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Design theory analysis of biface technology
at the Botanie Lake Dam site (EcRj 15), south-central British Columbia

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A design analysis is applied to six bifacial tools recovered from the Botanie Lake Dam site (EcRj 15) on the Plateau of southern British Columbia. While these artifacts, selected from the lithic assemblage of this late pre-contact period mat lodge campsite, show some internal variation, they share important characteristics indicative of their use by Plateau peoples. Acute edge angles and less durable raw material suggests that these bifacial tools were used to cut relatively soft contact materials such as herbaceous plants. Their lengthy use lives and multifunctionality make them effective solutions for the requirements of plant and animal processing during a mobile seasonal round. This application of design theory to a small sample of lithic artifacts from a seasonal camp site with an hypothesized focus on root resource harvesting and processing adds to the growing number of studies employing this approach to lithic analysis.

Introduction

The function of thin biface tools within prehistoric Plateau cultural adaptations has received surprisingly little attention from archaeologists (Hayden et al. 2000; Prentiss and Kuijt 2004; Rousseau 2004a). It has generally been assumed that these tools were used for a variety of butchering and cutting tasks, but these assumptions have never been tested (Chatters 1984:51-66; Magne 1985:232; Pokotylo and Mitchell 1998:97-98). There are a number of methods by which such testing can be undertaken, including microwear, experimental replication and use, residue, and design theory analyses (Andrefsky 1998; Grace 1996; Kealhofer et al. 1999; Shea 1992; Stemp and Stemp 2001; Vaughan 1985; Yerkes and Kardulias 1993). This study attempts to apply design theory to the analysis of several thin biface tools recovered from a late prehistoric context on the Interior Plateau of British Columbia. Design theory is an approach to the analysis of material culture which seeks to apprehend the nature of tool use through a consideration of the physical properties of artifacts and their implications for past societies. Central to this analytical method is a detailed assessment of the decision making process from the selection of raw materials to the final modification of an artifact. The specific goals of the current study are to determine the function of these selected bifaces within the lithic technological system of this Plateau culture and to attempt a limited reconstruction of the nature of the problem or circumstances they were designed to address. Through a design analysis of these artifacts it is possible to arrive at a more comprehensive understanding of part of the function of thin bifaces within Plateau technology during the Late Prehistoric Period.

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This type of consideration of lithic tool forms and materials has been applied with some success at the Keatley Creek site (EeRl 7; Hayden et al. 1996, 2000). The close proximity of Keatley Creek to EcRj 15 suggests a similar analysis may prove equally informative.

Background to the analysis

Site EcRj 15 (Botanie Lake Dam) is located approximately seventeen kilometers north of Lytton, British Columbia, on the Interior Plateau (Figure 1). The site encompasses the area immediately south of Botanie Lake on both sides of Botanie Creek. It is a medium-size (ca. 150 m north-south by 100 m east-west) Pre-Contact and Contact Period cultural depression, lithic scatter, and historic refuse site. The site was subdivided into five specific "management areas" for the purpose of mitigative data recovery and analysis (Rousseau 1998). Cultural materials were absent from Areas 2 and 4, but present in Areas 1, 3, and 5. Excavations were undertaken in 1998 to sample all three management areas containing artifacts and cultural features prior to dam construction (Antiquus 1999).

Culture historical context

The only regional culture historical synthesis developed for the Fraser Plateau (also known as the Northern or Canadian Plateau) based upon thorough comparative analysis is that of Richards and Rousseau (1987; Rousseau 2004b; Stryd and Rousseau 1996) for the Late Prehistoric Period. On the basis of habitations, economic adaptations, and lithic assemblages, they defined the Plateau Pithouse Tradition (PPT), spanning the last 4500 years BP. During the PPT, lifeways were considered to be generally similar to those described for the ethnographic Interior Salish of the Canadian Plateau (Richards and Rousseau 1987:49; Rousseau 2004b:13; Stryd and Rousseau 1996:198). The period is characterized by the use of semi-subterranean pithouse dwellings in semi-permanent winter villages, a hunter-gatherer lifeway with an emphasis on salmon fishing and food storage in underground pits, and a logistically organized, seasonally regulated subsistence-settlement pattern. The relative importance of fishing, hunting and gathering varied through time and across space, although the diet throughout was primarily composed of anadromous salmon, supplemented by deer, elk, a variety of small mammals, non-anadromous fish, fresh water mussels, birds and an assortment of roots and berries (for more on common cultural patterns of the PPT, see

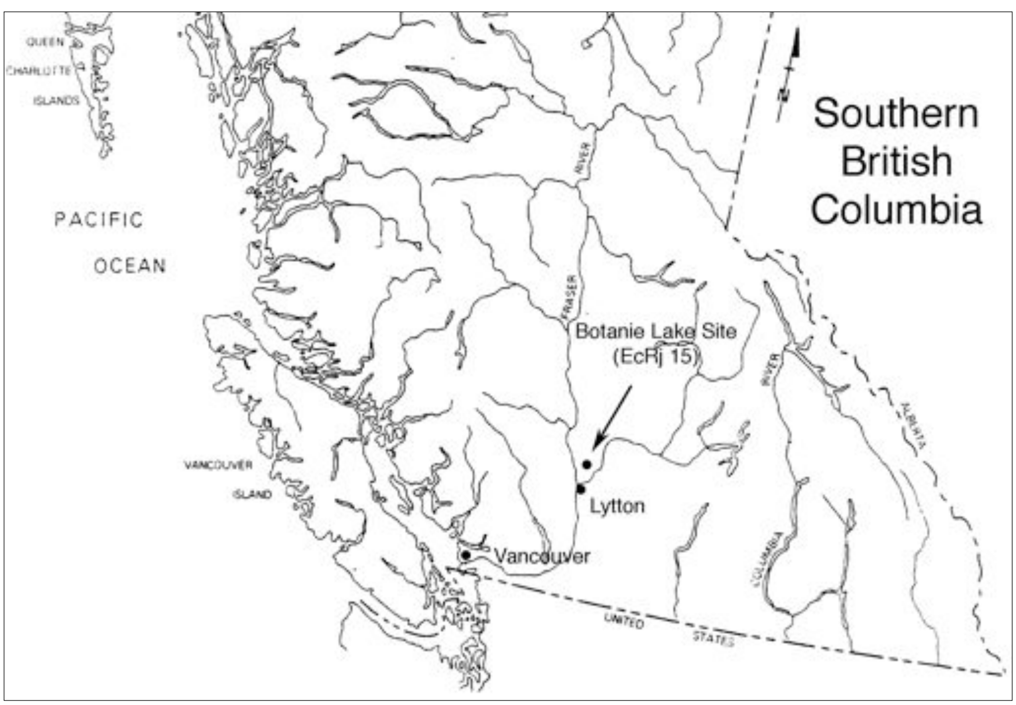

Figure 1. Location of the Botanie Lake Dam site (EcRj 15) on the Plateau of southern British Columbia, Canada.

Figure 2. General post excavation view of Area 5, looking northwest and down from part way up a large fir tree. Excavation units 20 and 23, southernmost in Area 5, are not in the frame. Reproduced courtesy of Antiquus Archaeological Consultants Ltd., photo by Simon Kaltenrieder.

Richards and Rousseau 1987:50-51; Rousseau 2004b:13).

Comparison between temporal and spatial distributions of specific technological traits present among components, rather than regional or local phases, were used to define three pan-regional cultural horizons: the Shuswap (3500 - 2400 BP), Plateau (2400 - 1200 BP) and Kamloops (1200 - 200 BP) horizons (Richards and Rousseau 1987; Rousseau 2004b). During the Shuswap horizon, subsistence appears to have focused on hunting large and small land mammals and birds, collecting fresh water mussels, and fishing for salmon, trout, and other fresh water species. No evidence for harvesting of plant resources is available, although it is hypothesized to have taken place. It is also suggested, on the basis of a lack of identified Shuswap horizon components in mid-altitude or upland areas, that subsistence-settlement systems may have focused primarily upon valley bottom contexts. The most significant change in subsistence patterns observed for the ensuing Plateau horizon was the commencement of intensive exploitation of mid-altitude root resources. For the Kamloops horizon, evidence indicates a sophisticated fishing technology, a continued dependence on wild root resources, and an almost complete reliance on the bow and arrow for hunting (of primarily deer).

