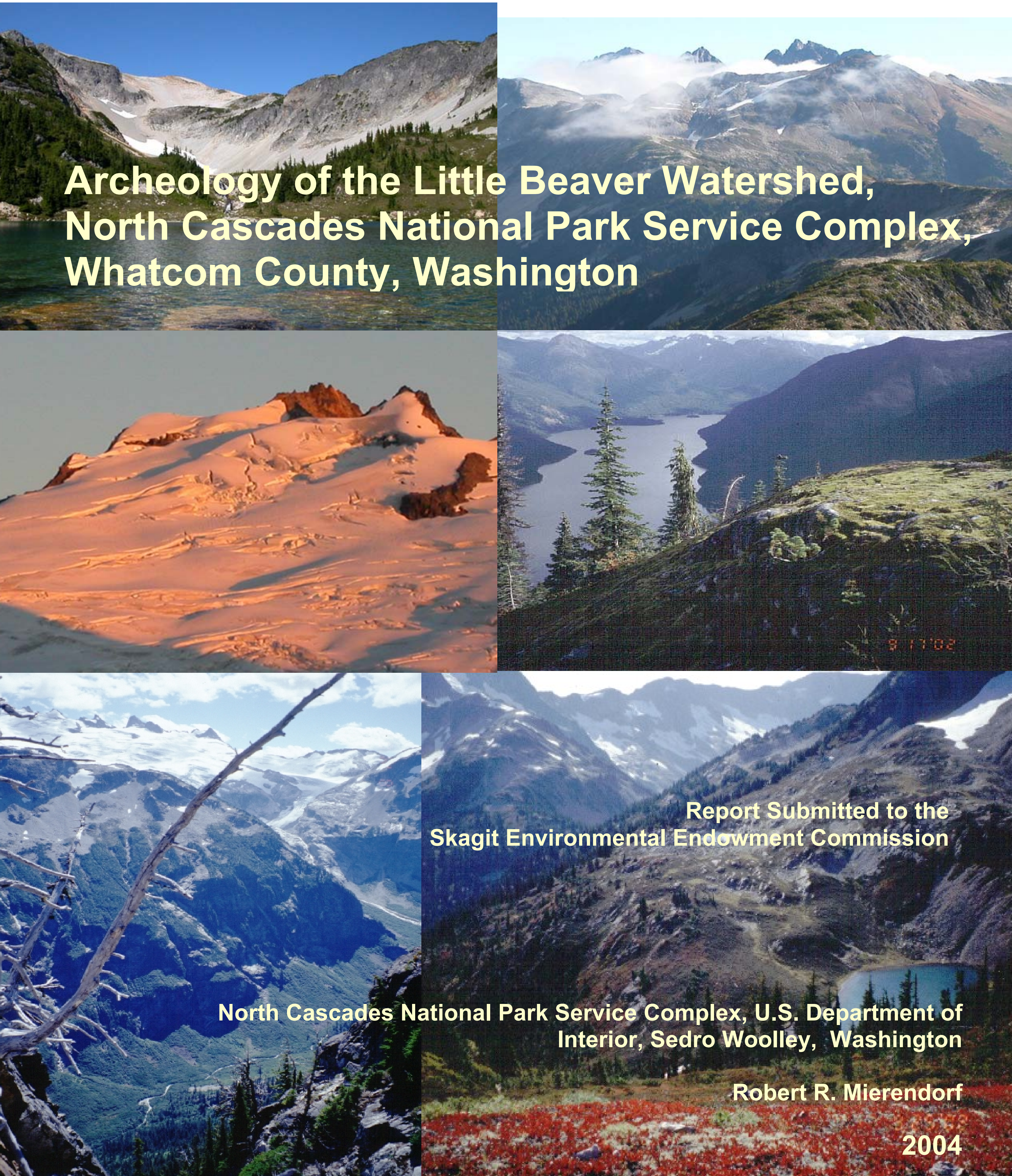

Archeology of the Little Beaver Watershed, North Cascades National Park Service Complex, Whatcom County, Washington

Report Submitted to the
Skagit Environmental Endowment Commission

North Cascades National Park Service Complex, U.S. Department of
Interior, Sedro Woolley, Washington

Robert R. Mierendorf

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by

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Report prepared for the Skagit Environmental Endowment Commission
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Report prepared by the National Park Service
North Cascades National Park Service Complex
Sedro Woolley, Washington

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This indicates fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation.

The Skagit Environmental Endowment Commission administers the Skagit Environmental Endowment Fund which was established by an agreement between the City of Seattle and the Province of British Columbia, settling the issue of raising Ross Dam. Its primary purposes are to conserve and protect the wilderness and wildlife habitat values and the enhance the recreational opportunities that are consistent with these values in the Skagit River valley upstream from Ross Dam.

ACKNOWLEDGMENTS

Because this report is the product of several kinds of cultural resource investigations spanning many years, it represents the cumulative efforts of many individuals and organizations. There is not enough room to mention them all.

The Skagit Environmental Endowment Commission and the National Park Service supported this work through funding and encouragement of the importance of understanding the long history of human involvement in the high elevation landscapes of the northern Cascades.

Traditional knowledge from the indigenous first people has been shared through numerous conversations, some during our Ross Lake tours, and through ethnohistoric records and documents that record indigenous experiences. Particular thanks to Upper Skagit, Stó:lō , Sauk-Suiattle, and Nlakápamux people for sharing their knowledge of traditional mountain ways. This form of knowledge, from those whose ancestors held tenure to the land for millennia, is a reality apart from all others.

At one time or another, members of all staff divisions of North Cascades National Park Service Complex participated in this project, as did cultural resources staff from the Seattle Office of the National Park Service. Margie Allen and Pat Young extended continuous administrative support to the project; Ron Holmes offered needed computer support.

As in earlier archeological projects funded by the Skagit Environmental Endowment Commission, staff and participants of the Student Conservation Association assisted us in the field for the excavation of archeological site 45WH220, which is discussed in this report. Gerry Cook made it possible to excavate the site for the mutual benefit of archeology and the SCA members.

Thanks to the on-going collaboration with my British Columbia colleagues, particularly Dave Schaepe and Stó:lō First Nation for the loan of artifacts for analysis from the Chilliwack Lake sites.

Craig Skinner, Northwest Research Obsidian Studies Laboratory, performed geochemical characterization of vitrophyre source samples. Tim Wahl provided the electronic version of the 1866 boundary survey map.

Those most directly involved in the implementation of the project and preparation of this final report are Brooke Larrabee, Andrea Weiser, and Jesse Kennedy. Archeological field assistance was rendered by Kevin Baldwin, Greg Burtchard, Dave Conca, Brooke Larrabee, Lance Martin, Dan Mulligan, Gregg Sullivan, and Andrea Weiser. Editorial review and comment was provided by Greg Burtchard and Brooke Larrabee

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1.0 INTRODUCTION

This technical report describes the results of an archeological survey funded by the Skagit Environmental Endowment Commission (SEEC). The goal of such a survey is to recognize and record the archeological remains of past human activity from both the pre-contact and contact time periods. The survey was conducted by National Park Service (NPS) staff in the watershed of Little Beaver Creek, which is a large tributary of the upper Skagit River in eastern Whatcom County, Washington (Figure 1). With the exception of a small area at the mouth of Little Beaver Creek, the watershed is within the Stephen T. Mather Wilderness, which is administered by North Cascades National Park Complex (herein, “the park”). The portion not managed as wilderness is within in the Ross Lake National Recreation Area, which is also managed as part of the park complex.

The survey targets the upper-most elevations of the watershed, comprised of the subalpine and alpine vegetation zones. The area is high in elevation (1525-2130 m above sea level), remote, and mostly lacking in maintained trails. Prior to implementation of this survey, only limited investigations had been made in the high country of the Little Beaver watershed.

Figure 1. Map of Pacific Northwest and the project area

All phases of the project were directed by R. Mierendorf, park archeologist for the park. Fieldwork was conducted during the summers of 2002 and 2003 by a team of archeologists consisting of between two and four members. In 2002 the team consisted of the author and Brooke Larrabee (park staff); in 2003 it consisted of the author, Andrea Weiser (staff archeologist at the park), Dave Conca (NPS archeologist at Olympic National Park), and Greg Burtchard (NPS archeologist at Mount Rainier National Park). The first surveys in the project area were conducted by the author and his archeological staff (Lance Martin and Greg Sullivan) between the mid-1980s and the mid-1990s.

The primary goal of this report is a comprehensive technical and descriptive record of the archeological resources in the project area. Such a goal typically dictates the use of a scientific writing style that many will find overly technical, particularly in the use of archeological terms having specific and often highly esoteric meanings. The language and style of scientific writing also reflects the need for objectivity and for a clear accounting of the relationship between the methodology applied to the problem and the data thusly acquired. In order to render the technical language more comprehensible to a general audience, Appendix A-1 offers a glossary of the most common technical terms used in this report.

2.0 ENVIRONMENT, CULTURE, AND ARCHEOLOGICAL RESEARCH IN THE NORTHERN CASCADES

2.1 Project Environment

Although environmental data for the project area are sparse, it is possible to summarize several of the primary characteristics of the watershed. Unlike lowland areas of the Pacific Northwest, little is known about contemporary climate, vegetation communities, and faunal populations in the mountainous interior of the northern Cascades. Even less is known about the paleoecological history, including the biogeography of plants and animals, role of fire and other disturbance processes, and the anthropogenic effects that the indigenous Northwest populations had on the landscape and its biota. In order to fully understand the human history here, it is necessary to know how human use of this landscape is influenced by mountain physiography, resource abundance and availability, climate, and human demography. This section details current knowledge regarding these influencing variables.

From the crest of the Pickett Range, Little Beaver Creek flows east for ca. 28 km (18 miles) before it joins the upper Skagit River (Figure 2). The watershed of Little Beaver covers an area of 166 km^2 (64 square miles) and constitutes one of the many remote, rugged, and untracked mountain valleys characteristic of the northern Cascade and Coast Ranges of Washington and British Columbia. The watershed is bordered by glaciated peaks and interconnecting alpine ridges that separate it from the watersheds of the upper Chilliwack River to the west, the Baker River to the southwest, Silver Creek to the north, and Big Beaver and Arctic Creeks to the south. Highest summits on the watershed divides are Mount Challenger at 2,523 m elevation (8,277 ft), Whatcom Pk. at 2,309 m (7,574 ft), Mox Peaks 2,593 m (8,504 ft), and Mount Spickard at 2,738 m (8,979 ft), with many other summits exceeding 2,000 m in elevation (Figure 3). There are presently 61 alpine glaciers in the watershed. Challenger Glacier, covering an area of ca. 3.4 km^2 (840 acres), is the largest and most prominent of these. It dominates the topography and scenery of the upper valley and the Whatcom Pass vicinity.

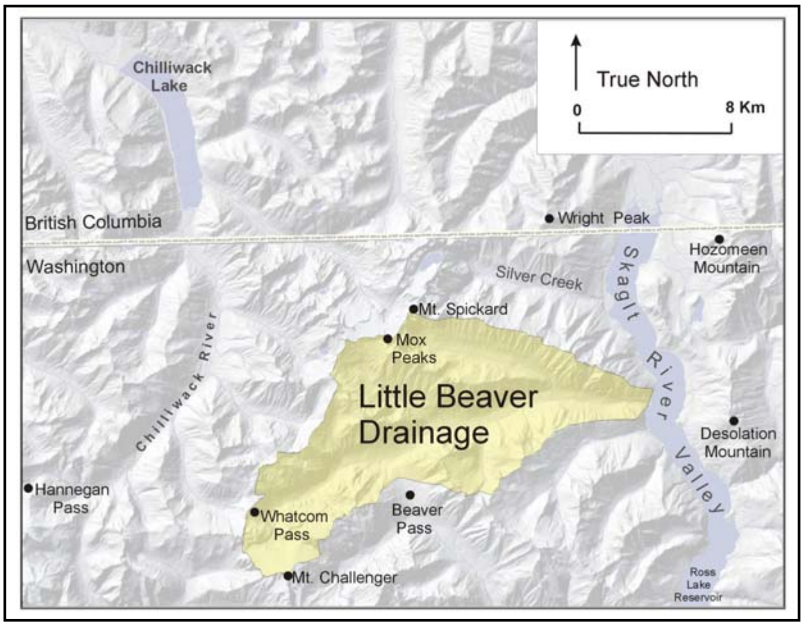

Figure 2. Map of Little Beaver watershed and vicinity and key geographic locations mentioned in the text.

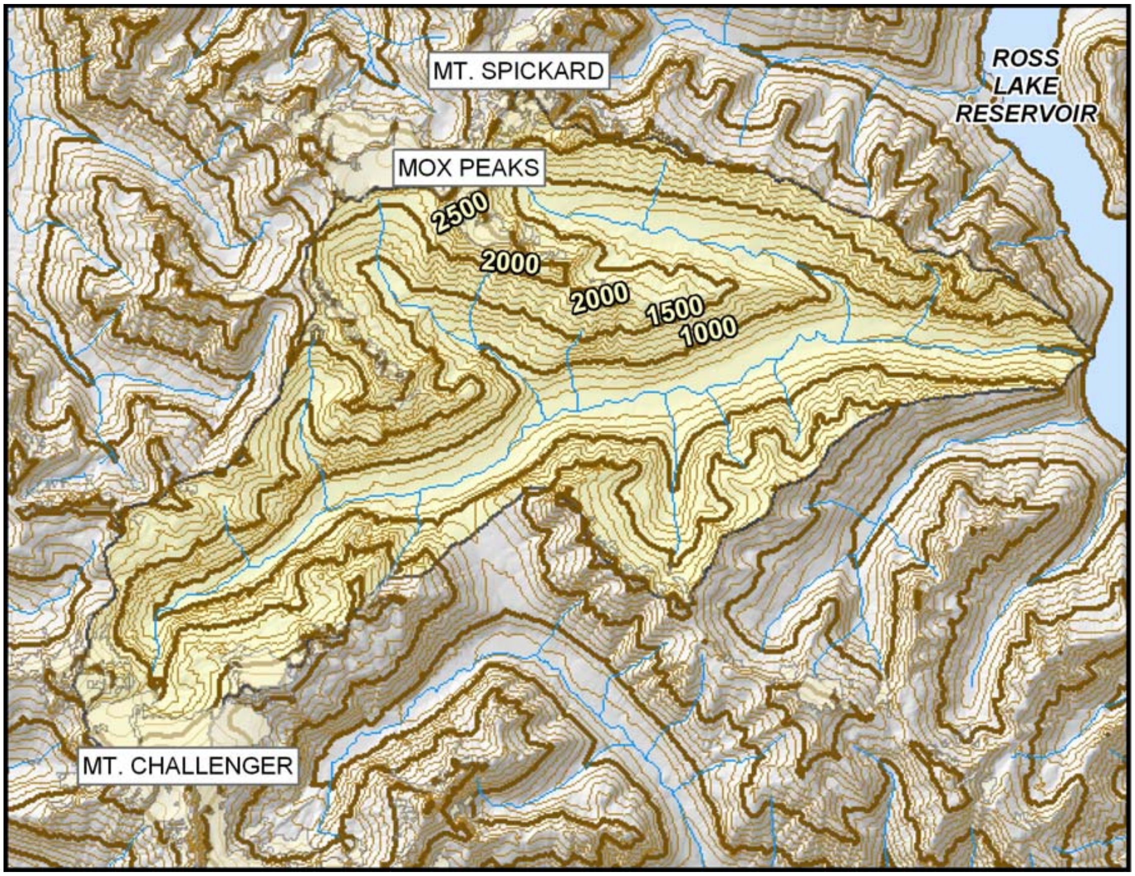

Figure 3. Topographic map of Little Beaver watershed vicinity; bolded index contour interval is 500 m; elevation of the index contour outlining Ross Lake is 500 m above mean sea level.

The only historic climate records of the watershed are from Beaver Pass, located along the southern watershed boundary at 1,890 m (3,600 ft). Annual precipitation at the mouth of Little Beaver Creek is ca. 0.8 m (30 in) and snowfall at Whatcom Pass is ca. 4.3 m (14 ft). At Hozomeen, near the international boundary, mean annual precipitation is 79 cm (31 in) (International Joint Commission 1971). Climate data from nearby recording stations in the Skagit Valley are shown in Table 1.

Table 1. Skagit River Climate Data[1]

Climate Station	Av. Max. T (^{o} F)	Av. Min. T (^{o} F)	Av. Total Precip.	Av. Total Snowfall
Skagit Power Plant 1931-1958	59.4	41.0	196 cm (77.14 in)	145. 3 cm (57.2 in)
Newhalem 1959-2003	57.5	41.5	203.1 cm (79.95 in)	94.7 cm (37.3 in)
Diablo Dam 1931-2003	57.4	39.7	191.0 cm (75.2 in)	141.5 cm (55.7 in)
Ross Dam 1960-2003	56.5	40.5	145. 3 cm (57.2 in)	121.7 (47.9 in)

[1]Data from Western Regional Climate Center (www.wrcc.dri.edu)

The eastern portion of the watershed is heavily forested on the valley bottom and along the valley walls. To the west the forest canopy becomes increasingly patchy, until the upper valley, where isolated tree islands are outlined by brushy avalanche communities, snow-maintained meadows, and rock walls, buttresses, and talus (Figure 4). Western hemlock *(Tsuga heteropylla)*, Douglas-fir *(Pseudotsuga menziesii)* and Western red-cedar *(Thuja plicata)* are most prevalent in the eastern portion of the watershed, and give way to a mostly late-successional mountain hemlock forest *(Tsuga mertensiana)* with co-subdominance of Alaska yellow-cedar *(Chamaecyparis nootkatensis)* and Pacific silver-fir *(Abies amabilis)* at sites like Beaver Pass. Much of the forest exhibits complex structure, with multi-storied layers of live, dead and dying trees, as well as many fallen trees. Some fallen trees are quite large, and all classes of decay are present. Along the valley bottom are several diverse vegetation communities within a riparian zone bordering the creek and shrubby communities growing on boulder fields associated with talus deposits, alluvial fans, glacial moraines, and rock slide deposits. This summary description draws on information in two environmental assessments published by the park, one for the Beaver Pass SNOTEL and the other for the Stillwell Camp trail reroute (National Park Service 2000 and 2001). It also draws on the park-wide vegetation map published in Agee and Pickford (1985).

Elevationally wide, subalpine parkland covers much of the western segment of the watershed and its higher elevations. This zone forms a heterogeneous patchwork of vegetation communities dominated by conifer trees, shrubs, herbs, and lichens. The alpine zone is relatively sparsely populated by plants, which have adapted to the extreme growing conditions among mostly permanent snow pack, bare bedrock, talus, glacial moraines, and glacial ice.

Dominant subalpine conifers include mountain hemlock *(Tsuga mertensiana)*, Pacific silver-fir *(Abies amabilis)*, and Alaska yellow-cedar *(Chamaecyparis nootkatensis)*. Subdominant species include White-bark pine (*Pinus albicaulis*) and subalpine fir *(Abies lasiocarpa)*. Like the montane forest below it, subalpine communities reflect an east-west gradient in elevation, precipitation, and other climate variables. Due to its greater habitat diversity, the subalpine exhibits a wide diversity in plant communities. Many subalpine meadows are dominated by the heather-huckleberry community, and other openings by lush herbaceous, dwarf sedge, and rawmark and low herbaceous communities of Franklin and

Figure 4. Little Beaver Cr. Valley, facing east, Hozomeen Peaks on the horizon at far left.

Dyrness (1988). Plants from these community types, observed within the boundaries of archeological sites recorded in the project area, include black alpine sedge *(Carex nigricans)*, partridgefoot *(Luetkea pectinata)*, white-flowered rhododendron *(Rhododendron albiflorum)*, mountain ash *(Sorbus sitchensis)*, boxwood *(Pachistima myrsinites)*, yarrow *(Achillea millefolium)*, parsley fern *(Cryptogramma crispa)*, Alaska saxifrage *(Saxifraga ferruginea)*, deerbrush *(Ceanothus velutinus)*, huckleberry *(Vaccinium membranaceum)*, subalpine spirea *(Spirea densiflora)*, serviceberry *(Amelanchier alnifolia)*, Sitka willow *(Salix sitchensis)*, wild strawberry *(Fragaria virginiana)*, kinnikinnick *(Arctostaphylos Columbiana)*, and mosses, lichens, and grasses. Throughout the project area subalpine, most often in heather-huckleberry communities, small trees, particularly Alaska yellow-cedar, are noticeably invading meadows and other openings. The only nearby study of modern meadow invasion by trees is reported from Chittenden Meadow, located on the Skagit Valley floodplain 11.5 km to the north (Lepofsky et al. 2000).

As indicated by historic records from the adjacent Skagit River valley, the Little Beaver watershed is likely to have been populated by a rich fauna that included black bear *(Ursus americanus)*, grizzly bear *(U. arctos)*, black-tailed deer *(Odocoileus hemionus columbianus)*,mule deer *(O. hemionus)*, mountain goat *(Oreamnos americanus)*, elk *(Cervus Canadensis)*, and cougar *(Felis concolor)*. Smaller mammals included beaver *(Castor Canadensis)*, marmot *(Marmota caligata)*, snowshoe hare *(Lepus americanus)*, bobcat *(Lynx rufus)*, lynx *(Lynx Canadensis)*, ermine *(Mustela eminea)*, river otter *(Lutra Canadensis)*, marten *(Martes americana)*, mink *(Mustela vison)*, red squirrel *(Tamiasciurus hudsonicus)* and Douglas squirrel *(Tamiasciurus doglasii)*. Over 170 bird species have been recorded in the valley (International Joint Commission 1971; Taber 1971).

Two broad groups of rocks comprise most of the watershed's bedrock. These are the granitic rocks of the Chilliwack Composite Batholith and the oceanic rocks of the Hozomeen terrane. Rocks of the Skagit Volcanics, a third type, are restricted to the northeastern extremity of the watershed. Exploratory archeological surveys of the Skagit Volcanic rocks immediately north of Little Beaver's watershed found no exposures of glassy rocks or evidence of their use (Mierendorf 1997). Figure 5 shows the approximate boundaries of the main rock groups in the project vicinity, as redrawn from the geologic map published in Tabor and Haugerud (1999). To the west, and outside of Little Beaver's watershed, rocks of the Hannegan volcanics include at least several dikes of glassy rocks, one of which was quarried and utilized as a source of tool stone for five millennia (Mierendorf 1999).

