CHAPTER 2

Paleoenvironments, the Tsini Tsini Site, and Nuxalk Oral Histories

DAVID R. HALL

Introduction

It has been argued that late Quaternary paleoenvironmental factors and geomorphological events and processes strongly influenced when and where habitable land was available for occupation in British Columbia during the late Pleistocene and early Holocene (Fladmark 2001; Mathews 1979). Accordingly, it is essential to gain an understanding of the nature of the geologic, geomorphological, and climatic changes that occurred during the late Quaternary, particularly in coastal regions, if one is to attain a clear understanding of the early prehistory of any particular region within British Columbia (Borden 1979). The following paper evolved out of an attempt to place the assemblage recovered during Simon Fraser University's 1995 and 1996 excavations at the Tsini Tsini Site (FcSm 011) (Hall 1997, 1998; Hobler 1995, 1996; Hobler and Hall 1997) within its larger context and to gain a greater understanding of the late Quaternary paleoenvironmental, geologic, and geomorphological processes in the Bella Coola region, which may have affected both the context of the assemblage recovered from the site and the lifeways of its inhabitants. I also explore the possible identification of past geomorphological events in Nuxalk oral histories.

The Tsini Tsini Site

The Tsini Tsini site is located in the Talchako River valley on the central coast of British Columbia, approximately 500 km north of Vancouver (Figure 2:1). The site is situated approximately 30 m above the left bank of the Talchako River about 45 km east of Bella Coola and 2 km west of the community of Stuie.

The assemblage recovered from the site is dominated by mid-to-late stage biface reduction debris primarily fashioned from an unusual form of relatively fine-grained, moderately-to-heavily patinated andesite. A total of 149,660 artifacts were recovered during the 1995 and 1996 excavations. All but five of these artifacts were fashioned from lithic raw materials. Three possible features were also identified: a cache pit, a roasting pit, and a living floor. The vast majority of the items recovered (a total of 148,729 artifacts or over 99% of the total assemblage recovered) consist of andesite debitage. Of the remaining 931 artifacts, 393 consist of various amounts of obsidian, argillite, chert, jasper, basalt, quartz crystal, quartzite, and vein quartz debitage. The remaining 538 artifacts are formed tools, again almost all primarily of andesite, in the form of utilized and retouched flakes, denticulates, piercers, cores and core fragments, biface preforms, biface fragments, unifacial and bifacial choppers, a small number of projectile points (including a quartz crystal point), a single piece esquillee, and various forms of scrapers, spurs, and notches. A small but significant microlithic assemblage was also recovered including an obsidian microblade core platform rejuvenation flake, 16 obsidian microblades and microblade fragments, and a single possible basalt microblade fragment. Overall, the assemblage consists of a large typologically early-looking component with similarities to the early components at coastal sites such as Namu (ElSx 001) (Carlson 1997, 2000; Hobler 1995, 1996), and a poorly represented component (dating to approximately 500 BP) probably associated with a relatively recent Athapaskan presence within the upper Bella Coola valley.

Geomorphology

In the Bella Coola region, two important geomorphological processes aside from the fluvial actions of the Bella Coola River and its tributaries have significantly influenced both the timing and the potential location of prehistoric

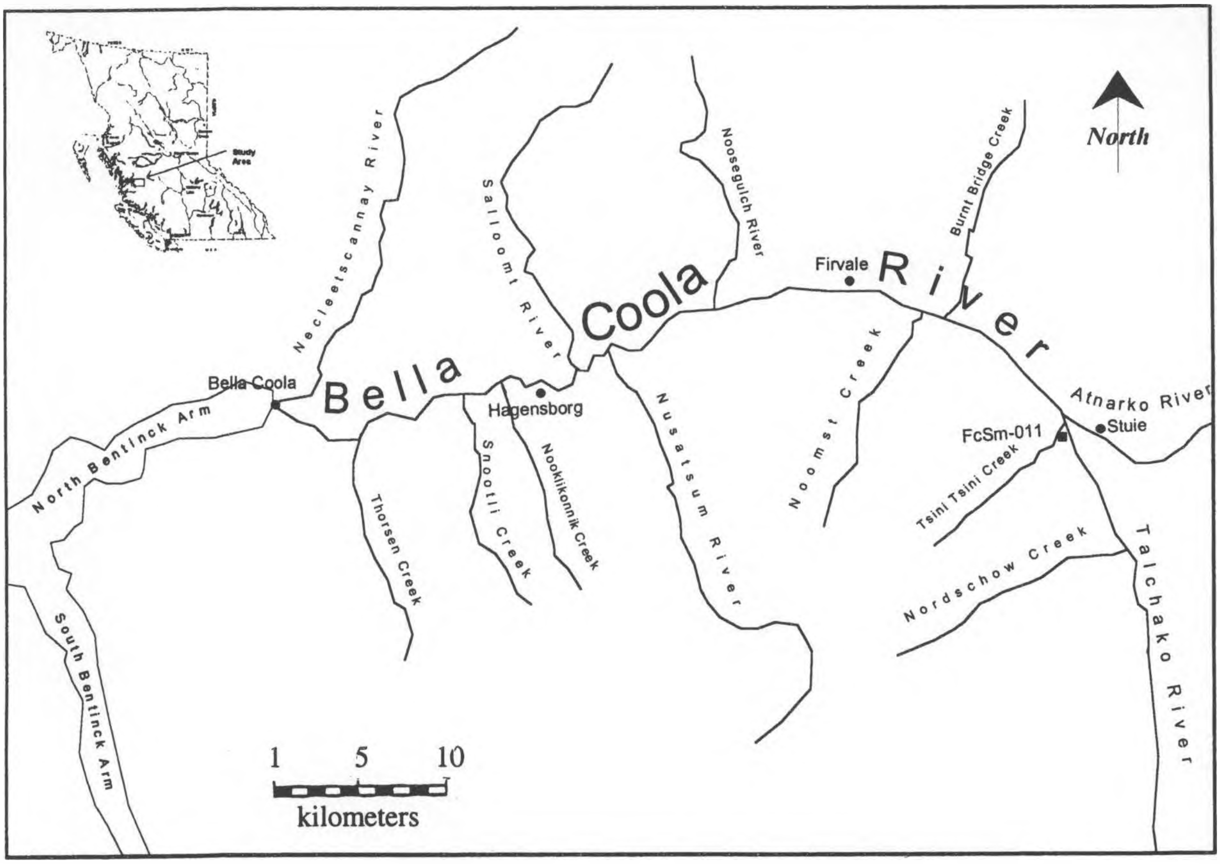

Figure 2:1. **Location of Tsini Tsini (FcSm 011) and other Places mentioned in the Text.**

habitation within the valley and surrounding region. These processes consist of Pleistocene and Holocene glacial fluctuations and changes in relative sea levels (Andrews and Retherford 1978:341; Retherford 1972:2). Throughout the Pleistocene and Holocene the relative land-sea interface along the Northwest Coast has been constantly fluctuating (Clague 1975; Fladmark 1974; Heusser 1960; Hebda and Frederick 1990:321; Holland 1976). These changes, which appear to have been caused by interaction between diastrophism (the tectonic movement of the earth's crust), eustacy (the raising and lowering of available water in the ocean), and glacio-isostacy (isostatic uplift and depression caused by the weight of late Quaternary glaciers), undoubtedly influenced both the timing and the location of habitable land within the region (Andrews and Retherford 1978; Clague 1975:17, 1983:321; Clague et al. 1982:598; Fladmark 1974; Heusser 1960:189; Holland 1976:116; Josenhans et al. 1995:75). Therefore, a discussion of both the late Pleistocene/Holocene glacial history of the region and the record of sea level fluctuations within the Bella Coola locality will be presented as an investigation of the history of these two geomorphological processes that can provide clues as to the maximum dates for the human occupation of any particular location within the Bella Coola basin, and insights into the forces that created the majority of the physiographic features and landforms in the region.