With regard to social organization on the Fraser Plateau, Hayden and Schulting (1997) and Pokotylo and Mitchell (1998) present several lines of evidence indicating the development of stratified hunter-gatherer societies in parts of this region during the Plateau horizon. Burial and housepit data suggest the existence of residential corporate groups as well as potential variability in socioeconomic status both among and within households (Hayden 2000). By two thousand years ago on the Fraser Plateau there was a degree of social inequality that differs significantly from the traditional model of hunter-gatherer egalitarian social organization. A thousand years earlier most of the characteristics commonly attributed to ethnographic Plateau cultures are present archaeologically. However, during the Plateau horizon many of these traits are visible in excess of the scale and dimensions reported for the region ethnographically (Rousseau 2004b:19-21).

EcRj 15 excavation results summary

Management Area 5 included the cultural surface features identified at the site (sizable depressions that were observed in the ground surface) and was the focus of the majority of excavation (Figure 2). Two four-by-one-half meter trenches were initially laid out, one

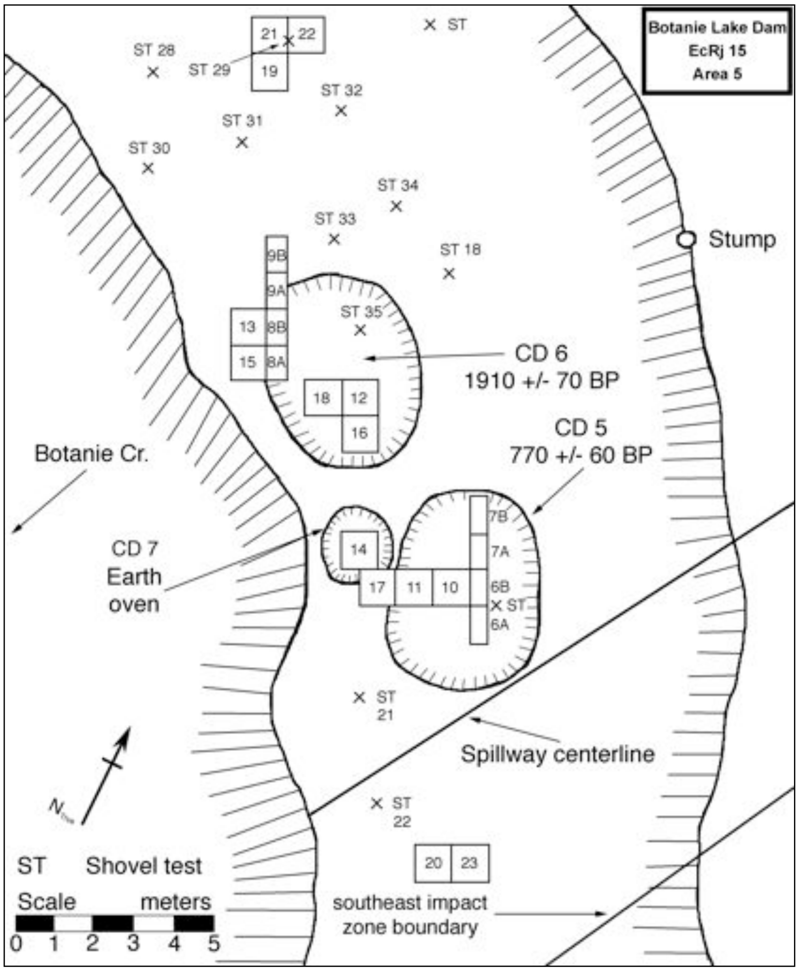

Figure 3. Map of Management Area 5 at the Botanie Lake Dam site. Two small, ovoid mat lodge depressions (CD 5 and 6) are shown. Each depression had a maximum diameter of approximately 5.5 meters. Both depressions were very shallow, with maximum depths of 25 or 30 centimeters, and both had low, discontinuous, ephemeral rims. Two small roasting pit features were also identified. The first, situated just west of Cultural Depression 5, was visible on the ground surface (CD 7). The second, however, was not evident as a surface depression, and was encountered through excavation of the southernmost units of Area 5. ST indicates the location of a shovel test made during the initial impact assessment of the site, and the proposed dam spillway is also shown. This part of the site has been destroyed north of the southeast impact zone boundary as part of dam construction.

bisecting the interior of Cultural Depression 5, and the other excavated through the edge of Cultural Depression 6 (Figure 3). One-by-one meter excavation units were judgmentally placed adjacent to these small trenches and to the north and south of the visible cultural depressions. As is typical of the Plateau, cultural deposits at the site are shallow (Chatters 1984; Grabert 1974; Rousseau et al. 1991), and sterile glacial drift was generally encountered between 35 and 40 centimeters below ground surface (Figure 4). A total of approximately 18.0 cubic meters was removed during work in Area 5. Of this, 5.0 m3 were excavated from Cultural Depression 5, and 7.0 m3 were excavated from Cultural Depression 6. The remainder of the excavations in Area 5 occurred outside these cultural depressions, and involved the excavation of a further 6.0 m3.

A Plateau and Kamloops horizon inhabitation of Area 5 was suggested by the presence of thirteen projectile points diagnostic of those cultural horizons. This evidence is supported by two conventional radiocarbon dates.[1] The first, 770 ± 60 BP (Beta 124243), falls wholly within the Kamloops horizon (1200 - 200 BP) at the two sigma range. This date was obtained on a wood charcoal sample from a hearth in Unit 10, Cultural Depression 5. This hearth was shallowly buried, and fire-altered rock and charcoal were observable after the removal of the first two or three centimeters of sediments. Fire-altered rock, charcoal, and fire-reddened sediments were abundant, and formed an extensive hearth deposit more than 20 cm thick. The second date, 1910 ± 70 BP (Beta 124244), falls completely within the Plateau horizon (2400 - 1200 BP) at the two sigma range. This date was derived from a wood

[1] Radiocarbon dating was undertaken by Beta Analytic Inc. Dates are presented in uncalibrated radiocarbon years (Antiquus 1999:Appendix 8).

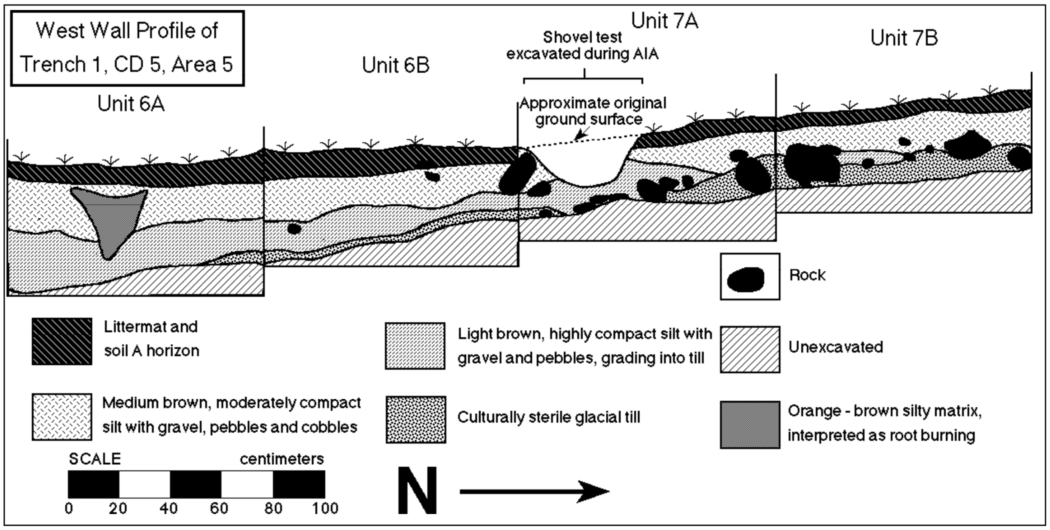

Figure 4. Profile drawing of the west wall of Trench 1 (4 metres long) in Cultural Depression 5, Management Area 5.

charcoal sample recovered from a hearth feature in Unit 18, Cultural Depression 6.

An assemblage of 153 artifacts was recovered from Area 5, consisting entirely of lithic tools with the exception of a single bone point fragment. Of the lithic artifacts 40.8% (n=62) are utilized flakes, and a further 20.3% (n=31) are retouched flakes. In decreasing order, projectile points, bifaces, scrapers, and sandstone abrader fragments are the next most common artifact types. Lithic debitage was abundant, with 41,239 pieces recovered from Area 5 alone.[2] What is striking is the relative scarcity of larger flakes, with approximately 77% of the debitage having a maximum dimension of one centimeter or less. Cortex is present on only 137 debitage flakes, or one third of one percent of all debitage from this part of the site. The majority of lithic artifacts from Area 5 are manufactured of dacite (84%), while chert (6%) and chalcedony (8%) are also represented in small but significant numbers. The use of cryptocrystalline silicates is restricted to a few drills, scrapers, utilized and retouched flakes, and two biface fragments. Obsidian (1%) and sandstone (1%) tools are also found in the artifact assemblage. The Area 5 debitage shows similar patterning in raw material use, with an assemblage composed of ninety-five percent dacite followed by 4.2% chert. Other raw material types account for less than 1% of the Area 5 debitage.

