT, human behavioral ecologists see existing behaviors as a result of those processes and believe that analyzing the economic tradeoffs between humans and their environments as more useful for explaining the presence or absence of certain behaviors, e.g., why some prey species are selected and others not (Alvard and Kuznar 2001; Kaplan et al 2000).

In HBE, such analyses require testing hypotheses about a possible fitness-related goal for the behavior of interest, with alternate strategies to achieve that goal (including constraints that limit the field of possible strategies). By stating up front what the costs and benefits associated with each strategy, and the currencies in which those costs and benefits are to be measured, hypotheses can be made to predict what optimal patterns of behavior would look like (Mulder 2003). However, in order to differentiate between behaviors or strategies that allow humans to maximize their returns per each investment of time and energy expended in a variety of activities, the use of optimization models
allow researchers to identify different manifestations of cultural “efficiency” and, hence, which suites of behaviors are most beneficial to a population at a certain time. Kuhn (2004) suggests that such economic models are popular because it is much easier to measure economic efficiency than it is to measure reproductive success. Economic efficiency can be used as a rough proxy for the replicative likelihood of a behavior: individuals who obtain resources with minimum effort have more time and energy to devote to other activities like childcare, social networking, gambling or sex (Bliege Bird and Smith 2005; Heinrich et al 2005).

Similar to the controversy over mathematical and game theory models, optimizing concepts employed by HBE do not presuppose humans behave optimally, rather, they provide a standard against which different behaviors can be measured (Shennan 2008). In archaeological contexts, the models used by human behavioral ecologists are primarily related to foraging models used in evolutionary ecology (Winterhalder and Smith 2000). Because these models have been used to study animal behaviors, the same framework, it has been argued, can and should be used to understand the principles of human behavior.

The most widely used HBE models used in archaeology are taken from optimal foraging theory (OFT) which consists of a family of related models that examine how variables like prey availability, round-trip distance from site to source, “patch” size, and foraging behaviors affect how humans decide what resources are best to pursue (Gremillion 2002). Often the selection of certain behaviors are determined by an economic logic that rewards the one that provides highest number of calories/time returned to those spent (Kaplan and Hill 1992). In terms of the acquisition of lithic materials even the most optimal foraging strategy could never result in more calories.
returned than lost. This suggests that that one of the most important decisions in acquiring lithic materials would be to select technologies and resources that best allow foragers to balance their utilization and need for adequate materials while limiting the amount of calories and time spent.

As Winterhalder and Smith (2000) explain, in order to use foraging models efficiently a researcher has to recognize that some aspects of the archaeological record—in this case, why a lithic assemblage appears the way it does—cannot be explained equally well through all models and that potential costs may have to be examined differently. The selection of lithic materials is hampered by different aspects of cost—the time and energy required to find, capture, process, and transport said prey—that are associated with lithic resources and not, necessarily, the same as those with faunal or floral resources. In terms of how we calculate the respective costs and benefits of certain behaviors in the Mid-Fraser, the diet breadth model (DBM) may be the most adequate model to use. One reason for this is that as all of the lithic deposits in the Mid-Fraser are from secondary deposits (most of them the result of glacial processes) models like the central-place foraging models are rendered useless since they require analysts to compare discrete distances between resource deposits and transport destinations (see Beck et al. 2002). Unfortunately, as there is significant overlap in the visual appearance of almost all the major lithic materials used in the Mid-Fraser (Rousseau 2000), linking materials to particular locations on the landscape is dangerously unreliable.

The DBM, however, approaches archaeological diets (even lithic ones) with a logic that should hold true for the interpretation of the lithic assemblages, as much as faunal ones, with little conjecture about travel costs or knowing where resources came
from. The DBM proceeds from the assumption that the diet of an economically-minded forager will consist of resources that maximize their net energy intake (or conservation) per unit of foraging time (Bettinger 1991: 84). All things being equal, resources that provide the highest rate of return will be selected: for faunal and floral based diets, this will be measured by the net caloric gain. In similar situations, we should imagine that as rocks are calorie free, desirable lithic materials for chipped stone technologies would be those that have superior physical properties like conchoidal fracture, durability, and strength. Yet, although the DBM works under implicit notions of resource ranking based on potential gain, e.g., which one contains the most calories, or may have superior physical characteristics, the highest ranked resources may be the least acquired because other materials may be harvested more efficiently, ultimately providing higher economic returns. Madsen and Schmitt (1998: 446) write the DBM predicts that a forager will pursue and take a prey type (that is, will include that type in its diet) only if the return rate (the amount of energy acquired minus the amount of energy necessary to attack and process the prey type) is as high or higher than the average return of searching for and handling other higher ranked potential prey types. More explicitly, the model predicts that a prey type will be included in the diet only when the abundance of higher ranked types (i.e. those with higher energy acquisition to energy cost ratios) decreases to the point where it is economically viable to take prey types with lower return rates. In short, ‘the inclusion of a type [in the diet] does not depend on its own encounter rate (Stevens & Krebs, 1986: 23),’ but rather on that of higher ranked items.

For example, the biomass per acre of forest is greater for mice than deer, prehistoric hunters hunted deer, not mice, because pursuing deer provided higher return rates than do mice; it would take inordinately higher investment on the part of foragers to find, catch, and process enough mice to equal one deer (Kelly 1992: 54). In terms of
lithic materials, high quality materials like obsidian and cherts may not tempt foragers, not because there were even higher quality materials on the landscape, but because there were higher post-foraging returns associated with other resources. This suggests that, like the pursuit of deer, the selection of specific lithic resources is likely a balance of economic foraging efficiency and aspects of resource utility (Bettinger 1991:85). This would likely remain the case until one type of resource became more expensive to pursue—perhaps as a result of over-exploitation—which might make other lower ranked resources like field mice or shale an attractive alternative.

The Costs Associated With a Lithic Diet Breadth Model

In using the DBM to understand the selection of lithic resources we have to examine the potential costs associated with each. Unlike the decision-making situation in which a forager must balance the costs associated with the selection of particular floral or faunal resources, the costs of lithic procurement are significantly different (Shennan 2002: 143). As several researchers have noted (Hawkes and O’Connell 1992; Minichillo 2006) although there may a priori exist ideal ranking systems in which some resources should always be pursued when encountered, costs associated with floral, faunal, and lithic resources—especially the cost of searching for resources—will affect how much time and energy will be spent on pursuing them.

In subsistence diets, a resource’s rank is determined by its total number of calories it could potentially contribute regardless of other costs (Bettinger 1991). Ideally, given the opportunity to select between a deer and a mouse, a forager will more than likely select the deer because it provides a greater caloric return. Resource rank is independent
of other issues like access, availability, or abundance. For lithic materials determining rank can be problematic as they lack easy to measure variables like number of calories. Any number of factors like nodule size and differences in functional tool requirements could potentially be used to define rank. However, I believe that all other factors being equal lithic materials used for chipped-stone technologies can be ranked on the basis of fracture mechanics including hardness, strength, conchoidal fracture and durability all of which have been especially important in separating useable toolstones from non-useable ones across space and time (Rapp 2009: 76; Yonekura et al. 2006). Researchers have been able to show that lithic materials that have been preferred for millennia were likely chosen because of their isomorphic crystalline structures which allow them to simultaneously possess high values of strength and hardness (Koukis et al. 2007: 464) as well as durability, in terms of resistance to wear, that also increases with decreasing grain size and decreasing volume of pore spaces (Yonekura et al. 2006). Cherts and chert-like materials are generally known for their extremely small grain size and relatively homogenous ground-masses with internal structures that have low proportions of ‘impurities’ or inclusions that enable knappers to have more control over how energy is directed through the material, allowing him or her to reliably remove flakes. The idea here is that as lithic materials possess a range of different crystalline structures, those that are stronger and more durable can be used more intensively than softer, weaker, and less easily manipulated materials, resulting in better performance characteristics.

Luckily, despite the different varieties of toolstone available in the Mid-Fraser people used them much the same way, primarily in an expedient block core technology to produce high proportions of expedient tools with infrequent instances of formal tool
production. Because of this and the lack of evidence for specialized uses of lithic materials, factors like technological organization and functional tool requirements can be held nearly constant. In the Mid-Fraser, the most commonly used lithics are primarily restricted to a variety of cherts and chert-like materials (including pisolite, chalcedony, and jaspers) as well as dacites, other materials like obsidian and mudstone are extremely rare. On the basis of previous research (Hayden et al. 1996, 2000; Luedtke 1992; Rapp 2009) the superior physical characteristics of cherts make them more highly ranked than dacites, quartzites, and other chippable materials which are not nearly as homogenous in structure and whose strength, durability, and hardness, while still fairly high and generally adequate for tool production, are not necessarily the equal of cherts. Although this ranking needs to be tested more thoroughly, on the basis of grain size, flakability, hardness and strength we should assume that cherts and chert-like materials like jaspers, chalcedonies, and pisolites would be the highest ranked materials in the Mid-Fraser on the basis of their physical characteristics. Dacite, despite slightly larger grain sizes and decreased hardness and durability, is ranked second. Basalts, as a rougher and less chippable material closely related to dacite is third. Ortho-quartzites despite being hard and durable do not flake well and comparatively have very large grains are fourth.