The Bella Coola basin was the locus of a significant amount of glacial activity during the late Pleistocene and early Holocene (Desloges and Church 1987:99; Kostaschuk 1984; Munday 1937). During the Fraser glaciation, most alpine areas of the Coast mountains such as those surrounding the Bella Coola valley, served as major centres of ice accumulation and dispersal with the main valleys, such as the Bella Coola, having served as channels through which coalescing Coast mountain glacial complexes flowed westward to the sea (Heusser 1960; Holland 1976; Munday 1934-1935; Ryder and Thomson 1986). At the height of the Fraser glaciation, approximately 15,000 [17,940 cal] BP (Blaise et al. 1990:282; Desloges 1987:24), confluencing glaciers eventually met and filled almost all of the major pre-glacial valleys in the Coast mountain region including the Bella Coola valley (Clague

1984:1; Desloges 1987:24; Ryder and Thomson 1986:273). This complex of glaciers encompassed almost all of the major pre-glacial divides within the Coast mountain physiographic region and enveloped almost all of the land on the mainland coast (with the exception of some of the higher peaks), eventually terminating on the continental shelf to the west on the outer coast (Clague 1984; Desloges 1987; Ryder and Thomson 1986). At its maximum extent, the ice sheet was most extensive over the mainland fjords, less extensive on the innermost section of the continental shelf, and relatively thin and/or completely absent from the continental shelf on the outer coast (Clague 1983:322).

During glaciation glaciers flowed westward from the Monarch Icefields through the Bella Coola valley (Desloges 1987:24). This western movement, which is indicated by the presence of striations along the valley walls and on mountains in the immediate vicinity, suggests that glacial ice flowed down the main and tributary valleys in a similar manner to modern drainage patterns (Baer 1973:8; Munday 1937:45, 1939a: 526). At the height of glaciation, a number of peaks in the Coast Mountains including some within the Bella Coola valley, protruded as nunataks above the ice sheets (Desloges 1990:107; Holland 1976:42; Ministry of Environment and Parks 1986:14; Retherford 1972:17). The maximum elevation of the ice sheet present within the Bella Coola valley is estimated as reaching approximately 2000-2100 m (Baer 1967:9, 1973:8). This estimate is based on the presence of distinct morphological changes at this elevational range at various locations including the sides of Mount Nusatsum and Salloomt Peak (Baer 1967:9, 1973:8). Mountain peaks within the Bella Coola valley at elevations below this elevational threshold were completely overridden, and were rounded off (Ministry of Environment and Parks 1986; Munday 1939a).

In general, it appears that the glacial chronology and the accompanying creation of glacial landforms within the Bella Coola valley would have been analogous to the glacial chronology and the accompanying creation of landforms that occurred in the Smithers-Terrace-Prince Rupert map area during the same period as reported by Clague (1984, 1985). This region therefore provides an analogous model by which the glaciation of the Bella Coola valley can be interpreted as, based on the geologic principle of the law of similar conditions (see Stokes 1960:34), it can be expected that the geomorphological processes that occurred within the Smithers-Terrace-Prince Rupert map area and the resulting landforms created would have been similar to those processes that occurred and resulting landforms created within the Bella Coola region based on the topographic similarity of the two regions.

In the Smithers-Terrace-Prince Rupert area, the outer coast was the first area to be deglaciated. This occurred approximately 13,000 [cal 15,600] BP (Clague 1984:1, 1985:256). Evidence from the Prince Rupert, Kitimat, and Bella

Figure 2:2. **View across the Bella Coola Valley from the Tsini Tsini Site, looking North.**

Bella regions suggest that deglaciation by calving and frontal retreat (Clague 1984:1, 1985:256), occurred relatively rapidly with glaciers retreating to the heads of coastal fjords by approximately 12,500 [cal 14,800] BP (Andrews and Retherford 1978; Clague 1983). Evidence from other areas of the coast suggests that local ice persisted in isolated areas of the inner central coast until approximately 11,000-10,000 [cal 13,000-11,400] BP (Church 1983:172; Clague et al. 1982:600; Josenhans et al. 1995:77) with glaciers having withdrawn from the majority of the major coastal valleys prior to approximate 9600 [cal 10,800] BP (Desloges and Ryder 1990:281).

It seems that the entire B.C. coast was isostatically depressed by the weight of Pleistocene icesheets with the sea subsequently transgressing these depressed regions. Following the isostatic depression and marine transgression, these areas isostatically rebounded (Andrews and Retherford 1978; Armstrong 1981; Clague 1975, 1983, 1984, 1985; Fyles 1963; Heusser 1960; Josenhans et al. 1995; Kerr 1936). This apparently coast-wide scenario (isostatic depression followed by marine transgression and then isostatic uplift and rebound), that was first recognized in a series of articles by George Dawson (1877, 1890), has been recognized within the Bella Coola region by a number of authors (see Andrews and Retherford 1978; Baer 1973; Church 1983:172; Clague 1983; Desloges 1987; Retherford 1972). The temporal sequence and the magnitude of relative sea level shifts within the Bella Coola valley are very similar to those reported for other areas of the B.C. coast (see Clague et al. 1982; Clague 1975, 1984, 1985; Fyles 1963; Armstrong 1981). This phenomenon is not exclusive to the B.C. coast, as this pattern has also been noted as having occurred on the glaciated portion of the eastern seaboard of the United States (Crossen 1991:127), in the Arctic (Bednarski 1986, 1989; Dredge 1991; Retelle et al. 1989), and along the coast of Norway (Postma and Cruickshank 1988).

The isostatic warping of the B.C. coast appears to have been in response to the weight of the Cordilleran icesheet while its unloading and subsequent uplift were the result of its subsequent melting and retreat (Holland 1976:116). Along the glaciated coast, the weight of Pleistocene icesheets isostatically depressed the earth's crust (Dawson 1890:161; Hebda and Frederick 1990:321), and this displacement was significant enough to counteract the lower eustatic ocean levels that are suggested to have been occurring during the same period (Andrews and Retherford 1978:390; Clague 1984:51, 1985:263; Clague et al. 1982:614; Luternauer et al. 1989:67). Consequently, glacial seas subsequently transgressed areas of lower elevation along the coast including most present day coastal lowlands.

Many lines of evidence indicate that marine transgressions occurred along the B.C. coast during the last glaciation (see Andrews and Retherford 1978; Armstrong 1981; Clague 1975, 1983, 1984, 1985; Dawson 1877, 1890; Fyles 1963; Heusser 1960; Josenhans et al. 1995). During the marine transgression, previously terrestrial areas became the sites of glaciomarine sedimentation that resulted in the creation of a number of glaciomarine landforms. In these areas, large amounts of sediments, which were transported by meltwater streams issuing from receding glaciers, were deposited on various valley bottom floodplains and coastal lowlands (Clague 1984:1; 1985:256). At the same time, outwash from valley glaciers, which occupied the various hanging valleys along the coast and within the Bella Coola valley, built deltas into the transgressed sea waters (Retherford 1972:7). The glaciers that were present within the valley deposited various forms of glaciofluvial sediments in the valley including various till and morainal formations, kames, and ice contact terraces (Desloges 1987:26-27; Desloges and Church 1987:99; Leany and Morris 1981:15).

Following the isostatic depression and the marine inundation of the B.C. coast, as the coast became freer of glacial ice, the crust isostatically rebounded as the glaciers ablated (Clague et al. 1982; Clague 1984:6; Dawson 1877, 1890; Hebda and Frederick 1990:321; Holland 1976:116). This isostatic rebound is generally thought to have occurred at the same time as the off-loading of the weight of the glacial icesheets (Holland 1976:116). This off-loading is thought to have been caused by the degradation of the ice sheets due to calving and melting (Holland 1976:116). As the land isostatically rose relative to the sea, previously subaerial glaciomarine landforms and deposits including previously subaqueous deltas were aerially exposed. Isostatic rebound also caused a re-emergence of previously submerged lowlands, which had been the subject of substantial glaciomarine sedimentation (Clague 1984:51). The isostatic rebound along the coast appears to have been a time transgressive event (Ryder, Fulton, and Clague 1991). This, it has been suggested, may have been due to micro-regional and macro-regional variations in the magnitude and extent of glacial masses along with regional variations in the thickness of the crust (Apland 1982:15).

In terms of the Bella Coola valley, the presence, location, and elevation of raised deltas and fill terraces as well as dates derived from shells and peat samples from within the Bella Coola valley have been used to delineate the timing and the magnitude of the marine transgression within the valley (Andrews and Retherford 1978; Desloges 1987:291; Retherford 1972:iii, 17). These data have also been used to delineate a sea level curve for the Bella Coola (Retherford 1972) and central coast regions (Andrews and Retherford 1978).