The features and artifacts recorded in Area 5 indicate that this was likely the location of a seasonal mat lodge campsite. Cultural Depressions 5 and 6 can be interpreted as the material remains of mat lodge structures. On the basis of ethnographic and ecological data, the occupation of Area 5 was most likely focused on the collection and processing of a variety of wild root crops. The Botanie Valley is well known as an unusually productive root gathering locale. Ethnographic descriptions suggest that the area was visited for root procurement by considerable numbers of people from throughout Thompson territory and beyond (Pokotylo and Froese 1983:151; Teit 1900:294). The two sandstone abrader fragments and two probable roasting pit features identified at the site provide material evidence for root processing activities. Even more compelling is the small artifact assemblage of predominately utilized and retouched flakes together with over 41,000 flakes of debitage, more than three quarters of which are one centimeter or less in maximum dimension. This evidence may be interpreted as representing the production, resharpening, and recycling of flake tools and could be associated with root resource procurement and processing (Antiquus 1999:79-80, 85). The few preserved faunal remains from the site (n=122) suggest that the occupants engaged in limited hunting or trapping, primarily directed at deer. The recovered faunal assemblage is very small, highly

[2] Lithic debitage is considered separately and is not included in artifact totals.

fragmented, and dominated by burned and calcined bone. This is likely the result of natural taphonomic attrition and the processing of bone for marrow and grease. Similar taphonomic processes have been shown to have modified faunal assemblages at other Plateau sites (e.g., Ewonus 1999). Taphonomic considerations notwithstanding, plant resources appear to be the most logical subsistence focus for groups inhabiting the site. While paleobotanical data are not available for EcRj 15, the nature of the plant and animal resources of the Botanie Valley together with traditional use of this area for large-scale root gathering suggests subsistence activities centered on these local plant species. A more detailed examination of a small sample of lithic tools may provide indirect evidence of the nature of subsistence tasks.

Study sample selection

In order to accumulate a sample of biface and biface fragments for analysis, the previously un-analyzed lithic artifacts from Management Area 5 at Botanie Lake Dam were inspected and six specimens that could be unequivocally classified as bifaces were removed. In this study bifaces are considered to include three types of formed tools: large thin bifaces, small thick bifaces and bifacial knives produced from large flake blanks (Hayden et al. 2000:195-196). However, no obvious projectile points, drills, or perforators were included in the study sample, as these very specialized tool types are clearly different from thin bifaces with regard to their function and deserve separate consideration. This study focuses on artifacts from a portion of the site, Management Area 5, in order to reduce sample size and better control for temporal and site formational factors. As previously described, Management Area 5 was the location of the most intensive excavation during the mitigation project. By limiting the study sample to this area, the effects of technological changes through time as well as variability in site function and post-depositional taphonomic processes are less than if all bifaces excavated from the entire site are included in the study sample. Based upon recovered artifact types and two radiocarbon dates from Area 5, this portion of the site is unlikely to pre-date 2400 BP, the inception of the Plateau horizon.

Study sample characteristics

Each biface or biface fragment (n=6) was assigned an artifact number on the basis of provenience (Figure 5). This number consists of the excavation unit and level from which the artifact originated, separated by a dash (Table 1). A single sample artifact was recovered from an Area 5 shovel test, made during the archaeological impact assessment (AIA) for the Botanie Lake Dam upgrading project, and was assigned the number for that test (ST27). This was done in order to distinguish between the sample bifaces prior to the cataloging of the collection of lithics from the site.[3] Two of the sample bifaces are from the same unit and level, 10-2a and 10-2b, and so are given an arbitrary letter postscript ("a" represents the larger of the two bifaces). The bifaces were weighed using an electric vernier balance and the maximum dimensions of length, width and thickness were measured using dial calipers. A subjective description of the completeness of each artifact, the raw material from which they were manufactured, and the existence of any cortex material was recorded. The curvature of the two faces of the artifacts was noted as either convex, concave or straight. On flake tools, these faces would commonly be referred to as ventral and dorsal. Each usable edge, separated by a non-working edge or break, was described for the extent of retouch visible (none, minimal, moderate, or extensive[4]) and the type of retouch made (unifacial or bifacial). Finally, the edge angle, measured using a contact goniometer, and the curvature (as observed in plan view;

[3] Subsequent to artifact cataloguing the provisional artifact numbers were retained, as they include descriptive information on the provenience of the sample bifaces. Table 1 gives the corresponding site catalogue numbers in addition to the provisional numbers adopted for this analysis. The catalogue numbers are EcRj 15:7, 28, 71, 72, 118, and 151.

[4] Minimal retouch is less than 5mm lengths of flake scars perpendicular to the tool edge, moderate is between 5mm and 10mm, and extensive is greater than 10mm.

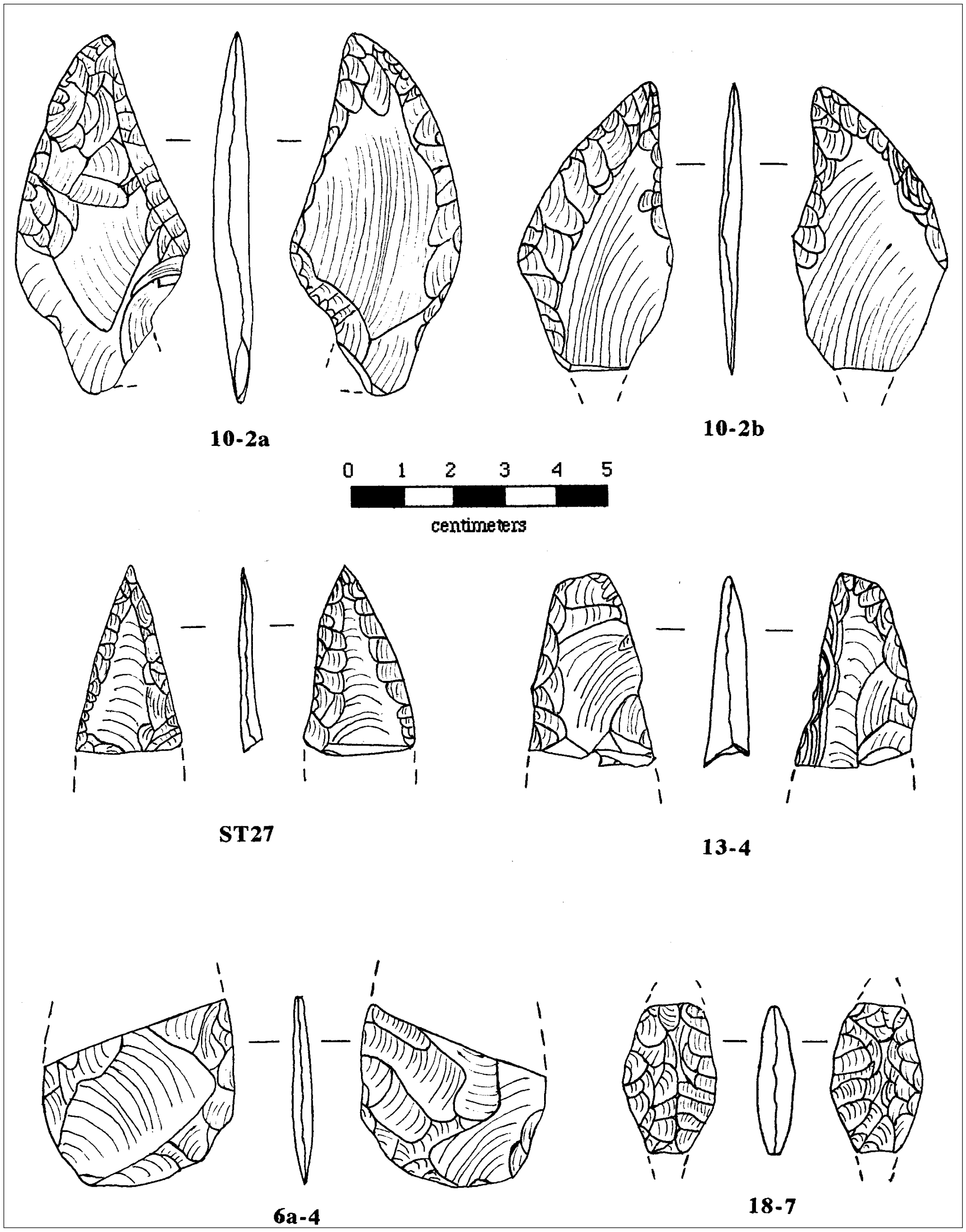

Figure 5. The study sample of bifaces from Botanie Lake Dam (EcRj 15) with associated provisional artifact numbers.

concave, convex, or straight) of each usable edge were recorded.