2.2 Environmental History

The environmental history and paleoecology of the watershed, as with most other mountain valleys in the northern Cascades, remains virtually unexamined. Nevertheless, data gathered from several local and regional investigations reveal the broad outlines of this history. Prior to ca. 12,000 years ago, the project area was mostly covered by the Cordilleran Ice Sheet, which advanced in several phases. At its maximum advance during the Vashon stade, ca. 14,500 years ago, only the highest peaks and ridges protruded above the glacier surface. By 12,000 years ago the glacier terminus had retreated north of the 49th parallel, and was followed by the brief re-advance of the Sumas stade, ca. 11,500 years ago. The long history and great extent of glacial erosion of the Little Beaver watershed is today expressed by the steepness of the local topography, the U-shaped cross-valley profile, the presence of non-local rock types derived from northern sources, and glacially smoothed and striated bedrock surfaces found at an elevation of at least 2,088 m. After the cordilleran glacier retreated, the highest peaks continued to support local alpine glaciers, as they do today.

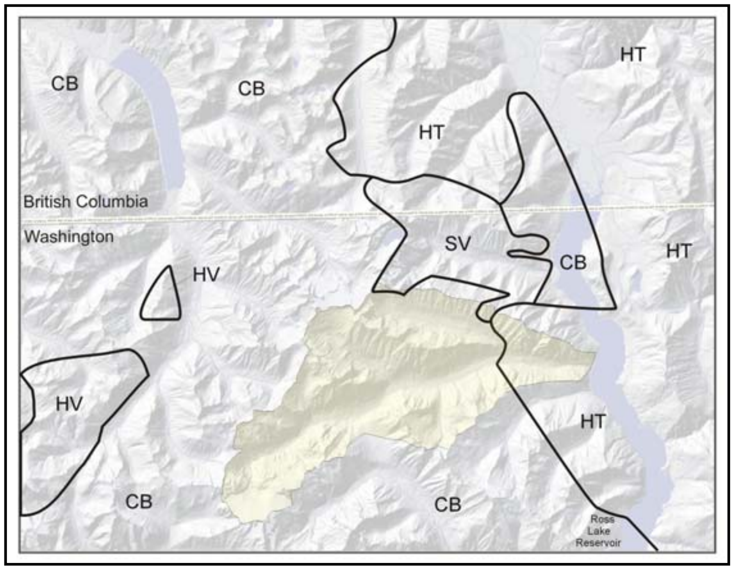

Figure 5. Geologic map of the project area; map unit boundaries approximate; HT, rocks of the Hozomeen terrain; CB, granitic rocks of the Chilliwack composite batholith; SV, Skagit volcanic rocks; and HV, Hannegan volcanic rocks are yellow.

Rapid regional warming of the climate marked the end of the Pleistocene and the beginning of the Holocene in lowland and coastal areas of the Pacific Northwest. This warmer period lasted until ca. 8,000 years ago, at which time the climate became cooler. During this warm period, Doug-fir and red alder became dominant tree species and fires occurred frequently. Following a shift to cooler conditions, the climate and vegetation became more like today, with the establishment of western hemlock and red-cedar forests. In the interior and montane portions of the Pacific Northwest, this shift to cooler and moister conditions was delayed until about 4,500 years ago or later. But the paleoclimate record of the lowlands may be of limited use for understanding the paleoecological history of interior Cascade valleys like the Little Beaver, which are transitional between coastal and interior environments.

After ca. 4,500 years ago, the spread of late-successional forests of hemlock and cedar contributed to increasing closure of forest canopies, compared with before; after ca. 2,500 years ago, similar forest types spread to western subranges of the Rocky Mountains of eastern Washington, northern Idaho, and southern British Columbia. The cooler and moister climate regime of the last 4,500 years also coincides with cycles in the advance and retreat of local alpine glaciers. The largest of these advances in the North Cascades is also the most recent; this “Little Ice Age” was a global event that occurred between ca. A.D. 1300 and A.D. 1850. In the last 150 years, alpine glaciers have generally retreated, in some cases dramatically.

Current understanding of the Holocene environmental history of the project area benefits from a recent paleoecological study in the Thunder Creek watershed, located ca. 40 km southeast. Here, Prichard (2003) examined forest and fire vegetation dynamics along several steep altitudinal gradients on a valley wall and the Holocene fire and vegetation history as inferred from preserved charcoal, macrofossils, and pollen in a mid-elevation lake (Panther

Potholes is at 1,100 m elevation) sediment core. Thunder Creek is a major tributary of the Skagit River and is comparable in its salient environmental characteristics with the Little Beaver watershed.

Prichard's study of forest dynamics revealed a surprisingly high diversity of conifer species (12) and that the "combination of steep environmental gradients, slow rates of forest succession, frequent fire, and other disturbances maintain a diversity of species assemblages and structures." (Prichard 2003). She found that low-elevation forests have similar composition and dynamics to lowland forests of the maritime Pacific Northwest. High elevation forests (>1,200 m), in contrast, are much more diverse and cannot be characterized by a single forest assemblage. The Holocene vegetation history inferred from the lake sediment core corresponds with the regional climate and vegetation pattern. No major changes in fire frequency were found over the ca. 10,000 year record of lake sediment charcoal. In summarizing the results of her own and other paleoecological studies in mountains, Prichard notes that climate variation measured at millennial time scales drives regional vegetation changes, while fire and other disturbances drive vegetation change at decadal to century scales. Also, unlike the case at low elevations, the response of high elevation forests to climate change is very site dependent. This means that in high elevation areas, "The type and timing of vegetation changes may not have been analogous to lowland sites due to differences in elevation, heterogeneous terrain, and more extreme growing conditions." (Prichard 2003:44).

2.3 Research Into Indigenous Use of the High Elevation, Northern Cascades Interior

The marine-influenced mountains of the Pacific Northwest cover vast tracts of the Northwest Coast and Plateau culture areas, but most authorities consider the mountains unimportant for understanding the pre-contact history of indigenous populations. Historically, the rugged and interior mountain areas attracted little serious anthropological and archaeological interest. There are several reasons for this, not the least of which is the difficulty of access, often necessitating travel across permanent snow pack, glaciers, avalanche paths, and steep topography, requiring skills not usually required of professional archeologists. Furthermore, there is no evidence to suggest that the high country supported other than very low population densities compared with the higher densities of lowland Coast and Plateau groups. Also contrasting with the lowlands, indigenous groups generally used the high country between spring and fall rather than year-around. Contributing further to the historical view is the loss of most traditional oral literature and traditional practices relating to use of the high country that followed the population decimation after the introduction of European diseases in the contact period. As a result, traditional subsistence activities and regular travel expeditions to the mountains ceased and mountain-oriented bands became displaced by early settlement and mining activities. Finally, a pervasive methodological limitation of archeological investigations also contributes to the lack of professional interest. This constraint, caused by the obscuring effects of extremely dense vegetation, limits the visibility of archeological remains. For decades, these factors combined to support the view among archeologists that few if any archeological remains would ever be found in the mountainous interior, which in turn reinforced entrenched beliefs that high elevation research would likely be unproductive. The cumulative effect of all of these factors has been the tacit denial that indigenous people had any real presence in the mountainous interior of the Northwest Coast culture area, this in spite of the fact that such landscapes cover the majority of the land area in northern Washington and British Columbia.

This view is now being challenged by new evidence. The last two decades have seen an increased level of interest and archeological inventory activity in the Pacific Northwest high country. Surveys in widespread high elevation landscapes of the Northwest Coast have revealed the presence of numerous pre-contact period archeological resources. The empirical data acquired in these surveys forms the basis for a revisionist consideration of pre-contact indigenous use of, and adaptation to, the high mountains. It may have been the case that some bands developed strategies especially adapted to the mountainous interior.

Although relatively few systematic surveys have been conducted in high elevation lands of the northern Cascades, results so far reveal that archeological remains are widely distributed. In the northern Cascades of Washington and British Columbia, subalpine and alpine archeological sites of pre-contact age have been recorded in watersheds adjacent to the project area. In North Cascades National Park, such sites are reported in the upper Skagit River watershed (Mierendorf 1997 and 1999) and in the Chilliwack River (a tributary to the Fraser River) watershed (Mierendorf 1987 and 1999). On the British Columbia side of the international boundary, high elevation sites are described in the Skagit River watershed of Manning and Skagit Valley Provincial Parks (Franck 2000 and 2003), and from the Chilliwack River watershed (Schaepe 1998 and 1999). High elevation archeological resources are also reported in the eastern North Cascades, in the Similkameen River watershed in Cathedral Provincial Park of British Columbia (Vivian 1989; Reimer 2000), and in the Methow River (Fulkerson 1988) and Stehekin-Chelan River watersheds of the Okanogan National Forest and the North Cascades park complex (Mierendorf 1986 and 1999).

Controlled excavations of high elevation archeological sites in the northern Cascades are even more infrequent than surveys. Test excavations have been conducted in only three localities in the northern Cascades subalpine anywhere near to the project area. In chronological order, these are in the upper Nooksack River watershed (McClure and Markos 1987), in the upper Chilliwack River watershed of North Cascades National Park (Mierendorf 1999), and in the upper Skagit River watershed of Manning Provincial Park (Franck 2003).

In contrast with the high elevations, more extensive archeological research has been conducted in bottom lands of the adjacent upper Skagit River valley, both around the shoreline of, and on the bottom of Ross Lake reservoir. The earliest surveys to inventory sites were conducted in the mid- to late-1970s by two separate university-based archeological contractors (Rice n.d.; Grabert and Pint 1978). Neither of these surveys recorded archeological remains at the mouth of Little Beaver Creek, although only Grabert and Pint (1978) specifically identify this area as one of their survey tracts. In 1984 site 45WH220 was the first recorded in the Little Beaver watershed during a reconnaissance survey conducted by archeologists also working under contract with the NPS (Mierendorf 1986).

Beginning in the late 1980s, an intensive site survey and evaluation program within the reservoir drawdown zone (the reservoir bottom exposed during each spring's lowered pool level) was conducted as part of the studies preceding the City of Seattle's application for a relicense to continue operation of its Skagit Hydroelectric Project. By the early 1990s, 144 pre-contact age archeological sites were recorded and nearly 40 of these were test excavated in order to assess their scientific and cultural significance (Mierendorf et. al. 1998).

In a separate investigation funded by SEEC, radiocarbon age estimates of a large quarry (45WH224), located not far from Little Beaver valley, revealed indigenous use of this portion of the Skagit River extending to at least 7,600 radiocarbon years (8,400 calibrated years). Test excavations conducted over several seasons (1987-1989) documented, for the first time in the Northwest Coast, the intensive quarrying, collection, and processing of local chert outcrops and deposits for the manufacture of stone tools (Mierendorf 1993). Largely due to inherent characteristics of the tool stone in massive outcrops, the quarrying and primary reduction activities left quarry assemblages dominated by poor tool-stone quality shatter and broken flakes. The much higher quality "quarry blanks" were transported to other sites in the Skagit Valley for later stages of tool fabrication (Mierendorf et. al. 1998). The information generated by these studies constitutes the most extensive archeological data available for an interior valley of the northern Cascade Range. As will be seen in the discussion of results, these data provide important comparative information necessary for understanding indigenous use of the Little Beaver watershed.

Currently, the City of Seattle, in partnership with NPS, is implementing the relicense phase of the Ross Lake archeological project, which requires the mitigation of reservoir effects to those sites determined eligible to the National Register of Historic Places. Now, 16 such sites are listed as contributing historic properties to the Upper Skagit River Valley Archeological District. Treatment and mitigation of these historic properties will be on-going for several years.

Within the project area proper, all previous archeological field investigations have consisted of either low intensity reconnaissance surveys, or intensive inventory level surveys conducted on small land tracts as part of environmental reviews required to assess the potential effects of park undertakings. Such undertakings consist of trail reroutes and bridge construction. One limited site assessment, consisting of the excavation of two archeological test units, resulted in the "hardening" of the floor of a historic shelter in order to protect a buried archeological component. The data recorded from these activities is maintained in park files and has not been published previously. The inclusion of this information later in this report constitutes the first synthesis of the current body of archeological data gathered for the Little Beaver watershed.

2.4 Pre-contact History of the Project Area

The following summary of the pre-contact history draws largely from the results of the Ross Lake archeological project (Mierendorf et. al. 1998) and related studies in the upper Skagit River Valley. The archeological survey phase covered 47 km^2 and recorded 150 sites, 36 of which were test excavated and assessed for National Register eligibility. Sixteen of the 36 sites are listed as contributing properties to the Upper Skagit River Valley Archeological District. Based on these studies, four main chronological periods are defined primarily on the basis of radiocarbon dates and to less extent, on diagnostic artifact types. The current sample of all archeological radiocarbon dates from the upper Skagit Valley is 38 and the sample of time-sensitive artifacts is 117. Time period boundaries are approximate. The first period spans 10,000-7,000 years ago; the second 5,500-3,500; the third 2,000-1,000; and the most recent 600-250 years ago.

Initial use of the upper Skagit Valley by indigenous populations began in the early Holocene, following retreat of the Cordilleran Ice Sheet, approximately 10,000 years ago. The earliest cultural levels of Desolation chert quarry (45WH224), dated 8,400 (calibrated) years ago, reveal that the first visitors to the area sought out the abundant tool stone sources, particularly of Hozomeen chert (Mierendorf 1993). The lowest levels of TU 14 at 45WH224 comprise the only excavated component dated to this period. Sites reflecting the second period appear to be more frequent. Based on frequencies of certain morphological types in the sample of 117 projectile points, the most intensive use of the project area was during the second and third periods, which span the middle and late Holocene. However, the largest number of radiocarbon-dated components is from the last two periods, which reflect a continuation of the procurement and use of Hozomeen chert along with a suite of other local and non-local tool stone types. The presence of well-preserved cooking features suggests longer-duration seasonal encampments than in earlier periods. The identification of animal taxa from bone fragments within cooking hearths from the last two periods indicates exploitation of local fauna, including mountain goat *(Oreamnos americanus)*, beaver *(Castor Canadensis)*, Cervidae (deer and elk), and unidentifiable small mammals (Mierendorf et al. 1998: Appendix H). The presence of tools manufactured from non-local sources (such as obsidian derived from sources in today's Oregon) indicate that the inhabitants utilized high quality tool stone procured via interregional exchange networks. The diversity of diagnostic tool forms and non-local tool stone types reveal that indigenous bands or groups from north, west and east of the northern Cascades traveled through the project area, procuring tool stone and gathering some of the many subsistence resources along the way. There is no current evidence to support an assertion for permanent or long-term habitation in any of these time periods, and all residential sites appear to reflect relatively short-term, seasonal occupation.

The closest permanent habitation sites to the project area are in the Chilliwack River valley of British Columbia, northwest of the project area. Through preliminary archeological investigation of a pithouse settlement (DgRk-10), one house dated 4,130 radiocarbon years old (Merchant et. al. 1999). A stemmed projectile point from this site, made of Hozomeen chert, corroborates the age estimate. If dated accurately, this constitutes the earliest known circular pithouse on the Northwest Coast (Merchant et. al. 1999:61). This habitation site is located 12 km upstream of the mouth of the Chilliwack River. Even closer to the project area, house pits have been confirmed at site DgRi-1, located on the moraine at the north end of Chilliwack Lake (Schaepe 1998). Like at DgRk-10, Hozomeen chert was also utilized as tool stone by the site inhabitants. Unlike the upper Skagit River valley, where pithouses have yet to be found, archeological and ethnohistoric evidence indicates that the upper Chilliwack River valley supported pithouse villages for at least four millennia.

The only chronological data that addresses periods of high elevation use are from test excavations at 45WH484, located in the subalpine of the upper Chilliwack River watershed. At this site, a continuous record of hearth use, along with exploitation of local vitrophyre (obsidian) tool stone and other subsistence resources, is documented for the last 4,500 radiocarbon years (Mierendorf 1999). The charcoal used to date the site was excavated from a repeatedly-used campfire/hearth area; the presence of St. Helen's W tephra near the top of the hearth area, bracketed by lithic artifacts, indicates the site was used after A.D. 1480. Currently, this is the only well-dated, excavated subalpine archeological assemblage in the northern Cascades. Although excavation data from this important site are presently unpublished, the assemblage is quantitatively dominated by a very high density of chipped stone debitage resulting from the bipolar reduction of vitrophyre from Copper Ridge geochemical source B (section 4.6 of this report). A much smaller proportion of the site's artifacts consist of tool resharpening flakes dominated by tool stone types from distant (exotic) and unknown sources. Although this site spans the last three of the four time periods identified above, no discernable differences in assemblage characteristics or site content were observed, suggesting little change in site use since the mid-Holocene. Given the long tradition of high elevation use suggested by radiocarbon dates from 45WH484, it is critical that more of the high elevation sites in the northern Cascades be test excavated in order to understand this poorly understood aspect of indigenous Northwest Coast life (Franck 2003).

Archeological remains representing the proto-historic period (i.e., the very end of the late pre-contact period) have not been found in the project area.

2.5 Ethnohistoric Background

In most anthropological literature, generalized maps depicting tribal or indigenous group territories fail to identify the Little Beaver watershed, which is ambiguously located among the hinterland boundaries of several Salish-speaking groups of people, in particular, the Upper Skagit, Nooksack, Stó:lō , and Nlakápamux (Lower Thompson) of northern Washington and southern British Columbia. Yet, scattered throughout anthropological and ethnohistoric documents are numerous local accounts of indigenous traditions of travel, resource use, and inter-group encounters in a broad interior portion of the northern Cascades that includes the project area (cf. Smith 1988). In summarizing the ethnohistoric details of the project area, this section of the report relies on Allan Smith's (1988) compilation of mostly published sources that were available in the mid and late-1980s, the period when Dr. Smith prepared the park's ethnographic overview. Most of Smith's compilation draws from the early works by Duff (1952), M. Smith (1952 and 1956), Hill-Tout (1904), Suttles (1957), Teit (1900), and others cited by Smith. Although his overview constitutes the first anthropological treatment of lands within the project area, certain archival documents unavailable to Dr. Smith, and more recently published documents, are used here to supplement Smith's data. Boxberger (1996) also uses ethnohistoric data, but his study is directed, instead, at assessing the available information regarding contemporary park-associated American Indian groups and the basis for claims of cultural affiliation with park areas. Majors (1984b), Wells (1987), Schaepe (1998), Boxberger and Schaepe (2001), and Franck (2003) provide additional new information.

Culturally, the Little Beaver watershed is within the territory of two historically very different indigenous groups. The first is the Nlakápamux, whose main populations lived to the north, along the Fraser River and the northern extremity of the Cascades in British Columbia. The second group is the Chilliwack, a tribe affiliated with the Stó:lō, the main villages of the latter concentrated along the Fraser River south and west of Nlakápamux territory. Although Smith (1988) characterizes both groups as mountain and high-land oriented tribes, significant cultural differences characterized the Nlakápamux and the Stó:lō. Linguistically and culturally, the Nlakápamux affiliated with people of the interior Canadian Plateau, and ranged widely through the northern Cascades and hunted the salmon-free valley of the upper Skagit River. In contrast, the Stó:lō people linguistically and culturally affiliated with Halkomelem peoples of the lower Fraser River, the Straits, and southeast Vancouver Island. According to Smith (1988), the Chilliwack appear to be unique among Stó:lō peoples for their close ties to the somewhat isolated Chilliwack valley, to the rugged mountains of its headwaters, and extending south into a portion of the upper Nooksack River valley. Unlike the upper Skagit River above the gorge, salmon abounded in the Chilliwack River system and constituted a staple subsistence food of the Chilliwack people. Both groups lived in winter villages consisting of semisubterranean dwellings. Despite the limited data available to Smith, contemporary evidence supports his inferences and assertions regarding indigenous use of the park's high country generally, and the project area, in particular. Subsequently, I have relied on Smith's conclusions to formulate my own ideas suggesting a strong mountain orientation in the adaptation of several groups, such as the Stó:lō and Nlakápamux (Mierendorf 1999).

In addition to the data compiled by Smith (1988), Wells' (1987:217) map plots indigenous trails along the Chilliwack River valley, connecting to the upper Nooksack River and the Skagit River via the Little Beaver. It also shows the upper Chilliwack River watershed (inside the park) was hunted for grizzly bear and beaver and fished for salmon. Majors (1984b), Boxberger (1996), Boxberger and Schaepe (2001) published copies of maps secured through the work of the U.S. Boundary Commission and others. These maps reveal the wide geographic area covered by traditional Stó:lo knowledge, particularly in the project area and it's vicinity.

The surveyor Henry Custer is the only ethnohistoric source (see Majors 1984b) providing a direct reference to an indigenous structure near to the project area in 1859. Custer's travel party observed a hut made of cedar in the Chilliwack valley a short distance west of the Little Beaver-Chilliwack divide (see 2.6 below). Schaepe (1998:6) provides archeological and ethnohistoric details regarding the pithouse village at the northern end of Chilliwack Lake, in addition to archeological excavation data confirming their function and integrity.

Among all ethnohistoric documents, Teit (1900:241) is unique for providing the only reference to indigenous knowledge of tool stone geography near to the project area: "The Lower Thompsons found stone for their arrow-heads near the head waters of Skagit River. Many were made out of large chipped heads, which are found in great numbers near the head waters of Skagit River." Based on the compatibility of this statement with independent linguistic and archeological data, Mierendorf (1993) infers a direct linkage to Hozomeen chert, one of several abundant tool stone types naturally-occurring in the upper Skagit River valley, and including the project area. Interestingly, no other ethnohistoric reference alludes to or anticipates the extent of indigenous knowledge and exploitation of tool stone found in and adjacent to the Little Beaver watershed.

The ethnohistoric data leave little doubt that the Stó:lo and Nlakápamux (and several other indigenous groups, such as the Nooksack and Upper Skagit) maintained historical linkages to places like the Little Beaver watershed. For their part, archeological remains can, in a sense, preserve some of the lost history of such places, and where historic documentation is weak, and knowledge of traditional practices are nearly forgotten, such remains reveal aspects about past cultures that developed from a long familiarity and involvement with the mountainous interior of the Northwest Coast.