Dates from glaciomarine sediments within the Bella Coola valley indicate that the marine transgression within the valley occurred prior to 10,500 (cal 12,200) BP [Retherford 1972: iii]. A radiocarbon sample of marine shells recovered from marine clays at a site near Mills Creek across from Hagensborg which was dated to 10,570±85 [cal 12,200] BP suggests that the marine transgression of the valley was still occurring by this date (Hobler 1995:18) with the glacial sea extending to a depth of approximately 10-15 m near the mouth of the Salloomt River (Hobler and Bedard 1992:65). The land/sea interface would then have been near the mouth of the Nusatsum River, approximately 25 km west of the Tsini Tsini site (Hobler and Bedard 1992:65). A 600 year marine shell correction puts this date at 10,000 [cal 11,400] BP. During the marine inundation of the valley, relative sea levels ranging between 150 to 200+ m above present sea level appear to have occurred within the Bella Coola valley (Andrews and Retherford 1978; Desloges 1987; Retherford 1972:iii). From its maximum marine limit, the Bella Coola valley was isostatically uplifted between ca. 10,500-9500 [cal 12,200-10,800] BP thereby resulting in an accompanying drop in relative sea level (Clague et al. 1982). This drop in relative sea level was continuous with relative sea levels being about 20 m above modern relative sea levels by at least 9500 [cal 10,800] BP with relative sea levels continuing to fall after this date (Retherford 1972: iv). Near present sea levels were finally reached by 6500-6000 [cal 7450-6900] BP (Retherford 1972: iv). However, the residual affects of continued isostatic adjustment caused relative sea levels to continue to fall after this date with the land/sea interface being at least 2 m below present day relative sea level between 3500-3000 (cal 3800-3200)BP (Retherford 1972: iv). After approximately 3000 [cal 3200] BP however, relative sea level is thought to have risen slowly on a gradual curve until near present day relative sea levels were achieved (Retherford 1972:90). The sequence noted above for the Bella Coola region differs from that on the outer coast where recent research indicates that there was a steady decrease in relative sea levels throughout the Holocene (Cannon 2000). Radiocarbon dates from Namu (ElSx-001) and other sites on the outer coast indicate that the outer coast was aerially exposed by at least 9700 [cal 11,000] BP (Cannon 2000; Carlson 1996a). It appears that the isostatic adjustment of the earth's crust that began during the last major Pleistocene glaciation continues to effect the relative position of the land-sea interface as it has been suggested that the outer central coast is submerging at a rate of approximately 2 mm/year while the inner coast is simultaneously emerging at approximately the same rate (F.E. Stephenson, personal communication 1982 in Hobler 1990:301).

It should be noted that several authors have suggested that the isostatic rebound that occurred along the British Columbia coast took place as a series of waves or pulses (Andrews and Retherford 1978; Retherford 1972). Retherford (1972:iii) suggests that the presence of relict raised glaciomarine deltas in the Bella Coola valley, which appear to be scaled to past shorelines at different elevations, indicates that a number of distinct periods of stable sea level and/or periods of high sedimentation rates occurred during the marine transgression of the valley. Retherford (1972) further suggests that the raised marine features within the Bella Coola valley that cluster around elevations of 10, 70, 160 and 230 m respectively appear to represent former relative sea levels within the valley with the latter two groups of scaled raised marine features dating to approximately 11,000-10,000 [cal 13,000-11,400] BP and 13,000-12,000 [cal 15,600-14,000] BP respectively. Thus, according to Retherford (1972), there appears to be an association between the formation of raised glaciomarine deltas, stillstands of the ocean, and pulses of glacial activity. This interpretation has also been posited for other areas that have been subject to both isostatic depression/uplift and marine transgressions (e.g., Ashley et al. 1991:121; Heusser 1960:20).

Evidence from the outer central coast of B.C. has also been used to infer that the late Holocene marine transgression occurred in a series of small pulses (Andrews and Retherford 1978:346). These researchers point to the presence of a number of alternating layers of peat near the site of Namu (ElSx-001) on the outer central coast as evidence of this process. Clague et al. (1982:598) later challenged this inference in that they argued that the alternating bands of peat seen at Namu might not be related to glacial activity. Rather, they argued that these bands could have been the result of catastrophic floods and/or significant storm events. Despite the fact that this inference has yet to be proven conclusively, a scenario in which the marine transgression occurred in a series of pulses would help to explain the varied locations and elevations of marine deposits that have been identified by various authors within the Bella Coola valley (see Andrews and Retherford 1978; Baer 1973; Desloges 1987; Retherford 1972).

It should be noted that it has also been suggested that there is an apparent pattern along the central coast whereby raised marine features occur at high elevations at the heads of fjords and on the outer coast and at low elevations in the middle of fjords (Andrews and Retherford 1978:346). Andrews and Retherford (1978:346) attempted to explain this apparently anomalous pattern by suggesting that this pattern could have been caused by variations in the rate of ice retreat. However, continued geomorphological research along the Northwest Coast suggests that this apparently anomalous pattern may instead be the result of the effects of glacial forebulge.

Peltier (1974 in Clague 1983:333), Walcott (1970, 1972), Clark, Farrell, and Peltier (1978), and Ryder, Fulton, and Clague (1991) have described the forebulge effect. This phenomenon is created by the displacement of molten mantle material to those areas peripheral to the area immediately underneath the centre and weight of glacial mass and its subsequent lateral movement during the ablation phase of glaciation (Peltier 1974 in Clague 1983:333; Walcott 1970). During glaciation, molten material is displaced in front of the advancing glaciers. This causes a depletion of molten material beneath the ice mass and areas of uplift in front of and adjacent to the advancing glacial mass. As the ice sheet ablates, the molten material which caused the uplift reverses its flow and begins to flow back towards the centre of glacial mass, thereby resulting in a upward vertical displacement in this area (Clark et al. 1978; Peltier 1974 in Clague 1983:333). At the same time, in areas peripheral to the areas directly affected by advancing glaciers, the molten material flowing back towards the uplifted region causes a simultaneous depletion in the available amount of molten material in those areas away from the area of uplift (Clark et al. 1978). This results in submergence and depression of the earth's crust in these more distal areas (Walcott 1972). The forebulge caused by these various flow pattern changes in molten material is not thought to collapse in one place. Rather, it is thought that the forebulge migrates back towards the centre of glacial mass as the glacial mass ablates (Peltier 1974 in Clague 1983:333).

Recent studies have suggested that the migration and collapse of a glacial forebulge may have caused the rapid transgressions identified within the coastal fjords of B.C. (Luternauer, Conway, Barrie, Blaise, and Mathews 1989:357). Luternauer et al. (1989:357) in their analysis of cores from the northern end of Vancouver Island suggested that the rapid marine transgressions that they identified as having occurred on the continental shelf of British Columbia occurred at approximately the same time as the marine regressions, which occurred at the mainland heads of fjords. Consequently, they suggested that the marine transgression on the outer continental shelf and the marine regressions in mainland fjords might be genetically linked. They therefore suggested that the isostatic uplift apparent in the fjords of mainland coast and the crustal displacement of the Western Canadian continental shelf during the late Pleistocene/early Holocene might have been the result of the migration and collapse of a glacial forebulge (Luternauer et al. 1989:359). It appears that the effects of a glacial forebulge would appear to represent the most plausible explanation of the apparently anomalous pattern of marine features noted by Andrews and Retherford (1978). This recognition provides a model by which further research regarding marine features along the central coast might be interpreted.

Thus, synthesizing and summarizing the proceeding, it appears that from its maximum extent in the Bella Coola valley approximately 15,000 [cal 18,000] BP, the icesheet within the Bella Coola valley receded. At approximately 12,500 [cal 14,800] BP, certain areas within the valley were probably aerially exposed with local ice persisting until approximately 11,000-10,000 [cal13,000-11,400] BP. The entire valley appears to have been aerially exposed by at least 9500 [cal 10,800] BP. Marine inundation of the valley appears to have occurred between 12,500 and 10,500 [cal 14,800-12,200] BP with the valley being isostatically uplifted and the sea regressing between 10,500-9500 [cal 12,200-10,800] BP (Desloges 1987:24).