Because ranking is independent of other factors, being highly ranked does not guarantee that a resource will be selected. Availability and abundance on a landscape strongly affect how much any resource is utilized regardless of its rank. As a result of having fixed positions on the landscape and are therefore likely to be known to foragers living in an area for a long period of time, search costs are likely negated for lithic resources in most situations. And in the absence of search costs, handling costs, or the
decision to “pursue, capture, process, and consume (Hawkes and O’Connell 1992: 63)” becomes the primary cost that will likely effect lithic selection. Theoretically, we could imagine a situation in which a forager traveling across a landscape reaches a fork in the path. Each fork will take this hypothetical forager to an area where lithic deposits exist. The one to the right will take him to an area with very high quality jasper, but because it occurs at very low densities requires a lot of time to find. The fork to the left takes him to a dacite outcrop, which although having slightly lower quality than jasper, is very abundant and easy to find. In situations where the forager only needs small amount we should imagine that he would target the jasper, which despite having higher initial costs would result in a nodule of material that could potentially be used more intensively than dacite. That is to say, that in activities where durability and hardness are extremely important, as in heavy scraping activities, jasper would have to reworked less often. However, in situations where someone needed a lot of material—enough to outfit his house for winter—we should imagine dacite would be selected, which despite differences in quality, would ultimately prove more economical. It is simply that as the amount of material needed increases, so does handling time (figure 3.1), so while some areas might be comparatively investment-neutral for small amounts, this will change as the quantities needed increases and lower density resources become more expensive than higher density resources with lower costs. Although figure 3.1 presents this relationship in an idealized situation where differences in a few physical characteristics are the limiting factor, other factors like differences in shape, size, quality, and abundance will also, ultimately, affect the selection of lithic materials.
Thus, an area associated with low quantities of toolstone might be utilized by a forager needing only a small amount of material, the same forager might forgo the same area if their goal is to procure large quantities (Kuhn 2006; Winterhalder and Goland 1997). Thus, while the search costs, or time it takes to find prey is the same—here an area known to have deposits of lithic materials—it is the difference between the availability of resources in areas that make them more attractive. This is not to say that toolstone physical characteristics and search costs do not influence lithic selection. It is essential that such factors are fully accounted for. High ranking resources, i.e., those that potentially provide the best return in terms of superior physical properties, should be pursued in cases where search and handling costs are not influential. However, as Mid-Fraser foragers were likely caching large amounts of lithic material for use over the winter, we should imagine that they pursued strategies that according to Bettinger (1991: 27)
84) consist of a combination of resource types that represent optimal post-investment return per amount of time and energy spent. With significant short-term investments of time and energy, these resources could more efficiently produce reliable surpluses than would have possible pursuing lower density, less predictable and therefore more expensive resources. If the selection of lithic materials follows the expectations of the DBM, we should expect that the lithic diet at the Bridge River will likely show a balance between quality and availability.
CHAPTER 4: METHODOLOGY

The purpose of this chapter is to outline the methodology that I will follow to understand why dacite was seemingly preferred over non-dacite materials in the production of chipped stone tools. In this chapter I will outline the methodology that I will use to investigate the lithic assemblage at Bridge River. By combining aspects of the diet breadth model with general nodule analysis, I will be able to examine and compare potential factors leading to the selection, transport, and use of lithic materials at the Bridge River site. Here I will be able to examine the affect of lithic quality and density on the acquisition and use of lithic materials.

Transport Context

As outlined earlier, a confusing aspect of the transport and use of lithic materials to the Bridge River village among others in the Mid-Fraser is that despite multiple, scattered sources of high quality lithic raw materials throughout the region there is an overwhelming preference for dacite that spans the thousands of years of human occupation in the area (Bakewell 2000; Sanger 1970; Stryd 1972; Teit 1900:192). What makes this especially perplexing is that nearly all Mid-Fraser village sites are in relatively close proximity (1~30 km) to a variety of areas with non-dacite materials like cherts and chalcedonies. And while non-dacite materials do occur in assemblages, it is generally at significantly lower frequencies.

A limiting factor to our current understanding of lithic selection has been the nearly exclusive focus on lithic selection as a result of theoretically established techno-
functional/socio-economic expectations that the rarest materials in an assemblage are also the most likely to be sensitive to social differences between people or housepits. In particular, cherts (including chalcedonies, jaspers, and pisolites) are considered highly desired or socially significant materials in winter housepits for their superior physical characteristics of strength and durability. These materials are also considered to be theoretically diagnostic of areas controlled by housepits, meaning that the presence of certain materials may be indicative of a housepit’s foraging territory (Hayden et al. 1996, 2000). Conversely, dacite is implicitly depicted as being of less importance because of its seemingly ready availability to anyone in the Mid-Fraser, and its slightly lower physical qualities. The problem with focusing almost exclusively on chert and chert-like materials for understanding lithic selection writ large is that there is little evidence for neither discrete chert sources on a landscape nor clearly defined exploitation of particular cherts for particular tools both claims are, as of the present, unsupported by anything other than theoretical conjecture.

Understanding Lithic Use-Strategies at the Bridge Rive Site

General Nodule Analysis

I can explain the selection and use of lithic materials by examining and comparing various use-strategies and activities that resulted in the Bridge River assemblage. As preparation for winter months involved stockpiling a variety of calorically high density, seasonally abundant resources like salmon, roots, and berries, the selection and transport of lithic materials was potentially based around similar foraging principles that would provide Mid-Fraser foragers a significant resource base to draw from all winter
(Alexander 1992; Turner et al. 2008). Yet unlike the seasonal availability of plant and animal resources, lithic materials are available almost year round and harvesting them could potentially occur at any time convenient to Mid-Fraser foragers, other than during the winter months when snow and ice covered the landscape (Alexander 1992).

Because one of the underlying assumptions for any lithic analysis is the possibility for all lithic materials to be brought onto a site for the same purpose—for the production and use of tools—establishing an objective process to examine that assumption is needed. General nodule analysis (GNA) is an ideal approach for discerning and explaining differences in lithic assemblages like the one from Bridge River that was produced over many occupational periods and consists of raw material types that have overlapping visual characteristics and thus are not readily identifiable to discrete points from the surrounding landscape (Knell 2004). Following Knell’s (2004) approach, GNA will allow me to determine whether differences existed in the transport and use of lithic materials. This line of analysis will show whether people living at the Bridge River Village truly preferred dacite for all tool types at the Bridge River Village, or if its occurrence at high frequencies only satisfied a small selection of tool types. Conversely, it would also be important to understand if non-dacites “filled” specific niches in the lithic technology that dacite was not used for, potentially as a result of differences in raw material quality.

Because GNA proceeds from the presumption that raw materials are transported to and used at sites for different purposes, use-patterns that emerge from an assemblage will indicate whether raw materials were used in similar or different fashion (Knell 2004). Conceptually, these nodules represent a material’s use life at a site, represented by
the kinds and frequencies of tools, debitage, and cores recovered. Differences or similarities in raw material use then provide a way to look at and interpret the importance of a lithic material’s quality, frequency, and utility. As Figure 4.1 shows, there exist a variety of ways to conceptualize how lithic materials will enter, be used at, and potentially leave a site.

In the first two scenarios, lithic materials are transported to the Bridge River site as part of or with the intent to include them in the winter technological strategy, i.e., the production, use, and maintenance of tools on site. These two scenarios are part of ‘production’ nodules that have high tool diversity with an emphasis on expedient tools, high artifact frequencies, and a wide range of debitage size ranges. Whereas scenarios three and four represent the ‘accidental’ or incidental transport of lithic materials and/or already manufactured tools that were part of other, off-site technological strategies.

Figure 4.1. Flow model and implications for four technological organizations. (A) Transport of toolstone and tools to Bridge River; (B) on-site tool manufacture, use, or maintenance; (C) transport of tools away from Bridge River.
Ingbar (1994) refers to these as field luggage, or materials that were carried to a site without the intent to include them in the larger technological strategy. Because most of the materials from scenarios three and four arrived on site outside of an intentional stockpiling strategy focused on procuring a particular material they are thought of as being part of ‘transport’ nodules and are noteworthy for very low tool diversity, low artifact frequencies, low expedient to formal tool ratios, and a narrow range of debitage sizes—the result of many artifacts arriving on-site as already manufactured tools. A more complete way of summarizing these relationships are presented in fig. 4.2.