2.6 Post-contact History

Like many other interior, glaciated watersheds of the northern Cascades, historic records and documents reveal little about early post-contact history of the Little Beaver. The valley may have been visited by trappers deployed from Hudson's Bay Co. forts in the early 19th Century. Only a few exploratory expeditions entered the watershed in the 19th Century, and none of these mentioned evidence of prior human use or habitation. Although only one early contact-period description of the Little Beaver watershed exists, it is revealing. The description ranks among the earliest natural history narratives of the Cascade Range of Washington due principally to the energetic efforts of Henry Custer (Heinrich Küster, of Swiss citizenship), an employee of the U.S. Boundary Commission. It was Custer's task to survey portions of the 49th parallel between today's British Columbia and Washington State. Of all early non-Native narratives detailing exploration of the northern Cascades high country, Custer's is unique in that it was derived from an extended period of time spent in subalpine and alpine terrain, rather than just a day or two (Majors 1984a). This contrasts with Alexander Ross' crossing of Cascade Pass in 1814; William Tolmie's exploration northwest of Mount Rainier in 1833; George McClellan's approach to Snoqualmie Pass in 1853; Edmond Coleman's ascent of Mount Baker in 1868; and Henry Pierce's crossing of Cascade Pass in 1882 (Majors 1984a).

Of particular relevance to the project area is Custer's 1859 trip up the Chilliwack River, over Whatcom Pass, and down the length of Little Beaver Creek to its junction with the Skagit River, with a party consisting of two other non-Indians and nine Indian porters and guides. Custer acknowledged the role of his indigenous employees in insuring the success of his surveys. He also expressed appreciation for the accuracy of the map drawn for him by Thiusoloc (reproduced in Majors 1984b, Boxberger 1996:41, Schaepe and Boxberger 2001:125, and Franck 2003:15), one of his Stó:lō guides in 1859. This map (not reproduced here, see reproduction in references cited) depicts and names the main watersheds and geographic features of a portion of the northwestern Cascades. On this map, the Little Beaver Creek reads "Sko-mel-poa-nook" and Whatcom Pass is depicted as a series of parallel hatch marks, with a straight line connecting the Little Beaver with the upper Chilliwack River. Using Thiusoloc's map information combined with the maps and notes of Custer and other surveyors (including John G. Parke U.S. Engineers, Chief Astr: and Surveyor, G. Clinton Gardner, Assist. Astr: and Surveyor, and Jos.S. Harris, Chas. T.

Gardner, George Gibbs, Francis Hudson and R.V. Peabody), the U. S. Boundary Commission in 1866 published a detailed map, a portion of which is shown in Figure 6. On this map, Little Beaver is labeled “Sko-mel-pua-nook Cr.”; Mt. Challenger is “Mt. Wil-a-kin-a-haist”. Whatcom Pass is located under the elevation label “5107” and the Chilliwack River is “Klah-heh Cr.”. Unlike Thiusoloc’s map, no line is drawn through the pass, connecting the Little Beaver and Chilliwack watersheds, and no trail is shown through the Little Beaver watershed.

Custer’s notes, sketches and maps are drawn on for the following account of his August 1859 excursion south, up the Chilliwack and then east, over the high divide that separates it from the Little Beaver, as edited and annotated in Majors (1984b).

In only one place did Custer and his party encounter evidence of prior indigenous activity along their route. On the afternoon of August 9, Custer’s party established an overnight camp on the Chilliwack River about 0.8 km above the mouth of today’s Brush Creek, and ca. six km west of Whatcom Pass. Their camp was “near an Indian hut, made of the bark of the Cedar”. Although Custer provides no additional information about this structure, its presence speaks clearly to an indigenous presence in the upper Chilliwack in the early historic period. This “hut” was likely an expediently-built, overnight shelter used by a small group traveling through the valley.

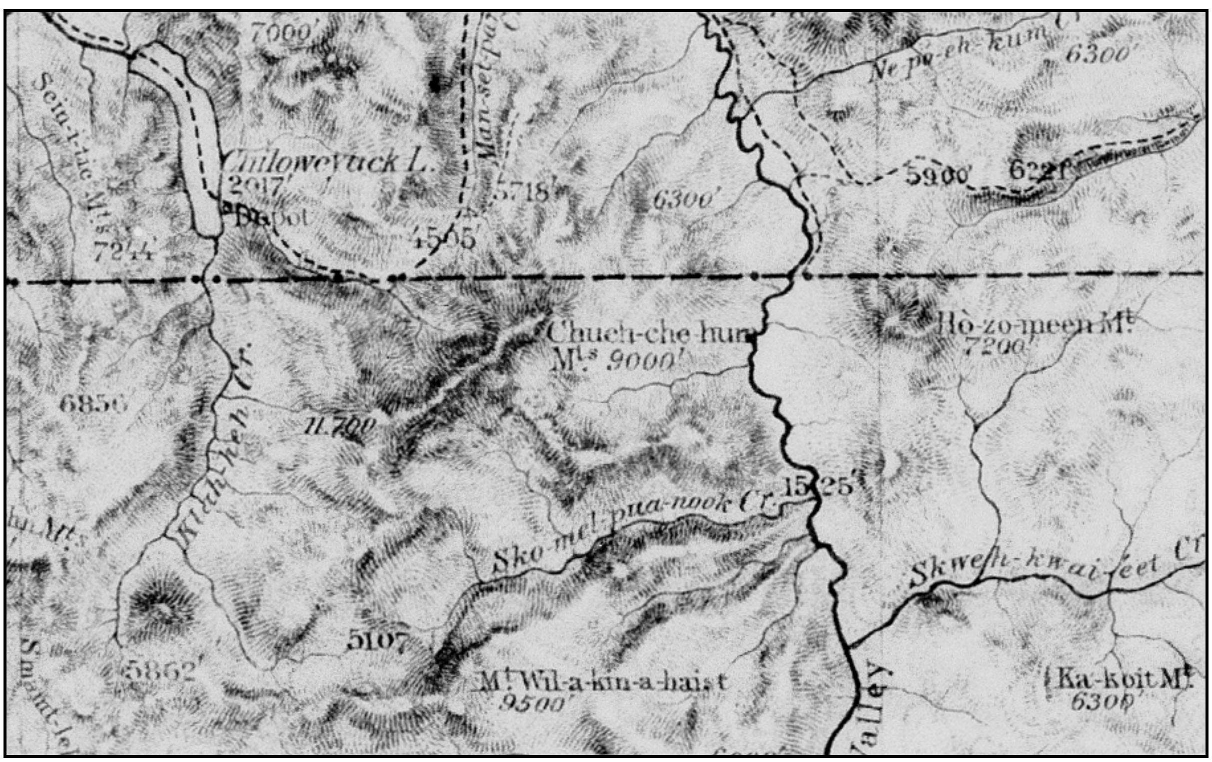

Figure 6. Portion of U. S. Boundary Commission Map, 1866, showing the project area and near vicinity.

Subsequent entries in Custer’s notes do not directly relate to indigenous history, but they offer insights into the natural history of the Little Beaver watershed. More than this, the account serves as a rough yardstick for the travel capabilities and perceptions of the landscape revealed by Custer's energetic travel party. In certain details, his party must have mirrored the experiences of travel parties that for millennia penetrated the mountainous Cascade interior. Most travel today through the project area is on maintained trails, and it is only the rare intrepid hiker who ascends and descends slopes in the manner described by Custer. Lacking the luxury of today's maintained trails, Custer and his party sought the paths of least resistance. In many cases, this required that they walk on the gravel bars of stream channels, involving frequent re-crossings of the stream to avoid obstructions, particularly log jams and dense brush dominated by vine maple (*Acer circinatum*). On several occasions the party ascended and descended the fall line of steep valley walls between the valley bottoms and ridgelines. One such descent was from Whatcom Pass to Little Beaver Creek (976 m elevation loss) on August 11, which Custer described as:

> "..the steepest and most dangerous I ever have made. Had it not been, for the bushes and small trees, which gave us an occasional point of appuy [apply=support], we would have found it impracticable. As it was, it could only be overcome, by the utmost caution on our part, by using our hands, arms, legs, and sti[c]ks, freely in a multitude of novel positions. Once to have lost foothold here, nothing would have been left to the unlucky climber, but to resign himself to the inevitable fate of being dashed to pieces [sic] on the sharp and frightful rocks below him."(from Majors 1984b:152).

During this trip, Custer became the first to note in writing the presence of white and pink heather (*Cassiope mertensiana* and *Phyllodoce empetriformis*) and of Mt. Challenger and its glacier. Following their descent into Little Beaver valley, the party established three different camps in trekking their way to the creek's junction with Skagit Valley. Their camp of August 13, their last in the valley, was on the south side of Little Beaver Cr. opposite the mouth of today's Perry Creek. The next morning Custer and his aid Mitchly scaled partway up the steep and rocky mountain to the east in order to reconnoiter their position. Had rain and clouds not turned them around, they would have ascended to the top of the ridge crest that is informally referred to as "Little Beaver Ridge" and whether or not they would have recognized the fact, Custer and Mitchly would have then arrived at an ancient ridgeline route connecting several Hozomeen chert quarries.

Between the 1880s and 1890s several surveyors, including R. M. Lyle and Banning Austin, explored the mountains in the vicinity of Hannegan and Whatcom passes in search of a route that would connect to the Ruby Creek mining claims. Contrary to Austin's recommendation, the Washington State Road Commission failed to appropriate funds to build a road over Whatcom Pass to the Skagit valley (Beckey 2003:278). The explorations of others, particularly early geologists, brought them into the Little Beaver watershed for scientific purposes. Later, under management of the U.S. Forest Service, trails were built primarily to aid in fire suppression. Today this trail system provides access to hikers, climbers, and packers who cross the Pickett range while traveling between the Little Beaver valley and Chilliwack valleys. This is the only maintained trail that today crosses the rugged Picket Range.

3.0 RESEARCH DESIGN AND METHODS

3.1 A Research Framework for Understanding the Little Beaver Watershed

The highest elevations of mountain cordillera seem to most observers an unlikely landscape to investigate the relationship of indigenous populations to their environment. Such areas offer, after all, a harsh and limiting environment for human use much of the time, and there is no general acknowledgment of the importance of such landscapes to pre-contact indigenous populations over much of North America. Nevertheless, evidence from mountain cordillera around the world reveals the important influences they exert on the human populations that reside in and near to them.

Perhaps there is no better place than right here in the Pacific Northwest to examine the reciprocal influences of human groups and montane ecosystems. After all, much of the land area is ruggedly mountainous, and the juxtapositions of oceans and sounds, cordillera, plateaus, and basins, result in an ecosystem diversity and richness that exerted profound influences on indigenous populations. The marine-influenced mountain ranges of the Pacific Northwest possess several ecological characteristics not found in the continentally-influenced ranges of western North America. Pacific Northwest mountains exhibit maturely-glaciated valleys, great elevational relief, and heavy snow accumulation resulting in numerous active alpine glaciers and permanent snow patches, and an elevationally broad and lush subalpine belt (Mierendorf 1999). By contrast, continentally-influenced ranges exhibit less mature glacial erosion, moderate relief, and lower annual snowfall resulting in few active glaciers and a narrow subalpine belt. Historically, continentally-influenced ranges, such as the Rocky Mountains, have a long tradition of archaeological research, whereas maritime-influenced ranges like the northern Cascades, do not. Archeological assemblage characteristics, chronology of use, the structure of subsistence resources, the effects of population aggradation, more intensive use of subsistence resources, and the effects of climate change are several of the important but poorly understood problems to be investigated in Pacific Northwest high country studies. Investigation of these issues promises to shed new light on the pre-contact history of Pacific Northwest indigenous groups.

Understanding of the Little Beaver watershed's archeology is achieved by considering four main factors, and their differing relationships at different temporal and spatial scales. The four variables considered necessary and sufficient for understanding (and ultimately, explaining) archeological assemblages are resource structure, climate, physiography, and demography (or socio-cultural factors) (Mierendorf 1999). However, the relationships between these variables is not constant, but varies according to scale. Thus for example, the annual distribution of subsistence foods in Little Beaver watershed over one year may have little to do with the distribution of these same resources across the entire Pacific Northwest over the last several thousand years.

Resource structure consists of the temporal and geographic availability of food and utilitarian resources. Those who study pre-contact history have known for a long time that the dispersion of subsistence resources over time and space results in very different human foraging strategies compared with landscapes having subsistence resources concentrated in time and space. Within the Little Beaver watershed, resources tend to be concentrated due to the steep gradients in slopes and climate variables, and due to strong seasonal differences in these variables. But at a regional scale, these same resources are dispersed across many such watersheds, and have been for millennia. As noted in section 2.2, climate variations occurring at millennial scales tends to drive regional vegetation changes while fire and other disturbances drive vegetation change at decadal to century time scales. The abundance and availability of indigenous animal and plant food resources are controlled largely by climate variables, but local climate effects more than just food. It may, for example, render certain mountain landforms unfavorable for habitation, due to pervasive cold air drainage or winds, as controlled by local physiography, the third variable necessary to consider. Local physiography may not be an important variable in many lowland landscapes, but in montane environments it assumes great importance at both local and regional scales. The last variable, demography (or socio-cultural phenomena), acknowledges the importance of cultural influences on how groups used montane landscapes like the project area. A remarkable quality of the Little Beaver watershed, in fact, derives from the interaction of physiography and demography, resulting in two very different demographic conditions when comparing the eastern and western extremities of the watershed. Not a great distance to the west and north of the western extremity lies the broad Fraser River valley, characterized by large, dense populations dwelling in large winter villages. The pithouse villages extending up the Chilliwack River valley, as far as Chilliwack Lake, are even closer to the project area. In contrast, the eastern extremity is distant from any such population centers or any permanent settlements. Here, only dispersed mobile groups, from widely separated and distant population centers, foraged seasonally across a vast expanse of the upper Skagit River valley and its tributaries. In this sense, the Little Beaver watershed serves as a demographic boundary, a characteristic that has been associated with high mountain massifs that form the headwaters of the largest regional watersheds, such as the Fraser and Skagit Rivers (Mierendorf 1999:17).

One goal of this project is to investigate archeological sites in an extreme environment, where the factors of physiography and climate are considerably more constraining to human activity than in the lowland terrestrial environments of the region. Partly this is because extreme (or "marginal") environments can be sensitive to certain kinds of cultural change, be they triggered by demographic or climatic influences. From this perspective, the Little Beaver project offers an optimum area for investigating pre-contact indigenous adaptations to montane environments.

3.2 Survey and Inventory Methodology

Archeological survey refers to the set of techniques used to discover, describe, and inventory previously undetected archeological resources. The primary survey technique employed in the project area requires walking a series of transects in order to visually detect archeological sites. Ideally, transects are spaced close together, with each crew member walking approximately parallel transects. While following each transect, crew members walk a more or less sinuous route in order to see more of the ground along the transect. Due to the constraints imposed by demanding field conditions, however, transects are rarely parallel;

rather, their course is most often determined by the need to avoid steep slopes and cliffs and other obstructions. The extreme relief that characterizes the Little Beaver project area overrides other factors, frequently requiring crew members to judgmentally select only safe routes.

Surveyors are trained to detect a range of cultural resource types, including stone tools and the debris produced during tool manufacture and maintenance; on-the-ground features such as pits and trenches, and stacked rock features such as walls and cairns; charcoal concentrations, especially in association with fire-modified rocks or other artifact types; culturally-modified trees; rock art; structures such as cabins; and historic artifact concentrations and debris scatters.

Cultural resource data are recorded on-site on site inventory forms. In most cases, site locations were recorded with a hand-held GPS (Global Positioning System) unit; in other cases, site locations were determined with the aid of an altimeter and 1:24,000 scale U.S. Geological Survey topographic map. Sites are assigned a field number at the time of discovery and all subsequent field notes and records are referenced to this number. Later, in the laboratory, another site form is prepared and sent to the state Office of Archeology and Historic Preservation in Olympia, where each site is assigned a Smithsonian trinomial number.

Removal and collection of artifacts from sites is limited to formed tools, culturally and temporally diagnostic artifacts, small samples of flaking debris (≤5 items) and representative samples of natural rock or mineral specimens, as dictated by analytic tests, such as X-Ray Fluorescence analyses (see section 3.3 below).

3.3 Special Analyses: X-Ray Fluorescence Analysis of Vitrophyre, Electron Microprobe Analysis of Tephra, Radiocarbon Dating of Charcoal

The analysis of archeological remains in the study area utilizes several laboratory techniques requiring specialized scientific equipment. The results of these analyses provide the data necessary to identify tool stone sources and volcanic ashes, and to date organic remains. Below, each technique is briefly described, accompanied by the name of the laboratory and references to more technical information about these analyses.

X-Ray Fluorescence analysis (XRF) of obsidian provides a way to obtain the chemical "signature" of known obsidian sources. Archeologists have successfully used such signatures to follow the indigenous routes of obsidian movement in Northwest Coast (Carlson 1994). Because the test is non-destructive and requires no chemical pretreatment, all samples, including artifacts, are unaltered by the analysis. A Spectrace 5000 energy dispersive X-ray fluorescence spectrometer measures peak signals corresponding to the quantity of individual trace elements in each sample. These signals are then converted to trace element quantities in parts per million (ppm) (for detailed information about the analysis of North Cascades samples, see Skinner 1999a and 1999b). The trace element composition in ppm for the suite of measured elements makes up the chemical signature of the sample.

A total of four artifacts from the project area was analyzed using XRF in order to determine if any could be correlated with known, chemically-characterized obsidian sources. Three of the samples are from 45WH631 and one sample is from 45WH515. All samples were collected from the site surfaces by NPS archeologists as part of site documentation. In later sections of this report, the results of these analyses are compared with the chemical signatures of vitrophyre (obsidian) sources and artifacts from several other sites in the northern Cascades (see Appendix A-2 for trace element data). This comparison is made possible by the use of XRF data obtained on a large sample of vitrophyre specimens removed from source outcrops from the adjacent Chilliwack watershed. These data, previously unpublished, are derived from a long-term research effort by the author to identify, verify, and chemically characterize glassy tool stone types found in the park's volcanic terrain. All XRF analyses used in this study were conducted at the Northwest Research Obsidian Studies Laboratory, a commercial laboratory operated by Craig Skinner in Corvallis, Oregon. Results of the analysis are described in section 4.6.

Layers of volcanic ash are common in Northwest archeological sites. Electron microprobe analysis has been used successfully to identify the source volcano and ages of volcanic ash (tephra) layers. Similar to XRF, the technique provides a measure of the major element composition of glass shards within an ash sample in order to develop a chemical "signature" of the ash. Prior to analysis, each ash sample is cleaned by chemical pretreatment, permanently mounted on a slide, and then analyzed on the Cameca electron microprobe at the Geo-Analytical Laboratory located in the Department of Geology, Washington State University (see Foit et al. [1993] for a more detailed description of the technique). The chemistry of the sample is then compared to a database of tephra signatures of dated eruptive events. Results of the analysis are described in section 4.5.

One sample from a primary tephra layer was collected from 45WH631 and analyzed in order to identify its source. The chemical composition of the sample is matched to a known tephra from a dated eruptive event. The age of the event is then used to estimate the age of artifacts observed in association with the tephra layer. This tephra sample is also compared with several chemically similar tephra identified from other nearby localities outside of the project area (see Appendix A-3 for tephra sample chemistry data).

Radiocarbon dating of organic matter is one of the most accurate techniques for dating sites. The technique employs an extremely sensitive counter to measure the radioactivity of stable and unstable isotopes of the element carbon, which is found in all living things. The derived radiocarbon age of a sample is actually the estimated time that has transpired since the parent organism ceased incorporating atmospheric carbon into its body, in other words, since it has died. Artifacts and other archeological site components are dated directly if they are made of organic materials, or indirectly if they are themselves undatable, but are physically associated with dated organic matter. Radiocarbon samples are subjected to strong chemical pretreatment and are destroyed in the subsequent analysis.

Three charcoal samples from 45WH220 provide the most accurate estimate currently available of the duration of indigenous use of the Little Beaver Creek watershed. All three samples consisted of charred woody tissue recovered from *in situ* in excavation levels 3 and 4 of Test Unit 2 (hereafter, TU2). All samples were analyzed by Beta Analytic, Inc., a commercial radiocarbon-dating laboratory located in Florida. Results of the analysis are described in section 4.4.5.

3.4 Tool Stone Confidence Classes

The accurate identification of tool stone types in archeological assemblages is a critical step in investigating questions about pre-contact indigenous subsistence, settlement, and group movements. One of the main techniques used for such investigations requires the identification of the provenance of geologic sources of the stone materials used by indigenous people to manufacture tools. However, given the great variety of tool stone types found in northern Cascades archeological assemblages, the abundance of geologic source areas, and the overall scarcity of archeological studies, it is understandable why there is little comparative information to draw on. As a result, the provenance and descriptive data currently available for tool stone sources is uneven, and ranges in accuracy from extremely poor to good. It follows, then, that any inferences based on imprecise data will have a low confidence level.

As a means of addressing this problem, I have developed a method to rank the confidence level of tool stone identifications and geologic provenance data for the project area and the adjacent upper Skagit River valley. The method uses four criteria for ranking confidence (see section 4.2 for a detailed discussion of how this is done). Of seven distinctive lithic types described in the project area, only two ranked “high” in confidence level. Comparison of assemblages and inferences regarding subsistence, settlement, and mobility in the project area are based on these two tool stone types (Hozomeen chert and Hannegan vitrophyre).

3.5 Test Excavations

Included in this report are the results of a text excavation conducted in July, 1996, at site 45WH220, which is located on a rocky, glacially-scoured bedrock bench several hundred meters upstream of the junction of Little Beaver Creek with the Skagit River. The site is located above the point where the creek exits the Little Beaver valley and has built its alluvial fan on the Skagit River flood plain. The purpose of the test excavation was to assess the effects to the archeological site of stabilizing the ground surface inside a historic shelter. This shelter is a rectangular, three-sided log structure, 3 m by 3.9 m, built to accommodate the needs of recreational visitors. The exact date of construction of the shelter is unknown, although it predates NPS administration of the park.