In terms of the timing of the potential habitation of the Bella Coola valley, it is possible that the Bella Coola valley could have been physically habitable by 11,000 [cal 13,000] BP (although temperatures and catabatic winds at the time would have made habitation prohibitive). The marine transgression, which occurred in the valley prior to 10,500 [cal 12,200]] BP, does not preclude the possibility that prehistoric populations may have been present in the region and may have inhabited the valley at this time at higher elevations. Rather, only the lower valley floor would have been inhabitable at this time. In terms of the Tsini Tsini site specifically, as the land-sea interface is suggested as being near the mouth of the Nusatsum River by 10,570±85 [cal 12,200] BP, and the fact that the lower terrace at the Tsini Tsini site is approximately 175 m above present day sea level with the upper terrace being approximately 190 m above present day sea levels, suggests that the entire surface of the Tsini Tsini site would have been aerially exposed and available for human occupation by at least 10,500 [cal 12,200] BP.

The Tsini Tsini Raised Delta

The Tsini Tsini site is situated upon a landform that appears to be associated with the marine transgression that occurred in the Bella Coola valley. This inference is derived from a number of lines of evidence including the identification of marine organisms in sediment samples taken from the Tsini Tsini site in addition to a number of morphological and sedimentological characteristics of the landform itself. Specifically, the Tsini Tsini site is situated on what appears to be a relict, elevated, fjord-wall glaciomarine delta that was built out into a still stand of the sea more than 150 m above contemporary sea levels (Joseph Desloges, pers. com., 1995). The Tsini Tsini landform therefore is part of a series of glaciomarine features that are scaled to approximately 160 m above present day sea levels and associated with a 11,000-10,000 [cal 13,000-11,400] BP date (Retherford 1972).

The identification of the glaciomarine origin of the landform on which the site is situated has a number of paleoenvironmental and archaeological implications. One of the most important of these implications is that the association of the landform with one of the possible stillstands of the temporally delimited marine transgression in the Bella Coola valley provides a maximum date of occupation for the site. In addition, the identification of the landform as being associated with the marine transgression within the valley has a number of important implications regarding the archaeological and geomorphological context of the site, since mistaken contextual information could be inferred if the origin of the landform on which the site is situated is not correctly identified as being marine in origin, particularly if the landform in question is related to marine transgressions and regressions (cf. Kraft 1985; Kraft et al. 1985).

Raised glaciomarine deltas are common features along the coastline of B.C. (Retherford 1972:52). They are especially prevalent within fjords along coastal areas that were subjected to glaciation during the late Pleistocene and early Holocene (Retherford 1972:52). For example, these features have been identified in the Bella Coola valley (Andrews and Retherford 1978; Baer 1967, 1973; Joe Desloges, pers. com. 1996; Leany and Morris 1981; Retherford 1972), in the Prince Rupert region (Clague 1984, 1985), in the Vancouver area (Armstrong 1981), on Vancouver Island (Fyles 1963), and other areas of the B.C. coast (Clague and Luternauer 1982; Heusser 1960). Moreover, they have also been identified in the Arctic (Bednarski 1986, 1988; Dredge 1991; Retelle et al. 1989), along the glaciated part of the eastern U.S. seaboard (Ashley et al. 1991; Crossen 1991), along the coast of Norway (Corner and Fjalstad 1993; Postma and Cruickshank 1988), and along the coast of Northern Ireland (McCabe and Eyles 1988).

Modern glaciomarine deltas, the direct genetic precursors of raised deltas, have been observed being formed by modern glaciers in Alaska (Boulton and Deynoux 1981; Powell and Molina 1989). The formation of raised glaciomarine deltas is described in Ashley et al. (1991), Bednarski (1986, 1988), Boulton and Deynoux (1981), Clague (1984, 1985), Clague and Luternauer (1982), Crossen (1991), Postma and Cruickshank (1988), McCabe and Eyles (1988), Powell and Molina (1989), Retherford (1972), and Rust (1977). A processual reconstruction of the creation of the landform on which the Tsini Tsini site is situated synthesizing the work of these authors follows. This model is put forth in the hope that an understanding of the depositional and temporal context of the cultural material recovered from the site may be gained since it appears that the glaciomarine deposits constitute the stratigraphic, geologic, and geomorphologic context (cf. Gladfelter 1977) from which the cultural material was recovered at the site.

Raised glaciomarine deltas such as the Tsini Tsini landform are created by glacial outwash streams flowing beneath tributary valley glaciers within fjord-sidewalls as these sidewall glaciers debouched into glacial seas (Bednarski 1986:1343; Clague 1984:32, 1985:260). Glaciomarine deltas are primarily formed during the ablation phase of glaciation in situations where a tributary valley glacier that is in contact with a glacial sea becomes relatively stable for at least a short period of time (Clague and Luternauer 1982:26; Powell and Molina 1989). In tributary valleys within fjords, the interface between the margin of a glacier and the glacial sea often includes prominent submarine outwash systems especially when the glacier is ice rafted (Powell and Molina 1989:369; Rust 1977). These subaqueous outwash systems create subaqueous fans that build deltaic-like foreslopes into the glacial sea (Powell and Molina 1989:381). As this delta progrades, glaciofluvial sands and gravels are deposited over the foreslope in a manner similar to that observed in the formation of modern non-glacial deltas (Clague 1985:260; Powell 1980, 1981 in Clague and Luternauer 1982:26).

The hypothesized sequence of the creation of the Tsini Tsini landform begins at the height of the last glaciation. As previously noted, during the Fraser glacial maximum, which is though to have occurred at approximately 15,000 BP [cal 18.000] (Blaise et al. 1990:282; Desloges 1987:24), coalescing alpine and tributary valley glaciers filled the Bella Coola valley (Clague 1984:1; Desloges 1987:24; Ryder and Thomson 1986:273) resulting in isostatic depression of the valley because of weight of the glacial mass. At the onset of the ablation phase and as the glaciers begin to recede from their maximum extent, the continued effects of isostatic depression allowed for the marine inundation of the valley thereby causing a simultaneous rafting of some of the remaining glaciers within the region. As noted, this marine transgression is thought to have occurred sometime prior to 10,500 [cal 12,200] BP (Retherford 1972: iii). During the marine inundation of the valley, subaqueous outwash systems began to deposit deltaic foreslopes of glaciofluvial sands and gravels beneath the Tsini Tsini valley glacier into the glacial sea. At some point prior to 10,500 [cal 12,200] BP, it appears that there was a drop in the relative position of the land-sea interface as a result of isostatic uplift due to the offloading of the weight of the glacier masses (Clague et al. 1982 in Desloges 1990:99). Continued isostatic uplift accompanied by a simultaneous westward retreat in the land-sea interface eventually aerially exposed the top of the originally subaqueous landform. As relative sea levels continued to drop, more and more of the landform was aerially exposed. Eventually, with the continued drop in relative sea level, the original deltaic foreslope was subject to the effects of wave action and storm events thereby resulting in the formation of a wave-cut terrace at the distal end of the landform. The relative sea level continued to drop until the sea completely retreated to near modern day levels with the resulting present-day shape of the landform being exposed and therefore available for occupation by approximately 10,500 [cal 12,200] BP (Hobler and Bedard 1992). As the base level of the Bella Coola basin fell during isostatic rebound, Tsini Tsini Creek appears to have incised the unconsolidated deltaic sediments within the landform, thereby dissecting the original form of the deltaic feature at the outlet of Tsini Tsini Creek. Subsequent gullying of the unconsolidated deltaic deposits also appears to have occurred along the eastern flank of the landform in that it appears that an ephemeral stream has incised the eastern flank of the relict delta thereby creating a gully at the eastern extremity of the landform.

It has been suggested that the spatial distribution and relative elevation of relict raised deltas is primarily a function of the relative position of sea level at the time of their formation while the size of these features is primarily a function of sedimentation rates, available sediment budget, and the available energy budget of the various fluvial transport systems in place during their formation (Nemec 1990; Retherford 1972). Glaciomarine deltas can form very rapidly (Clague 1985:260; Corner and Fjalstad 1993; Powell and Molina 1989:381). Observations of modern glaciers suggest that the sedimentation rate in subaerial outwash systems can be quite substantial (Powell and Molina 1989:372). An example of the speed in which glaciomarine deltas can aggrade and prograde into the sea was recently observed in the Glacier Bay region of Alaska (Powell 1983 in Powell and Molina 1989:381). In 1979, the Riggs glacier terminated in the ocean at a depth of approximately 55 m (Powell 1983 in Powell and Molina 1989:381). Two years later, it was noted that a glaciomarine delta with a fully intertidal plain had extended approximately 200 m seaward from the glacier. Four years later, this deltaic plain had extended a further 100 m into the ocean (Powell 1983 in Powell and Molina 1989:381). Thus, in a short four year period, an estimated total of approximately 10,000,000 m^3 of sediments had been deposited in front of the glacier and an approximately 300 m inter-tidal plain had been created (Powell 1983 in Powell and Molina 1989:381).