One of the first steps in GNA is to establish general raw material nodules, which are essentially aggregates of similar materials. Because of Rousseau’s (2000: 172-180) repeated warnings that many Mid-Fraser lithic deposits overlap in the kind of materials, colors and textures that make linking materials to points on the landscape based on visual characteristics virtually useless, I was hesitant to use the typology commonly used for Mid-Fraser lithic assemblages that makes distinctions among cherts, jaspers, and chalcedonies. Instead, the Bridge River assemblage was broken into broadly defined raw material types. The category for dacite includes materials with a granular structure that can fluctuate between being visibly coarse to glasslike and range from light to dark grey, making these materials relatively easy to identify. The category for Mid-Fraser cherts has an extreme range of color variation and granular structure and include jaspers which are cherts that got their red and yellow colors from the presence of iron oxide. Mid-Fraser chalcedonies, like the cherts, also come in a wide array of colors and textures. Other materials like obsidian and pisolites seem to be relatively easy to identify due to the unique glassy black appearance of the former and the waxy, often pale-pink color with
visible inclusions of the latter. Other materials whose individual frequencies were so low they did not require their own categories like quartz, ortho-quartzite, and mudstone are aggregated under a category of *other*. These general nodes consist of debitage and tools for each general nodule.
Table 4.1 shows four different scenarios in which lithic materials may enter and leave an archaeological site.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Off-Site</th>
<th>On-Site</th>
<th>Tool Type</th>
<th>Tool Domain</th>
<th>Module</th>
<th>Expected Type</th>
<th>Frequency</th>
<th>Artifact Class</th>
<th>Behavioral</th>
<th>Material</th>
<th>Material Tool</th>
<th>Time</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>Off-Site</td>
<td>On-Site</td>
<td>Tool Type</td>
<td>Tool Domain</td>
<td>Module</td>
<td>Expected Type</td>
<td>Frequency</td>
<td>Artifact Class</td>
<td>Behavioral</td>
<td>Material</td>
<td>Material Tool</td>
<td>Time</td>
<td>Place</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Off-Site</td>
<td>On-Site</td>
<td>Tool Type</td>
<td>Tool Domain</td>
<td>Module</td>
<td>Expected Type</td>
<td>Frequency</td>
<td>Artifact Class</td>
<td>Behavioral</td>
<td>Material</td>
<td>Material Tool</td>
<td>Time</td>
<td>Place</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Off-Site</td>
<td>On-Site</td>
<td>Tool Type</td>
<td>Tool Domain</td>
<td>Module</td>
<td>Expected Type</td>
<td>Frequency</td>
<td>Artifact Class</td>
<td>Behavioral</td>
<td>Material</td>
<td>Material Tool</td>
<td>Time</td>
<td>Place</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Off-Site</td>
<td>On-Site</td>
<td>Tool Type</td>
<td>Tool Domain</td>
<td>Module</td>
<td>Expected Type</td>
<td>Frequency</td>
<td>Artifact Class</td>
<td>Behavioral</td>
<td>Material</td>
<td>Material Tool</td>
<td>Time</td>
<td>Place</td>
</tr>
</tbody>
</table>
After identifying general raw material nodules, these are further broken into different types of debitage, tools, cores, and unused raw material nodules. These provide analytical value for understanding different use strategies. As Knell’s scenarios suggest and other research has supported (Andrefsky 1994; MacDonald 2008; Nelson 1991) in largely sedentary situations where travel is constrained but with abundant lithic material available (like at the Bridge River village), there should be evidence for tool production to satisfy primarily on-site (expedient) and some off-site (formal, curated) activities. Clarke’s (2005) analysis of housepit assemblages shows that such patterns are present in winter housepits with toolstone primarily used for the production of expedient tools, followed by significantly lower proportions of formal tools. I use Andrefsky’s (1994:22) notion of formal tools as those which require extra effort to produce such as bifaces and endscrapers, as opposed to expedient or informal tools that have little effort expended in their production. Winter housepit assemblages are noteworthy for their wide array of tools that attest to a number of daily activities for which toolstone was employed. Intrigued by the possibility that there were specialized uses of toolstone to make specific tool categories (see Hayden et al. 2000), I decided to separate out tools from the assemblage based on the level of technological cost—expedient and formal tools—which were then segregated into more useful units based on the kind of activities they served. For example, there were a variety of scrapers that are identified in the tool typology by labels such as single, double, alternate, and convergent scrapers that have all been lumped under the more general category of expedient scrapers (see Appendix A).

The general idea here is that these categories will allow me to see how materials were used, for what kinds of activities (like heavy-duty scraping), and to evaluate how
much overlap occurs between lithic materials in these tool categories. Assuming that the majority of raw materials transported to the village were part of a larger strategy for stockpiling raw materials for winter use, there should be considerable overlap in how they were used and should be fairly consistent with previously established descriptions of technological organization at the Bridge River Village (Clarke 2005). However, there is the possibility that some materials may deviate from this pattern either because they were part of alternate use and transport strategies or, potentially, were simply ‘field baggage’. A general nodules analysis will help show, but not necessarily explain, differences in lithic material selection and use.

As Andrefsky (1994) and Brantingham et al. (2000) argue, the selection and use of so-called high or low quality lithic materials is normally context dependent and generally depends on one factor: the availability of raw materials. Thus, although there may be an ideal standard for what constitutes a high quality lithic material, such materials may be ignored on the basis that they are too difficult and expensive to find compared with other lithic materials. Ultimately, the general raw material nodules analysis can determine how useful rankings based on physical properties are for understanding lithic procurement.

**Combining General Nodule Analysis with the Diet Breadth Model**

The analytic value that comes from creating broad-spectrum material nodules is to be able to compare how different raw materials were transported and used at a site. In instances of largely sedentary contexts like the Bridge River village, this information can provide a general blueprint for comparing the importance of variables like lithic quality
and density on the landscape to their overall frequency and utility at the site. Discrepancies that emerge in the selection and use of particular lithic resources can potentially be explained using insight from the DBM.

Because the DBM views resource selection as a result of one or some resources having higher post-foraging returns than other resources, the distributions of lithic materials at the Bridge River Village should correlate approximately with lower costs resources being selected more than others with higher costs. Similarly, it is possible that the DBM and resource density on the landscape cannot account for resource selection, which may simply have been driven by the pursuit of high-quality resources. The criteria used here should not be too controversial since the purpose of foraging models is to be able to determine selection as a result of different currencies like the one used here: optimal conservation of time and energy by reduced search and handling costs. This analysis provides an essential new dimension since there is an often implicit understanding that differences in lithic use-strategies are only influenced by issues of physical characteristics, particularly durability (Hayden et al. 1996, 2000).

**Ranking Lithic Materials Based on Physical Properties**

Determining what factors may or may not constrain the selection of lithic materials can be extremely problematic since a wide array of variables are likely under simultaneous consideration (Andrefsky 2009; Bleed 1986; Hiscock 2004; Nelson 1992). Several constraints like task, material, technological necessity, and socioeconomy can influence the selection of one material over another. Lithic selection in the Mid-Fraser, however, has been largely understood based on differences in physical characteristics.
Because of the near universal appreciation and selection of fine grained, siliceous materials over others for tool production (when available) from the Paleolithic to the present (Rapp 2009) I can develop and test a preliminary ranking based on discernable and measurable physical differences between lithic materials that ostensibly affect performance during tool production activities. In particular, variables like hardness, durability, grain size, and presence of inclusions are very important in determining why certain materials were used for tool production. Ideally, in situations where factors like access and abundance are neutral we should expect people to consistently pursue those materials with superior physical qualities for a wide range of particular activities (Rapp 2009: 76).

Using those measures mentioned above, I can establish a proxy ranking of Mid-Fraser lithic materials that can be tested to see if lithic selection paralleled expectations for higher quality lithic materials to be most common within the Bridge River assemblage. I can approximate the hardness of different lithic materials using the durability, grain size, and presence of inclusions can be determined using previously published research (Hayden et al. 1996; Bakewell 2000; Greenough 2004). By comparing these features, I can better interpret the importance of lithic material ranking on the selection and use of raw materials using a variety of lines of evidence.

**Understanding Costs**

Unlike a normal DBM in which the selection of resources are based on foraging decisions to either select one resource or ignore it in hopes of finding an alternative that provides a highest return, the nature of lithic procurement is slightly
different. As other researchers have pointed out, many of the costs associated with pursuing faunal resources, like search costs, are not present for pursuing lithic materials which are almost entirely an issue of balancing lithic quality and handling costs—literally the pursuit, capture, process, and consumption of a resource after it has been found (Hawkes and O’Connell 1992: 63; Minichillo (2006)). Search costs associated with lithic resources are almost nil as most foragers living in an area long enough know where deposits of suitable lithic materials exist (rocks don’t move) and that the immediate transport costs for lithic materials in the Mid-Fraser can’t be compared between lithic materials as many lithic outcrops are unknown. Meaning, that as many of the places where chert and chert-like materials came from can’t be defined, their transport costs can’t be calculated or compared against dacite. And as the primary way lithic materials entered winter housepits was in the form of cores and pre-made tools, processing costs between material types would be negligible as the behaviors and scale that people were working with wouldn’t differ widely from one material to another (Minichillo 2006).

However, as the density of materials within deposits can vary widely and impair efficient procurement, some resources associated with higher resource densities may be pursued more than others even if it is potentially lower ranked. Because of their sustained occupation of the Mid-Fraser, it is safe to presume that foragers would know where many deposits of lithic materials were located on the landscape. And as these deposit sites do not move, the cost of searching for these deposit sites are very low. However, because many sites where lithic materials can be procured are secondary in nature, i.e., glacial deposits, the amount of time it would take to find adequate materials within these
locations would probably vary tremendously and would likely affect which areas and resources were targeted by Mid-Fraser foragers.

**Distribution and Density on the Landscape**

As Winterhalder and Goland (1997) point out, diets are generally the reflection of the comparable abundance and density of different resources on the landscape. The selection of one resource for consumption or use then is not necessarily limited to notions of quality but more closely related to the economic gains or losses associated with each resource. Thus, the approximate rank of resources is not as important as their abundance on a landscape. It is possible to conceive of a situation in which potential sources of toolstone dotting a landscape are associated with higher economic returns than others. Those areas associated with higher returns, which were likely related to ease of locating nodules of adequate quality, then became the sources of toolstone for use in winter housepits.

Figure 4.3 identifies a variety of locations on the landscape around the Bridge River village and throughout the Mid-Fraser where outcrops of lithic resources have been identified (Crossland and McKetta 2007; Greenough et al. 2004; Rousseau 2000). The use of the term outcrop, however, should not be interpreted as being bedrock or quarry sources, as these do not exist in the Mid-Fraser. Rather, marked sites simply represent places where lithic materials have been found and recorded. In some cases, sites in and around the Cache Creek region represent extensive and dense concentrations of dacite toolstone, whereas others are less concentrated and should only be thought of as reflecting the presence of toolstone. As few of these sites (except Cache, Maiden, and Medicine Creek) have any evidence or descriptions for use by indigenous knappers and
may have not have even existed when the Bridge River village was occupied, they should be thought of as only providing a baseline of evidence for the availability of lithic materials in the region.