In order to prevent erosion of the shelter floor, NPS staff proposed to harden the ground by placement of a layer of crushed rock. Prior to any such action, two 1 m square test units were excavated into the shelter floor in order to determine if archeological remains would be effected by this undertaking. This constitutes the only excavation done at this site to date. Following the excavation, the ground was hardened in a manner that helps to protect the important archeological remains.

Excavation was conducted in conformance with standard procedures used in the park and elsewhere. All soils and sediments were excavated with a trowel and were sieved through a 6.3 mm (1/4 in) mesh screen; excavation proceeded by successive 10 cm thick levels; however, several levels deviated ± several cm from this thickness in order to avoid mixing together natural stratigraphic layers. All artifacts, regardless of time period, were collected in labeled level bags. Excavation data is recorded in excavation level forms, plan view maps, stratigraphy diagrams, a bag catalog list, crew field notes, photographs, and photograph roll logs.

The test excavation at 45WH220 was directed by the author; the field work was performed by two NPS staff archeologists, eight Student Conservation Association (SCA) volunteers, and their two SCA leaders. SCA volunteer groups annually work in the park to assist in the construction and maintenance of recreational facilities. The "international" SCA group consists of high school students from British Columbia and the U.S.A. Given that one of their tasks involved the rehabilitation of the shelter, the SCA volunteers first spent one week excavating the two test units under the direction of the NPS archeologists.

The test excavations conducted at 45WH220 were initiated by the park in compliance with the need for cultural review of recreation facility improvements. This compliance is unrelated to the on-going archeological investigations in Ross Lake that have been mandated by the City of Seattle's settlement agreement on historic resources, a condition of its license of the Skagit Hydroelectric Project (FERC No. 553), granted by the Federal Energy Regulatory Commission. The activity of the 1996 international SCA group was funded by SEEC.

3.6 Curation of Project Collections

All collections from this project are accessioned, cataloged, and permanently preserved at the park's curation facility located at the NPS Skagit District Ranger Station, Marblemount, Washington. The collections consist of artifacts and geologic specimens, and archival records of project notes, site maps, photographs, and related documentation. The curation facility meets federal standards developed for collection repositories.

4.0 RESULTS OF INVESTIGATIONS

It is important to note that this report does not follow conventional practices of most technical archeological reports regarding the disclosure of site locations. No exact site locations are reported here, and photographs and other information that could lead to relocation of archeological remains are avoided. Even the site locations plotted on maps are generalized. This policy is meant to protect cultural remains from vandalism and unauthorized collection of artifacts. The policy is an acknowledgment of not only the scientific value of ancient archeological remains, but also of the cultural value of such resources to the heritage and traditions of contemporary indigenous groups and the interested public. This confidentiality is in keeping with federal statutory and regulatory guidelines and the administrative policies of the NPS that are meant to protect significant cultural resources.

4.1 Field Survey Results

The total of areas surveyed (1.16 km^2) covers only a small proportion (ca. 0.7%) of the entire watershed (166 km^2). The observed site density for the sampled area is 6.9sites/km^2. This density value is not likely to be representative of the entire watershed for several reasons. First, it is probable that the most culturally sensitive survey tracts were selected for examination. In particular, the sample is biased in favor of flat landforms and unfavorable to steep slopes of the valley walls. Although a probabilistic survey strategy is desirable, it is expensive and impractical in the densely wooded, steep slopes of the project area (for many reasons, it is also the case that a probabilistic sampling strategy does not assure a representative sample). The other major source of sample bias is caused by the obscuring effect of dense vegetation and other ground cover, which render subsurface and surface archeological remains invisible in the absence of extraordinary efforts to make them so.

Four previously unrecorded cultural resources were inventoried in the project area during implementation of the field surveys (Table 2). Two of these are documented as archeological sites (45WH631 and 45WH633) and the other two as isolated finds (IF-117 and IF-119). The following narrative provides a brief description of each of these cultural resources.

Table 2. Archeological Resources Inventoried in Survey

			Flaked Artifacts		Lithic Material Type		
Trinomial Site No.	Collection Type	Artifact Count	Formed Tools/ Diagnostics	Flakes and Shatter	Hozomeen Chert	Vitrophyre	Other
45WH631	Surface	75	1 Olcott biface; 1 side-notched point base	73	4	66	1 obsidian; 1 banded CCS; 1 Cache Ck. basalt; 1 metasediment; 1 Allenby Chert
45WH633	Surface	11	1 hammerstone	10	10	0	Unknown
IF 117	Surface	1	0	1	1	0	0
IF 119	Surface	0	0	-	0	0	Limonite
Totals		87	3	84	15	66	6

4.1.1 45WH631

The site is an open scatter of chipped stone on exposed mineral soil, located in a subalpine saddle at 1,587 m (5,200 ft) elevation. The site boundaries encompass an area ca. 400 m^2 (like so many high elevation sites, the actual site dimensions are likely to exceed the observed dimensions). The observed artifact assemblage totaled 75 flaked items, the majority consisting of whole and broken flakes. With 7 distinctive tool stone types represented in this assemblage, the site exhibits the greatest lithic material richness (diversity) of any in the watershed. Based on X-ray fluorescence analysis of 3 artifacts collected from the site surface, combined with visual assignment of other similar-appearing artifacts to the lithic category "vitrophyre", it is inferred that 88% of the assemblage is dominated by vitrophyre derived from Hannegan volcanics (see section 4.6).

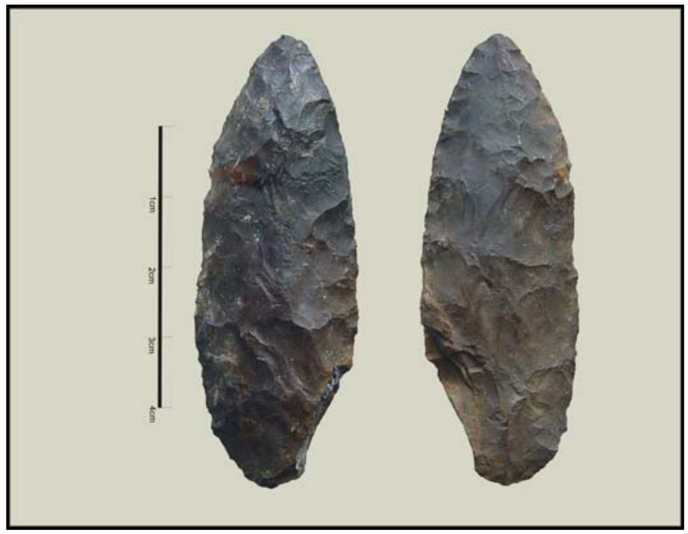

Figure 7. Olcott Series biface, 45WH631.

One early-style (Figure 7) and one late-style (Figure 8) projectile point are the only formed tools observed at the site. Table 3 shows metric attributes of the points. The early morphological point type belongs to the Olcott series, which is estimated to date between ca. 9,000 and 5,000 years ago; this estimated age range is derived from dated sites outside of the park because it has yet to be recovered from datable contexts within the park. For this reason, use of Olcott points as the sole dating technique is problematic, and it has been suggested that their use may extend even into the late period (Mierendorf et. al. 1998:352). The "point" was probably hafted in a socketed shaft and functioned as a spear point or a cutting knife, or both. It is made of a dark brown, fine-grained variety of chert, tentatively identified as "Allenby chert." Vivian (1989) describes the source location of this tool stone and its appearance in outcrops in the Similkameen River valley of southern British Columbia. Olcott series points occur in relatively high frequencies in the upper Skagit River valley at the eastern margin of the project area (the series is included within morphological Type 3 in Mierendorf et al. 1998:500-501). One of several Allenby chert reference specimens provided by Vivian and housed at the NPS curation facility in Marblemount closely matches this Olcott tool stone. Artifacts made of Allenby chert were also found in sites in the Ross Lake area and comprised <1% of the total of all lithic assemblages analyzed (Mierendorf et al. 1998). This Olcott series point may be the oldest (based on morphology and style) formed tool recorded in the subalpine of the park.

The late-style point consists of a basal (proximal) fragment of a small side-notched point. It is made of a black, fine-grained basalt that is visually-similar to Cache Creek basalt, which outcrops upstream of the Fraser River valley canyon (Rousseau 2000). Like Allenby chert, Cache Creek basalt is one of the exotic tool stones that occur in <1% of all upper Skagit River valley archeological assemblages. Identification of this material type as Cache Creek basalt is based on reference samples stored at the NPS curation facility in Marblemount. Points of this style (classed as morphological Type 15 in Mierendorf et al. 1998:514) are widespread in the upper Skagit River valley and elsewhere in the park and are associated with radiocarbon age estimates between ca. 600 and 300 years old. The point may have tipped an arrow shaft, but the neck width of 10.45 mm is intermediate between arrow point and dart point sample means (Mierendorf et al. 1998:353-355), so that either is a possibility. Based on these two time-sensitive point styles, use of this site may span the time between 9,000 and 300 years ago.

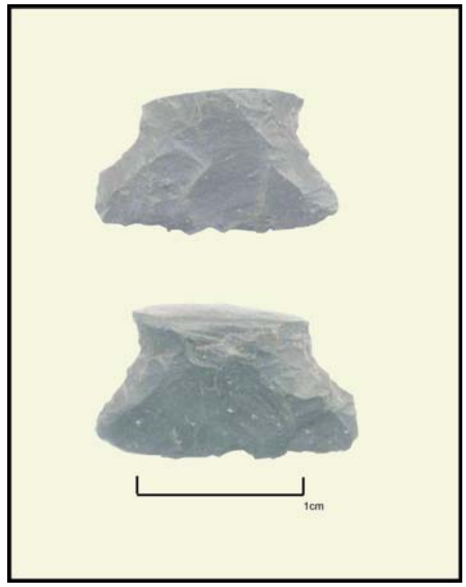

Figure 8. Distal end of Late-style projectile point, 45WH631.

A primary tephra (volcanic ash) sample was collected from the site to help estimate the date of occupation. The layer, ca. 1cm thick, is exposed in the side of several trail treads crossing the site. The tephra is encased within the intact soil A horizon that has developed under a subalpine tundra vegetation community. The sample was identified as layer "W" from Mount St. Helens, which was deposited following an eruption in A.D. 1482 (Mullineaux 1986). The presence of vitrophyre artifacts above and below this tephra indicates that the site was used by indigenous people both before and after this layer was deposited. It also indicates that buried, and presumably intact, artifact-bearing deposits at the site extend to a depth of at least ca. 6 cm below the ground surface.

4.1.2 45WH633

The site is an open scatter of chipped stone on exposed mineral soil, located on a small bedrock bench along the crest of a narrow, subalpine ridge at 1,280 m (4,200 ft) elevation. The site boundaries cover an area ca. 330 m^2 (as with 45WH631, the actual site dimensions are likely to exceed the observed dimensions). The observed artifact assemblage totaled 10 chipped stone artifacts, a hammerstone, and on-site outcrops of Hozomeen chert bedrock exhibiting hammer impact marks (conchoidal fracture scars) from quarrying of tool stone.

Table 3. Projectile Point Metric Data, 45WH631

Oject Name	Catalog Number	Length (mm)	Width (mm)	Thickness (mm)
Olcott series biface	NOCA 22185	65.5	22.86	9.66
Side-notched biface[1]	NOCA 11963	9.3	16.16	4.1

[1]Neck width of biface is 10.45 mm

Most of artifacts of the category “shatter” are made of the most common variety of Hozomeen chert, which is characterized by a microcrystalline, dark gray groundmass, complexly mottled with white, macro crystalline quartz veins. Also present in the assemblage is the sub-variety of Hozomeen chert informally named “Little Beaver gray”, a finer-grained microcrystalline tool stone recognized by its homogeneous, medium gray groundmass and near-absence of macro crystalline quartz veins (Mierendorf 1993). The shatter exhibits clear remnant flake scars; several of these pieces retain the tabular shape and weathered cortex of the “ribbon” beds of chert observed on local outcrops.

Most of the site area is covered by a carpet of moss (Figure 9). In several places where we removed the moss cover, we observed that more of the chert beds had been hammered, which left impact scars (negative flake scars, equivalent to partial conchoidal fractures). Such “hammered” bedrock constitutes a type of site feature that appears to be common in several other sites in the upper Skagit River valley where chert was removed from bedrock as the first stage in the procurement of tool stone. (Mierendorf 1993). It is almost certain that removal of more of the obscuring moss carpet would reveal additional artifacts and areas of hammered chert bedrock.

Figure 9. General Area of 45WH633, showing moss-covered Hozomeen chert bedrock (backpack on ground provides scale).

This site is another case of the large class of “quarry” sites that have been recorded in the upper Skagit River valley (Mierendorf 1993; Mierendorf et al. 1998; Franck 1999). Such quarries are the locations where artifact and feature assemblages indicate that indigenous people procured and then initially reduced nodules of chert from bedrock outcrops. Although there is no evidence yet for a quantitative estimate of site age, it appears to belong to a pre-contact time period.

4.1.3 IF 117

This isolated artifact of chipped stone was found at the surface of exposed mineral soil, located on a side-slope several meters below a small bedrock bench at 1,463 m (4,800 ft) elevation, on the same narrow ridge as 45WH633. This flat bench is at the top of a bald, rocky cliff supporting mostly moss, brush, and small tree islands (which are beginning to form krummholz). Only restricted areas of mineral soil are visible. On the bench is a small (<1 m high and several m long) but prominent outcrop of Hozomeen chert displaying a striking pattern of ribbon layering (Figure 10).

The one observed artifact is a primary decortication flake made of dark gray Hozomeen chert. The ventral surface reveals an interior that is glossy and relatively free of inclusions and impurities, qualities that are sought after in good tool stone. The dorsal surface is dull brown and weathered, much like the weathering on the adjacent bedrock. The flake is inferred to mark the procurement of Hozomeen chert from another bedrock source. As in the case of 45WH633, removal of obscuring moss and ground-cover would most probably reveal additional artifacts of chert.

4.1.4 IF 119

This is the location of a mineral deposit with the potential to have cultural significance as a resource collecting area. The deposit has formed as part of the shoreline of a subalpine cirque lake at 1,770 m (5,600 ft) elevation. Here, a reddish-brown bog iron forms as a chemical precipitate along a series of groundwater seeps flowing from the base of a cliff along the lake shore. As the groundwater passes through granodiorite in the mountain above the lake, it leaches iron from crystals of pyrite (iron sulfide) and deposits the iron as limonite (Tabor and Haugerud 1999). This mineral deposit comprises a constructional landform at the east side of the lake outlet and along the lake's eastern shoreline. This landform covers an area of several thousand square meters, and although the depth of the deposit is unknown, it appears to comprise a large volume. This is the only mineral deposit of this type I am aware of in the park. Limonite is one of a class of chemically similar iron oxide compounds, some of which were highly valued by indigenous populations for their use in pigmentation. Stó:lō people, for example, used red mineral pigments to paint masks and in guardian spirit ceremonies (Smith 1988:144).

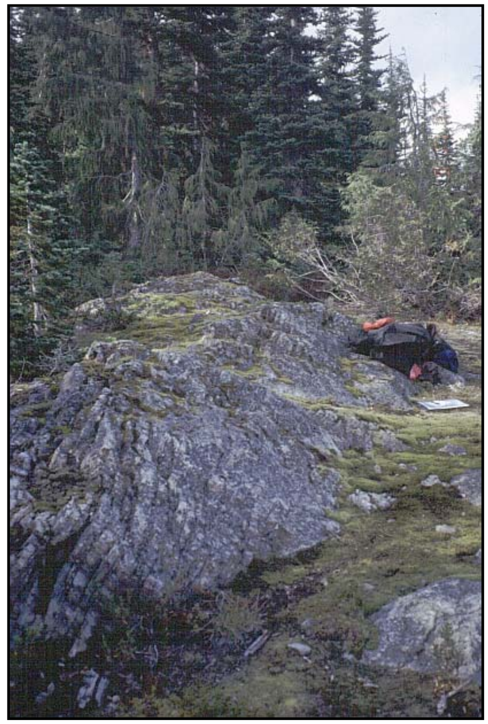

Figure 10. Ribbon bedding of Hozomeen chert at IF 117.

A total assemblage of 87 artifacts was observed at these four archeological resources (Table 2). Eighty-six percent of these were observed at 45WH631. Seventy-six percent of these are comprised of vitrophyre, 17% are Hozomeen chert, and the remainder is of other tool stone categories. The abundance of vitrophyre and Hozomeen chert in the assemblage is not surprising, considering the close proximity of the sites to the geologic sources of these materials. The most abundant morphological artifact categories in this inventory are shatter and flake.

The presence of the two stone points from 45WH631 may be evidence of hunting, but they also represent a tool type that was common whenever travel through the mountains was required. The primary flaking debris and hammerstone at 45WH633 and IF 117 are consequents of quarrying, the set of activities involving the procurement and initial shaping of Hozomeen chert nodules removed directly from bedrock outcrops. Based on chronological assignment of Olcott series biface, it is inferred that indigenous groups utilized the Little Beaver subalpine terrain over a time span as great as ca. 8,000 years.

These simple inferences contribute importantly to our understanding of the northern Cascades high country. They revise conventional ideas about the nature and extent of indigenous adaptations to the high country, chronologically extending the indigenous presence well into the mid-Holocene, a time-span encompassing considerable climatic and ecological variation. The empirical basis for these inferences is limited, however, by the small sample of archeological remains, and to the sample bias introduced by vegetation-obscured surfaces, unsupplemented by controlled excavation data. Another limitation in these data stems from the fact that projectile point morphology is, most often, an imprecise technique for dating archeological assemblages.

Given these concerns, it would be helpful if additional data were available to extend our coverage of the Little Beaver archeological assemblages. Fortunately, this can be accomplished by expanding the geographic scale of the archeological analysis. This is accomplished by including the four archeological resources described above within the larger aggregate sample of all known archeological remains inventoried in the Little Beaver watershed prior to implementation of the SEEC-funded survey. This aggregate sample is constructed by compiling the results of unpublished site inventory records, excavation and research data, and small compliance surveys conducted over nearly two decades of archeological work in or near the project area. The following section describes the archeological patterns and relationships revealed in this larger, aggregate sample of data.

4.1.5 Aggregate Sample of All Little Beaver Archeological Sites

Tables 4 and 5 summarize descriptive site assemblage data and environmental characteristics for all eight archeological sites and the three isolated archeological remains recorded in the Little Beaver watershed. Figures 11 and 12 plot the spatial distribution of these sites in the watershed. These aggregated assemblage data reveal several general trends. All except one of the sites is "open", meaning they area unsheltered and, therefore, exposed to the natural effects of weathering. Nearly half of the sites are on ridges and those that are not are spread across diverse landform categories, such as steep slope, saddle, landslide, river terrace, and cirque lake. About half of the sites are in the subalpine, with all sites ranging in elevation between 500 and 1,756 m in elevation. Although all of the sites are assigned to a pre-contact time period, only two have age estimates, both indicating an indigenous presence in the watershed since the mid- to early-Holocene. The main activities inferred to have occurred at the sites include gathering (procurement) of Hozomeen chert, initial stages of tool manufacture (chert and vitrophyre reduction), with some evidence to suggest the extraction and processing of other resources, including some type of mammal (bone fragments were too small to specify the animal's size or taxonomic identity). Figure 11 plots approximate site locations along vertical and horizontal axes, showing that indigenous use spanned the geographic limits of the watershed.

Table 4. Inventory of Archeological Sites in the Little Beaver Watershed

Trinomial Site No.	Field Site No.	Cultural Resource Type	Landform Type	Age Estimate	Inferred Activity
45WH220	FS 6	Open Lithic Remain	Bedrock Bench	6540-1360 BP [1]	Lithic Procurement/Reduction
45WH446*	FS 129	Open Lithic Remain	Steep Slope	Pre-contact	Lithic Procurement/Reduction
45WH447*	FS 130	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Reduction
45WH463	FS 194	Open Lithic Remain	Saddle	Pre-contact	Lithic Reduction
45WH515	FS 233	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Reduction
45WH552	FS 270	Rock Shelter/Lithic Remain/Hearth	Landslide	Pre-contact	Lithic Reduction/Resource Processing
45WH631	FS 283	Open Lithic Remain	Saddle	9,000-300 BP [2]	Lithic Reduction
45WH633	FS 280	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Reduction
N/A	IF 93	Open Lithic Remain	River Terrace	Pre-contact	Resource Extraction/Processing
N/A	IF 117	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Lithic Reduction
N/A	IF 119	Open, Mineral Deposit	Glacial Cirque	Pre-contact	Mineral Extraction

*Sites reported and described in Mierendorf, 1993.

[1] Age range based on three radiocarbon dates.

[2] Age range based on diagnostic projectile point and primary tephra layer.