The six bifaces comprising the study sample can be divided into three rough groups. Most clearly similar in form are artifacts 10-2a and 10-2b. These two bifaces are both almost complete, and are both broken at virtually the same spot at the extreme proximal end, perhaps a result of breaking while hafted. They were uncovered only 15 cm apart horizontally and 2 cm vertically, within the limits of a cultural depression provisionally identified as a mat lodge feature. On the basis of their morphology and provenience, they are likely to date to the Kamloops horizon (1200 - 200 BP). They each show bifacial retouch along both edges, with one edge concave and one convex in plan view. Edge angles are very acute, ranging between 19° and 22°. They also both have one concave and one convex face and are made of a high quality vitreous dacite. They show fairly similar maximum length, width and thickness values,

Table 1. Qualitative and quantitative measurements made of the study sample bifaces and biface fragments

Artifact No. [a]	*Weight (g)*	*Max. Length (mm)*	*Max. Width (mm)*	*Max. Thickness (mm)*	*Condition*	*Raw Material*	*Cortex (Y/N)*	*Face Curvature*	*No. of Usable Edges*	*Edge No.*	*Extent and Type of Retouch*	*Edge Angle*	*Edge Curvature*
10-2a [71]	16.0	69.87	33.01	6.86	almost complete	vitrious dacite	N	convex/ concave	2	1	moderate bifacial	19°	concave
										2	extensive bifacial	19°	convex
10-2b [72]	8.1	57.66	29.48	5.76	almost complete	vitrious dacite	N	convex/ concave	2	1	minimal bifacial	20°	concave
										2	moderate bifacial	22°	convex
18-7 [151]	4.3	30.46	19.28	7.96	almost complete, highly resharpened	granular dacite	N	convex/ convex	2	1	extensive bifacial	33°	convex
										2	extensive bifacial	37°	convex
6a-4 [28]	10.2	46.00	37.79	6.68	basal half of thin foliate biface	vitrious dacite	N	convex/ convex	1	1	extensive bifacial	21°	convex
13-4 [118]	8.1	38.18	26.12	9.14	distal tip	granular dacite	N	straight/ straight	2	1	moderate bifacial	51°	convex
										2	moderate bifacial	60°	convex
ST27 [7]	5.0	37.18	22.86	7.17	distal tip	vitrious dacite	N	straight/ straight	2	1	moderate bifacial	26°	convex
										2	minimal bifacial	26°	convex

[a] Site catalogue numbers are shown in brackets below provisional artifact designations.

although 10-2b is approximately half the weight of 10-2a, a result of the modification of a thinner flake. The striking similarity of these two specimens would suggest a standardized form, a type of biface (bifacial knife or bifacially retouched flake). Their curved plan outline is less suggestive of a projectile function than of use as a cutting implement. Their very acute edge angles are well outside the range of documented scraping tools (about 50 - 90°; Andrefsky 1998:168, 193), suggestive of use for cutting tasks. A similar tool was briefly described (and illustrated) by James Teit (1900:183-184) as used for cutting and carving among the ethnographic Thompson Indians and his illustration is reproduced in Figure 6. This shows one possible method of hafting such a biface, but any direct analogy between this ethnographic tool and the archaeological specimens at this point is premature.

Distal biface fragments 13-4 and ST27 show many similarities, but their fragmentary nature makes conclusions based on these similarities less certain than for the above two bifaces. The only notable differences between these two artifacts are weight, raw material, and edge angle. The specimen of much finer vitreous dacite weighs far less than the specimen of granular dacite, despite very similar maximum length, width and thickness values. The heavier, coarser grained biface tip also exhibits much steeper edge angles (51 and 60°) than the lighter, finer grained specimen (26°). Both bifaces have straight faces and convex edges, with bifacial retouch evident on all usable edges. Both specimens are broken at virtually the same place, resulting in fragments of similar dimensions, although the point of ST27 is much sharper than that of 13-4 (this may have much to do with ease of working a finer grade of

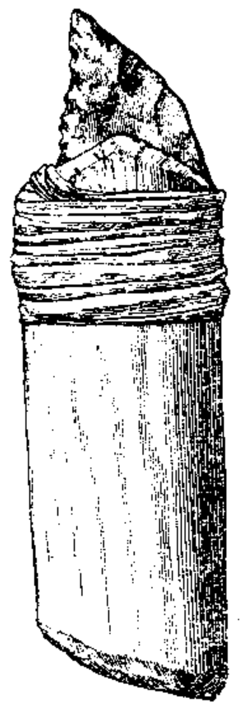

Figure 6. A hafted chipped stone knife recorded by James Teit as used by the ethnographic Thompson Indians, "1/2 natural size" (Teit 1900:Figure 125).

dacite). Judging from what remains of these two artifacts, they probably represent the distal thirds of medium sized leaf-shaped bifaces. Artifacts 18-7 and 6a-4 are foliate bifaces, one is almost complete and the other is roughly the proximal half. The almost complete specimen, 18-7, shows evidence of an incipient stem and a rounded distal tip exhibiting either impact damage or attempted edge rejuvenation following a break. This biface has been thoroughly billet flaked and shows a number of step and hinge flake scar terminations. It is made of a granular dacite and is the lightest and smallest specimen in the sample. However, it is thicker than all other sample bifaces, save only the other artifact also constructed of a similar coarse-grained dacite (13-4). Edge angles are fairly acute (33° and 37°), but greater than all the bifaces of vitreous dacite, and exceeded only by those of the other granular dacite specimen. The small size, incipient stem, and potential impact damage to the distal portion of this artifact suggest that it may have been used as a projectile point. However, evidence of extensive bifacial resharpening, relatively thick cross-section, and its overall leaf-shape are characteristic of a more general purpose cutting, scraping, and potentially projectile tool.

Specimen 6a-4 is the basal portion of a thin, well made foliate biface, broken obliquely across the middle. It is characterized by a highly acute, well formed continuous edge extending over the sides and base of the tool. It is of vitreous dacite and exhibits a remarkably uniform thickness for a tool showing no evidence of primary flake scars.

Despite the small subsample size, including only one artifact type, and a limited variation in raw materials, the study sample of bifaces show a significant degree of overall variability. The two curved bifaces are very similar and seem to represent a biface subtype, while the other four specimens vary considerably between themselves and the two curved pieces. Raw material seems to be correlated with variability in other descriptive characteristics, such as edge angle, thickness, and quality of workmanship. The two granular dacite artifacts are notably thicker, of poorer finished form, and exhibit steeper edge angles than the bifaces of vitreous dacite. Another characteristic which appears to explain some of the variability within the sample is the amount of bifacial reduction to which a specimen has been subjected. Two of the three above mentioned groups of artifacts show obvious primary flake scars on one or both faces, indicating the bifacial modification of medium-sized flake blanks. The third group, 18-7 and 6a-4, show secondary billet flake scars over the entirety of both faces, indicating a more complete modification of the initial (and probably thicker) flake or core blank. In general, the amount of bifacial reduction evident on each specimen varies considerably, with only the two extensively worked artifacts (18-7 and 6a-4) having the same extent of retouch (see Table 1). However, breakage patterns show some similarities over the sample, with three bifaces missing only extreme proximal portions (possibly the result of haft damage) and two others consisting of similarly sized and shaped distal biface tips.