It has been argued that during the last glacial retreat that the volume of meltwater streams and their energy budgets would have been considerably greater than those observable today and that the amount of sediments available for transport and redeposition would have also been far greater as a result of the newly formed extensive till and morainal deposits that would have been continuously exposed to significant meltwater discharges (Retherford 1972:54). Consequently, it has been suggested that sedimentation rates within outwash of Pleistocene glaciers would have been extremely high for short periods of time during glacial retreats (Retherford 1972:79). This would thereby suggest that the

Tsini Tsini landform seen today may have been formed in a relatively short period of time and moreover that the creation of the landform would have necessitated only a very short period of relatively stable sea levels for it to be created.

In terms of their morphology, glaciomarine deltas often display what is described as a well developed Gilbert-type deltaic stratigraphy consisting of moderately sloping topset beds with steeply dipping delta-front deposits (foreset beds) overlaying relatively flat bottomset beds (Clague 1984:32, 1985:260; Corner and Fjalstad 1993; Fyles 1963:85; Retherford 1972:49). The foreset bedding apparent within glaciomarine deltas is thought to be indicative of the deposition of prograding deposits into standing water (Bednarski 1986:1343; Clague 1984:32). The sediments directly underlying raised deltas (bottomset beds) are often noted as having an either flat or gently inclined orientation while beneath the foreslope, foreset sediments are noted as often dipping parallel to the foreslope surface (Clague 1984:32). In general, topset beds within glaciomarine deltas are noted as having variable thicknesses, but as being relatively thin (Fyles 1963:85). Topset beds are thought to be generally courser than those beds that form the underlying sand and gravel foreset beds (Fyles 1963:85). Typically, prograding topset beds are described as being quite sandy (Joseph Desloges, pers. com., 1995) while bottomset beds are often described as being comprised of mainly silts (Clague 1985:260).

Sedimentologically, it has been suggested that sediments within glaciomarine deltas reflect the unstable nature of the glaciofluvial environment in which they are formed with them often displaying abrupt and distinct morphological and sedimentological changes between strata including the presence of lenses of poorly sorted gravels (Clague 1984:30; McCabe and Eyles 1988:1). Courser deposits within these features tend to be deposited closer to their sediment source (e.g., at the mouths of tributary valleys) with finer sediments generally being deposited in more distal areas (Clague 1985:260; Powell and Molina 1989:380). The finer sediments apparent within these features are thought to be the result of clays and silts settling from suspension and/or the result of turbidity flows caused by various types of slope failures and mass wastage episodes (Clague 1985:256).

A number of researchers have noted several morphological characteristics that many raised glaciomarine deltas, including the Tsini Tsini landform, share. For example, many raised deltas display scarps on their distal end and occasionally on their proximal sides (Clague 1984:32, 1985:260; Crossen 1991:129). These scarps have been interpreted as representing wave-cut cliffs formed during coastal erosion as they were modified by ocean currents and tidal processes (Ashley et al. 1991:123; Carobene and Ferrini 1993:234; Clague 1985:257; Crossen 1991:129; Dumas et al. 1993). It has also been suggested that within raised glaciomarine deltas, layers of course glaciomarine sediments are often stratigraphically superimposed over finer deltaic sediments as lag deposits. These types of lag deposits have been identified by a number of authors as being associated with marine regression (Corner and Fjalstad 1993:155; Corner et al. 1990:164; Postma and Cruickshank 1988:151; Fedje et al. 1996:136; Retherford 1972:25). For example, Retherford (1972:34) suggests that the presence of these course layers superimposed over fine layers and the coarsening upwards of sediments within raised deltas within the Bella Coola valley indicate that when the glacial sea receded from the Bella Coola valley, the regression must have occurred both relatively rapidly and continuously; otherwise the uncompacted gravels and fine clays retained in some of these features would have been washed away by the significant currents and glaciofluvial outwash systems which would have been prevalent within the valley at this time. This inference is consistent with the relatively short timeframe within which the regression appears to have taken place (between 11,000-10,000 [cal 13,000-11,400] BP). In Alaska, this same pattern (i.e., course sediments overlaying finer sediments) has also been interpreted as representing the seaward migration of the land-sea interface (Andrews 1978:390).

Definitively determining whether a landform represents a raised delta is somewhat problematic. In many cases it is unclear whether a terraced feature is deltaic, fluvial, or a combination of both (Clague 1984:32). One way to definitively differentiate whether or not a feature represents a fluvial terrace rather than a raised delta is to look for evidence that indicates that deltas were built up into the sea (Clague 1984:32). This evidence includes the presence of foreset bedding, the presence of a moderately steep depositional surface or delta foreslope (Clague 1984:32), and the presence of worm tubes (Retherford 1972:34). One of the only uniquely diagnostic ways of determining if a landform is definitively associated with a marine environment is the identification within the landform of the presence of marine shells and marine muds (Boulton and Deynoux 1981:418). In this way one can discount other possible sources for the features such as landslide dams, coalescing river deltas, or whether or not the landform represents a paraglacial alluvial fan (see Ryder 1971; Retherford 1972:55; Clague 1984:32, 1985:260). Thus, through the identification of a number of morphological characteristics of raised deltas, it is possible, although difficult, to positively identify these landforms.

One of the most diagnostic lines of evidence concerning the glaciomarine origin of the Tsini Tsini landform was provided by an analysis of a sediment sample from the site itself. Samples of a sterile sandy stratum from an excavation unit on the upper terrace of the site were subjected to a diatom analysis by Daryl Fedje of Parks Canada and produced some illuminating results. Diatom analysis is a type of analysis that has been found to be particularly informative in terms of the reconstruction of paleoenvironments (Anderson and Vos 1992) especially in those areas subject to marine transgressions and regressions (i.e., Pienitz et al. 1991). These types of analyses have been instrumental in the delineation of past-sea levels (i.e., Stabell 1980), the identification of the extent of uplift of formerly glaciated regions, and in the identification of paleoenvironmental change especially in coastal areas as a number of marine diatoms have specific tolerances in terms of temperature, salinity, and water depth (Pienitz et al. 1991; Vos and de Wolf 1993a, 1993b). The analysis conducted by Fedje of the sample taken from the sandy layer beneath the main culture-bearing strata at the site revealed the presence of a number of saltwater diatoms and a single sponge spicule (Hobler 1995:7). Of the marine diatoms identified within the sample examined by Fedje, only one could be identified to species level (Daryl Fedje, personal communication 1997). This consisted of the marine plantonic diatom *Paralia sulcata* (Daryl Fedje, pers. com. 1997) or *Melrosia sulcata*, as it is known in early literature regarding diatoms (Stabell 1996:156).

Paralia sulcata is a common form of microscopic unicellular coastal algae (Hendey 1964:2) that is considered a true bottom form (Hendey 1964:73). This particular type of diatom is often found in fossil marine sediments (Loseva 1988:83) and is often found in the basal sand layer of oceans (Pienitz et al. 1991), thereby suggesting that the sandy strata beneath the main culture bearing deposit within the Tsini Tsini feature was once the bottom of a glacial sea. The diatom *Paralia sulcata* is considered to be tide-indifferent (Vos and de Wolf 1993a) with a salinity tolerance of greater than 20% (Vos and De Wolf 1993a:289). It is considered to represent a type of diatom easily transported (i.e., by tidal actions). Therefore the presence of this particular species of diatom can only provide information about the wider surrounding environment and not the specific location in which it was found (Vos and De Wolf 1993a:291). As such, *Paralia* diatoms have been described as being less useful for paleoenvironmental reconstructions than other types of diatoms (Anderson and Vos 1992:24) as one can only suggest that the environment at the time of the deposition of the diatom was strongly influenced by the sea (Anderson and Vos 1992:24; Vos and De Wolf 1993b:304). Unfortunately no datable material was recovered in the samples examined by Fedje (personal communication 1997). The identification of the marine material in the sandy stratum beneath the main culture-bearing deposit at the site and the sandy nature of the uppermost strata at the site (which is thought to be a characteristic of deltaic topset beds) suggests therefore that the uppermost layers of the site at one time represented the top layer of a subaqueous delta and therefore the bottom of a glacial sea.