Table 5. Artifact inventory, All Archeological Resources in Little Beaver Watershed

Trinomial Site No.	Collection Type	Artifact Count	Formed Tools/ Diagnostics	Tool Stone Type			MNT
				Hozomeen Chert	Vitrophyre	Other	
45WH220	Test Excavation						-
	TU1: Lv. 1	165	0	156	0	9 metasediment	-
	TU1: Lv. 2	137	1 biface fragment (H)	135	0	2 metasediment	-
	TU1: Lv. 3	30	0	30	0	0	-
	TU1:Lv. 4	7	0	7	0	0	-
	TU1: Lv 2,3,4,:wall cleanings	3	0	3	0	0	-
	TU1: Lv. 5	1	0	1	0	0	-
	TU2: Lv. 1	73	0	68	0	5 metasediment	-
	TU2: Lv. 2	159	1 biface fragment (H), 1 bedrock corner (H)	158	0	1 metasediment	-
	TU2: Lv. 3	146	0	146	0	0	-
	TU2: Lv. 4	38	0	38	0	0	-
	TU2: Lv. 5	5	0	5	0	0	-
	TU2: Lv. 6	1	0	1	0	0	-
	Excavation Subtotal	765	2	748	0	17	-
45WH220	Surface	74	1 blade (H); 1 unifacial scraper (H)	72	0	1 metasediment; 1 obsidian; 1 bone fragment	3
45WH446	Surface	405	0	405	0	0	0
45WH447	Surface	9	0	9	0	0	0
45WH463	Surface	10	0	0	10	0	1
45WH515	Surface	13	0	0	13	0	1
45WH552	Surface	5	0	0	0	1 metasediment; 4 bone	1
45WH631	Surface	75	1 lanceolate biface (Olcott style); 1 side-notched point base	4	66	1 obsidian; 1 banded CCS; 1 Cache Ck. basalt; 1 metasediment; 1 Allenby Chert	7
45WH633	Surface	11	1 hammerstone	10	0	1 granite	1
IF 93	Surface	1	1 biface (M)	0	0	1 metasediment	1
IF 117	Surface	1	0	1	0	0	0
IF 119	Surface	0	0	0	0	Limonite	0
	Surface Subtotal	604	7	501	89	10	15
	Grand Total	1,369					

The combined artifact count for all sites is 1,369 (Table 5), but slightly more than half of these (765 items) were recovered from the excavation of two 1x1 m test units at site 45WH220 (excavation results are described in section 4.4). Not counting the excavated assemblage, the total of 604 artifacts observed on the surface of all sites far exceeds the sample of 87 artifacts described in Table 2. Noticeable in Table 5 is the low proportion of stone tools relative to other flaked stone categories, which consist mostly of flake and shatter. This observation is consistent with a geographically broader pattern identified in the adjacent Skagit River valley (Mierendorf 1993; Mierendorf et al. 1998). The abundance of flaking debris is a consequence of stone procurement and reduction in a landscape where tool-quality stone must be selected from a larger, heterogeneous body of inferior (non-tool stone) lithic material. Consequently, at the source locations of tool stone materials, the process of extracting tool stone nodules, cleaning them, assuring their quality, and fashioning them into portable shapes, results in a large number of waste flakes and flake fragments. Collectively, such deposits are lumped together as "primary quarrying debris". This quarrying debris is so abundant that it tends to quantitatively or statistically drown out any finished tool forms that may be present. Further numerical disparity between tool and quarrying debris category frequencies is an outcome of the fact that the shaping of tools into their finished forms tends to be done at locations distant from the sources of the tool stone, so that few completed tools are ever discarded at quarries (this tendency was strongly expressed at 45WH224). It is not surprising, then, that a total of only three formed tools are reported in Table 2 and only eight are reported in Table 3.

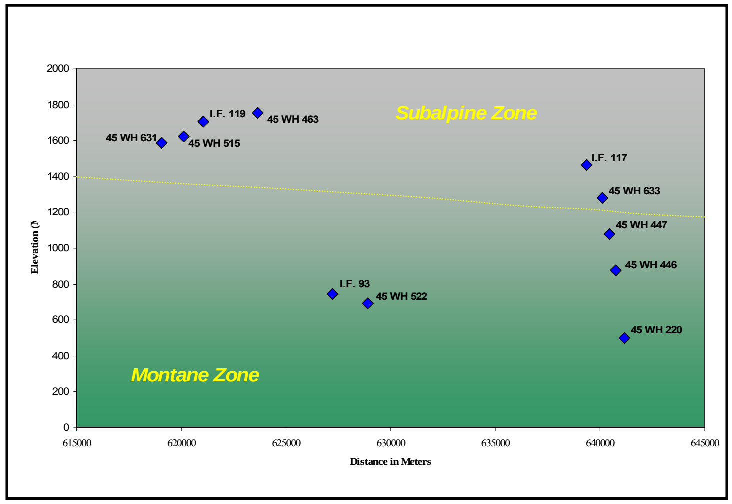

Figure 11. All Little Beaver archeological resources plotted against elevation and east-west distance in meters.

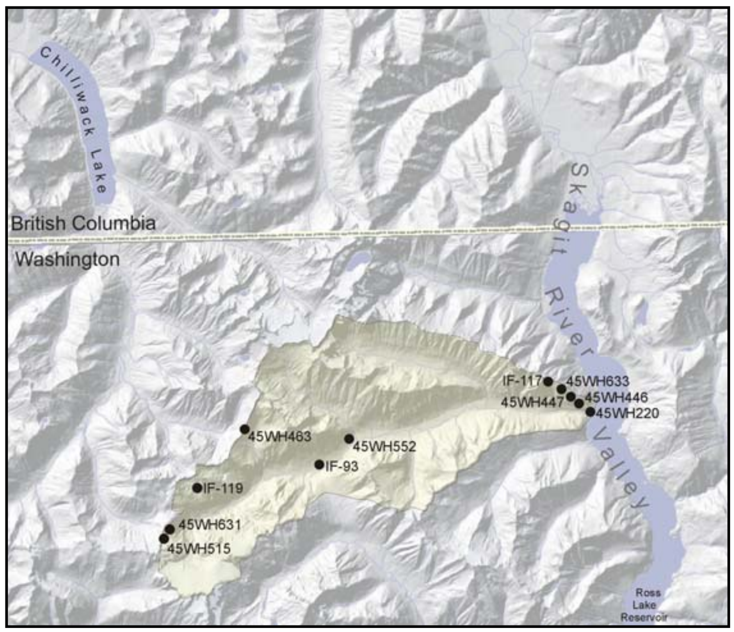

Figure 12. Map of all archeological resources inventoried in Little Beaver watershed.

4.2 Tool Stone Sources

Techniques that are used to accurately identify the variety of lithic materials used for tool stone and to locate the sources where they naturally occur contribute data that is crucial for understanding indigenous use of the project area. The linkage between artifacts and the sources of the materials they are made of—the "source-to-artifact-correlation"—is useful because it is influenced by several cultural and natural factors of interest, including trade, social relationships, band subsistence, demography, mountain geography, bedrock geology, and glacial history. It is seldom easy, however, to accurately identify tool stone sources, and the degree of success depends on many factors. It is fortunate for the present study that positive results have been achieved in characterizing and locating tool stone sources in the mountains surrounding the project area. Based on earlier studies, we can now outline the geographic distribution of several naturally-occurring stone materials utilized by indigenous people in this part of the northern Cascades. East of the project area, Hozomeen chert and metasediment are the two locally available lithic types that dominate archeological assemblages in the upper Skagit River valley (Mierendorf et al. 1998). To the west, vitrophyre derived from the Hannegan volcanic rocks dominates archeological assemblages in the upper Chilliwack River valley (Mierendorf 1987 and 1999). That these two types dominate the Little Beaver aggregate assemblage is consistent with the close proximity of these lithic types in the adjacent watersheds.

Table 6 shows the proportion of the seven distinct tool stone types in the sample (n = 598) of flaked stone artifacts from all Little Beaver watershed sites (does not include artifacts excavated from 45WH220). Hozomeen chert comprises 83% of the sample, and 15% is made of Hannegan volcanics vitrophyre. Allenby chert, basalt, exotic obsidian, metasediment, and chalcedony comprise the remaining 2%. Non-local types were often transported long distances, and are as important as local types for understanding pre-contact cultures.

Table 6. Tool Stone Types by Site in the Little Beaver Watershed

Trinomial Site No.	Hozomeen Chert	Vitrophyre	Metasediment	Allenby Chert	Cache Cr. Basalt	Obsidian	C.C.S.[2]	Totals	Ratio V/T	Ratio H/T
45WH220	71	-	1	-	-	1	-	73	0.00	0.97
45WH446[1]	405	-	-	-	-	-	-	405	0.00	1.00
45WH447[1]	9	-	-	-	-	-	-	9	0.00	1.00
45WH463	-	10	-	-	-	-	-	10	1.00	0.00
45WH515	-	13	-	-	-	-	-	13	1.00	0.00
45WH552	-	-	1	-	-	-	-	1	0.00	0.00
45WH631	4	66	1	1	1	1	1	75	0.88	0.05
45WH633	10	-	-	-	-	-	-	10	0.00	1.00
IF 93	-	-	1	-	-	-	-	1	0.00	0.00
IF 117	1	-	-	-	-	-	-	1	0.00	1.00
Totals	500	89	4	1	1	2	1	598	-	-
Percent	83	15	1	0.2	0.2	0.4	0.2	100	-	-

[1]Sites reported and described in Mierendorf (1993)

[2] Lithic material exhibited alternate bands of chalcedony and chert

A variety of techniques are used to identify tool stone types, but for several reasons, these cannot be applied uniformly to all materials in all localities. This is because the chemical or mineral composition of the material dictates the appropriate analytic technique. Materials of glassy composition, for example, (especially obsidian and vitrophyre) are identified most accurately by chemical characterization using the XRF technique. XRF does not work for crystalline materials like chert and metasediment, which can be characterized by using yet other quantitative techniques. A limitation of the XRF technique is that the artifacts must be at least 1.5 mm thick.

Due to the wide variety of lithic types and the generally high cost of laboratory analysis, not all tool stone types recovered in the project area can be identified with equal levels of confidence. Some identifications are made with a high degree of confidence, while others are made at lower confidence levels. In order to address this problem, I have ranked the seven identified tool stone types in the aggregate archeological assemblage into one of three confidence levels, as shown in Table 7. Four criteria are used to rank the types. The criteria are, 1) presence of a macroscopic description or availability of comparative reference specimens, 2) presence of a petrographic analysis, 3) a chemical characterization or other equivalent quantitative analysis, and 4) description of a material's natural geographic distribution and source locations. The confidence level of an identification is ranked 1 or "low" if it is based on only one of the four criteria; it is ranked 2 or "moderate" if based on two criteria; and it is 3 or "high" if based on three or more criteria. Depending on environmental factors and the nature of the archeological remains in question, any number of other criteria might be considered in assigning confidence levels, but these four are sufficient for this project area.

Table 7. Tool Stone Identification Confidence Levels for Little Beaver Site Sample

Level	Macro Desc/Ref	Petrographic Analysis	XRF	Lithic Landscape	Confidence	Lithic Raw Material Type
1	X	-		-	Low	Cache Cr. Basalt
1	X	-		-	Low	Metasediment
1	X	-		-	Low	Banded CCS
2	X	-		X	Moderate	Allenby Chert
2	X	-		X	Moderate	Exotic Obsidian
3	X	X		X	High	Hozomeen Chert
3	X	-	X	X	High	Copper Ridge Vitrophyre

The first criterion requires that there be a detailed description of the physical properties, including texture, color, grain-size, and other major physical properties of the tool stone or that representative comparative samples are available to categorize tool stone types during analyses. The second criterion requires a petrographic description of the stone to assist in identification or analysis of comparative type specimens. The third criterion entails some type of chemical characterization technique (such as XRF analysis of vitrophyre) that identifies a "fingerprint" for any particular tool stone type. The fourth criterion necessitates an understanding of the local bedrock geology sufficient to identify all available tool stone sources and their geographic distribution. Knowing the geography of tool stone is critical for making artifact-to-source correlations and requires an ability to spatially define and map the extent of separate "lithic provinces" or "lithic landscapes" as they are referred to in tool stone sourcing studies (see Mierendorf 1993:81). However, the difficulties inherent in finding, defining, and mapping tool stone geography requires a long and direct involvement with complex landscapes, especially in the northern Cascades, before this degree of knowledge is acquired.

Hozomeen chert and Hannegan volcanics vitrophyre (Figure 13) are the only tool stone types in Table 7 identifiable to a high level of confidence; both meet three of the four criteria. For Hozomeen chert, a macroscopic description, semi-quantitative petrographic analyses, and a description of its geographic distribution, including several recorded bedrock quarries, have been published (Mierendorf 1993, Mierendorf et al. 1998). In the case of Hannegan volcanics vitrophyre, macroscopic description, x-ray fluorescence of ca. 120 samples from bedrock outcrops and of artifacts, and geographic distribution have been reported and published in technical reports and professional presentations. Field description of source outcrops and their associated quarry assemblages have been reported in Mierendorf (1987 and 1999) and Mierendorf and Skinner (1997). Skinner (1999a, 1999b, 1999c, and 2003), and Skinner and Davis (1996) report the XRF data on source samples and artifacts collected by the author. Maps of the major rock formations from whence the tool stone sources derive are published by Staatz et al. (1972), Tabor and Haugerud (1999), and Tabor et al. (2003).

The level 1 ranking shown in Table 7 for basalt and metasediment reveals that petrologically-distinct types are difficult to separate on the basis of macroscopic descriptions and comparison between reference specimens and unknowns. Both types are usually black to dark gray, opaque, and fine-grained in field-examined specimens. Although these types ought to reveal distinctive mineral compositions, individual artifacts often require laboratory analysis due to field limitations, such as surface weathering and soil adhesions on artifact surfaces, small crystal sizes of diagnostic crystals in rock matrix, and the small size of many artifacts. The cost of performing petrographic analysis on large samples of archeological specimens is prohibitive. Further research will be required before a shift is possible to a higher confidence level in identifying and

Figure 13. Photographs of dominant tool stone types in project area. upper, Hozomeen chert, Little Beaver gray variety; center, Hozomeen chert, common dk. gray variety; bottom, Hannegan Volcanics vitrophyre, from Copper Ridge.

discriminating basalt and metasediment tool stone in the northern Cascades. The results of petrographic analysis of several samples from the upper Skagit Valley, compared with a “field” identification of the same samples (Cache Cr. basalt and metasediment) revealed the difficultly in distinguishing these types in hand specimens (Mierendorf et. al. 1998).

Both Allenby chert and exotic obsidian tool stone types are imported to the project area from distant sources. The geography of Allenby chert is described in Vivian (1989), and reference samples provided by Vivian to the author were used to assign artifacts to this tool stone type. The level 2 ranking reflects that fact that there is great variation in hand-specimen samples of these cherts and no petrographic or chemical data are available to characterize or fingerprint the material. The exotic obsidian artifacts from the project area are too thin (<1.5 mm) for XRF analysis, but they exhibit visual characteristics that are similar to other samples from the upper Skagit River valley that correlated with obsidian sources in central Oregon and northern California based on XRF analyses (Mierendorf et al. 1998).

The local dominance of Hozomeen chert reflects its abundance in bedrock formations at the extreme eastern portion of the watershed and that primary reduction at local bedrock quarries deposited a large amount of flaking debris. This is consistent with results reported for the adjacent Skagit River valley, where this lithic type was quarried and procured from numerous local sources (Mierendorf et al. 1998:Table 9.12, p. 78). All sites in Table 6 that are dominated by Hozomeen chert are located at the eastern margin of the watershed.

Hannegan vitrophyre does not occur naturally in the Little Beaver, but it dominates site assemblages at the extreme western margin of the watershed (45WH463, -515, -and 631). This tool stone has yet to be identified in the upper Skagit River valley or in the eastern portion of the project area (although vitrophyre artifacts were recovered from the upper Skagit sites, they apparently are derived from other sources whose locations currently remain unknown [Mierendorf 1997, Mierendorf et al. 1998:360-368]). The presence of vitrophyre tool stone is consistent with the knowledge that sources of this material, associated with pre-contact age quarries, are located only ca. 9 km northwest of the Little Beaver watershed. Only one site, 45WH631, contains artifacts of both Hozomeen chert and vitrophyre. Accordingly, although Hannegan vitrophyre cannot be shown, at present, to have been utilized by inhabitants in the upper Skagit River valley, it was used by those who visited the divide between the Chilliwack and Little Beaver watersheds.

This geographic disparity in the use of these two tool stone types shows quantitatively in Table 6 in the last two columns on the right-hand side. The first of these columns lists the ratio of vitrophyre artifacts to the total number of artifacts in each site (V/T); the second column shows the ratio of Hozomeen chert to the total number (H/T). A ratio of 1 means all of the artifacts are of the type; a ratio of 0 means none are of that type. Note that with the exception of 45WH631, virtually every site exhibits a ratio of 1 or 0 (45WH220 is <1 due to the minor presence of two other tool stone types).

Although ranked at lower confidence levels of identification, the remaining lithic types convey useful information. The presence of metasediment in sites throughout the watershed is not unexpected, given this type’s abundance in bedrock of the northern Cascades. The four remaining tool stone types are certain to be exotic in origin, and therefore indicate that the people who utilized the project area carried with them tools made of materials that were traded or procured from distant sources. Assuming the identifications are correct, these exotic source locations are on the order of 100 km (Allenby chert), 240 km (Cache Cr. basalt), and 600 km (Oregon/California obsidians) distant. Finally, it may be noteworthy that 45WH631 is unique among all sites in the watershed for having all seven lithic types represented in its assemblage. This information suggests that indigenous groups who used the northern Cascades interior in the pre-contact past had access to high quality tool stone for the tools they carried with them into the mountains. These conclusions are consistent with the results of tool stone identification and sourcing evidence from the upper Skagit River valley (Mierendorf et al. 1998) and from other widely separated valleys in the North Cascades National Park Service Complex.

4.3 Minimum Number of Tools (MNT)

The seven "formed tools/diagnostics" inventoried in Table 5 are likely to comprise only a subset of the larger assemblage of tools that were used and discarded at the sites reported here. It is often the case that tools used at any site are retained and used again at other, far-removed locations. Although "unseen," such tools can leave evidence of their presence in the form of re-sharpening flakes or broken and discarded fragments. For this reason, the raw count of tools and diagnostics shown in Table 5 is likely to under-represent the actual number of tools that were used at these sites. Shott (2000) has compiled and reviewed techniques previously used by archeologists to address this problem of under-representation. The techniques are similar to those used by archeologists to infer the number of whole pots represented by many pot fragments or the minimum number of animals inferred from an assemblage of animal bone fragments. In the case of flaked lithic remains, several pooled criteria, when applied to a lithic assemblage, can lead to an inference of the minimum number of tools (MNT) represented in a lithic archeological assemblage.

Criteria applied to lithic artifact assemblages for this purpose include tool stone type, whether any of the artifacts fit together, tool dimensions and morphology, manufacturing technology, or any other empirical observations that indicate the incompatibility of different objects. Incompatible objects are those that can be eliminated as once having been part of the same tool or artifact. Using this procedure, a small tool fragment is equivalent to a complete tool in that they both count as 1, as long as they are shown to be incompatible. Even a small resharpening flake, if it is made of a tool stone that does not match any other material at the site, counts as one tool. Any number of separate tool fragments, should they fit together (hence are compatible), count as one tool, no more.

Table 5 shows the MNT for the Little Beaver sites in the far right column. Note that flaking debris representing primary reduction of lithic material at a quarry is not counted as a tool (such as at 45WH446 and 45WH447), unless one of the above criteria unambiguously indicates the presence of a tool (such as the hammerstone at 45WH633). However, the presence of exotic, Hannegan vitrophyre flaking debris (non-local and non-quarrying) at 45WH515 and 45WH631 counted as one in each case; this is because, at a minimum, at least one nodule or core was transported to each site and flaked there. In the absence of a refitting analysis at these two sites, there is no evidence to indicate incompatibility of the flaking debris, so I conclude that no more than one flake core was reduced at each site.

The total of 15 MNT shown in Table 5 is twice the number indicated by the raw count of tools. Most of this disparity is from 45WH631's assemblage, which has a raw count of two tools but a MNT of eight. The significantly larger MNT count is inferred from the presence of incompatible flakes made of several distinct tool stone types. This suggests that the raw count of tools in Little Beaver's aggregate archeological assemblage, and particularly at site 45WH631, under-represents the extent of actual tool use. This is because tools were used and probably resharpened at 45WH631 that were then carried on to other locations. No other site in the current Little Beaver sample of sites displays this amount of tool stone richness (diversity).

4.4 Results of Excavation at 45WH220

4.4.1 Test Units

This section describes the results of the excavation of two 1X1 m test units in site 45WH220. These results do not constitute a final and complete report of the excavation; instead they describe the cultural remains recovered in the test units and relate these to the other site assemblages from the Little Beaver watershed. By combining the watershed's site surface data (survey results) with subsurface data (excavation results), a more complete picture of indigenous use of the area is achieved.

The excavation data from 45WH220 is critical for estimating the time span of human occupation of the valley with far more accuracy than is possible from using surface data alone. There are two primary reasons for this. First, no other site in the watershed has been excavated; consequently, the 45WH220 excavated assemblage is the only one with unambiguous spatial and contextual association of artifacts, soils, and radiocarbon-dated charcoal samples. The second reason is that artifacts excavated from intact (undisturbed) site deposits will usually reveal meaningful associations among soil horizons and weathering zones, geologic layers, including volcanic ashes, and anthropogenic deposits. These associations provide the data necessary to infer local and regional climatic and environmental influences, as well as to investigate on-site subsistence and settlement activities, leading to inferences about site function.

Both test units (TU1 and TU2) were oriented to true north and were placed 10 cm apart, but TU2 was off-set 30 cm south of TU1. This particular positioning of the test units was controlled by several factors, including a confined space within the walls of the wooden shelter and by the presence of bedrock exposed at the ground. As excavation proceeded through the first two levels, it quickly became obvious that the northern half of each test unit was comprised of the top of a bedrock ledge of Hozomeen chert. As a result, the majority of the excavated soils came from the southern half of each unit, immediately adjacent to the ledge. The excavation levels were dominated by a sandy silt matrix encasing abundant granules, pebbles, and cobbles, and flaked stone debitage. Glaciers deposited most of this matrix, which is the parent material within which several natural soil horizons have developed.

No pre-contact age, anthropogenic features were recognized in the test units or elsewhere on-site.

4.4.2 Artifacts Recovered by Test Unit and Level

Table 5 inventories artifacts, including diagnostics and formed tools, recovered by level from each test unit. Only two formed tools/diagnostics were found in the excavated assemblage. Both are fragmentary bifaces that were broken mid-section and both were made of Hozomeen chert. Both are also stage III bifaces, which means that the pattern of flake scars and other morphological characteristics indicate that they had reached an intermediate stage of tool manufacture at the time that they broke and were discarded. Note that each biface was recovered from level two (ca. 10-20 cm below ground surface), but in separate test units, and each is associated with a high density of flaking debris. Also from level 2 of TU2, note the diagnostic item identified in the table as "bedrock corner." This morphologically unique category reflects the intentional removal of chert fragments from bedrock formations. "Bedrock corner" is thus diagnostic of a quarrying technique (first recognized at 45WH224, see Mierendorf, 1993:p. E-4) wherein indigenous quarry workers selectively exploited outside corners or other protuberances in the bedrock by directly applying a great percussive force with a hammerstone. This quarry technique provides an efficient way to remove workable chert fragments from bedrock formations, and it results in morphologically distinctive bedrock corner fragments among the quarrying debris. The corner fragment from TU2 is composed of a tool stone-quality, local sub-variety of Hozomeen chert referred to as "Little Beaver gray" due to its apparent restriction to the lower (eastern) Little Beaver Cr. valley; the direction of flake removals shown by the flake scars and the presence of outcrop cortex preserved on the remnant corner faces reveals a characteristic "pyramid" shape. This shape results from the intersection of the two joining bedrock surfaces, with the third face formed by the irregular fracture plane created where the piece became detached from the bedrock mass. Outcrops of this chert variety are abundant across 45WH220, and the presence of this artifact category in the flaking debris supports the claim that bedrock was quarried on-site.