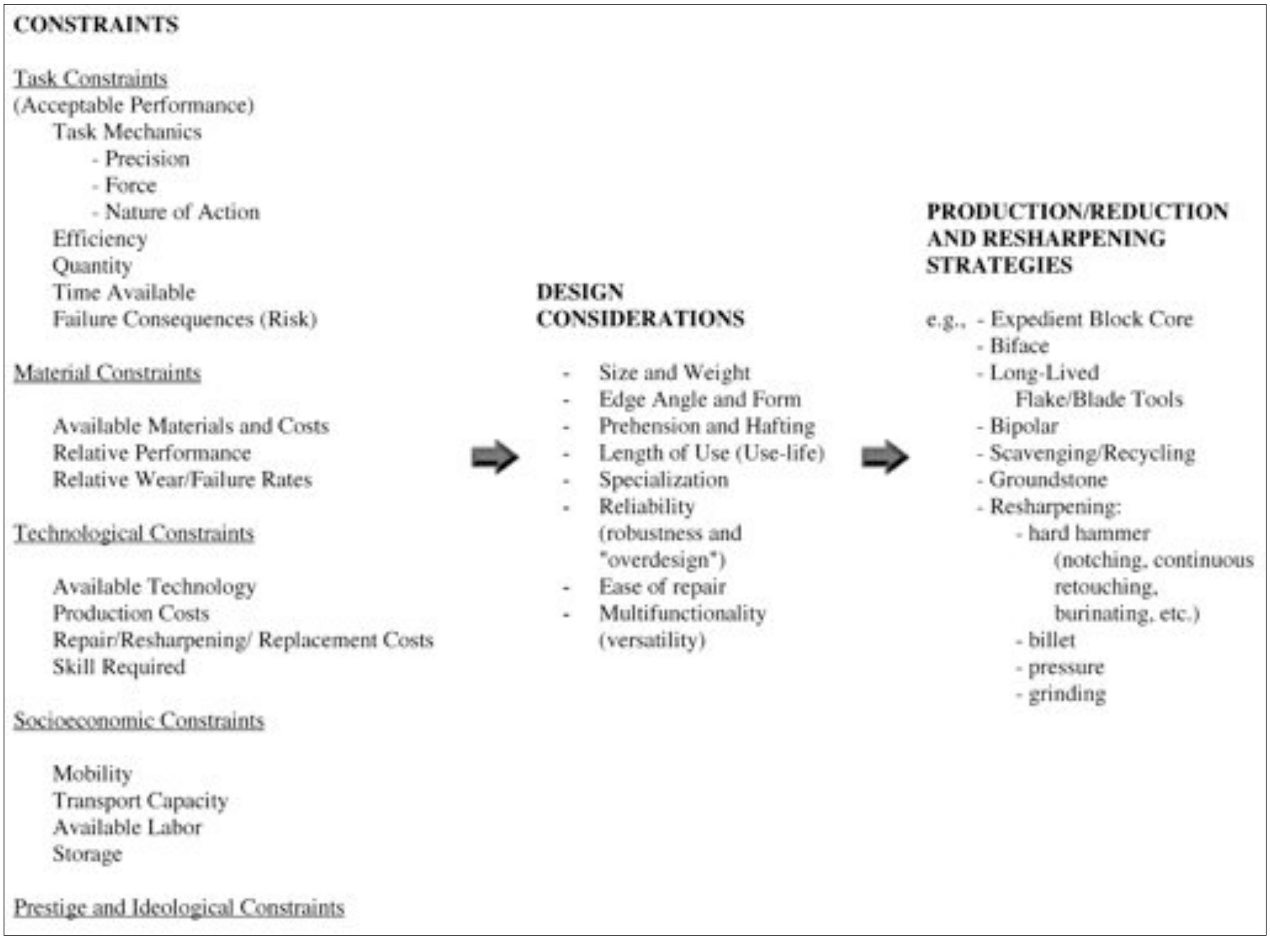

Figure 7. Schematic representation of the design factors affecting lithic systems and their interelationships. After Hayden et al. 1996:Figure 1.

Design theory analysis

Design theory addresses the process of selection and modification of raw materials in order to attempt to solve an activity-related or technological problem. The problem is always specific to a certain context and may be functional, economic, or social. The goal of design theory analysis is to permit cultural inferences regarding the decision-making processes associated with how the tool was conceived, constructed, used, and resharpened (Horsfall 1987:333; Kleindienst 1975; Rousseau 1992:14). It is assumed that a number of constraints affect the production and finished form of the artifact, and that these constraints operate interactively and may conflict with each other. The interaction of these constraining factors is variable and is determined by the particular context of the problem, for which there may be a number of different effective solutions (Horsfall 1987:334; Rousseau 1992:14). Some examples of such constraints are raw material physical properties and availability, functional efficiency, technological capability, the quantity of materials to be processed, the time available for processing, the consequences of failure, mobility and transport (size and weight), and ideology/prestige considerations (Hayden et al. 1996:10-12, 2000:188-189; Horsfall 1987:334, 369-70; Hutchings 1991:21; Rousseau 1992:14; see Figure 7 for a complete list). Less essential but also important are "design considerations," such as reliability, maintainability, longevity (similar to curation), versatility (or multifunctionality), and flexibility (Figure 7), which further affect the form of solutions to specific problems (Hayden et al. 1996:11-14; Hutchings 1991:26;

Nelson 1991:66-77; Rousseau 1992:14-15). Through an evaluation of the representation of these constraints and design considerations in the final product (the artifacts), the design analyst attempts to understand their relative importance to the culture in question, and to use this information to help reveal the nature of the specific circumstance for which the materials were intended (Horsfall 1987:336). The following design analysis of the study sample of bifaces from Botanie Lake Dam is based on the procedure developed by Hayden et al. (1996).

Constraints

Biface task constraints

Bifaces are one of the most versatile, or multifunctional, tool types. They can also be quite flexible, in that they can be retouched into a variety of other forms (Johnson 1987; Kelly 1988; Nelson 1991). They have been suggested as general purpose butchering, woodworking (Hayden et al. 1996, 2000:194-196; Johnson 1987; Nelson 1991), and plant food processing tools (Lepofsky et al. 2000:409). They are also well suited to processing large quantities of materials, as they have a large amount of usable edge per tool and are easily resharpened. When resharpening is by soft hammer or pressure methods, an acute edge angle can be maintained over numerous successive resharpenings. They can also be hafted to allow more efficient manipulation of the tool. Bifaces can be effectively used to process large amounts of material in a relatively short time, exceeded in efficiency at (some) cutting tasks only by groundstone knives (Hayden 1987), such as those common on the southern Northwest Coast after 3000 BP. Because the edge angles observed in the sample of bifaces from Botanie Lake Dam are so acute, it seems unlikely that they could have been used as effective woodworking tools. Under the significant stress associated with cutting or planing wood, all usable edges on the bifaces would suffer immediate and extensive damage, and it seems unlikely that any of the observed edges could have been maintained while working even softwoods. Another type of tool that has been documented for the region, the key-shaped uniface, would be far better suited to woodworking tasks (Rousseau 1992), as indeed would expedient burins, notches, or even unmodified hard hammer and bipolar flakes. However, the acute edge angles may have been well suited for the processing of softer plant food materials. It seems likely that thin bifaces such as these were also used for many different cutting tasks in an opportunistic manner. For example, if a specific length of Indian hemp fiber was desired, a conveniently nearby biface might be used to cut the strand of hemp. Smaller bifaces, such as these, may also have been used in fish processing (Rousseau 2004a). On the basis of edge morphology it appears that the sample bifaces were intended for cutting soft materials, such as skin, fat and meat, as well as herbaceous plant stems and leaves. They could also have been used as cores for the production of billet flakes. These flakes have a high ratio of usable edge to weight, and can be retouched into a variety of flake tool forms with thin edges (Kelly 1988; Nelson 1991:74). As such, bifaces are excellent functional adaptations when mobility is high and transport capacity is low.

Material constraints:

Several researchers have emphasized the importance of raw material considerations to the intended function of lithic artifacts (e.g., Horsfall 1987:369; Kelly 1988; Rousseau 1992:18). Horsfall (1987:369) has even concluded that classification of raw material into geological types is too broad for archaeological analysis, and that variation within these geological categories relates to variation in artifact function. All bifaces in the sample are made of dacite, four of a fine-grained variety and two of a course-grained type, with a corresponding clustering of edge angle (Table 1). Dacite, also known as basalt, is a relatively common raw material on the Interior Plateau (Mallory-Greenough et al. 2002:41; Rousseau 1992:18) and occurs in the region in larger amounts and nodule sizes than do higher quality cryptocrystalline silicates (e.g., cherts, chalcedonies, agates; Hayden et al. 1996:24; Rousseau 2000). There are three major known sources of dacite in the area surrounding Botanie Lake, located in the nearby Upper Hat Creek Valley, the Maiden Creek Valley, and at Cache Creek (Rousseau 2000). Dacite from these sources can be differentiated on the basis of cortex characteristics. However, no cortex remains on any of the study sample bifaces, therefore eliminating the possibility of sourcing the study materials without high resolution petrography and geochemical analysis (Mallory-Greenough et al. 2002). All three of these dacite sources are within a few days walk of Botanie Lake, as are a number of smaller sources of fine-grained silicates (e.g., cherts and chalcedonies, as well as some opal and petrified wood). In addition, pebbles and cobbles of dacite can be occasionally found throughout the valleys of the Mid Fraser-Thompson area. Cryptocrystalline silicates are both harder and tougher than the dacites available near Botanie Lake (Rousseau 1992:18), and are known to show good flakability (ease of removing controlled flakes during flintknapping). Based upon raw material considerations only, these silicates should have been preferred over dacite for making bifaces, tools which are thought to have long use-lives and likely were carried as personal gear (Hayden et al. 1996; Kelly 1988). However, this seems not to have been the case at Botanie Lake Dam during the later Plateau Pithouse Tradition (Antiquus 1999:appendix 2). Apparently, most bifaces that have entered the archaeological record there were manufactured of dacite, an observation that has important implications for the function of those tools. The hardest and toughest available materials were not used (chalcedony, chert, agate), probably because they were not as common as dacite, and were not usually available in the area as larger nodules. Additionally, many of these Plateau silicates require heat treatment prior to secondary reduction, in order to improve flakability by annealing flaws such as fracture planes and large inclusions (Rousseau 1992:19), thus increasing the cost of their use. Those nodules of fine-grained silicates that were procured were likely used to manufacture other types of tools used to work harder contact materials (such as key-shaped unifaces used to work wood). The relative paucity of bifaces made of such silicates supports the hypothesis that the sample tools were used to process soft contact materials such as skin, meat, and herbaceous plants.

Technological and socioeconomic constraints:

The production of bifaces by soft hammer percussion from hard hammer flake blanks is a relatively time and effort consuming process, one requiring a moderate to high degree of skill and specialized tools (billets of various sizes). Hayden et al. (1996:24) suggest that bifaces require a greater amount of these assets than do any other chipped stone artifacts found at the Keatley Creek site, a large Plateau Pithouse Tradition village site near the town of Lillooet, not far from Botanie Lake. Chipped stone bifaces were manufactured by the inhabitants of the Mid Fraser-Thompson River region during the PPT, to the general exclusion of roughly functionally similar groundstone knives, despite knowledge of groundstone reduction techniques (evidenced by groundstone pendants, nephrite adzes and cultural interactions with the Northwest Coast, where groundstone technology was an important aspect of most contemporaneous lithic assembles [Ames and Maschner 1999; Darwent 1998; Hayden and Schulting 1997; Mitchell 1990; Pokotylo and Mitchell 1998; Richards and Rousseau 1987]). The emphasis on chipped stone over groundstone technology for the production of thin cutting tools undoubtedly was influenced by a number of factors, such as raw material availability, but there are certain advantages to chipped stone bifaces that may be relevant. The most obvious of these is that chipped stone bifaces can serve as cores for the production of thin, sharp billet flakes useful for making a variety of expedient tools (such as expedient and backed knives that could be used to process fish; Kelly 1988). Under situations of high mobility and limited transport capacity this aspect of biface technology could be valuable (e.g., on the Interior Plateau during logistical resource procurement forays or seasonally mobile residential settlement moves [Binford 1980], both common during the PPT). Both the multifunctionality (or versatility) and flexibility of bifaces would be advantageous to mobile hunter-gatherers (whether logistically or residentially organized; Sassaman 1992). In a biface, a hunter-gatherer has a tool suited to a variety of tasks and that, if necessary, can be further reduced to produce a completely different tool form with a limited amount of effort. Also, resharpening a chipped stone biface is less effort intensive than is regrinding an edge on a groundstone knife (Hayden 1987). When processing volumes are not too great and raw material not too scarce (e.g., occasional butchering of medium-sized mammals and/or fish on the Plateau; in contrast with intensive processing of salmon on the Northwest Coast), the time and effort expended in the manufacture and maintenance of groundstone tools is likely not justified by that saved through reduction of raw material procurement costs. It should be noted that upper Botanie Creek is not known to have ever been a major salmon procurement location, due to its small size and close proximity to excellent fishing areas on both the Fraser and Thompson Rivers (Kew 1992; Teit 1900).

Design considerations

Several factors have been emphasized by various authors as fundamental for understanding the organization of lithic technology and these factors have become known as "design considerations" (Bleed 1986; Hayden et al. 1996; Nelson 1991; Torrence 1989). They include the concepts of reliability, maintainability, versatility (or multifunctionality), flexibility and longevity. Generally, reliable tools can be depended upon to work when needed, and have characteristics such as overdesigned, well made, redundant and standby components which are not usually used at full stress capacity.[5] Maintainable tools are those which are quickly and easily modified to function when needed under a variety of circumstances, even if they are broken or not perfectly suited to a certain task. Versatility is defined as the number of different tasks which a tool can be used to perform. Flexibility is the extent to which a tool can be reshaped to produce new types of tools suited to the completion of different tasks. Finally, longevity concerns the (potential) use-life of a tool, and is similar to the concept of curation (amount of utility extracted) as defined by Shott (1996).

When evaluating the strategies underlying the use of biface technology at the Keatley Creek site, Hayden et al. (1996) emphasize mobility (raw material availability and transport capacity), task, longevity and multifunctionality design factors over considerations of risk, maintainability, reliability, flexibility and specialization. Hayden (1987; Hayden et al. 1996:25) suggests that thin biface technology was designed to conserve acute edge angles over many episodes of resharpening and provide a source of thin, sharp billet flakes when required. It served as an effective solution to situations in which mobile hunter-gatherers were confronted with a scarcity of quality raw materials (geographically or seasonally), a limited capacity for the transport of tools and cores, and moderate or high processing requirements. Hayden et al. (1996:26) also propose that bifaces were multifunctional tools, based upon comparative use-wear and theoretical arguments. Their overall morphology, characterized by large, uniform cutting edges, sharply pointed tips, and wide, flat bases well suited for prehension or hafting, certainly is indicative of the potential for versatility. Owing in part to the difficulty identifying bifaces at Keatley Creek as either reliable (clearly thin bifaces are not overdesigned), maintainable (no evidence for subsystems arranged in series, ready-to-use extra components, or modular design) or both, Hayden et al. (1996) chose not to emphasize these concepts as important to an understanding of the technological role of bifaces (contra Bleed 1986; Torrence 1989). The subjective nature of the means by which the design concepts of reliability and maintainability, as well as specialization and

[5] Overdesigned is defined as displaying greater robusticity than required for intended tasks. Standby components are those which are not required during normal tool use, but are reserved for high stress scenarios.

flexibility, must be operationalized archaeologically contributed to Hayden et al.'s reluctance to assign them a primary role in structuring lithic technology.

The sample of bifaces from Botanie Lake Dam shares many similarities with that from Keatley Creek. This is not surprising considering that both are residential sites of roughly the same age, separated geographically by fewer than 50 kilometers. The Botanie Lake bifaces certainly are portable, and represent an effective solution to limited raw material availability and transport capacity. The limits on raw material availability that have been documented for the area surrounding Keatley Creek (Hayden et al. 1996; Rousseau 2000) are likely also to be broadly applicable to the Botanie Lake area, on the basis of their close proximity and geological similarity. Area 5 at Botanie Lake Dam has been interpreted as a mat lodge residential site (Antiquus 1999; Kaltenrieder and Ewonus 1999) which, when compared with ethnographic descriptions of Interior Plateau subsistence-settlement patterns (which are probably not without some comparative validity during the Plateau and Kamloops horizons), is suggestive of a non-winter seasonal resource procurement local and/or base camp (Campbell 1985; Chatters 1986; Teit 1900, 1930). In either case, significant amounts of materials, such as mats, skins, bone and wood tools, as well as food for immediate consumption and storage for the winter would have to be transported. If the residence/base camp was relocated, all such goods would need transportation, while only part of the total would be affected if logistical task groups embarked on resource procurement forays. The domestic dog is the only aid known to have been used to help in transporting loads overland (such as to or from Botanie Lake) in the Mid Fraser region prior to the introduction of the horse (Crellin 1994; Crellin and Heffner 2000). The implication is that lithic strategies which reduced the total size and weight of cores and tools that were necessary for task performance during periods of seasonal mobility should be favoured over those requiring transport of larger amounts of lithic materials. Considering that processing requirements were likely substantial, biface technology represents an effective solution to this problem.