In the case of the Tsini Tsini landform, the identification of the presence of marine diatoms and sponges within matrix samples recovered from the site, the presence within the Tsini Tsini landform of a number of previously noted morphological and sedimentological characteristics of raised deltas, and the identification of the landform as a raised delta by Joseph Desloges, combine to suggest that the landform on which the Tsini Tsini site is situated represents a relict raised glaciomarine delta formed during the marine transgression within the valley. However, the fact that no definite foreset beds have yet been identified within the landform makes this inference somewhat problematic. A 2 m profile of the landform excavated during the 1995 field season by the author and Farid Rahemtulla failed to reveal the presence of foreset beds. However, it is possible that a larger profile of the landform needs to be excavated in order to expose any forset bedding, since topset beds within glaciomarine deltas have been identified as being up to 3 m thick (Corner and Fjalstad 1993:155; Corner et al. 1990:161). Moreover, the suggestion that glaciomarine deltas are known to be particularly subject to a great deal of subaqueous slumping and sliding and other forms of mass movement (Carlson and Powell 1992:572; Phillips and Smith 1992:93), processes which may have obscured the original depositional profile of the landform, further suggests a possible reason for the lack of identifiable foreset bedding within the excavated sample profile.

It should be noted that there is an alternative explanation as to the genesis of the Tsini Tsini landform. It is possible that the Tsini Tsini landform was formed behind the coalescing delta that is thought to have existed for a short period in the valley somewhere between 11,000-10,000 [cal 13,000-11,400] BP (Baer 1973:11; Retherford 1972:91). This is similar to a situation described in Clague (1984) for the Smithers-Terrace-Prince Rupert map area. A dammed lake, thought to have occurred as a result of the coalescing of the deltas of the Nusatsum and Salloomt rivers, is thought to have had only a brief existence in the valley as the uncompacted sediments within the delta would only have briefly been able to withstand the significant erosional forces within the valley at this time (Retherford 1972:112). Evidence that is suggestive of the presence of this coalesced dammed lake includes the presence of terraces along both the Nusatsum and Salloomt River valleys and the presence of varved sediments approximately 327 m upslope of the old bridge at Hagensborg (Baer 1973:11). It should be noted that laminated clays situated 300 m above Noomst creek (Munday 1937:47) may also be the result of this damming phenomena.

If the Tsini Tsini landform was formed during the period that the coalesced delta dammed lake is thought to have existed in the Bella Coola valley, it is possible that the Tsini Tsini landform would share many of the morphological features of raised glaciomarine deltas including the presence of marine diatoms and sponges, since the coalesced delta could have trapped ocean water behind it (Retherford 1972:112). Ocean water trapped behind its walls would have provided the opportunity and the mechanism by which the marine organisms identified within matrix samples recovered from the site could have been incorporated within the Tsini Tsini landform.

Alternatively, it is possible that the marine diatoms and sponges were incorporated into the matrix of the landform as a result of a particularly large Tsunami. Significant tsunamis occurred often during the Holocene along the west coast of British Columbia (Hutchinson and McMillan 1997, Ng et al. 1990). However, as current estimates suggest that the magnitude of Tsunami waves at fjord heads in other areas would probably not have attained levels substantially above 15 m (Ng et al. 1990:1250), it is unlikely that the marine organisms were introduced to the site in this manner. Nevertheless, a particularly powerful Tsunami could have lead to the deposition of the marine organisms within the Tsini Tsini landform.

Despite the existence of these alternative explanations, the identification of the Tsini Tsini landform as a relict raised glaciomarine delta appears to be the most plausible explanation of its origin. The identification of the Tsini Tsini landform as a raised delta is not unique within the Bella Coola valley, as a number of raised deltas have previously been identified there. These include those at the mouths of Thorsen, Noomst, and Nooklikonnik creeks and those at the mouths of the Salloomt, Nusatsum, and Necleetsconnay rivers (Baer 1967:9, 1973:10; Retherford 1972:44).

Since the Tsini Tsini landform exhibits a number of morphological and sedimentological characteristics of raised deltas, marine organisms are present within the Tsini Tsini feature, and the elevation of the feature above present day relative sea level is consistent with the identification of other local glaciomarine features, the most reasonable conclusion is that the landform on which the Tsini Tsini site is situated represents a relict raised glaciomarine delta associated with an earlier higher stand of a glacial sea. Previous researchers within the valley either failed to note the feature (Retherford 1972) or identified the feature as representing either an alluvial or a deltaic feature without being more specific (Baer 1973, Map 1329A). Thus, it appears that Hobler (1995) was the first researcher in the valley to correctly suggest that the landform present at the outlet of Tsini Tsini Creek is indeed a relict raised delta. Thus, as is evident, the previous discussion of the genesis of the Tsini Tsini landform has provided insight and sources of hypotheses as to the depositional context in which the cultural material at the site was found and has provided a suggested maximum date for the occupation for the site. Further geoarchaeological research at the site needs to be conducted in order for the hypotheses put forth in the proceeding to be rejected or validated.

A Paleoenvironmental Reconstruction for the Bella Coola Region

The climate of a region strongly influences the biotic composition and the availability of resources within any region and therefore imposes constraints upon the types of adaptations, subsistence strategies, and types of settlement patterns possible, and in turn influences the resulting form of technology. Therefore, determining the past paleoenvironment of a region is important as it can provide valuable clues as to the available resources in a region for earlier populations and can help identify the constraints under which human adaptive responses and technological strategies were selected for. Moreover, it can also provide a baseline by which comparisons with modern climate and available resources can be made.

The paleoclimate and the paleoenvironment of a region can be inferred from the identification of glacial fluctuations and the presence/absence and/or relative proportion of environmentally sensitive indicator species within pollen cores. Utilizing these data, Hebda (1995:75-77) recently published a synthesis of the paleoclimatic record of British Columbia. He proposes the following revised classificatory scheme of Holocene climatic phases for the coast of British Columbia. This scheme will be utilized in order to present a proposed paleoclimatic reconstruction for the Bella Coola valley during the Holocene. Within his classification scheme, Hebda proposes that a xerothermic or hypsithermal event (Deevey and Flint 1957; Heusser 1960:185) (a dryer and warmer period than today) occurred between approximately 9500 and 7000 [cal 10,800-7800] BP immediately following the withdrawal of early Holocene glaciers (Hebda 1995:77; see also Clague and Mathewes 1989; Mathewes 1985; Pellatt and Mathewes 1997). During this period, Hebda suggests that mean temperatures between 2-4° C warmer than modern temperature ranges occurred with maximum temperatures between 9000-7500 [cal 10,200-8400] BP, and with a phase of increased moisture between 8500 and 6000 [cal 9150-6800] BP. Following this period, between approximately 7000 and 4500 BP [cal 7800-5100], a warm and moist mesothermic period with modern annual precipitation occurred, but with temperatures exceeding modern levels. Following this mesothermic period, he suggests that during the period from approximately 4500 [cal 5100] BP to the present, moderate temperatures and moist conditions prevailed, but with a possible increase in moisture between 4500-3000 [cal 5100-3200] BP.

While this scheme can be utilized to provide an overall impression of the paleoclimatic history of the Bella Coola valley, macroclimatic/paleoclimatic classificatory schemes such as that proposed by Hebda, while useful for delineating overall trends, tend not to be as valuable as interpretations derived from cores within any specific area under investigation, because an increase in distance from data sites results in an increase in the uncertainty as to the applicability and validity of the reconstruction of the region in question (cf. Mann and Hamilton 1995:449). However, as of yet, no datable pollen cores that could aid in the paleoclimatic reconstruction of the Holocene paleoclimatic record within the Bella Coola valley have been obtained. Nevertheless, a number of palynological cores have been obtained from regions surrounding the Bella Coola valley. These cores will be utilized within this study in order to make microclimatic/paleoclimatic inferences.