A total of 765 artifacts were excavated from both test units, which is more than double the total number of artifacts inventoried from the surface of all sites in the watershed (n=604). The tool stone type column in Table 5 shows that virtually all artifacts are made from Hozomeen chert, but for 17 pieces of flaked metasediment. The great abundance of flaking debris and the absence of complete tool forms is consistent with excavation results at Desolation chert quarry (45WH224), where a large assemblage of flaking debris was characterized the primary reduction of Hozomeen chert from bedrock formations and from naturally-occurring nodules (Mierendorf 1993). Both sites (45WH220 and -224) reveal the co-occurrence of abundant primary flaking debris and chert bedrock (usually displaying hammerstone impact marks). Although a quantitative lithic analysis of flaking debris from 45WH220 has not been performed, a qualitative examination of the entire assemblage indicates that biface thinning flakes are abundant. The presence of biface thinning flakes in direct association with early-stage biface fragments, and the absence of evidence for finished tool manufacture, together support the conclusion that the site inhabitants used the locally procured Hozomeen chert for the production of mid-stage bifaces.

Several additional tools, although they were recovered from the surface rather than from excavation, contribute additional useful site information. The blade listed in Table 5 is described morphologically as a mid-section fragment of a Hozomeen chert flake that is trapezoidal in cross-section, and on the dorsal surface exhibits two parallel ridges formed by the removal of three linear flakes. The blade is thin (0.2 cm) and exhibits a transverse fracture at both ends, which has reduced its length to 1.2 cm. The width of the blade is also 1.2 cm. Linear flakes that look like blades are sometimes unintentionally created as a by-product of other technologies, and such flakes are typically triangular in cross-section. The trapezoidal cross-section of this flake, however, may indicate an on-site blade technology. This conclusion is consistent with the results of the Ross Lake archeological project, where the use of microblade technology and microblades are documented at several sites in the upper Skagit Valley (Mierendorf et al. 1998).

The unifacial scraper listed in Table 5 is a thick, broken flake of high tool stone-quality Hozomeen chert. The scraper edge exhibits a consecutive series of short, parallel flake scars on the dorsal surface of the distal flake margin. The scraper edge is continuous across both straight and excurvate segments of the acute-angled margin. The high points on this edge are noticeably smoothed and rounded, indicating that the tool was used against a relatively soft material. Although there is uncertainly as to whether or not the “scraper” was used in other ways, such as for cutting, its presence on-site is evidence that other domestic activities, apart from stone procurement and quarry reduction, were conducted at 45WH220.

The obsidian flake fragment noted in Table 5 is too small for XRF analysis, but simply its presence on-site indicates that another tool form, made from a unique tool stone type compared with all other artifacts from the site, was used at this location. Based on these surface artifacts, combined with the excavated assemblage, it is concluded that site 45WH220 served as an important source of tool-making chert, and as a place where domestic activities were conducted. These activities are consistent with short-term or seasonal camping episodes.

4.4.3 Test Unit Stratigraphy

During excavation, the irregular conformation of the bedrock ledge that covered the northern half of the test units and the abundance of glacial cobbles made it difficult to maintain uniform walls and level floors. As excavation proceeded, it became clear that TU1 had sustained extensive post-occupation disturbance, while TU2 presented a relatively undisturbed sedimentary matrix. For this reason, only the stratigraphy of TU2 is described in this section.

A schematic diagram of the stratigraphy exposed in the southern half of TU2 is shown in Figure 14. Depicted are the vertical and horizontal extent of excavation levels 1 through 5, the bedrock formation exposed in the test unit, and the locations of the three radiocarbon-dated charcoal samples discussed in section 4.4.5 below.

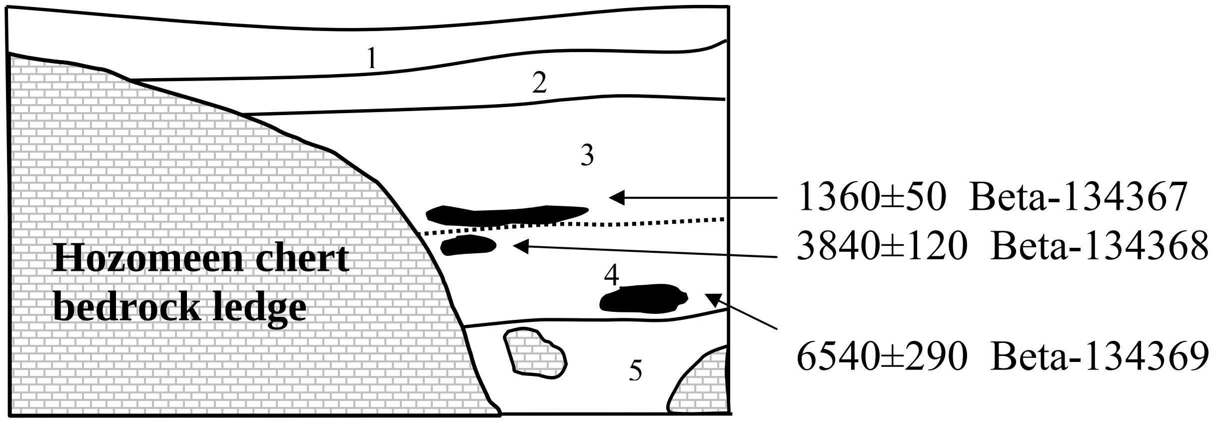

Figure 14. Test unit 2, 45WH220, description of soils and sediments by excavation level (for scale, TU is 1 m wide).

Table 8 provides a detailed description of the soil and sedimentary properties observed in the excavation levels, the artifact categories found in each level, the degree of disturbance, and notes regarding the possible origin of the deposit. The first two levels contained historic artifacts mixed with pre-contact age lithic artifacts, indicating that modern use of the landform for recreational activities has resulted in mixing of the upper site deposits; this recent anthropogenic influence is designated the “Ap” soil horizon in level 1. Level 2 is a mix of the disturbed Ap soil horizon above, mingled with subsurface, pre-contact age B horizon (subsoil) sediments from below. Level 2 is more silt-enriched than any other soil horizon. Levels 3 and 4 contain only flaked lithic artifacts and together these two levels encompass most of the weathered, iron-rich soil B horizon, along with high densities of flaking debris and soil charcoal. This charcoal appears to be anthropogenic in origin. Soil charcoal in level 3 dated 1,360±50 radiocarbon years old; soil charcoal in level 4 dated 3,840±120 and 6,540±290 radiocarbon years old (see section 4.4.5). The frequency of artifacts decreased abruptly in the level 5 matrix, and the test unit was terminated on the top of compact and rocky glacial till.

Generally, the finest (silt dominated) sediments are near the top, and the coarsest (rockiest) sediments are at the test unit bottom. It would be useful if the source of this silt could be known, but this is presently not possible. The site is positioned so far above the Little Beaver Creek and Skagit River flood plains that it would be impossible for flood events to deposit over bank silts on the site. Another source for this silt may be volcanic ash derived from Cascade volcano eruptions. Although the site sediments are likely to contain dispersed or redeposited volcanic silts, discrete layers of volcanic ash were not observed. Another possibility is for the silt to be a type of loess, which is the term applied to deposits of wind-blown silt. Loess typically forms downwind of major silt accumulations, including glacial outwash trains and glacial lake deposits, such as the kind that filled Puget Sound and the lower Skagit valley during the melting of the Puget glacier lobe, between ca. 13,000 and 10,000 years ago. Silt can also become windblown during arid climatic intervals, such as when droughts cause a decrease in vegetative cover resulting in wind erosion of soil.

Whatever the explanation, the co-occurrence of a silt-enriched, weathered soil B horizon with a high density of primary reduction flaking debris, is most consistent with the results of test excavations at several test units at Desolation chert quarry (Mierendorf 1993: see especially the results from TUs 1, 2, 7, 8, 9, 11 at 45WH224). If the age estimates derived from the soil charcoal are free of errors, it suggests that silty parent materials continued to accumulate in the soils at 45WH220 throughout the middle and late Holocene. During this same time span, indigenous groups repeatedly visited the site to exploit its readily-available outcrops of chert, and in the process, deposited dense quarrying debris and charcoal within the soil matrix. Clearly the soil characteristics observed in TUs 1 and 2 are explained only by a combination of anthropogenic and non-anthropogenic causes.

Table 8. Description of Test Unit 2 Deposits by Excavation Level, 45WH220

Excavation Level	Soil Symbol[1]	Description of Excavated Deposits
1: 0-10 cm	Ap	Brown (10YR5/3), pebbly silt, mixed with scattered charcoal fragments; topsoil eroded away; deposits mixed with historic artifacts made of glass, metal, plastic, nylon, including .22 bullet casings, coins dating no earlier than 1976, and nylon rope. Contains high density of Hozomeen chert flaking debris. The top of level is the ground surface under the shelter prior to excavation.
2: 10-26 cm	Ap/B	Light yellowish-brown (10YR6/4) silt, with some angular and subangular pebbles; recent historic artifacts of glass, metal, plastic, and fiber. High density of Hozomeen chert flaking debris. Level is disturbed by historic mixing, particularly near the bedrock ledge. The characteristics of both Levels 1and 2 are a product of modern tent camping and campfire use for decades, and of construction and maintenance of the wooden structure.
3: 20-30 cm	Bo1	Yellowish-brown (10YR5/4), gravelly silt; gravels are angular and subangular clasts of Hozomeen chert from adjacent bedrock, supported in the silt matrix; the soil zone of maximum weathering, and color appears to be imparted by formation of iron oxide coatings on soil particles and artifacts; absence of historic artifacts; one tight pocket of charcoal collected from ***in situ*** submitted for radiocarbon dating. Moderate density of Hozomeen chert flaking debris. This Level is an intact remnant of an old, weathered, and relatively stable soil that has formed in place on one of the largest expanses of flat land atop a bedrock formation of ribbon chert of the Hozomeen group of rocks. **Dated sample lab number is Beta-134367.**
4: 30-40 cm	Bo2	Yellowish-brown (10YR5/4), gravelly silt; exhibits same pedological characteristics as level 3; gravels are angular and subangular clasts of mixed lithology, including igneous (granitic) and metasedimentary types, including Hozomeen chert; gravels increase in density at bottom of level; collected from ***in situ*** two concentrations of charcoal; the lowest was wedged between cobbles, near bottom of the level and appears to have been intact a long time; bottom of level is at the top of glacial till. **Dated sample lab numbers Beta-134368 and Beta-134369**.
5: 40-50 cm, 50-60 cm	C	Very pale brown (10YR7/3), poorly sorted, silty gravel; the brown silt of levels 3 and 4 forms the silty matrix at top of level, grading to compact glacial till at the bottom; large clasts in the till show a variety of igneous and weakly and strongly metamorphosed rock types; some rocks coated with clayey, weathered surfaces.

[1]Master soil horizon nomenclature according to Schoeneberger et al. 1998.

4.4.4 Local and Regional Context of Excavation Results

When compared with the 36 archeological sites test excavated in the adjacent Upper Skagit River valley, both the artifact assemblage and environmental setting of 45WH220 is most similar to those of 45WH224. Both sites reflect quarrying of bedrock and the manufacture of "blanks", the equivalent of "refined raw material" in that the raw rock was cleaned of imperfections and made portable. At both of these sites, the absence of finished tools made from the on-site chert bedrock means that final manufacturing was completed elsewhere. Sites 45WH220 and portions of 45WH224 are located on flat, rocky, valley-marginal landforms covered by a half-meter or so of post-glacial loess. At both, dense flaking debris is dispersed throughout the soil matrix, but most noticeably in the reddened, iron oxide-rich zone that forms the present soil B horizon. Both locations also offer good solar exposure, a local climatic factor important in the selection of even short-term mountain encampments (Mierendorf 1986). Overall however, the artifact assemblages speak to task-specific activities centered around collecting chert and reducing it into generic biface forms.

Such quarries are one part of a broader, valley-wide pattern of a well-developed biface production technology in the Upper Skagit. The technology developed in response to the presence of a locally abundant chert, extracted in bulk by indigenous populations for millennia (Mierendorf et al. 1998). The Hozomeen chert was mined and collected from bedrock outcrops and from the gravels deposited in alluvial fans, glacial till, flood plains, and river gravels. As described here, this quarrying technology signifies a local montane-oriented, industrial-level of indigenous quarrying unlike any other reported in western Washington or the southern Northwest Coast.

4.4.5 Radiocarbon Age Estimates

Dating of charred plant remains is a precise and reliable way to estimate the age of pre-contact period sites and the human activities they reflect. One of the noteworthy discoveries from the excavation of TU 2 at 45WH220 was the presence of discrete pockets of charred wood fragments in the silty and somewhat rocky, weathered subsoil. These concentrations appeared strikingly different from the many small, dispersed charcoal fragments observed throughout the soil matrix. Much of this dispersed charcoal is the result of natural forest fires. Three of the charcoal samples collected during excavation of TU2 met the field criteria used to assess a sample's potential reliability. The criteria are that 1) the sample is intact and is recovered from in situ, 2) it is in direct physical association with artifacts, and 3) that it lacks any evidence of matrix disturbance, mixing, large root penetration, or intact tree or root burning.

The three samples were collected from *in situ* in the unit floor during excavation (none of the samples was recovered from the screen). At the time of collection samples were placed in labeled, zip-lock plastic bags. Samples were cleaned, weighed, and packaged for shipment at the park's archeological lab in Marblemount.

The age estimates obtained from the samples are shown in Table 9 along with the sample provenience, the depths below the ground surface, and the conventional and calibrated ages.

Table 9. Radiocarbon Age Estimates From Site 45WH220[1]

Sample Lab. Number	Test Unit	Excavation Level	Depth Below Unit Datum	Conventional Radiocarbon Age[2]	Calibrated Age[3]
Beta-134367	2	3	26-27 cm	1360±50	1335-1185
Beta-134368	2	4	30-31 cm	3840±120	4540-3895
Beta-134369	2	4	38-39 cm	6540±290	7945-6760

[1]All ages reported here are conventional dates on charcoal, excavated from in direct association with lithic artifacts

[2]Age in radiocarbon years before present after C13/C12 adjustment

[3]Calibrated date at two Sigma (95% confidence interval), using tree ring calibration curve to estimate age in calendar years

Figure 14 and Table 9 show the provenience of the samples in TU2 (Table 8 describes the soil and sedimentary context of each sample). The sample depth and age columns in Table 9 reveal that the sample ages increase with increasing depth below ground surface. This is the spatial relationship expected if the charcoal is in original (i.e. undisturbed) depositional context. The table also shows the conventional radiocarbon ages corrected for error by calibrating them to calendar years. These age estimates reveal that people began to use the site as early as 8,000 to 6,700 years ago. The physical remains associated with each sample, described below, leads to other inferences from the radiocarbon dates.

Beta-134367 (1,360±50), the uppermost sample, appeared as a concentration covering an area ca. 25 cm x 8 cm in the top of level 3, immediately next to a sloping face of Hozomeen chert bedrock. The sample co-occurred with abundant flaking debris, and angular nodules of Hozomeen chert from the surrounding soil matrix which appear to have been anthropogenically detached from the bedrock outcrop. This is the largest of the three samples (6.6 g dry weight before pretreatment).

Beta-134368 (3,840±120) was recovered in the top of level 4, 1-2 cm below the northern extent of Beta-134367 and immediately adjacent to the sloping face of bedrock, and in direct association with abundant Hozomeen chert flaking debris. The submitted sample weighed 2.4 g dry, before pretreatment.

Beta-134369 (6,540±290) was collected from an area about 10 cm in diameter, where it formed a tight pocket wedged among a grouping of rocks. Of the three, this sample was farthest removed from the bedrock face. It also was in direct association with a high density of flaking debris. This was also the smallest sample (1.4 g dry weight before pretreatment) and it required extended counting time for a reliable age estimate (the small sample size accounts for the wide standard deviation).

In order to formulate reliable inferences from these dates, it is necessary to know the origin of the charred woody fragments. Were these concentrations the result of human activity or is the charcoal's presence an outcome of natural, soil-forming processes as influenced by forest and shrub plant communities? A clear pattern of association with dense flaking debris and with charred woody fragments occurring in well-defined concentrations could support the case for an anthropogenic origin to the charcoal. At the same time, a natural origin cannot be ruled out, given that the presence of forest fire-created charcoal in soil profiles of coastal temperate forests of the region is well-demonstrated (Gavin 2001, Gavin et al. 2003). Assuming the dated charcoal samples at 45WH220 are anthropogenic in origin, there is still the problem of the inbuilt error in the dates. This error is the time that lapses between the death of the organism (in this case, trees or shrubs) and the occurrence of the event being dated (anthropogenic burning, such as in a campfire). This means that woody tissue that died a century before being burned in a fire will yield a radiocarbon date 100 years older than the event being dated (campfire burning). Although the anthropogenic origin of the charcoal samples cannot be demonstrated conclusively, their occurrence in association with abundant artifacts and as discrete concentrations of charred fragments is indicative of human activity.

For comparison, there are no other radiocarbon-dated archeological sites in the Little Beaver watershed, but a series of sites was dated in the adjacent upper Skagit River valley, within the Ross Lake drawdown zone. Many of the drawdown dates correlate with the youngest date from 45WH220, 1,360 years ago, which falls in a time period when indigenous groups made extensive seasonal use of the Skagit valley. But none of the dated Ross Lake sites have radiocarbon age estimates that correlate with the two earlier dates from 45WH220. The one site that does correlate, however, is Desolation Chert Quarry (45WH224). This site closely resembles 45WH220 in terms of artifact classes present, artifact abundance, radiocarbon age estimates, and geologic characteristics. This quarry is located several km to the southeast and across the valley from 45WH220.

The correlation between these two sites is seen clearly in the comparison of excavation levels 3 and 4 of Test Unit 2 at 45WH220 with Stratum 3 (excavation levels 4 through 8) of Test Unit 2 at 45WH224. At the latter site, a small concentration of charcoal was found encased in brown, weathered silts and in direct association with a high density of Hozomeen chert flaking debris. The charcoal was excavated from *in situ* from 80 cm below ground surface and was dated at 4470±200 years old (WSU-3813) (Mierendorf 1993:45, D-4). This date falls between the two older dates from 45WH220.

Based on the near-equivalency of artifact assemblages, age, and geologic context, the archeological excavation data from 45WH220 upholds two conclusions formed more than a decade ago, based on data from 45WH224, that 1) indigenous inhabitants began to utilize local rock outcrops to procure and initially reduce Hozomeen chert at least by the mid-Holocene, and 2) that flaking debris resulting from this activity is preserved in a weathered subsurface soil horizon in direct association with datable soil charcoal of probable anthropogenic origin. These results, in turn, support the assertion of the upper Skagit Valley as a Northwest Coast tool stone source for many millennia.

4.5 Electron-microprobe Identification of Tephra (Volcanic Ash) Sample

One primary tephra sample was collected from 45WH631 and submitted for identification to Dr. Franklin J. Foit, Jr., at the Department of Geology, Washington State University. The sample (NOCA 22171) closely matches the chemistry (0.99 similarity coefficient) of Mount St. Helen's W, a chemically-distinctive tephra deposited from an A.D. 1480 eruption (Mullineaux 1986, Yamaguchi 1983). This layer has been chemically identified previously at other archeological sites in the park, including at 45WH484 on Copper Ridge to the west (Mierendorf 1999) and from several sites in the Ross Lake vicinity to the east (Mierendorf et al. 1998). The ash from this event must have blanketed the watershed immediately following the eruption.

This volcanic ash sample was removed from 4 cm below the ground surface, from within a well-defined, black soil A-horizon formed under a subalpine meadow community. The tephra layer outcrops at several locations inside the site boundaries, but it was sampled at the place where it appeared to be a primary deposit (meaning the layer is undisturbed and in the original location of its deposition). The primary tephra was observed here to form a continuous layer of very light-gray silt, ca. 1 cm thick, aligned parallel to the ground surface, but beneath the dense root zone of the meadow vegetation (which is dominated by heather, huckleberry, and *Luetkea*.. At one location on-site, flakes of vitrophyre were observed both above and below this ash, indicating use of the site both before and after ca. A.D. 1480. This finding is consistent with the results of the test excavations at 45WH484, where a high density of vitrophyre flaking debris also was found both above and below a primary layer of St. Helens W tephra (Mierendorf 1999). This also indicates that indigenous use of 45WH631 was contemporaneous with the use of 45WH484, which is located close to one of several vitrophyre quarries.