Schmitt and Madsen (1998) argue that more than anything else the density of a resources on the landscape will determine its selection. By using maps like figure 4.3 and reports from previous surveys in the area (Bakewell 2000; Crossland and McKetta 2007; Mallory-Greenough et al 2004; Rousseau 2000), I will be able to determine and compare the general distribution and density of known deposits. Although there is no incontrovertible evidence that each of the identified deposits were specifically targeted by

Figure 4.3  (1) Confluence of the Bridge and Yalakom/Yalakom River Moraine Chert deposits; (2) Camoo chert, chaledony, and dacite deposits (3) Applespring chert and dacite deposits (4) Moran chaledony outcrop; (5) Blue Ridge Chalcedony outcrop (6) Glen Fraser silicate outcrop (7) Bridge River Arbor chert, chaledony, and dacite deposits (8) Fountain Ridge Pisolite deposit (9) Pavilion Mountain chert outcrops (10) Cornwall chert outcrop (11) Maiden Creek dacite and silicate source 12) Cache Creek Dacite source 13) Upper Hat Creek dacite and silicate source (http://atlas.nrcan.gc.ca)
people living at the Bridge River, there are no other deposits reported, effectively constraining my investigation to these deposits.

What figure 4.3 illustrates is that a variety of opportunities potentially existed for foragers from the Bridge River Village to utilize a wide range of local materials. Indeed, it is clear that a variety of lithic outcrops potentially existed close to the Bridge River site, many of them dominated by cherts and in lesser amounts dacite and chalcedony. What makes this situation especially intriguing is that there did not seem to be any clear reason why, with so many potential deposits located close to the village, foragers transported dacite almost to the exclusion of other materials. Indeed, as most of the dacite seems to have come from more than 40 km away, further than all other resources, one would have suspected that local materials would play a larger role in the Bridge River lithic technology. In light of these results I am lead to concur with C.J. Kind (1996) that the ubiquity of a material at a site does not mean that it was necessarily available locally. Indeed, it seems as though foragers largely ignored immediately available materials while targeting non-local dacites for use at the Bridge River Village.

**Summary**

The diet breadth model assumes that in any diet there will be higher and lower ranked resources depending on their potential caloric contribution, or in this case, due to their physical characteristics (Bettinger 1991). Yet, no matter how desirable higher-ranked resources may be, their selection is often a matter of how often they are encountered or the amount of time and energy it takes to find, capture, process, and transport them. Again, ranking and utilization are independent of each other. In the Mid-Fraser, there are a variety of high-quality chert and chert-like materials, in addition to a
range of dacitic and basalt materials, which would be high to mid ranked based on their physical characteristics. The cultural phenomenon that needs to be explored in the next chapter though is whether the selection and use of lithic materials in the Mid-Fraser are based on raw material quality or performance potential or if other factors like access and handling costs possibly influenced foraging decisions. GNA will allow me to identify whether different transport strategies existed, compare differences in how lithic materials were used, and to examine how important high-ranked resources were to winter housepit technologies.
CHAPTER 5: ANALYSIS OF THE BRIDGE RIVER ASSEMBLAGE

This chapter will examine and compare the selection and use of lithic materials in the Bridge River village using general nodule analysis. These results will be used to examine whether higher-ranked resources like cherts are used more intensively or selectively than lower-ranked resources like dacites. The logic of the diet breadth model will be used to help explain differences in lithic material selection and use.

Establishing Bridge River 2 General Nodules

In the previous chapter, I outlined the methodology that I would follow to determine which lithic materials were likely transported into the Bridge River village for the production and use of chipped stone tools primarily for winter village activities and, correspondingly, which factors influenced the transport of these materials. This chapter proceeds in two steps. The first is to determine which lithic material types likely constitute production nodules. Following the identification of production nodules, I will then re-center my analysis to compare aspects of materials from production and transport nodules to understand potential factors that influenced why some materials were preferentially selected for transport. The explanatory logic of the diet breadth model will provide structure to my interpretations and help frame discussion of my results.

Before sorting and sifting the assemblage into raw material nodules, I first ran a chi-squared test (table 5.1) to assess the significance of the difference between lithic raw materials represented in the Bridge River 2 and Bridge River 3 assemblages from the site.
### Bridge River 2 Bridge River 3 Total

<table>
<thead>
<tr>
<th></th>
<th>BR2</th>
<th>BR3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacite</td>
<td>1260</td>
<td>10987</td>
<td>12247</td>
</tr>
<tr>
<td>Non-dacite</td>
<td>80</td>
<td>1185</td>
<td>1265</td>
</tr>
<tr>
<td>Total</td>
<td>1340</td>
<td>12172</td>
<td>13512</td>
</tr>
</tbody>
</table>

#### Chi-square without Yates correction

Chi squared equals 20.168 with 1 degrees of freedom.
The two-tailed P value is less than 0.0001

The association between rows (groups) and columns (outcomes) is considered to be extremely statistically significant.

Table 5.1: Chi-squared test for dacite and non-dacite materials during BR2 and BR3.

The chi-squared equaled 20.168 with 1 degree of freedom. The resulting two-tailed P value of .0001 suggests that the increase in materials during Bridge River 3 was extremely statistically significant and that there seems to be some kind of association between BR2 and BR3, meaning I should be able to compare results from the two time periods. It should be noted, however, that because substantially more BR3 contexts were excavated than BR2 contexts (Prentiss et al. 2009) rarer materials are more likely to turn up in higher frequencies with increasing sample size (Plog and Hegmon 1993) and the true behavioral significance of less frequently occurring materials will remain somewhat ambiguous until further data can be compiled.

This chapter begins by first dividing the assemblages from BR2 and BR3 into production and transport nodules in order to see what raw materials Mid-Fraser foragers transported for use into a Mid-Fraser winter village. Logically, then, we can begin isolating production nodules by first comparing differences in raw material frequencies and then examining the range of activities that they were being used for.
What figure 5.1 clearly shows is that dacite was overwhelming transported to the Bridge River village and seems to have played an extremely significant role in the lithic technology during Bridge River 2. Dacite represents nearly 90% of the tools and just over 90% of the debitage for the entire assemblage. Comparatively, non-dacite materials vary little in their representation: chert and basalt have the highest proportions of tools and debitage while obsidian, chalcedony, pisolite, and *other* have a single tool between them, the remainder being debitage. From an interpretive stand point, it is difficult to say too much about potential transport and use patterns for non-dacite materials as they comprise such a low proportion of the overall assemblage—only 100 of 1341 pieces of debitage and only 10 of 104 tools. Due to these results, it does not appear as though non-dacites contributed as significantly to the Bridge River winter village lithic technology as dacites did.

Figure 5.1: Proportional distribution of lithic materials for BR2
Examination of Lithic Tool Distributions

Understanding a materials importance at a site can be partially determined by examining which tools and tool categories were produced from it. Figure 5.1. strongly demonstrates that dacite was transported and used the most at the Bridge River village and tables 5.2 and 5.3 shows that, in addition to high transport frequencies, dacite was also used for every tool category found on site. Dacite was used for nearly all of the expedient and formal tools at Bridge River village. Whereas, not a single non-dacite material contributed significantly to a particular tool category to the raw proportions shown in table 5.2. Proportional differences like these may potentially be explained, as Hayden et al. (2000) have proposed, if physical characteristics for materials like cherts and chalcedonies that generally have exceptional durability, hardness, and flakability resulted in their being transported and used as either formalized tools or heavy duty tools (like drills and boring tools) with the intention of being used repeatedly over a longer period of time than expedient tools. Such conditions would preclude the necessity of transporting large amounts of material, potentially resulting in lower proportions of some non-dacites.
<table>
<thead>
<tr>
<th>BR2</th>
<th>raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dacite</td>
</tr>
<tr>
<td>utilized flake</td>
<td>86.4%</td>
</tr>
<tr>
<td>expedient scraper</td>
<td>92.9%</td>
</tr>
<tr>
<td>expedient knife</td>
<td>91.9%</td>
</tr>
<tr>
<td>formal knife</td>
<td>85.7%</td>
</tr>
<tr>
<td>Tool Category</td>
<td></td>
</tr>
<tr>
<td>Projectile Points</td>
<td>100.0%</td>
</tr>
<tr>
<td>Misc. Biface</td>
<td>100.0%</td>
</tr>
<tr>
<td>Drills/boring</td>
<td>100.0%</td>
</tr>
<tr>
<td>Piercers</td>
<td>83.3%</td>
</tr>
<tr>
<td>Nodule</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 5.2: Shows the presence or absence of tools within the BR2 assemblage, plus proportional distributions of different lithic materials.