The closest palynological cores to the Tsini Tsini site so far obtained include the cores from near the Tezli and Ulgatcho sites on the Plateau (Donahue and Habgood 1974), a core from Dwarf Birch Lake at Heckmann Pass approximately 25 km northeast of the Tsini Tsini site (unpublished data by Hebda and Allen 1993 cited in Hebda 1995), a core from Bear Cove Bog on Northern Vancouver Island (Hebda 1983), and a core from a bog near Prince Rupert (Banner, Pojar, and Rouse 1983). A further study of cores from the outer coast near Bella Bella conducted by H. Nichols is noted in Andrews and Retherford (1978). However, the results of this study have yet to be published.

The results of the analyses of the cores noted above appear to concur with Hebda's (1995) macroclimatic scheme, particularly in terms of the dating of the Hypsithermal event in the region. However, some differences do exist. For example, analysis of the core from Dwarf Birch Lake, which represents the closest dated pollen core to the Tsini Tsini site, suggests that just prior to 6000 [cal 6800] BP, the climate in the region was moister and possibly cooler than it was in the early Holocene (Hebda and Allen unpublished in Hebda 1995:69). This period of moist and cool temperatures is noted as having lasted until approximately 3800 [cal 4200] BP when drier conditions returned (Hebda 1995:69).

In addition to palynological analyses, it has been argued that Holocene Neoglacial advances can also provide information that can be utilized in paleoenvironmental reconstructions, in that it has been argued that glacial advances can be suggestive of regional climatic controls and/or the occurrence in specific areas of periods of below average temperatures and/or well above average rainfall (Desloges and Ryder 1990:289; Hebda 1995:77). In the Bella Coola valley, two major episodes of Neoglacial advances (defined as the rebirth and/or growth of glaciers following maximum shrinkage during the Hypsithermal interval ([Porter and Denton 1967:205]) have been identified including a series of advances which occurred between approximately 3500 and 2500 [cal 3800-2500] BP (Desloges and Ryder 1990:289; Retherford 1972:3) and a series of little Ice Age advances which occurred between approximately 800 and 1880 AD (Desloges 1990:99; Desloges and Church 1987:99; Desloges and Ryder 1990:281). Both of these periods of Neoglacial advances appear to be contemporaneous with glacial advances that occurred in the southern coast mountains (Ryder and Thomson 1986), in the Canadian Rockies (Luckman et al. 1993; Osborn and Karlstrom 1989), and in other regions (Kerr 1936; Porter and Denton 1967; Ricker 1983) although the exact maxima for Neoglacial conditions seems to be a time transgressive event (Mann and Hamilton 1995:464). Nevertheless, the apparent synchronicity of these advances in a number of different areas indicates that a macro-regional climatic change occurred during these periods (Desloges and Ryder 1990:289). Thus, it appears that periods of below average temperatures and/or well above average rainfall occurred within the Bella Coola valley between 3500-2500 [cal 3800-2500] BP and from approximately 1200 BP to 120 BP.

Thus, synthesizing the work of the authors noted above, a hypothesized paleoenvironmental reconstruction of the paleoclimate of the Bella Coola valley is presented below in the absence of the absence of any paleoenvironmental research within the Bella Coola Valley itself. It appears that the climate within the Bella Coola valley from approximately 9000-7000 [cal 10,200-7800] BP during the Hypsithermal event was considerably warmer and drier than at present. From approximately 7000-4000 [cal 7800-4500] BP, it appears that the climate in the Bella Coola valley was cooler and moister than during the preceding period. From about 4000 [cal 4500] BP on it appears that near modern climatic regimes were established with this period being punctuated by cooler and/or wetter periods during periods of Neoglacial advances between 3500-2500 [cal 3800-2700] BP and during the little Ice Age (1200-120 [cal 1150-95] BP).

The hypothesized changes in overall climate would have undoubtedly affected both the biotic composition and the hydrological regime of the Bella Coola region in addition to the frequency of storm events, flooding, and forest fires in a manner similar to that suggested for other areas (see Franklin et al. 1991). This climatic change would in turn have affected the availability of resource species within the valley thereby placing constraints on any human population there at that time (Hebda and Frederick 1990:327). Moreover, it has been demonstrated that tree lines and the extent of alpine areas changed during the Holocene in relation to macro and micro-regional climatic influences (see Clague et al. 1992; Pellatt and Mathewes 1997). This too would have imposed constraints on human populations within the valley in that the distribution of tree species and utilized resource species within alpine areas both in the valley and in the surrounding region would have been affected. It has also been demonstrated that species migrations took place in response to macro-regional climatic change during the Holocene (see Erlandson and Moss 1996; Hebda and Mathewes 1984), This change would have affected the relative makeup of the biome in the valley during the Holocene, and would have imposed constraints on human populations living in the region. However, as the response of biotic communities to climatic change varies and the response of specific species to climatic change appears to be species dependant (cf. Mathewes and King 1989:1822), the exact nature of these changes is difficult to infer.

Many ethnographically important riverine resources would have undoubtedly also been affected by climatic change during the Holocene. For example, it has been suggested that the various anadromous salmon species are susceptible to even minute changes in their environmental regime and accordingly that their reproductive success therefore fluctuates in response to climatic change (Fladmark 1974; Francis and Sibley 1991; McBean et al. 1991; Nehlsen and Lichatowich 1997; Neitzel et al. 1991; Shalk 1977). This would have undoubtedly been the case during the Holocene, as they almost assuredly would have been affected by the significant climatic changes that occurred during that period. In the Columbia River basin, for example it has been argued that conditions for salmon were poorest during the Hypsithermal with optimum conditions being reached during the Neoglacial (Chatters et al. 1995) thereby resulting in more populous and successful runs during this period. The success of salmon runs during the Neoglacial period also appears to be evident on the central coast as suggested by the maximum values for salmonoid resources at Namu coinciding with this period (see Carlson 1991, 1995). Within the Bella Coola Valley itself, modern observations of fish populations within the Bella Coola River system confirm that even year to year small scale climatic changes can have a considerable impact on the availability and viability of riverine resources (see Boland 1974), thereby further suggesting the possible affects that paleoclimatic changes would have had on salmonoid resources within the valley.

While the proposed changes in biotic composition and resource species can be inferred, determining the specific ecological changes and the corresponding changes in species availability that occurred within the Bella Coola area during the many changes in climate that are known to have occurred in the region during the Holocene is problematic and represents an avenue for further research.

Nuxalk Oral Traditions and Paleoenvironments

An attempt will now be made to integrate the results of the proceeding investigation with the oral history of the Nuxalk peoples. There are numerous references within Nuxalk oral histories to events that seem to have a number of specific geomorphological and paleoenvironmental corollaries. The numerous occurrences of these corollaries suggests that a deep continuity in time exists within Nuxalk oral traditions. Among the geologic and geomorphological events that occur frequently within Nuxalk oral histories is the marine transgression in the valley. For example, Filip Jacobsen (1895) recorded an oral tradition in which it is stated that the sea extended far up the Bella Coola valley in mythological time (in Boas 1898:52-53) while in another story, North Bentinck arm is described at the beginning of creation as extending past Stuie (Andy Schooner Sr. n.d. in Storie 1973:75). McIlwraith (1948 I:89) and Davis and Saunders (1980:71) also record a story in which it is stated that in the beginning of time, the ocean resided to the east of Bella Coola with land being located to the west of the valley. In this story, Raven is thought to have altered the land and sea to its present position and that most ocean dwellers followed the sea to its new home in the west, although a number of mussels stayed with their human friends and are still present in the upper valley (McIlwraith 1948 I:89). These mussels, which are present in the upper valley and which are called by the Nuxalk the same name as ocean mussels, were pointed to as proof to McIlwraith that saltwater was at one time present within the upper Bella Coola valley (McIlwraith 1948 I:89; Andy Schooner Sr. n.d. in Storie 1973:75).

It could be argued that the various oral histories noted above refer to a time at the end of the Fraser glaciation in which the marine transgression of the Bella Coola valley and the collapse of a glacial forebulge were occurring simultaneousl. The effects of a collapsing glacial forebulge could explain the apparently anomalous suggestion apparent in Nuxalk oral histories that the present day seafloor in the past was at a higher elevation than the present day relative position of dry land. Further, the effects of a collapsing forebulge could also explain the pattern of the present day land being underwater as the transgressed sea waters within the Bella Coola valley could have been present within the valley at approximately the same time as the forebulge was collapsing. Thus, although intuitively the reversal of the land-sea relationship referred to in Nuxalk oral histories initially does not appear plausible, there is a possible specific geomorphological explanation for this scenario.