4.6 X-Ray Fluorescence (XRF) of Vitrophyre

Three artifacts from 45WH631 and one from 45WH515 were analyzed, and all four were identified as coming from Copper Ridge geochemical source B (detailed results are shown in Appendix A-2). This source is one of nine separate vitrophyre dikes, associated with the Hannegan volcanics that were mapped in the park by the author between 1986 and 1998. In the nine outcrops, four geochemical sources could be discriminated, but with high intrasource variation. Copper Ridge geochemical source B is the best defined of the four,

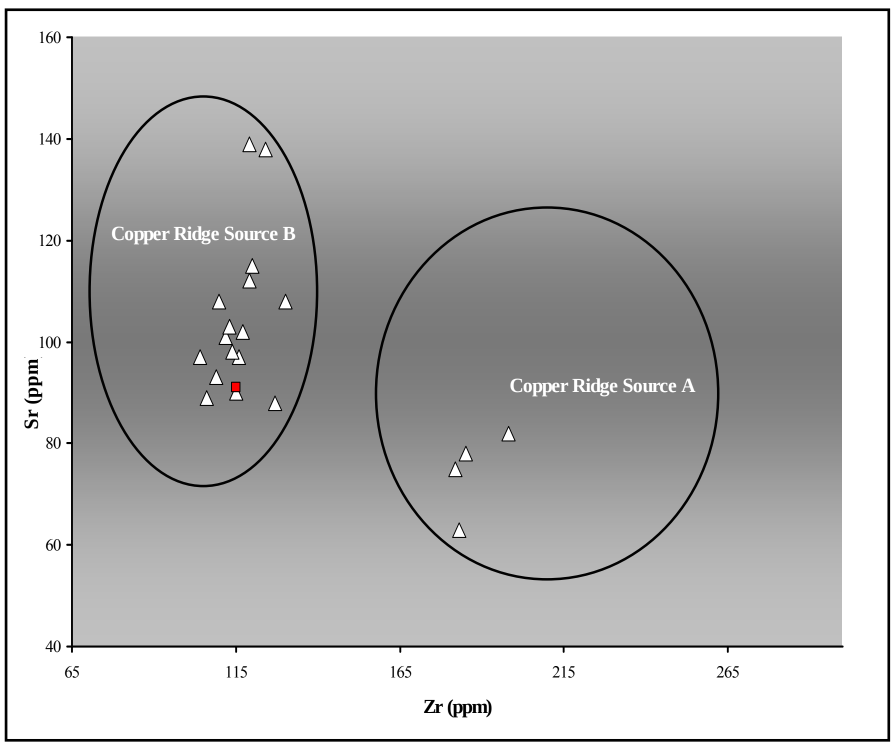

Figure 15. Scatter plot of Strontium (Sr) vs. Zirconium (Zr) in part per million, of all artifacts in Appendix A-2. Black lines circumscribe the plotted values from 67 vitrophyre source samples from nine outcrops used to define geochemical sources A and B on Copper Ridge (Skinner 1999b:Fig. 3, p.8). Triangles are artifacts, the red square represents a geologic sample (see appendix A-2).

but the others (A, C, and D) exhibit wider variation in trace element composition.

Figure 15 plots the results shown in Appendix A-2, using Strontium and Zirconium (in parts per million) as diagnostic trace elements (following Skinner 1999a and 1999b). The ellipses in Figure 15 outline the areas defined by the scatter plot of 67 geologic source samples published in Skinner and Davis (1996) and Skinner (1999a and 1999b). Note that four artifacts are correlated with Copper Ridge source A, but these are derived from a site located to the southwest of the project area.

Figure 16 maps the locations of sources A and B on Copper Ridge. The outcrops consist of veins or dikes of mostly black vitrophyre derived from volcanic activity associated with formation of the Hannegan caldera (Tabor and Haugerud 1999, Tabor et. al. 2003). The dikes intrude into the older and lighter-colored granitic rocks of the Chilliwack Composite Batholith. In some cases the dikes have weathered and eroded to the degree that no dike structure is visible, resulting in the formation of vitrophyre nodules in scree deposits below outcrops.

Geochemical source A is comprised of eight separate dikes located along the southern extent of Copper Ridge. The vitrophyre outcrops exhibit wide variation in tool stone quality. The majority of each outcrop generally consists of stone that is marginal, at best, for tool use. Nevertheless, a small portion of some outcrops consists of glassy, tool stone-quality vitrophyre. Wherever these latter outcrops occur, they are associated with nearby quarrying sites dominated by primary flaking debris.

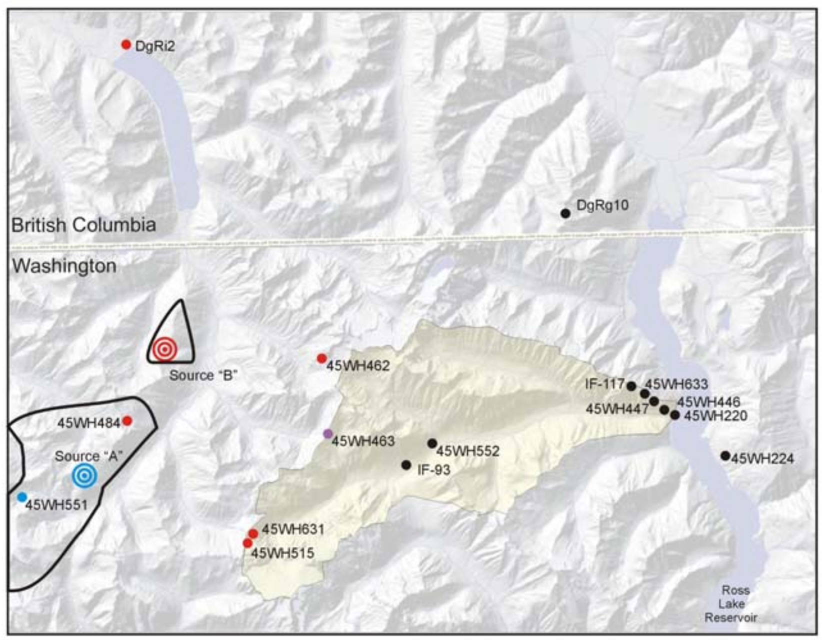

Figure 16. Map showing Little Beaver watershed sites with artifacts correlated to vitrophyre tool stone source locations; red dots denote artifacts from Source B; blue dots denote artifacts from Source A; purple dot no data; black dots denote sites lacking vitrophyre.

The geochemical source identified by XRF as "Copper Ridge Variety B" occurs as a single outcrop that has eroded from the side of an unnamed summit on northern Copper Ridge. Although quite glassy, this outcrop is highly fractured and weathered, resulting in an abundance of small (<4cm), rounded nodules. This outcrop is also associated with primary flaking debris.

In addition to these two geochemical sources, Figure 16 shows archeological sites in the project area vicinity, color-matched to the geochemical source of the site's vitrophyre artifacts. Artifacts made from source B are found in two sites at the head of the Little Beaver watershed, at the lower end of Chilliwack Lake, at one site just west of the Little Beaver watershed (45WH462) and on Copper Ridge (several other sites on Copper Ridge, not plotted in Figure 16, also contain artifacts geochemically sourced to B). To date, artifacts made from Hannegan volcanic rocks have not been identified in the upper Skagit River valley, and their only occurrence in the Little Beaver watershed is along the divide that separates Little Beaver from the Chilliwack. The map shows that all vitrophyre artifacts from along this divide are geochemically correlated with Copper Ridge source B (the only exception is that vitrophyre artifacts from 45WH463 have yet to be collected for sourcing). Two artifacts made from Copper Ridge source B were found in site DgRi-2 at the northern end of Chilliwack Lake, a distance of 12 km from its outcrop location (analysis of these artifacts and the geologic specimen was made possible through a loan to the author by Dave Schaepe). A single geologic specimen, although not visibly modified, could have been transported by people to DgRi-1, located near to DgRi-2, and it too is correlated with source B. All eight artifacts analyzed from 45WH462, which is located in a deep cirque bowl on the Chilliwack side of the ridge separating it from the Little Beaver watershed, correlated with source B. Artifacts from 45WH551 shown in Figure 16, which sits in a subalpine basin below the southern end of Copper Ridge, were mostly vitrophyre from source A (one of these five samples shown in Appendix A-2 is from source B). Due to the geochemical variation in the eight outcrops that define this source, the artifacts linked to source A could have come from any of these outcrops. Given that 45WH551 is the most proximate site to the source A outcrops, dominance of this source within the artifact sample makes intuitive sense. The presence of one artifact correlated to source B at this site, combined with the other artifact-to-source correlations, indicates that artifacts from source B are widely-distributed in the upper Chilliwack and upper Little Beaver watersheds.

Figure 17. Outcrop ii, Copper Ridge geochemical source B.

The fact that the locations of sources A and B are approximately equally distant from the upper Little Beaver-Chilliwack divide might suggest that tool stone from both sources should have an equal probability of being transported to the divide. The source-to-artifact data from the sample of artifacts analyzed for this project reveals that only vitrophyre from source B was brought to the upper Little Beaver. Any number of ad hoc inferences could be invoked to explain this distribution of source B tool stone, including that there was a preference for source B. But the current state of knowledge is limited by small sample sizes and a large deficit in survey data covering a broad area of northern Cascades. Much of the mountainous terrain that exposes the Hannegan volcanic rocks is administered by agencies other than the NPS and has not been surveyed for tool stone sources. Surveys notwithstanding, there are likely to be other volcanic tool stone sources remaining undiscovered. In spite of these limitations, the methodologies and analytic tools are in place to investigate millennial patterns in the movement of tool stone as these relates to indigenous adaptations to high elevation terrain of western North America.

5.0 DISCUSSION OF LITTLE BEAVER WATERSHED ARCHEOLOGY

5.1 Cultural Chronology of the Little Beaver Area

The long pre-contact period of the Northwest Coast's indigenous history has been summarized and described by archeologists through the creation of a sequence of cultural-historical periods within a defined geographic area. The time span assigned to each period relies primarily on extensive use of radiocarbon dates from archeological sites. Cultural histories of this type are inferred from analysis of thousands of diagnostic artifacts, archeological site features, geologic contexts, and other characteristics deemed relevant to explaining patterns in the archeological record. Figure 18 shows both regional and local cultural chronologies for selected locations in the Northwest Coast. Cultural histories are based on decades of archeological research at many sites.

	Time Scale in Thousands of Years Before Present[1]														
	13	12	11	10	9	8	7	6	5	4	3	2	1	0.5	Present→
Chronology/Period															
General Chronology[2]	Paleoindian			Archaic				Early Pacific			Middle Pacific		Late Pacific		
Strait of Georgia[2]					Old Cordilleran/Olcott			St. Mungo			Lacarno Beach	Marpole	Gulf of Georgia		
Fraser River Canyon[3]			? Pasika		Milliken		Mazama	Eayem			Baldwin	Skamel	Emery	Esilao	
Little Beaver Watershed Time Markers[4]							♦	6,540		3,840			1,360	St. Helens W ♦	

[1]Time scale based on radiocarbon dated archeological assemblages; *note that scale is not in even increments*

[2]From Ames and Maschner (1999)

[3]From Haley (1996) and Mitchell and Pokotylo (1996)

[4]Time markers consist of three radiocarbon dates and one identified tephra layer, as reported in text

♦Designates a time-sensitive (diagnostic) artifact type

Figure 18. Regional and local chronological/cultural periods of the Northwest Coast culture area compared with time markers derived from the Little Beaver watershed.

For this reason, direct comparison of these schemes with the project area is problematic, reflecting the comparatively limited extent of archeological investigations in the mountains. Even so, by plotting the project area time markers against these chronologies, the Little Beaver sites are considered within the larger regional view of cultural developments. The time markers are shown along the bottom row, and consist of the two diagnostic tools illustrated in Figs. 7 and 8, the three radiocarbon dates reported in Table 9, and the single volcanic ash identified in section 4.5. As shown in Figure 18, the Little Beaver sites cover a long span of the archeological history of the Northwest Coast. Although the Little Beaver dates suggest intermittent use of the watershed, this likely reflects a sampling bias introduced by the small number of sites and dated assemblages.

The earliest dates from the Little Beaver fall within the "Archaic" of Ames and Maschner (1999), a poorly understood period characterized by extensive environmental changes and the development of early subsistence economies that preceded the rise of permanent settlements, resource intensification, and complex social organizations. Indigenous use of the North Cascades at this period is reflective of small mobile bands of people who subsisted by utilizing a wide array of local plant and animal resources from terrestrial and riverine environments (Mierendorf 1986). A partial dependence on terrestrial mammals in this period is revealed at the Glenrose Cannery Site, located near the mouth of the Fraser River. Here, Matson (1996) recovered bones predominately of elk and deer, in association with leaf-shaped (Olcott) points that are morphologically identical to the one from 45WH631 (Figure 7). He argued that this assemblage represents a seasonal occupation within a land mammal adaptation (Matson 1996:122). Somewhat closer to the project area is the Milliken Site, located in the Fraser River canyon, where leaf-shaped points were recovered in association with a distinctive river-cobble flaking technology. This site is also believed to be hunting related (Mitchell and Pokotylo 1996).

The other time markers from the project area fall within the "Pacific" period of Ames and Maschner (1999). Indigenous populations of this period developed several characteristics not seen previously, including economies oriented toward the intensive use of local subsistence resources; a dependence on food storage; complex stone, bone, wood, and fiber technologies; large houses and villages; warfare and social stratification; a highly-developed artistic expression; funerary rituals; and a peak in total population. Although little is known about this period in the Fraser River canyon, assemblages are characterized by chipped stone and ground tools, including microblades in the Early and Middle Pacific, and by the absence of microblade technology in the Late Pacific (Ames and Maschner 1999). Northwest Coast culture in much of this period, particularly in the Late Pacific, was nearly identical to the cultures observed and described by European visitors at the beginning of the contact period.

Given that the indigenous groups that traveled through and utilized the Little Beaver watershed spanned these cultural developments, one might expect that its archeological sites should also reflect these broader regional patterns, such as has been predicted for some high elevation landscapes in the North Cascades (Mierendorf 1999). At the same time, it is necessary to be aware that the general schemes of Ames and Maschner (1999), and others, are biased toward the saltwater margins of the Northwest Coast, and to a lesser degree, the lowland, riverine interior. If true understanding of the mountainous interior is to be achieved, it must derive from an independent empirical data base from interior mountain archeological assemblages, rather than from the lowlands.

5.2 Archeological Assemblages

Two overall patterns of tool stone use are shown in the site assemblages. The first relates to local tool stone procurement and primary reduction of lithic raw materials: the pre-contact equivalent of a mining-and-refining industry that supplies material to other stone tool technologies. Five of the eight sites inventoried in the Little Beaver watershed (Table 4) exhibit evidence that tool stone in the site had been gathered from local sources.

Additionally, based on excavation results from 45WH220 and -224, and on the surface assemblages described in Table 5 from 45WH220, -446, 447, and -663, it is possible to derive a characteristic "signature" of these mining and refining activities, as defined by morphological categories of artifact types. This characteristic assemblage is defined by the dominance of four artifact morphological categories and the presence of at least one feature type. The categories include primary flake, broken flake, shatter, early-stage biface, and hammerstone. Intact bedrock formations exhibiting evidence of flaking and cultural fragmentation define the feature type. The diversity (richness) of tool stone types in these assemblages mirrors the diversity of tool stone types within the local bedrock formations, which is generally low.

The second overall pattern relates to the transport, repair, and reuse of finished tools. This assemblage pattern is characterized by morphological categories that include tool (and tool fragment), biface-thinning flake, and pressure flake. Diversity of tool stone types is greater than exhibited by local bedrock formations, and some types are derived from distant source areas. Only site 45WH631 revealed this pattern clearly, and 45WH220 to a slight degree.

Although the sample of Little Beaver sites is small, artifact assemblages suggest different flaking technologies applied to each of the two main tool stone types. The biface production technology on Hozomeen chert leaves morphologically distinct artifact categories compared with those produced by bipolar reduction of the small Hannegan vitrophyre nodules. The Hozomeen chert biface technology is well represented in the upper Skagit River valley sites. Bifaces are highly portable and were exported to other valleys far beyond the geographic provenance of Hozomeen chert tool stone. Exportation occurred in one or both of two ways, 1) through either transmontane transport along exchange routes, and 2) by subsistence and traveling parties who utilized the local chert to reprovision expended parts of tool kits during subsistence forays. During the eight millennia that Hozomeen chert was used, some indigenous groups in and around the northern Cascades must have known of this distinctive tool stone, or heard stories of its quarries, and many are likely to have seen or utilized tools made of this northern Cascades resource.

A technological analysis of all vitrophyre in park site assemblages does not yet exist; however, the recurring abundance of broken flakes, shatter, and split and shattered nodules of vitrophyre, along with an absence of biface tools and thinning flakes, suggests a reliance on bi-polar techniques for reduction and flake production. This technique is particularly useful when reducing small tool stone nodules or fragments. Although I have yet to see finished tools made of this vitrophyre, even small pieces offer extremely sharp cutting edges. Glass fragments would serve as bits for wood and soft-stone carving, as was practiced by many Northwest Coast people, particularly the Stó:lō (Smith 1988).

5.3 The Geography of Tool Stone

The geography of tool stone sources forms the basis for inferring group movements and subsistence activities in the project area. The data reported here reveal that these source areas constitute an important component of the subsistence resource base. The procurement and incorporation of local tool stone into the tool kits of the mountain-dwelling bands has been an important aspect of their subsistence pursuits for millennia. With the aid of accurate artifact-to-source correlations, the linkage among dispersed mountain sites with identifiable tool stone sources presents an opportunity to infer exchange and subsistence routes within the Little Beaver watershed.

Figure 19 maps the generalized source areas for the three types of tool stone, identifiable to a high confidence level, found in the Little Beaver archeological sites. The types are Hozomeen chert, and two geochemically distinct types of Hannegan vitrophyre, Copper Ridge sources A and B. The data used to prepare this map derives from decades of field mapping, description, and analysis of rock formations by professional geologists. Archeologists are dependent on geologic maps to identify potential sources of tool stone, but following the procedure adopted in this study, the assignment of the term "tool stone" is an inference based on empirical (i.e. archeological) evidence of its use, rather than on assessments of the potential utility based on the attributes of the material alone. This empirical requirement commits investigators of tool stone sources in rugged, montane environments to a long-term research effort. Anything short of this level of commitment will fail to achieve the extent of indigenous knowledge of localized tool stone sources or to successfully apply the full range of techniques required for successful artifact-to-source correlations.

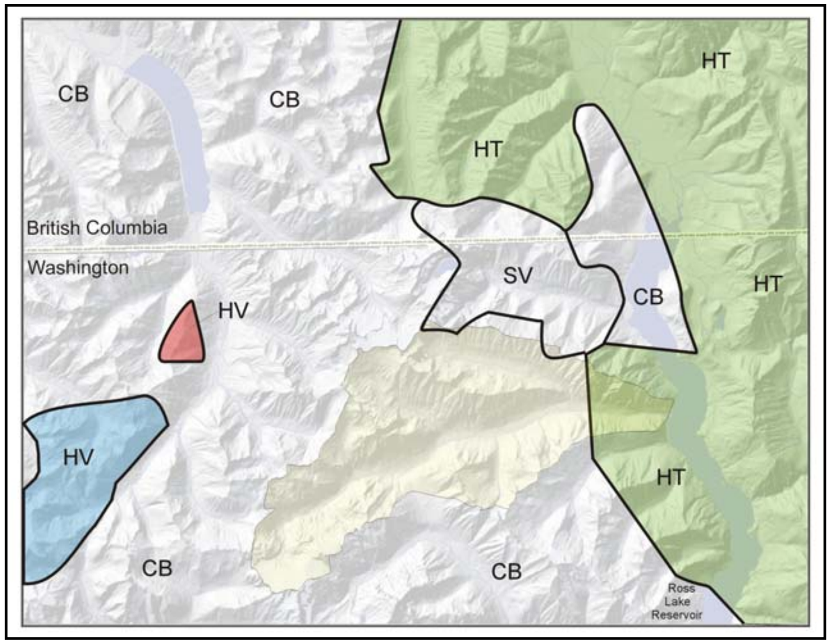

Figure 19. Tool stone source areas in the project vicinity; green is Hozomeen chert; red is Copper Ridge source B; blue is Copper Ridge source A; yellow is Little Beaver watershed.

Hozomeen chert tool stone is only locally available in outcrops and in the glacial and alluvial gravels eroded from them; such sources are restricted to the eastern end of the Little Beaver watershed (Figure 19). Vitrophyre sources in the Hannegan volcanic rocks occur some distance west of the watershed.

Figure 20 plots archeological sites in the project area, color-coded to reflect assemblages dominated by Hozomeen chert. This map forms the basis for the inferred dispersal routes of Hozomeen chert shown in Figures 21.

Based on the site and tool stone geographic data, Figure 21 shows the inferred route by which Hozomeen chert was transported through the project area. This is not necessarily the only such route; however, because others might exist that are not accounted for due to the absence of comparable data over much of the northern Cascades. Until the geographic provenance of all Hozomeen chert tool stone sources is defined, inferences about anthropogenic routes of transportation must be treated with caution. Lacking the necessary data, a route is not shown in the Chilliwack Valley connecting with site DgRi-2, because there remains the possibility that this chert was brought along other transportation routes that may link more directly to Hozomeen Chert outcrops east of the divide separating Chilliwack Lake from the upper Skagit River valley.

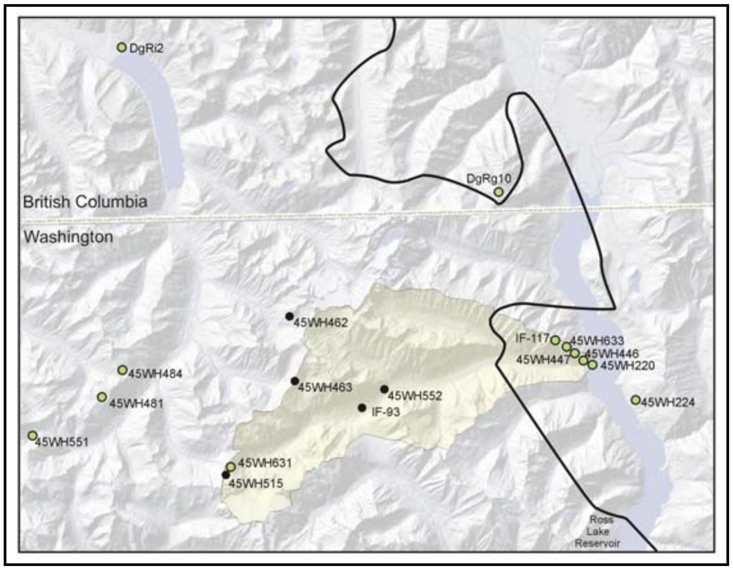

Figure 20. Map plotting assemblages containing Hozomeen chert in green; black dot means Hozomeen chert is absent.

Based on geochemical characterization of vitrophyre tool stone from source outcrops and archeological site locations (see Figure 16), a similar map of inferred transportation and subsistence routes is shown in Figure 22. As with Figure 21, the full geographic provenance of the Hannegan volcanic tool stone sources remains unknown, as the XRF data reveal that other geochemically distinct, but as yet undocumented sources exist. This also means that more routes are likely to exist than can be inferred from present data. Nevertheless, it is clear that vitrophyre from Copper Ridge geochemical source B is present in archeological assemblages in the upper Chilliwack watershed, and that this tool stone was carried, possibly along the transportation routes shown, to the Chilliwack and Little Beaver divide.