<table>
<thead>
<tr>
<th>BR2</th>
<th>raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dacite</td>
</tr>
<tr>
<td>utilized flake</td>
<td>19</td>
</tr>
<tr>
<td>expedient scraper</td>
<td>13</td>
</tr>
<tr>
<td>expedient knife</td>
<td>34</td>
</tr>
<tr>
<td>formal knife</td>
<td>6</td>
</tr>
<tr>
<td>Projectile Points</td>
<td>5</td>
</tr>
<tr>
<td>Misc. Biface</td>
<td>7</td>
</tr>
<tr>
<td>Drills/boring</td>
<td>4</td>
</tr>
<tr>
<td>Piercers</td>
<td>5</td>
</tr>
<tr>
<td>Nodules</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 5.3: shows the raw counts of tool types by raw material within the BR2 assemblage.
However, table 5.2 shows that for all the tools recovered from BR2 that would normally be considered ideal for such ‘heavy-duty’ tasks, like drilling and boring, dacite was the raw material used for the all them. In fact, as dacite comprises the majority of all tool categories (expedient and formal) it seems clear that with the absence of non-dacite tool specialization for formal tools, dacite appears to be a preferred tool material since it obviously met the requirements of indigenous knappers for a range of activities both on and off-site.

When we compare the kinds of expedient to formal tools for each lithic material, table 5.2, a pattern emerges that closely parallels Shott’s (1986:19) assertion that the range of tools produced increases under sedentary conditions where resource stresses are generally limited, permitting a greater range of tools to be produced for a variety of different activities. And as production seems strongly skewed towards expedient tools, which are generally more wasteful of raw material (Bamforth 1986), we should presume that in the domestic sphere material conservation was not an apparent concern and was potentially a result of ample stockpiles of lithic material cached earlier in the year for the use over the winter (Nelson 1991: 64). Under conditions of reduced risk and immediate access to lithic materials, we should expect that the proportion of expedient tools should be considerably larger than formal tools. Figure 5.4 shows that within general nodule categories, all of the materials resemble the patterns described by Clarke (2005) and Prentiss (2000) for higher proportions of expedient to formal tools, but the comparison of frequencies between these materials may not be entirely reliable as the size of the largest non-dacite nodule (3 chert tools) prevents a meaningful comparison with dacites (100
The overall low frequencies and lack of tool diversity among non-dacite materials suggests that these materials were not only infrequently transported to the site, but did not really figure into a more comprehensive winter technology. It is extremely likely that the lithic technology at the Bridge River Village consisted of a wide array of tools for a range of diverse activities both on and off site because people were able to transport large quantities of dacite to the site for use over the winter.

The extant differences between material types suggest two things. The first and most obvious is that dacite played an important role in producing expedient and formal tools for on and off-site activities during the winter months. The second is that the conditions that result in such a large array of tools made from a single material implies that Mid-Fraser foragers must have transported dacite almost to the exclusion of other materials. The results above suggest that non-dacites materials likely did not enter the site as part of a coherent transport strategy, or if they did, their use-patterns are not clear or comparable with dacite. When we compare the results from this general nodules to
previous understandings of selection based on differences in physical characteristics, dacite is undoubtedly selected and used more frequently than higher-ranking resources. Conversely, non-dacite materials during BR2 lack the proportional (<4% for each material type) and utilitarian depths to be considered as contributing significantly to the overall lithic technology which provisionally demonstrates that rank does not guarantee selection.

**Establishing Bridge River 3 Production Nodules**

As in the previous section, the lithic assemblage for BR3 was first divided into general nodules with all debitage, tools, cores, and nodules of the same lithic material types. The general nodules from BR2 to BR3 did not change significantly. Figure 5.3, shows that the trend for dacite materials from BR2 continues and remains overwhelmingly selected compared to other materials, which combined barely exceed 10% of the chipped stone assemblage.

![Proportional distribution of lithic materials for BR3.](image)

Figure 5.3  Proportional distribution of lithic materials for BR3.
Although the frequency of non-dacite materials increases, it is hard to determine whether that increase was the product of higher transport and use frequencies or merely a result of far more BR3 cultural contexts excavated (Plog and Hegmon 1993). A two-tailed chi-square test (table 5.5) comparing only the increase of tools from BR2 to BR3 resulted in a calculated chi-square of .980 with 1 degrees of freedom and a two-tailed P value of .3223 which demonstrates that the increase in lithic materials is not statistically significant. Because this result contradicts an earlier chi-square test (table 5.1) that suggested there was a close association between BR2 and BR3 assemblages, another chi-square test was performed on the amounts of debitage without tools (table 5.8) which resulted in a chi-square of 19.610 with 1 degree of freedom and two-tailed P value of .0001, suggesting the association between BR2 and BR3 are extremely statistically significant. These results suggest that although the use of non-chert tools may have stayed the same at the Bridge River site, there seems to have been an increase in the amount of production or maintenance of these materials on-site but were discarded off-site. This would conform with previous expectations for most non-dacite materials, particularly the chert and chert-like materials to be part of transport nodules and not necessarily intended for use within housepits. Obviously, these results are preliminary and will need more analysis in the future.
Examination of Lithic Tools Distributions

The distribution of lithic materials within tool categories, as shown in figure 5.6, also shows that tools made from dacite continued to be the most widely represented at the Bridge River village. As in BR2, the BR3 assemblage has a wide spectrum of tool categories, again notable for the extremely high incidences of dacite for both expedient and formal tools (table 5.7). The strongly skewed representation of expedient to formal
tools for dacite shows a clear pattern of technological utilization of expedient-block core technology that we should expect for these housepits (Prentiss 1998; Spafford 1991). An interesting aspect of non-dacite tool use, primarily among cherts, is that despite having higher representation in formal tools is that many of them do not demonstrate the same diversity of tool types we would expect from a material intended for use at a winter housepit village, i.e., high proportions of expedient tools used in a variety of activities.

It is clear from table 5.7 that if our arguments are to remain consistent with previous assumptions of expedient block core technologies then we should expect lithic materials in the Bridge River village to be used for a wide range of activities. Again, dacite was used for a full range of tool types, followed closely by cherts, which, despite having low frequencies shows a more diverse range of tool types than in BR2. However, other toolstones like basalt, pisolite, and chalcedony show a remarkable lack of tool diversity and are primarily restricted for the use of expedient tools. And while chert and other non-dacites like pisolite and chalcedony may be high-ranking lithic materials in the Mid-Fraser, their presence in the BR3 assemblage is well below 10% of the total assemblage, and do not appear to have been intentionally sought out as intensely as dacite for the production of any particular tool type. In fact, the use of pisolite and chalcedony for expedient tools should be rather surprising given the fact that their physical properties should ostensibly make them more suitable for other tool types.
<table>
<thead>
<tr>
<th>Tool Category</th>
<th>raw material</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BR3</td>
<td>dacite</td>
<td>pisolite</td>
<td>basalt</td>
<td>chert</td>
<td>chalcedony</td>
<td>Other</td>
<td>dacite</td>
<td>pisolite</td>
<td>basalt</td>
<td>chert</td>
</tr>
<tr>
<td>utilized flake</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>90.8%</td>
<td>3.1%</td>
<td>3.1%</td>
<td>1.5%</td>
</tr>
<tr>
<td>expedient scraper</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>88.0%</td>
<td></td>
<td>0.9%</td>
<td>4.6%</td>
</tr>
<tr>
<td>expedient knife</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>94.3%</td>
<td></td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>formal knife</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>formal scraper</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88.2%</td>
<td></td>
<td></td>
<td>11.8%</td>
</tr>
<tr>
<td>Projectile Points</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>97.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misc. Biface</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>79.3%</td>
<td>3.4%</td>
<td></td>
<td>13.8%</td>
</tr>
<tr>
<td>Drills/boring</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90.9%</td>
<td>9.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piercers</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-esq wedge</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>81.8%</td>
<td></td>
<td></td>
<td>9.1%</td>
</tr>
<tr>
<td>ores</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57.1%</td>
<td>7.1%</td>
<td>14.3%</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

Table 5.7 Distribution of tool types by raw material, plus proportional distributions.
<table>
<thead>
<tr>
<th>Tool Category</th>
<th>BR3</th>
<th>dacite</th>
<th>pisolite</th>
<th>basalt</th>
<th>chert</th>
<th>chalcedony</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>utilized flake</td>
<td>59</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>expedient scraper</td>
<td>95</td>
<td>.</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>expedient knife</td>
<td>99</td>
<td>.</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>formal knife</td>
<td>17</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>formal scraper</td>
<td>15</td>
<td>.</td>
<td>.</td>
<td>2</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Projectile Points</td>
<td>36</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Misc. Biface</td>
<td>23</td>
<td>1</td>
<td>.</td>
<td>4</td>
<td>.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Drills/boring</td>
<td>10</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Piercers</td>
<td>15</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>P-esq/wedge</td>
<td>9</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>cores</td>
<td>8</td>
<td>.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>387</td>
<td>4</td>
<td>5</td>
<td>17</td>
<td>11</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 Raw counts of BR3 tool types by raw material.
It is possible that Mid-Fraser foragers preferred to produce formal tools from non-dacites rather than expedient tools, but there is no evidence to suggest that it was selected over dacite. This could be an issue related to size, quality, or abundance of the nodules available. As figure 5.4 clearly shows, the use of lithic materials at the Bridge River site during BR3 clearly follows the pattern we should expect for expedient block core technologies: low proportions of formal expedient tools. In fact, despite extreme differences in frequency there seems to be little difference in how lithic materials are used at a general scale of analysis.

![Proportional Distribution of BR3 Formal and Expedient Tools](image)

**Figure 5.4**

Analysis of debitage from the BR3 assemblage shows that in terms of size grades all of the lithic materials except basalt followed a similar trajectory, with decreasing proportions from extra-small, small, to medium sized flakes (figure 5.5). This supports the idea that these materials, despite extreme differences in frequency, may have been used under similar conditions, including the production and maintenance of tools. The similar distribution of sizes shows that materials had a regular distribution of flakes that
are consistent with those activities (Cotterell and Kamminga 1987). However, any analyses after this become rather unreliable since the sample size for non-dacites are significantly lower than dacite materials.