Based upon the morphology of the intact proximal portions of the study sample bifaces, it appears that they were manufactured with ease of holding or hafting in mind. Their thin, flat, smooth bases would provide a firm grip for the hand or a natural fit for a haft element. Hafting these bifaces would also have improved their efficiency at many tasks, due to an increase in weight, leverage, and prehension area. It has also been suggested that hafting may increase the longevity of biface tools, by allowing the use of highly resharpened specimens too small to be effectively hand held (Hayden et al. 1996:25). While this observation is somewhat speculative (with regard to bifaces, although obvious when considering chipped stone adzes), there can be little doubt that the study sample bifaces were designed to have long use-lives, and that these tools were curated (sensu Shott 1996). The maximum potential utility of the largest bifaces in the sample is quite substantial. These specimens, were they complete, could be resharpened numerous times while maintaining their acute edge angles and enough usable edge length to permit the processing of large amounts of materials (e.g., butchering animals or processing herbaceous plants). The realization of that utility is indicated by sample artifact 18-7, which has been reduced to a very small size (Figure 5). The sample bifaces could also be considered versatile (multifunctional), but only in the sense that they could be used to perform a variety of cutting tasks. A tool with thin, sharp cutting edges and a thicker, more robust medial section can be used to cut a number of relatively soft materials. However, the thin edges of the sample bifaces are not well suited for scraping, carving or planing hard materials. Biface tools that could be easily hand held and were well suited to hafting, as well as having long use-lives (probably curated in its full sense) and applicability to a variety of cutting tasks would have been valuable tools to seasonally mobile hunter-gatherers, such as those of the Interior Plateau during the PPT. It is likely that such tools, which represent a significant time and energy investment, were used extensively for the completion of tasks important to the survival of their users. Efficient performance of subsistence related tasks, such the processing of animal carcasses and herbaceous plants, clearly is essential for survival and must be undertaken on a regular basis. While this does not exclude the possibility that these bifaces were used for other tasks, such as woodworking, the use of such valuable tools for less essential non-subsistence tasks and the associated risk of breakage suggests that using other types of tools, either more robust or more expedient, in these roles would make more sense.

Just as Hayden et al. (1996) found that the design concepts of reliability, maintainability, flexibility, and specialization were difficult to apply to bifaces in a meaningful way, so too are they of questionable significance for the Botanie Lake Dam sample. In fact, the very same problems exist with regard to reliability (not overdesigned) and maintainability (no evidence for subsystems arranged in series, ready-to-use extra components, or modular design) for the Botanie Lake bifaces. This ambiguity may well affect the classification of most thin bifaces as either reliable and/or maintainable. Flexibility is possible for many bifaces, including those of the study sample, mainly as a consequence of their size. However, as noted by Hayden et al. (1996) it is virtually impossible to ever know whether a thin biface was designed to be reshaped into some other tool at some point during its use-life, whether many other bifacially worked tools were originally thin bifaces, or whether those tools that can be suggested to have indeed been initially thin bifaces were merely discarded and later opportunistically recycled into something else. The question remains: were thin bifaces designed to be flexible or is the potential for recycling such bifaces into other tool types merely inherent in their size and form, characteristics which were influenced by other design constraints and considerations to the exclusion of flexibility? Furthermore, one must ask the question: why would anyone want to reshape a thin biface, a valuable tool representing a substantial investment of time and energy, into something else, when virtually all other possibilities could be constructed with less time and effort from smaller, less valuable nodules or flakes? The concept of flexibility is plagued by problems of operationalization, and as such will not be further considered here. The degree to which the sample bifaces were specialized tools is also somewhat problematic. They may have been specialized for butchering certain animals or processing certain plants, but consideration of their morphology suggests a multifunctional cutting tool. If cutting tasks can be considered some type of gross specialization, then the sample bifaces may have indeed been specialized tools. However, a generalized cutting tool seems logically more multifunctional than does a specialized one. In this case, comparative use-wear analysis could help to resolve the extent to which these tools were versatile or specialized. Nevertheless, on the basis of morphological considerations alone it seems reasonable for now to emphasize multifunctionality over specialization.

Conclusion

On the basis of design theory analysis of the six bifaces from Botanie Lake Dam, it can be said that these tools were probably used for cutting tasks involving relatively soft contact materials, such as skin, meat, and various herbaceous plants. They were not likely to have been used to scrape, plane, or carve harder materials, such as woody plants or hides. More robust and/or expedient tools with much steeper edge angles, such as key-shaped unifaces, burins, notches, gravers, adzes, sidescrapers and endscrapers, would have been far better suited to these heavier tasks. The use of dacite as the preferred raw material, over harder and tougher cryptocrystalline silicates, further supports a hypothesized cutting function for these bifaces. The sample bifaces were most likely also used as portable cores for the production of thin, sharp billet flakes useful for making a variety of expedient tools. As has been suggested elsewhere, bifaces are an effective solution to the problems of scarcity of quality raw material, limited capacity for the transport of lithic materials, and substantial processing requirements encountered by mobile hunter-gatherers. During the Plateau and Kamloops horizons on the Fraser Plateau, hunter-gatherer groups are thought to have been both seasonally logistically and residentially mobile and the Botanie Lake Dam site appears to represent an aspect of this subsistence-settlement pattern. The value of biface technology for such a way of life on the Fraser Plateau seems clear, and its representation at Botanie Lake logical. Not only are the sample bifaces solutions to these logistical problems, but they are also tools that can be comfortably hand held, are well suited for hafting, have substantial utility (including long use-lives), and can be used to complete a variety of cutting tasks (i.e. multifunctional).

The design constraints of mobility, transport capacity, raw material physical properties and availability, task mechanics, functional efficiency, quantity of processed materials, available technology, production costs, repair/resharpening/replacement costs, and necessary skill, as well as the design considerations of multifunctionality, longevity, prehension and hafting, edge angle and form, and size and weight proved the most useful in understanding the role of thin bifaces within the lithic technological system. However, the concepts of reliability, maintainability, flexibility and specialization were much less valuable to this analysis. Overall, the design theory approach was valuable. Despite limited knowledge regarding site function and the nature of the lithic assemblage as a whole, this approach permitted an outline of the technological function of thin bifaces at Botanie Lake Dam and provides the basis for further analysis of the sample artifacts. In addition to a more detailed analysis of the entire assemblage from the site, a potentially fruitful further step in the study of these bifaces would be the application of use-wear, residue, and experimental replication and use analyses. These studies would provide new lines of evidence with which to test the results of the design analysis.

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References

Ames, Kenneth M. and Herbert D.G. Maschner. 1999. *Peoples of the Northwest Coast: Their Archaeology and Prehistory.* Thames and Hudson: London.

Andrefsky, William, Jr. 1998. *Lithics: Macroscopic Approaches to Analysis.* Cambridge University Press: Cambridge.

Antiquus Archaeological Consultants Ltd. 1999. *Archaeological Investigations Conducted for the 1998 Botanie Lake Dam Upgrading Project at Site EcRj 15, Near Lytton, Southwestern B.C.* Unpublished permit report (1998-262) on file, Culture Department Library, Ministry of Sustainable Resource Management, Victoria, B.C.

Binford, Lewis R. 1980. Willow Smoke and Dog's Tails: Hunter-gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.

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

Campbell, Sarah K. 1985. *Summary of Results, Chief Joseph Dam Cultural Resources Project, Washington*. University of Washington: Seattle.

Chatters, James C. 1984. *Human Adaptation Along the Columbia River 4700 – 1600 BP.: A Report of Test Excavation at River Mile 590, North Central Washington.* Research Report 84-1, Central Washington University Graduate Studies and Research. Central Washington University: Ellensburg.

Chatters, James C. 1986. *The Wells Reservoir Archaeological Project, Washington, Volume I: Summary of Findings*. Central Washington University: Ellensburg.

Crellin, David F. 1994. *Is There a Dog in the House: the Cultural Significance of Prehistoric Domesticated Dogs in the Mid Fraser River Region of British Columbia*. Unpublished M.A. Thesis, Department of Archaeology, Simon Fraser University.

Crellin, David F. and Ty Heffner. 2000. The Cultural Significance of Domestic Dogs in Prehistoric Keatley Creek Society. In *The Ancient Past of Keatley Creek, Volume II: Socioeconomy*, edited by Brian Hayden, pp.151-164. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Darwent, John. 1998. *The Prehistoric Use of Nephrite on the British Columbia Plateau.* Simon Fraser University Department of Archaeology publication no. 25. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Ewonus, Paul. 1999. *Subsistence Patterns From 7500 BP: Faunal Analysis of the Stirling Creek Bridge Site (DiRa 9), Similkameen Valley, South-Central British Columbia.* Unpublished B.A. (honors) Thesis, Department of Archaeology, Simon Fraser University.

Grabert, G. F. 1974. *Okanagan Archaeology: 1966-67*. Syesis 7, supplement 2.