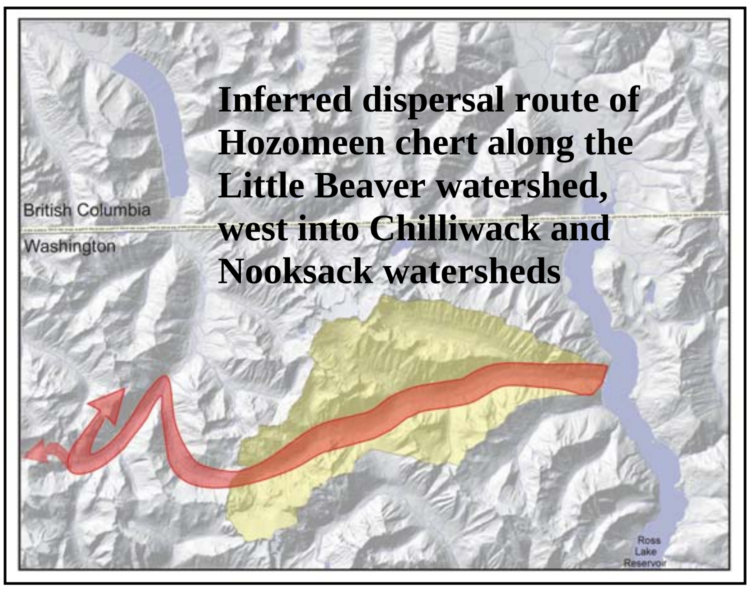

Figure 21. Map showing inferred dispersal route of Hozomeen chert from the upper Skagit watershed west to the Chilliwack and Nooksack watersheds.

These inferred routes of tool stone transport suggest that Hozomeen chert was carried to, and discarded at sites located well to the west and northwest of its source area in the Ross Lake area. However, a comparable movement of Hannegan vitrophyre to the east, down Little Beaver valley, is not indicated by the data. Given the present state of knowledge, it appears that Hozomeen chert use was more widespread in archeological sites of the northern Cascades than Hannegan vitrophyre.

5.4 Site Geography and the Demography of Travel Groups

For those readers who have experienced these high massifs on extended, off-trail trips across the backcountry, the site geography plotted in the above maps will have special significance. Those who lacking such direct involvement with this mountain environment may not readily appreciate the degree of knowledge and adaptive skills required by indigenous travel groups to successfully cope with this rugged terrain. If nothing else, data from the project area call for a consideration of how indigenous groups traveled the high country. Of the 11 total cultural resources in the Little Beaver aggregate sample, six are in the subalpine; eight are accessible from the valley bottoms only after ascending steep mountain slopes.

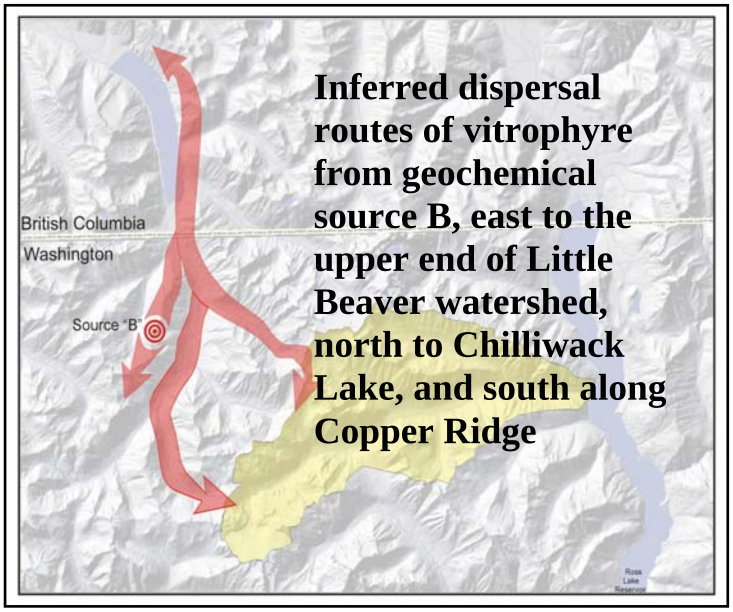

Figure 22. Map showing inferred dispersal routes of vitrophyre from Copper Ridge source B

Accessing these locations in the pre-contact past, as today, requires negotiating steep valley walls and traversing narrow and exposed ridge lines, accompanied by the recurrent loss and gain of elevation across short distances. In conducting archeological surveys in this terrain, crew members find that mountain goat, deer, and bear trails offer the most dependable routes. The presence of archeological assemblages, with evidence of at least short-term camping in this limiting alpine terrain, leads to an inquiry into the very nature of indigenous mountain travel. Understanding this aspect of indigenous adaptation to the mountain environment—strategies in group mobility—will surely enhance understanding of, and the ability to explain, high elevation archeological assemblages and traditional uses of alpine landscapes.

Examination of the social dimensions of high country travel offers several potentially rewarding lines of investigation. Consideration of the demography of travel groups is one of these. By looking at the composition of travel groups according to demographic characteristics, some of the factors influencing travel in the project area become apparent (this discussion draws on ideas articulated in Mierendorf 1996:46-47). For simplicity, consider two extreme types that encompass the full range of accommodations made by traveling parties to achieve certain levels of mobility. Social variables include age, gender, kinship, and purpose of the trip. Material considerations include the supplies and gear needed to sustain the traveling party, anticipated modes of travel, and resources that might be exploited along the way, such as tool stone to reprovision exhausted tools.

The first type of traveling party is the slowest, largest, and most secure of the two. It consists of a foraging group characterized by mixed gender and age—members of nuclear and extended families, including grandparents and grandchildren—who come together to collect berries, roots, trout and salmon, and basket materials and medicinals, and to hunt mountain goats, bear, deer, marmots, and birds. Such groups travel with deliberation, most often choosing the paths of least resistance, and with careful selection of overnight camps. They carry with them most of the tools for processing resources, and baskets and leather bags for gathering and transporting what they process and collect. Opportunistic encounters are readily exploited and adjusted to, be they for the chance meeting with a herd of elk or to heed an abrupt weather change forcing a bivouac for extra days. For such a group, the rate of travel was less important; cooking, consuming, and packaging the products of hunting, collecting, and fishing forays were of primary importance. So also was the passing to younger generations of traditional knowledge carried by elders about the names and origins of the places and beings encountered.

Much in contrast, the second kind of traveling party is small and highly mobile, carrying comparatively little gear. Such a party consists of one or a few members, spanning one or two generations, with gender composition dependent on the purpose of the trip. A party of women, for example, depart a base camp in the valley, ascend a ridge line several thousand feet to subalpine meadows, where they collect wild lily bulbs and medicinal plants, returning to their camp in the evening with full burden baskets. Or a husband and wife travel over Hannegan Pass to visit relatives in a Nooksack River village, carrying dried food and gear sufficient for them to move steadily between any suitable overnight stops along the way. If they carry too much, and find that their snowshoes are not needed, they cache them beneath a rock overhang, awaiting the return trip. A raiding party constitutes another kind of travel party, likely composed of one or two generations and a single gender, and characterized by extremely rapid mobility. In actuality, there existed any number of travel party combinations, each accommodated to purpose and terrain, and exploiting a large social and technological repertoire of adaptive techniques. For the high country of the Little Beaver and surrounding watersheds, there are few ethnohistoric details or specific references to the demography of travel and subsistence, much like the rest of the mountainous Northwest Coast interior. Allan Smith (1988:307) was so struck by this lack of knowledge while researching indigenous use of the North Cascades high country that he was compelled to ask "Why in their field research ethnographers in the Pacific Northwest have been remiss in inquiring into how high-altitude land masses have contributed to the traditional material, social, and religious existence of native American groups…?".

Are there demographic characteristics that could be inferred about the people who created the archeological assemblages described in the Little Beaver watershed? Due to small site samples and the limitations of site surface data, I can only offer the general impression that all of the high elevation sites resulted from small, mobile travel groups. The archeological signature of Hozomeen chert quarries in the lower montane zones reflects task-specific tool stone procurement and primary reduction, but at 45WH220 and 45WH552, there is a good possibility for encampment episodes by extended family groups. The tool-rich assemblage at 45WH631, with its abundance of non-local tool stone types, suggests a short-term travel camp, but much more data is necessary to support inferences regarding site function.

Regardless of limitations in the data, there should be little doubt that indigenous parties in the North Cascades traveled the high country at great risk and performed feats of endurance (that, perhaps, most anthropologists have never considered or performed themselves) as just a routine requirement of traveling across the landscape. Regardless of season, marine-influenced mountains are subject to abrupt weather changes and extremes, and any successful mountain adaptation to these conditions implies the requisite skills for basic mountain survival, including ability to bivouac in the subalpine under a variety of extreme conditions; to travel across snowfields, glaciers, and steep slopes; and to maintain and repair footwear and other key travel gear in order to sustain a maximum of mobility options. During most of the time spent on mountain travel, hypothermia and traumatic injuries are likely to have been the greatest threats.

In the absence of information regarding the details of mountain travel, perhaps the travel conditions and accomplishments of Henry Custer and his Indian guides in the summer of 1859 offer strong clues as to as to the nature of pre-contact indigenous travel in the northern Cascades. In spite of the limitations of historic documents and records, archeological remains will continue to yield the material remains accumulated in the ground by this little understood aspect of Northwest cultural history. For this reason, we are compelled to explore the archeology in the most extreme of Pacific Northwest terrestrial environments and to recognize the former existence of many cultural geographies, reflecting the visitation and use by any number of travel and task parties affiliated with any number of indigenous groups, beginning at least by the middle Holocene, ca. 8,000 years ago.

5.5 Summary and Conclusions

The results of this archeological project advances scientific knowledge of the upper Skagit River valley, its tributaries, and the adjacent mountains. A total of 11 archeological resources is described within the Little Beaver Creek watershed. Estimated site ages range from as old as 8,000 years to several hundred, based on radiocarbon dating, tephrochronology, and stylistic attributes of time-sensitive artifacts. Sites are located in the montane and subalpine vegetation zones, spanning the east-west range of the watershed. These sites reflect a range of subsistence activities, including collecting, quarrying, and refining of tool stone; processing and consuming local food resources; overnight camping, and travel. The scale of indigenous quarrying and refining of tool stone as revealed by archeological evidence from the project area far exceeds the level of tool stone usage based on ethnohistoric evidence in the larger Northwest Coast and the project area.

Out of seven tool stone materials found in the Little Beaver archeological assemblages, two are identifiable to a high level of confidence. The geographic provenance of the Hannegan volcanics and Hozomeen oceanic rocks are mapped, and pre-contact indigenous quarries in both areas have been studied. Hozomeen chert outcrops were quarried on subalpine ridge lines and steep slopes of the eastern extremity of the Little Beaver watershed. Hannegan volcanic rocks were quarried from subalpine outcrops in the upper Chilliwack River watershed to the west. Using artifact-to-source correlations with vitrophyre and Hozomeen chert, patterns in the anthropogenic transport of the tool stone are discerned. Hozomeen chert was transported west, up the Little Beaver and is found in archeological sites in the Chilliwack watershed. Hannegan vitrophyre from geochemical source B on Copper Ridge was transported by people east, at least as far as the divide separating the Little Beaver and Chilliwack watersheds.

The results of this project contribute information necessary for the informed management of park cultural resources. Several archeological sites in the Little Beaver watershed may be threatened by recreational uses, which will require that these sites be documented in more detail and monitored for any changes in site condition and use. Site data generated from this project is entered into several NPS site management and research data bases. Research data from this project supplements the final results of a collaborative high elevation archeological survey project between North Cascades, Olympic, and Mount Rainier National Parks. The data also link with archeological research and management issues current in British Columbia, as a consequence of tracing the source of vitrophyre artifacts from archeological sites at Chilliwack Lake to geochemical source B from Copper Ridge, located in the upper Chilliwack watershed of the park.

Ultimately, the value of this study will be determined by the extent to which it enlightens its readers regarding the history of human involvement in what today is considered a "wilderness" landscape. In spite of the fact that many today believe that the Cascades interior lacks any enduring involvement with human populations prior to the historic period, this report adds to the growing body of evidence supporting the assertions that mountain environments were important to at least some Northwest Coast Salish groups, and that some up-river bands maintained settlements and economies strongly oriented to the mountainous interior.

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APPENDICES

A-1. Glossary Of Technical Terms

A horizon: usually dark, organic-rich soil layer forming the topsoil immediately under modern vegetation, especially grasslands and meadows

alpine: specific sense refers to the vegetation community of the highest elevations, characterized by an absence of trees and dominated by sparse, low plant growth, or none at all; general meaning refers to the higher elevations of mountain masses

alpine glacier: one that exists due to snow accumulation from local mountain massifs, as distinct from cordilleran glaciers

anthropogenic: of human origin or cause

assemblage: a sample of artifacts collected for the purpose of archeological analysis or study

B horizon: weathered subsoil layer, forming iron and other mineral-rich accumulations in dense forests

basalt: a fine-grained, dark, opaque rock formed from the extrusion of magma at the earth surface; low in silica content

biface II: early stage in form in the manufacture of biface tools, resulting from cleaning and rough shaping into a generalized form, such that a variety of final tools could be made from the "blank"

bipolar: a technique for reducing small nodules of stone by placing the nodule on a stone anvil and applying direct force with a hammerstone

calibrated years: the age of a radiocarbon sample after it is adjusted to more accurately reflect calendar years, which are different than radiocarbon years

chert: a fine-grained rock type, similar to flint, that is high in silica; breaks with a conchoidal fracture; SiO_2

cordilleran glacier: a large glacier formed by the coalescence of many smaller glaciers formed in mountain cordillera

debitage: describes the accumulation of chipped stone debris created when tool stone is cleaned and tested, and when tools are manufactured

decortication flake: flake removed from the outer, weathered surface of a larger piece of stone; the dorsal surface comprises the weathered surface of the original, unflaked nodule

electron microprobe analysis: a way to measure the presence and quantity of major elements bound up within the matrix of glass fragments; creates a chemical fingerprint for glasses from different volcanic eruptions

flake: a thin piece of stone removed from a larger piece of stone through mechanical fracture induced by applying force, such as through hammering

glacial cirque: a usually deep mountain basin carved by erosion from an alpine glacier

Holocene: the non-glacial time period that followed disappearance of the cordilleran glacier; the present is considered part of the Holocene

lithic: of or referring to stone or mineral matter

lithic scatter: a generic archeological site type characterized by the dominance of stone tools, debitage, or other lithic artifact categories

loess: a deposit of fine, wind-blown (transported) silt-sized particles

metasediment: a generic term used to describe an array of metamorphosed sedimentary rocks, such as siltstone, claystone, slate, shale

nunatak: a mass of earth or rock that protrudes above the surface of a glacier; in the North Cascades, some mountain summits are nunataks

obsidian: rock of volcanic origin composed of predominately glass (SiO_2)

Olcott: an archeological term variously applied to certain leaf-shaped projectile (usually spear) points, or to a cultural pattern characterized by the presence of leaf-shaped points

paleoecology: study of the environments and natural history of time periods earlier than the present

pass: a low spot or saddle in a ridge line or mountain terrain that is utilized as a passage by people or animals

petrographic analysis: a way of identifying and quantifying the mineral composition of rocks, so as to identify the rock type

radiocarbon date: an age estimate of an organic (carbon-containing) material, based on the constant rate of decay of carbon isotopes

saddle: a low spot or dip in a ridge line or mountain terrain, not known to be used as a pass

shatter: angular, blocky fragments of stone produced during the flaking process

stade: a time period characterized by a glacial advance or glacial activity

subalpine: high elevation vegetation zone characterized a patchy mix of forest surrounded by meadows; a transition zone between the alpine zone above, and the montane forest zone below

tephra: volcanic ash, composed mostly of glass

tool stone: a lithic material that is or was utilized by indigenous populations

vitrophyre: a variety of obsidian characterized by the presence of larger crystals (phenocrysts) embedded in the glassy groundmass

X-ray fluorescence analysis (XRF): a technique used to measure the quantity of trace elements found in glassy rock types; creates a chemical fingerprint that is used to identify different volcanic glass deposits

A-2. Results of Obsidian X-Ray Fluorescence Analyses

*Appendix A-2 Results of XRF Analyses, North Cascades National Park, Washington, and British Columbia,Canada**

	Specimen			Trace Element Concentrations											
Site No.	No.	Catalog No.		Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe203T	Artifact Source
45-WH-631	5	NOCA 22183A		31	16	136	93	16	109	7	682	184	578	0.36	Copper Ridge Variety B
			±	7	4	4	9	3	7	1	75	45	28	0.11	
45-WH-631	6	NOCA 22183B		55	17	143	89	17	106	6	NM	NM	NM	NM	Copper Ridge Variety B**
			±	9	5	4	9	3	7	2	74	45	NM	0.11	
45-WH-631	7	NOCA 22183C		47	29	157	102	18	117	11	NM	NM	NM	NM	Copper Ridge Variety B**
			±	8	4	4	9	3	7	1	74	45	NM	0.11	
45-WH-462	2	NOCA 10123A		52	25	147	138	13	124	11	1005	302	NM	0.62	Copper Ridge Variety B?
			±	6	3	3	7	3	7	2	96	47	NM	0.11	
45-WH-462	3	NOCA 10123B		32	21	127	101	16	112	13	779	304	NM	0.63	Copper Ridge Variety B
			±	6	2	3	7	3	7	1	96	47	NM	0.11	
45-WH-462	4	NOCA 10124		29	26	136	90	13	115	8	721	247	NM	0.5	Copper Ridge Variety B
			±	7	2	3	7	3	7	2	96	47	NM	0.11	
45-WH-462	5	NOCA 10126		29	21	123	97	15	104	8	905	346	NM	0.83	Copper Ridge Variety B
			±	6	2	3	7	3	7	1	96	47	NM	0.11	
45-WH-462	6	NOCA 10127		21	21	130	139	17	119	10	812	253	NM	0.57	Copper Ridge Variety B?
			±	7	2	3	7	3	7	1	96	47	NM	0.11	
45-WH-462	7	NOCA 10128A		31	26	136	112	16	119	10	787	277	NM	0.7	Copper Ridge Variety B
			±	6	2	3	7	3	7	2	96	47	NM	0.11	
45-WH-462	8	NOCA 10128B		30	26	141	97	14	116	12	821	232	NM	0.53	Copper Ridge Variety B
			±	6	2	3	7	3	7	2	96	47	NM	0.11	
45-WH-462	9	NOCA 10128C		29	25	141	115	14	120	13	781	261	NM	0.6	Copper Ridge Variety B
			±	6	2	3	7	3	7	1	96	47	NM	0.11	
45-WH-462	10	NOCA 10128D		21	19	132	103	15	113	7	389	146	NM	0.18	Copper Ridge Variety B
			±	7	3	3	7	3	7	2	95	47	NM	0.11	
45-WH-515	11	NOCA 12314		30	19	138	108	17	130	10	727	232	NM	0.44	Copper Ridge Variety B
			±	6	2	3	7	3	7	2	96	47	NM	0.11	
45-WH-551	11	NOCA 19508		45	14	94	75	22	182	15	749	329	837	1.06	Copper Ridge Variety A
			±	6	2	3	7	3	7	1	96	47	13	0.11	
45-WH-551	12	NOCA 19509		33	23	135	98	16	114	12	593	289	691	0.46	Copper Ridge Variety B
			±	7	2	3	7	3	7	1	96	47	13	0.11	
45-WH-551	13	NOCA 19510A		43	11	91	63	23	183	13	401	196	756	0.5	Copper Ridge Variety A
			±	7	3	3	7	3	7	2	95	47	15	0.11	
45-WH-551	14	NOCA 19510B		40	13	92	78	23	185	11	875	365	731	1.05	Copper Ridge Variety A
			±	6	2	3	7	3	7	1	96	47	13	0.11	
45-WH-551	15	NOCA 19510C		34	20	106	82	20	198	16	634	200	662	0.54	Copper Ridge Variety A
			±	7	3	3	7	3	7	2	96	47	15	0.11	
Dg-Ri-2	17	DgRi-2-1		42	25	118	108	12	110	15	557	187	727	0.66	Copper Ridge Variety B
			±	8	3	4	7	3	7	2	95	47	14	0.11	
Dg-Ri-2	18	DgRi-2-2		31	23	136	88	15	127	11	488	257	708	0.35	Copper Ridge Variety B
			±	7	3	4	7	3	7	2	96	47	15	0.11	
Chilliwack Lake Moraine, BC	1	DgRi-1 Geo 1		40	24	130	91	14	115	12	788	282	639	0.56	Copper Ridge Variety B
			±	7	3	3	7	3	7	2	96	47	13	0.11	

All trace element values reported in parts per million; ±=analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide. NA=Not available; ND=Not detected; NM=Not measured.; **=Small sample. *=Data from Skinner (1999a, 1999b, 1999c, 2003), reports submitted to R. Mierendorf, NPS.

A.3 Results of Tephra Electron Microprobe Analyses

Analysis of major elements in the glass shards performed by Dr. Franklin J. Foit, Jr., Geo-Analytical Laboratory, Department of Geology, Washington State University. Results submitted to the author in letter dated December 15, 2003, on file at North Cascades National Park Service Complex, Curation Facility, Marblemount, WA.

Glass Chemistry of Tephra (Volcanic Ash) Sample (NOCA 22171)From 45WH631, North Cascades National Park

Oxide	Percentage*
SiO_2	74.77 (0.29)
Al_2O_3	13.92 (0.15)
Fe_2O_3	1.90 (0.06)
TiO_2	0.31 (0.02)
Na_2O	4.35 (0.12)
K_2O	2.30 (0.08)
MgO	0.41 (0.04)
CaO	1.91 (0.14)
Cl	0.12 (0.02)
Total**	100
Number of shards analyzed	19
Probable Source/Age***	Mt. St. Helen's W 1460±120 A.D.

*Standard deviations given in parentheses

**Analysis normalized to 100 percent weight

***Similarity Coefficient = 0.99