![BR3 Debitage Size Distribution](image)

Although there was a proportional increase of non-dacites between BR2 and BR3 their use at the Bridge River village did not appear to have intensified dramatically as relatively few non-dacite tools were recovered. Again it seems that dacite was more than suitable, and potentially preferred, to make tools for both on and off-site activities. These results again call into question the conventional wisdom that Mid-Fraser non-dacite materials like cherts and chalcedonies were more suitable for the manufacture of formal tools. Although, chert and chert-like materials have physical properties that make them more ideal in general it is possible that issues of density on the landscape may have prevented them from being easily incorporated into the Bridge River Village lithic universe. And because of the low frequencies and low tool diversity for non-dacites, they
do not seem to have been intended to outfit the housepit for a specific tool type or satisfy some range of activities.
Diet Breadth Models and the Selection of Raw Materials

Lithic Selection as a Result of Foraging Efficiency

As was established earlier, the transport and use of dacite at the Bridge River village seems to have been of primary importance to winter housepit villages. Although the physical properties of cherts, chalcedonies, and pisolites may have made them highly desirable, they were not pursued as heavily as dacite. This fact raises important questions about why such a discrepancy exists in the frequency that different materials were transported to the Bridge River Village. Although I was able to demonstrate through GNA that the selection of lithic materials was not necessarily driven by a need for the highest-ranking resources in the region, it does not serve as an adequate explanation for why materials were so differentially transported. The diet breadth (or resource selection) models provide invaluable insight into resource selection and helps explain why dacite was used more heavily than higher ranked lithic materials.

As Winterhalder and Goland (1997) point out, diets are generally the reflection of the comparable abundance and density of different resources on the landscape. The selection of one resource for consumption or use then is not necessarily limited to notions of quality or ranking but more closely related to the economic gains or losses associated with each resource. Thus, the approximate rank of resources is not as important as their abundance on a landscape. It is possible to conceive of a situation in which some potential sources of toolstone dotting a landscape are associated with higher economic returns than others.
Figure 5.6 identifies a variety of locations on the landscape around the Bridge River village and throughout the Mid-Fraser where outcrops of lithic resources have been identified. However, identifying what may or may not constitute a local lithic material is hard to determine for one reason. Since we do not know where people went in their off-winter months to forage, the idea of resources being local and non-local may not be that accurate as people were likely traveling across the landscape. However, as Prentiss et al (2009) identified pisolite, which is 8 km from the Bridge River village, as a non-local material, I will follow her lead and define all materials outside of that boundary as being non-local in origin. Many of the sites that Crossland and McKetta (2007) surveyed, except the Arbor (<1 k.m.), like the Camoo rock pit, Applesprings, and the confluence of the Yalakom and Bridge Rivers are all farther than 15 km from the Bridge River site making any of the materials present at those sites non-local in origin. At these sites, chert seems to have been more readily available, while other materials like dacite and chalcedonies occur at lower frequencies. Although the descriptions for these sources are spare, they do suggest that chert was relatively abundant at most of these sites and that dacite and chalcedony were present at lower quantities.
Another way of determining the selection of prey is to compare the likely
A similar situation emerges in Rousseau’s (2000) descriptions of lithic sources.
Many of the sites surveyed like the Rusty Creek chert source and Moran and Blue Ridge
chalcedony and chert deposits were relatively small with varying densities of extremely
small to medium sized nodules of mixed quality. The quality and density of other
deposits like the Glen Fraser chert deposits and the Fountain pisolite source are hard to
gauge since the former has been hard to locate (Kendall pers com 2010) and the presence
of the latter has been only hesitantly verified by Rousseau (2000) and may be
complicated by the potential for another pisolite source in the Pavilion Mountains
(Vanags 2000: 16). Other locations identified for lithic sources have been the Pavilion
Mountain and Cornwall chert outcrops (Vanags 2000: 16). Unfortunately determining

Figure 5.6  (1) Confluence of the Bridge and Yalakom/Yalakom River Moraine Chert
deposits; (2) Camoo chert, chalcedony, and dacite deposits (3) Applespring chert and dacite
deposits (4) Moran chalcedony outcrop; (5) Blue Ridge Chalcedony outcrop (6) Glen Fraser
silicate outcrop (7) Bridge River Arbor chert, chalcedony, and dacite deposits (8)Fountain
Ridge Pisolite deposit (9) Pavilion Mountain chert outcrops (10) Cornwall chert outcrop
(11) Maiden Creek dacite and silicate source 12) Medicine Creek dacite source 13) Cache
Creek Dacite source 14) Upper Hat Creek dacite and silicate source (http://atlas.nrcan.gc.ca)
source abundance, nodule size, or quality is impossible as these were only mentioned in passing.

Of all the reported Mid-Fraser lithic outcrops or deposits, the ones with the highest abundance and density of materials are the Cache Creek, Medicine Creek, and Maiden Creek drainages. According to several sources (Bakewell 2000; Greenough et al 2004; Mallory-Greenough et al 2002; Rousseau 2000) these areas not only tend to have large and densely packed outcrops of glacially-deposited lithic materials—primarily dacite—but are also some of the few places where there is clear evidence for both prehistoric use and confirmation by elders that at least one of these drainages (Maiden Creek) were utilized prehistorically (Rousseau 2000: 177). Although there are deposits of cherts, chalcedonies, opal, and silicified wood in this area they are generally located in close association with dacites, and in general their distribution within lithic source areas seem to be sparsely distributed and these non-dacite materials exhibit fair to poor flaking qualities (Rousseau 2000: 172-180).

Rousseau (2000:177) reports at the bottom of the Maiden Creek valley “a large and fairly abundant source of flakable [dacite] material was found which encompasses an estimated 20 square km.” He estimated that nearly 95% of the lithic material in this region was dacite with about 5% of poor quality cherts. In addition, in the uplands area above the valley bottom there were glacial drift and till deposits that were smeared across the source area (Rousseau 2000: 178). He calculated that about 50% of the material was dacite, 30% chalcedony or chert, and about 10% for opal and petrified wood. He notes that most of the cherts and chalcedonies were randomly distributed in clusters while dacite seem to have been scattered across the entire region (ibid.). The majority of dacite
materials were fine grained or better, while most of the chalcedonies and cherts were judged to be fair to poor. Greenough et al. (2004) also report extremely abundant concentrations of dacite in the Cache Creek region with one area being approximately 4 km² and 2 meters deep.

Figure 5.13 offers a glimpse into the ranges of lithic availability in the Mid-Fraser. On one hand, there are few areas (except Cache Creek and Maiden Creek) that almost exclusively consist of a single material. As non-dacite and dacite materials seem to co-occur at many areas it seems that if materials were coming from those locations there would be a good chance that they would be transported more evenly. In fact, we should imagine that when materials occur together there is a fair chance that a forager would be indifferent to which one he or she found. What we do know about many of the areas with non-dacite materials is that they were generally low density with fair to poor quality. These factors could have made it very expensive for foragers to find adequate materials for winter stockpiling a housepit. Dacite deposits from locations like Cache Creek and Maiden Creek are relatively uniform in their distribution of materials. Areas such as these would provide excellent economic benefits, primarily in the amount of time and energy conserved by targeting such locations that have such high densities of material. Indeed, the low handling costs and near uniform quality of resource areas like these would make excellent economic sense. And in light of the assemblages at Bridge River Village, we should suspect that Mid-Fraser foragers targeted these points on the landscape, or others close to them, to maximize their investment. In fact, we should imagine that Mid-Fraser foragers were targeting lithic source locations like these given the appearance of the assemblages, which are almost entirely composed of dacite. Such
areas would be selected given the fact that they, unlike animals and plants, have predictable source locations, with predictable returns, and predictable quality. It seems that other areas might have been ignored for either their low or unpredictable quality or high handling costs.

There are some interesting ramifications behind a lithic transport strategy that entails the mass harvest of lithic resources. One of them is that in the Mid-Fraser the ubiquitous evidence for the universal selection and use of dacite in housepits may suggest that communities were fairly well integrated. And that, similar to the ethnographic pattern, the foraging and hunting of neighbors and outsiders on lands close to villages was tolerated since many communities were not self-sufficient, and ultimately had to rely on their neighbors for spatially heterogenous resources (Ackerman 1994; Teit 1900: 294). At a theoretical and intuitive level, we should imagine that in regions where hunter-gatherer communities were not self-reliant aggressive economic and political territorialism of the landscape and its resources would lead to regional isolation for trade and marriage partners. Because the exploitation of dacite has such extreme time depth in the Mid-Fraser—spanning nearly 3,000 years (Sanger 1970)—and co-occurs in areas with glacially deposited cherts and chert-like materials, the direct use of non-dacites for evidence of foraging territories are unreliable be to infer the past extension of foraging ranges, since lithic resources can be acquired in a number of different ways, including direct or indirect procurement tactics and may have to be revisited (Borrero et al. 2009; Meltzer, 1989; Ingbar, 1994).
CHAPTER 6: DISCUSSION AND CONCLUSIONS

Analysis of the Bridge River assemblage demonstrates conclusively that not only was dacite the most preferred raw material in general, but it also used for the entire range of tool types for both BR2 and BR3 time periods. Non-dacite tools occur at low frequencies, and except for cherts during BR3, have exceptionally low tool diversity focused primarily on the production of expedient tools. Because the same technological processes seem to be affecting each resource similarly, i.e., the predominance of an expedient block core technology, there are no obvious reasons why a relatively low ranking resource like dacite would be used more often than higher-ranking resources. Although outcrops of cherts and chalcedony potentially exist more frequently than dacite ones, their actual abundance on the landscape is much lower. As the diet breadth model predicts, the basis of resource selection is not determined by rank but the comparative abundance between high and low ranked resources: if it is too expensive to acquire adequate amounts of higher ranked resources, lower ranked resources will be added to a diet. In this case, the lithic diet of the Bridge River village consists almost entirely of dacite, suggesting that at least for the purposes of outfitting winter villages, non-dacite resources were not substantially targeted.