Grace, R. 1996. Review Article: Use-Wear Analysis: The State of the Art. *Archaeometry* 38:209-229.

Hayden, Brian. 1987. From Chopper to Celt: the Evolution of Resharpening Techniques. *Lithic Technology* 16:33-43.

Hayden, Brian. 2000. *Socioeconomic Factors Influencing Housepit Assemblages. In The Ancient Past of Keatley Creek, Volume II: Socioeconomy*, edited by Brian Hayden, pp.3-27. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Hayden, Brian, Nora Franco, and Jim Spafford. 1996. Evaluating Lithic Strategies and Design Criteria. In *Stone Tools: Theoretical Insights into Human Prehistory*, edited by George H. Odell, pp. 9-45. Plenum Press: New York.

Hayden, Brian, Nora Franco, and Jim Spafford. 2000. Keatley Creek Lithic Strategies and Design. In *The Ancient Past of Keatley Creek, Volume I: Taphonomy*, edited by Brian Hayden, pp.185-211. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Hayden, Brian, and Rick Schulting. 1997. The Plateau Interaction Sphere and Late Prehistoric Cultural Complexity. *American Antiquity* 62:51-85.

Horsfall, Gayel. 1987. A Design Theory Perspective on Variability in Grinding Stones. In *Lithic Studies Among the Contemporary Highland Maya*, edited by Brian Hayden, pp. 332-377. University of Arizona Press: Tucson.

Hutchings, Wallace Karl. 1991. *The Nachcharini Composite Projectile: Design Theory and the Study of Hunting Systems Technology at Mugharat en-Nachcharini in the Post-Natufian Levant*. Unpublished M.A. Thesis, Department of Anthropology, University of Toronto.

Johnson, Jay. 1987. Introduction. In *The Organization of Core Technology*, edited by J. Johnson and C. Morrow, pp. 1-12. Westview Press: Boulder.

Kaltenrieder, Simon P. and Paul Ewonus. 1999. *Mat Lodge Campsites on the Canadian Plateau: New Data from the Botanie Lake Site*. Paper presented at the 31st Annual Meeting of the Canadian Archaeological Association, Whitehorse, Yukon, April 29, 1999.

Kealhofer, Lisa, Robin Torrence and Richard Fullagar. 1999. Integrating Phytoliths within Use-Wear/Residue Studies of Stone Tools. *Journal of Archaeological Science* 26:527-546.

Kelly, Robert L. 1988. The Three Sides of a Biface. *American Antiquity* 53:717-734.

Kew, Michael. 1992. Salmon Availability, Technology, and Cultural Adaptation in the Fraser River Watershed. In *A Complex Culture of the British Columbia Plateau: Traditional Stl'átl'imx Resource Use*, edited by Brian Hayden, pp. 177-221. University of British Columbia Press: Vancouver.

Kleindienst, Maxine R. 1975. Comment. *Current Anthropology* 16:382-383.

Lepofsky, Dana, Michael Blake, Douglas Brown, Sandra Morrison, Nicole Oakes, and Natasha Lyons. 2000. Archaeology of the Scowlitz Site, SW British Columbia. *Journal of Field Archaeology* 27:391-416.

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

Mallory-Greenough, Leanne M., James Baker and John D. Greenough. 2002. Preliminary Geochemical Fingerprinting of Dacite Lithic Artifacts from the British Columbia Interior Plateau. *Canadian Journal of Archaeology* 26:41-61.

Mitchell, Donald. 1990. Prehistory of the Coasts of Southern British Columbia and Northern Washington. In *Handbook of North American Indians, Volume 7: Northwest Coast*, edited by Wayne Suttles, pp. 340-358. Simthsonian Institution: Washington, D.C.

Nelson, Margaret C. 1991. The Study of Technological Organization. In *Archaeological Method and Theory, vol. 3*, edited by M. Schiffer, pp. 57-100. University of Arizona Press: Tucson.

Pokotylo, David L. and Patricia D. Froese. 1983. Archaeological Evidence for Prehistoric Root Gathering on the Southern Interior Plateau of British Columbia: A Case Study from Upper Hat Creek Valley. *Canadian Journal of Archaeology* 7(2):127-157.

Pokotylo, David, and Donald Mitchell. 1998. Prehistory of the Northern Plateau. In *Handbook of North American Indians, Volume 12*: Plateau, edited by Deward E. Walker, Jr., pp. 81-102. Smithsonian Institution: Washington, D.C.

Prentiss, William C. and Ian Kuijt. 2004. The Archaeology of the Plateau Region of Northwestern North America-Approaches to the Evolution of Complex Hunter-Gatherers. In *Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities on the Plateau of Northwestern North America*, edited by William C. Prentiss and Ian Kuijt, pp. vii-xvii. University of Utah Press: Salt Lake City.

Richards, T. H., and M. K. Rousseau. 1987. *Late Prehistoric Cultural Horizons on the Canadan Plateau*. Simon Fraser University Department of Archaeology publication no. 16. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Rousseau, Mike K. 1992. *Integrated Lithic Analysis: the Significance and Function of Key-Shaped Formed Unifaces on the Interior Plateau of Northwestern North America.* Simon Fraser University Department of Archaeology publication no. 20. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Rousseau, Mike K. 1998. *Application for a heritage investigation permit to conduct a detailed systematic data recovery program at site EcRj 15 within impact zones associated with Lytton First Nation's proposed Botanie Lake Dam upgrading project 17 km north of Lytton.* Permit application submitted by Antiquus Archaeological Consultants Ltd. to the British Columbia Archaeology Branch, Victoria.

Rousseau, Mike K. 2000. Results of the Keatley Creek Archaeological Project Lithic Source Study. In *The Ancient Past of Keatley Creek, Volume I: Taphonomy*, edited by Brian Hayden, pp.165-184. Archaeology Press, Simon Fraser University: Burnaby, B.C.

Rousseau, Mike K. 2004a. Old Cuts and Scrapes: Composite Chipped Stone Knives on the Canadian Plateau. *Canadian Journal of Archaeology* 28:1-31.

Rousseau, Mike K. 2004b. A Culture Historic Synthesis and Changes in Human Mobility, Sedentism, Subsistence, and Population on the Canadian Plateau, 7000-200 B.P. In *Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities on the Plateau of Northwestern North America*, edited by William C. Prentiss and Ian Kuijt, pp. 3-22. University of Utah Press: Salt Lake City.

Rousseau, M. K., R. Muir, D. Alexander, J. Breffitt, S. Woods, K. Berry, and T. Van Gaalen. 1991. Results of the 1989 Archaeological Investigations Conducted in the Oregon Jack Creek Locality, Thompson River Region, South-Central British Columbia. *Unpublished report submitted to the British Columbia Archaeology Branch, Victoria*.

Sassaman, Kenneth E. 1992. Lithic Technology and the Hunter-gatherer Sexual Division of Labor. *North American Archaeologist* 13:249-262.

Shea, John J. 1992. Lithic Microwear Analysis in Archaeology. *Evolutionary Anthropology* 4:143-150.

Shott, Michael J. 1996. An Exegesis of the Curation Concept. *Journal of Anthropological Research* 52:259-280.

Stemp, James W. and Michael Stemp. 2001. UBM Laser Profilometry and Lithic Use-Wear Analysis: A Variable Length Scale Investigation of Surface Topography. *Journal of Archaeological Science* 28:81-88.

Stryd, A. R., and M. K. Rousseau. 1996. The Early Prehistory of the Mid Fraser-Thompson River Area. In *Early Human Occupation in British Columbia*, edited by Roy L. Carlson and Luke Dalla Bona, pp. 177-204. Unversity of British Columbia Press: Vancouver.

Teit, James A. 1900. *The Thompson Indians of British Columbia. Publications of the Jesup North Pacific Expedition, vol. 1, part 4*, edited by Franz Boas. American Museum of Natural History: New York.

Teit, James A. 1930. *The Salishan Tribes of the Western Plateaus.* Bureau of American Ethnology, 45th Annual Report, 1927-28. Smithsonian Institution: Washington, D.C.

Torrence, Robin. 1989. Retooling: Towards a Behavioral Theory of Stone Tools. In *Time, Energy and Stone Tools*, edited by R. Torrence, pp. 57-66. Cambridge University Press: Cambridge.

Vaughan, Patrick C. 1985. *Use-Wear Analysis of Flaked Stone Tools.* University of Arizona Press: Tucson.

Yerkes, Richard W. and P. Nick Kardulias. 1993. Recent Developments in the Analysis of Lithic Artifacts. *Journal of Archaeological Research* 1:89-119.