Limitations of the Research

As with any research project, there will always be some limitations to what can be said as matter of the data collected. In no particular order of importance, I outline a few of the most limiting factors affecting my research. Outsiders may think the excavation strategy may have taken an unnecessarily restrictive view of housepit contexts as we
primarily targeted specific cultural contexts (hearths, cooking areas, and cache pits).
However, as many of these areas excavated came from different sectors of each housepit
they provide a rather exhaustive examination of a sector of housepits that, with the cache
pits that contained debitage and tools produced from many different events, likely
provide a rather democratic view of household activities. A second limitation to my
results is that by mixing primary, secondary, and tertiary contexts, as I’ve done here, I
have obscured or avoided a more fine-grained approach and implicitly assume a
normative behavior for lithic transport strategies across the village. This is indeed
unfortunate as it would be important, in the future, to take a closer look at individual
occupation layers within housepits potentially to determine whether non-dacite and dacite
transport strategies throughout time or between housepits. Additionally, a number of
scraper indices (like the Kuhn index (1992)) could provide a way to measure how
intensively tools of different material types were used.

However, as it seems that my biggest error was not developing explicit questions
for lithic analyses post-excavation in order to more thoroughly explore rather than reduce
variability in the artifact assemblage, the default here has been to describe the central
tendencies for the assemblage which provides a baseline that will allow us to understand
what constitutes variability and what the significance of such variability might be.
Although this essentially strips away the potential variability in how lithics entered and
left the site, I still feel that my approach to use the diet breadth model—especially with
the Bridge River assemblage that was practically homogenous for several hundred
years—was an effective strategy to answer the question why dacite was so preferentially
transported. And while there are plenty of examples to the contrary, human behaviors
seen in aggregate over a long enough time span tend to track, albeit sometimes haphazardly and maybe unconsciously, the most beneficial strategies (Rindos 1984; Ugan et al. 2002; Winterhalder and Goland 1997).

**Discussion of the Results**

GNA was used to (a) compare how lithic materials were used at the site to determine if differences existed in how people utilized lithic materials and (b) establish how accurate my proxy measure of ranking for lithic materials was based on physical differences. GNA results demonstrated that during both BR2 and BR3 people utilized dacite not only to produce tools for the dominant on-site technology (expedient tool production) but also for off-site tools (bifaces, projectile points, formal knives). For both time periods the use of non-dacites could be understood as occurring with irregular frequency and did not express the same range of tool diversity as dacite. However, as there was no clear preferred use for non-dacites, e.g., the production of formal tools, it seems that there was not a clear pattern of transport for these at the Bridge River village. This is not to say that they did not satisfy the needs of Mid-Fraser knappers, rather it seems that there was no clear pursuit of these materials and that they were used in approximately the same fashion as dacite materials in winter lithic technologies, implying a general use strategy for lithic materials prevailed throughout the village. Finding sites located away from the village, like hunting camps, could provide a more fine-grained view of off-site lithic use. In a study of such sites located on the east side of the river, Vanags (2000) has shown that dacite continued to be used almost to the exclusion of non-dacites. While this may be explained by closer proximity to the large dacite deposits as
Cache Creek and Maiden Creek, it would be important to understand a wider range of lithic-use patterns.

My results show that dacite was both the most highly transported lithic material (at ~90% of each assemblage) for both BR2 and BR3 and its use clearly mirrors descriptions of winter housepits at the Bridge River village with significantly higher proportions of expedient to formal tools and a very wide range of tool types. Conversely, in aggregate non-dacite materials like cherts and chalcedonies occurred at very low proportions (~10% of the total lithic assemblage) and do not show the same degree of tool diversity. Even the non-dacite material that occurred at the highest proportions during BR3, chert, actually showed a material signature that was the opposite of what we would expect with higher proportions of formal to expedient tools. Other non-dacites like basalt, chalcedony, and pisolite also failed to attain the same degree of diversity and were likely not transported to the village as part of a winter stockpiling strategy—potentially due to the costs related to mass harvesting these resources. Although these materials may have entered the village at the same time as dacite or independently during return trips to cache supplies, there is no evidence for people to have targeted these materials for any particular function.

Working from the assumptions of previous research (Hayden et al. 2000; Prentiss 2000: 215) that suggests lithic materials were stockpiled for winter use, the diet breadth model allowed me to treat lithic materials similar to other targeted resources (like salmon and roots) that occur in high densities and require, relatively speaking, lower overall investments of time and energy than would be spent pursuing other resources. Thus, the selection of lithic materials was likely based on notions of foraging efficiency rather than
abstract notions of social or political cachet of individual housepits or striving to have the highest quality materials possible. Assuming Mid-Fraser foragers sought to minimize how much energy and time spent on stockpiling winter resources, the structuring logic of my argument is that they would pursue those lithic materials with the highest associated post-foraging returns (or in this case, conservation) for the amount of time and energy invested (Winterhalder and Goland 1997).

The diet breadth model in conjunction with my analysis provides an adequate explanation for why dacite was preferentially transported. It has never been too problematic to suggest that one of the reasons why Mid-Fraser foragers tended to stockpile resources like salmon or roots was because they offered the opportunity to quickly harvest enough food for a winter in a short period of time. Although I am reading theory into this behavior, one of the explanations for this was that it reduced the costs associated with pursuing other resources. I used the example of the hunter going after the deer instead of the mouse earlier, but here the underlying lesson is made more clear. Salmon runs and root crops were (more or less) predictable resources with search (locating prey) and handling (capturing prey) costs that were very low and, most importantly, had predictable returns associated with them each year. And while processing costs were very high, the benefits related to a two week investment in drying salmon would more than offset the costs of pursuing other prey. Likewise, as Minichillo (2006: 362) points out, the costs associated with lithic resources are quite similar to those resources in that they (1) have static locations; (2) have known returns due to gradual depletion; (3) have physical characteristics that can be measured and compared against other resources.
And while some (Hayden et al. 2000) have speculated that non-dacite materials were likely ideal materials to be used for formal tools due to their superior durability and ability to hold an edge, the very high frequency and diversity of dacite use for formal tools makes that assumption seem baseless—at least in regards to Mid-Fraser assemblages. In fact, dacite’s ubiquitous role in both the production of formal and expedient tool types makes it clear that it was a quintessentially perfect material for indigenous knappers in the Mid-Fraser (Andrefsky 1994). We have to assume that if cherts and chalcedonies have superior mechanical qualities we should expect to see more evidence for attempts to acquire non-dacite toolstones. Based on reports by Rousseau (2000: 172-180) and Hayden et al. (2000) there is the potential that many locally occurring non-dacite materials had, in general, lower flaking qualities than dacites. Because of the relative neglect of non-dacites at the Bridge River Village, despite the presence of multiple places on located in close proximity, it is possible that material quality could have been a serious factor in deciding which materials to use. Those few specimens brought to the village could have represented the rare suitable nodule.

Andrefsky’s (1994) analysis shows that when in close association with high quality materials there is a tendency for foragers, regardless of whether a site is meant for short or long-term occupation, to use high quality local toolstone (if available) for both formal and expedient tools. I believe that conclusions like these have lead archaeologists in the Mid-Fraser to simply believe that dacite is ubiquitous across the landscape. It should be noted that although dacite can be found in glacial deposits in many places throughout the Mid-Fraser, the same can be said for non-dacites. A serious problem here is that there have been few systematic surveys of the lithic landscape. Information
available to researchers today suggest that there were likely ample opportunities for pre-
contact foragers to utilize non-dacites more consistently even if they had higher costs 
associated with them.

While I believe that Mid-Fraser foragers targeted dacite specifically because it 
could be mass harvested from several points on the landscape, the reasons behind it are 
more complex and theoretical. For one, as Minichillo (2006) points out, the search and 
processing costs for lithic materials are very low, making the difference in the availability 
of resources within deposits—the handling costs—the most important criteria for 
selection. Winterhalder and Goland (1997) support this view in their analysis of the 
emergence of agriculture that in the absence of search and processing costs, handling 
costs become the most important factor for selecting resources. An example of this would 
be that in one of two hypothetical fields was densely packed with edible grasses and the 
another only sparsely so. The search costs for finding the resource are evenly distributed, 
as are processing costs, however, the handling costs (to get the same return) would be 
higher for the second field. In the Mid-Fraser, it is possible that despite the travel distance 
to dacite deposits, the higher concentrations of nodules with more uniform quality would 
require less time and energy to harvest an adequate amount of material, especially if 
foragers practiced a mass harvesting strategy. Such targeted acquisition could c until 
some reason compelled some people from a housepit to be close to the Maiden Creek, 
Cache Creek, Hat Creek Valley regions. This strategy seems to be the most parsimonious 
as there were a variety of similar examples of resources that were mass harvested—at 
different times of the year—in those same areas including root harvesting and salmon 
Kuhn (2004b) provides an elegant extension of this reasoning that is in line with the expectations of the diet breadth model when he compares the expenses related to outfitting individuals whose need for material is substantially lower than for outfitting a village that require a more substantial investment in time and energy, especially to collect enough to last an entire winter. As outfitting an individual requires substantially less investment in time and energy, and can be done as Binford (1979) suggests, with minimal investment of time, targeting more inefficient deposits may not be a bad investment. However, using that same outcrop to outfit a village would require a higher investment of time and energy. Likewise, inefficient areas would likely be depleted over time making their utilization in the future more uneconomical.

The behaviors for Mid-Fraser foragers could be understood partially in relation to Binford’s (1979) notion of embedded procurement, where the acquisition, “of raw materials is embedded in basic subsistence schedules. [And] very rarely, and then only when things have gone wrong, does one go out into the environment for the express and exclusive purpose of obtaining raw material for tools” (Binford 1979: 259). But as it seems that Mid-Fraser foragers were very selective as to what resources they sought out, we can imagine two potential scenarios through which the transport lithic materials could have been done. One would be to delay the mass harvest of lithic materials to coincide either with their movements across the landscape that put them closer to source locations or as the acquisition of lithics seems to be crucial to winter housepits, Mid-Fraser foragers could have made procured lithic materials directly from the source. Although, this latter view is not popular, given the primary stress archaeologists put on food
harvesting, lithic materials were available almost year round, and a few people from each housepit could conceivably collect and transport enough material to last a winter.

Either way, the strategy to stockpile lithic resources essentially turns housepits into proxy quarry sites that could potentially be used not just as a resource base over the winter but also in the ensuing non-winter months. The evidence for this is the relatively restricted presence of non-dacites in the assemblages, which due to their close proximity to the village should be expected to have contributed more to the lithic technology, especially when, if there is resource stress after winter, people would likely target local resources—many of which are non-dacite. However, the transport of large enough quantities of dacite could have a dampening effect on how much foraging would actually be necessary in the first weeks of spring. Thus, the mass harvest of dacite could have short-term benefits, conservation of time and energy on the initial phase of lithic transport and then provide secondary benefits by negating the need to forage for other lithic material later in the year. By investing time and energy into a concerted effort to outfit housepits, indigenous knappers could have a high quality toolstone available almost year round.
CHAPTER 7: CONCLUSIONS

Although, this analysis is far from conclusive on what variables effectively constrained the selection of lithic materials primarily to dacite throughout the Mid-Fraser, I believe that it does open new avenues for research. As we saw above, there was little variation in the amounts of dacite and non-dacite transported to the Bridge River village between BR2 and BR3. The one consistent pattern for both periods is that dacite dominated each assemblage, all of the tool categories, and comprised the vast majority for both expedient and formal tools. Although the proportional frequency of non-dacite materials increased from BR2 and BR3 their total contribution to the assemblage was little more than 10%. There was no evidence for any specialized use of lithic materials, and no clear preference for non-dacites in the production or use of expedient and formal tools. Likewise, it appears that our theoretical understanding for what constitutes a desirable lithic material may need to be changed to focus on explicit instances of use rather than ideal notions of lithic quality.

I believe that the diet breadth model can be effectively used to understand the selection of lithic resources as the costs associated with lithics are similar to those of other resources. In this case, I was able to show that the selection of dacite was based on greater foraging efficiency due to its ability to be mass harvested for the stockpiling of winter housepits. As other lithic resources in the Mid-Fraser were likely more expensive to collect in large quantities, foragers would have preferred to target deposits that, analogous to salmon runs, would allow them to not only collect a lot of material but also to target one that had more or less uniform quality. As dacite was used for both expedient
and formal tools, nearly to the exclusion of other lithic materials, it is safe to presume that
dacite deposits in the Mid-Fraser allowed for both to occur.

Future research should include instituting an aggressive survey program with
local First Nation bands to generate more information about the lithic landscape on the
west side of the Fraser River. Although Crossland and McKetta’s (2007) report was a
good first step more needs to be done. In addition to this, I would suggest working with
geologists like those from UBC-Okanagon who have shown that dacite can be accurately
sourced to specific deposits on the landscape (Greenough et al 2004; Mallory Greenough
et al 2002). Heather Kendall from Simon Fraser University has just finished an extensive
sourcing program of Mid-Fraser lithics and preliminary results have shown that there are
no bedrock sources for these materials that could be used to reliably link these materials
to discrete positions on the landscape. What Kendall’s findings and Rousseau’s (2000)
repeated warnings demonstrate is that the use of visual characteristics to link lithic
resources with points on the landscape is not reliable. This suggests that previous uses
of non-dacites as evidence for either prestige as a result of access to ‘controlled’ deposits
need to abandoned or sufficiently tested to bring them in align with improved
understandings of local geology.
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Nelson, M. C.  

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Yonekura, Kaoru, Hiroyuki Hasegawa, and Tetsuya Susuki  
## Appendix A

### Expedient Tools

#### Utilized Flakes

<table>
<thead>
<tr>
<th>Tool Code</th>
<th>Tool Name</th>
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<tbody>
<tr>
<td>71</td>
<td>Used Flake on a break</td>
</tr>
<tr>
<td>72</td>
<td>Used Flake on a thin edge</td>
</tr>
<tr>
<td>73</td>
<td>Used Flake on a strong edge</td>
</tr>
<tr>
<td>180</td>
<td>Used Flake</td>
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#### Expedient Scraper

<table>
<thead>
<tr>
<th>Tool Code</th>
<th>Tool Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Small notch</td>
</tr>
<tr>
<td>141</td>
<td>Scraper like biface</td>
</tr>
<tr>
<td>150</td>
<td>Single scraper</td>
</tr>
<tr>
<td>154</td>
<td>Notch</td>
</tr>
<tr>
<td>156</td>
<td>Alternate Scraper</td>
</tr>
<tr>
<td>160</td>
<td>Unifacial denticulate</td>
</tr>
<tr>
<td>163</td>
<td>Inverse scraper</td>
</tr>
<tr>
<td>164</td>
<td>Double scraper</td>
</tr>
<tr>
<td>165</td>
<td>Convergent scraper</td>
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#### Piercer/perforators/wedges

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<tbody>
<tr>
<td>145</td>
<td>Piece esquillees</td>
</tr>
<tr>
<td>151</td>
<td>Unifacial perforator</td>
</tr>
<tr>
<td>152</td>
<td>Unifacial borer</td>
</tr>
<tr>
<td>153</td>
<td>Small piercer</td>
</tr>
<tr>
<td>224</td>
<td>Burin</td>
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#### Expedient Knife

<table>
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<tr>
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<th>Tool Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Expedient knife</td>
</tr>
<tr>
<td>74</td>
<td>lightly retouched exp. knife</td>
</tr>
<tr>
<td>140</td>
<td>Knife-like biface</td>
</tr>
<tr>
<td>144</td>
<td>Convergent knife-like biface</td>
</tr>
<tr>
<td>159</td>
<td>Unifacial knife</td>
</tr>
<tr>
<td>170</td>
<td>Expedient knife w/retouch</td>
</tr>
</tbody>
</table>
### Formal Tools

#### Drills/boring tools

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<tr>
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<th>Tool Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>132</td>
<td>Bifacial perforator</td>
</tr>
<tr>
<td>133</td>
<td>Bifacial drill</td>
</tr>
</tbody>
</table>

#### Formal Scraper

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<tr>
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<th>Tool Name</th>
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</thead>
<tbody>
<tr>
<td>158</td>
<td>Key-shaped scraper</td>
</tr>
<tr>
<td>161</td>
<td>Thumbnail scraper</td>
</tr>
<tr>
<td>162</td>
<td>End scraper</td>
</tr>
<tr>
<td>232</td>
<td>Stemmed scraper</td>
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#### Formal Knife

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<tr>
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</thead>
<tbody>
<tr>
<td>130</td>
<td>Bifacial knife</td>
</tr>
<tr>
<td>225</td>
<td>&quot;Tang&quot; knife</td>
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### Misc. Bifaces

<table>
<thead>
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<th>Tool Name</th>
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<tbody>
<tr>
<td>2</td>
<td>misc. Biface</td>
</tr>
<tr>
<td>131</td>
<td>Stage 4 biface</td>
</tr>
<tr>
<td>139</td>
<td>Fan-tailed biface</td>
</tr>
<tr>
<td>192</td>
<td>Stage 2 biface</td>
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<tr>
<td>193</td>
<td>Stage 3 biface</td>
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### Projectile Points

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</thead>
<tbody>
<tr>
<td>19</td>
<td>Late Plateau point</td>
</tr>
<tr>
<td>91</td>
<td>Small blank</td>
</tr>
<tr>
<td>99</td>
<td>Misc. Point</td>
</tr>
<tr>
<td>109</td>
<td>Side-notch point no base</td>
</tr>
<tr>
<td>110</td>
<td>Kamloops side-notch concave base</td>
</tr>
<tr>
<td>114</td>
<td>Kamloops Stemmed</td>
</tr>
<tr>
<td>134</td>
<td>Preform</td>
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<tr>
<td>191</td>
<td>Blank</td>
</tr>
</tbody>
</table>
## Cores

<table>
<thead>
<tr>
<th>Tool Code</th>
<th>Tool Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>186</td>
<td>Multi-Directional core</td>
</tr>
<tr>
<td>187</td>
<td>Small flake core</td>
</tr>
<tr>
<td>189</td>
<td>Unidirectional core</td>
</tr>
</tbody>
</table>