Another of the apparent geologic and geomorphological corollaries evident in Nuxalk oral histories is the reference to the existence of a prairie-like plain to the west of the mainland, west of Bella Bella and Namu. In the legend of the first salmon noted by Boas (1898:39) and Kirk (1986:82-83), Raven and Mouse traveled-west to the land of the salmon. In this story, the land of the salmon is described as a flat land comprising a vast prairie with no trees (Boas 1898:39). Recent research conducted by Barrier et al. (1993), Luternauer and Clague et al. (1989), Luternauer and Conway et al. (1989), Josenhans et al. (1995), and Josenhans et al. (1997) has indicated that at approximately 10,500 [cal 12,200] BP, a great deal of the Western Canadian Continental shelf was aerially exposed by the lower relative sea levels that occurred at this time due to the effects of a glacial forebulge. The portion of the sea floor on the Western Continental shelf to the west of Namu appears to be quite flat and, if vertically raised and aerially exposed, could have resembled the area described in Nuxalk oral histories.

Within Nuxalk oral histories there are also many references to a catastrophic flood occurring in the valley. For example, the flood story recorded by McIlwraith (1948 II: 503) and also noted and referred to in French (1994:23), Mack (1993:13), Munday (1937, 1939b), Palmer (1863:10), Storie (1973), and Lady Tweedsmuir (1938), states that,

> Once long ago, it began to rain steadily. The mountain creeks became swollen; then the rivers and the valleys became flooded. The people were forced to make canoes...The valleys were filled; at first a number of mountains were left exposed but finally the bare peak of Nusqualst, the highest mountain in the Bella Coola valley alone rose above the raging torrent. The Bella Coola (Nuxalk) were driven to this spot where a large camp was formed.

Flood stories within First Nation oral histories are ubiquitous along the Northwest Coast (see Harris 1997; Hill-Tout 1902) with the flood story noted above being nearly identical to that told to William Duncan at Metlakatla by the Tsimshian and recorded in Mayne (1862) and that told to Olson (1955) by the Kwakiutl. There are a number of potential explanations as to the source of these accounts. Firstly, it is possible that the flooding apparent in this story could

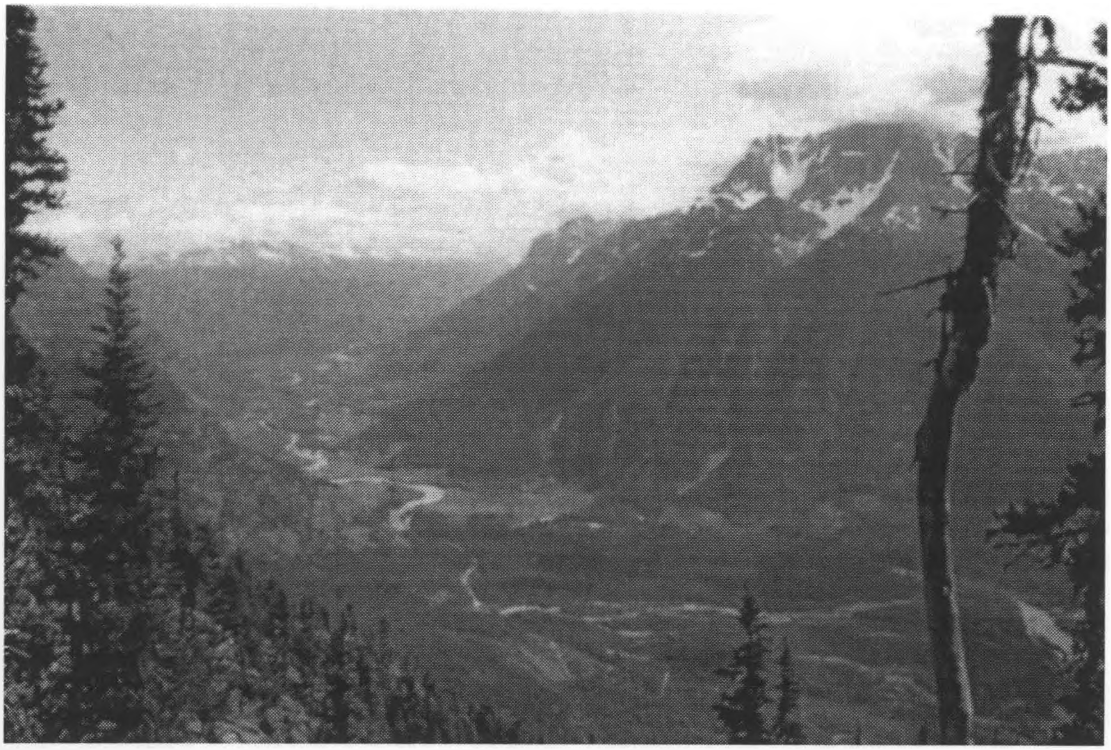

***Figure 2:3.* Looking East at the upper Bella Coola Valley immediately down-river from the Tsini Tsini Site. At the time of occupation at Tsini Tsini this valley was an arm of the sea (Photo: R. Carlson).**

have been the direct result of the various increases in rainfall that are known to have occurred during the Holocene. This flooding could have occurred during the transition from the Hypsithermal to the cooler and wetter period around 7000 BP (Hebda 1995:55, 77) or alternatively, it could have occurred during the Neoglacial advance between 3500 and 2500 BP (Desloges and Ryder 1990:289; Retherford 1972:3). It does not appear that this flooding could be related to the little Ice Age advance in the valley, as this advance would have occurred in relatively recent memory. Secondly, it could be possible that the flood referred to specifically in Nuxalk oral traditions may be referring to the presence of the coalescing delta dammed lake that is thought to have had a short presence in the valley between 11,000-10,000 [cal 13,000-11,400] BP between the Nusatsum and Salloomt rivers (Retherford 1972:112). This coalesced delta would have dammed the Bella Coola valley and most likely caused flooding once the dam broke. Determining which of these possible alternatives (or any other alternative) is responsible for the creation of this flood story is problematic as there does not appear to be enough specific information within Nuxalk oral histories to rule out any one possibility.

It should be also noted that a number of oral histories suggest that there was a great heat which followed the flood (McIlwraith 1948 I:309, 424, 500). It is possible that this great heat is referring to the hypothesized xerothermic event (warm and dry period) which is thought to have occurred following deglaciation and following the marine transgression between 9500 and 7000 BP (Hebda 1995:55, 77). Alternatively, it could be that the great heat is actually referring to a relative warming of the environment that is thought to have occurred following Neoglacial advances. The noting that a great heat followed the flooding in the valley does not favour any of the Nuxalk oral histories, as the great heat could have occurred after any of the previously suggested alternative explanations. Again, ruling out any one of these possibilities is problematic.

Finally, it should also be noted that there are a number of references within Nuxalk oral histories referring to glacier activity with one story referring to a period of bitter cold and perpetual ice (McIlwraith 1948 II:503) and another apparently referring to the actions of a glacier (McIlwraith 1948 I:307). Once again, there is not enough information to determine if the glacial advance being referred to in these stories is referring to early Holocene or more recent Neoglacial advances.

Taken as a whole, the numerous references to specific late Quaternary paleoenvironmental and geomorphological events within Nuxalk oral histories appear to preclude the possibility that these corollaries are purely coincidental thereby suggesting that a great time depth exists within Nuxalk oral histories. Moreover, the fact that obsidian from the Anahim Lake area to the east was recovered in a context dating to approximately 9700-9000 [cal 11,000-10,200] BP at Namu (Carlson 1994) to the west, a time when some of these geomorphological phenomena were still taking place, the identification of a number of surface finds within the Valley which suggest an early Holocene human presence in the valley, and the early nature of the artifacts recovered from the main component at the Tsini Tsini site and their similarity to the early components at Namu, combine to suggest that early populations were more than likely residing in the valley and/or traveling through the Bella Coola valley at a time when they could have witnessed many of the geomorphological events that occurred in the Late Pleistocene/Early Holocene period.

Conclusions

The preceding investigation into the geologic, geomorphological and paleoecological context of the Tsini Tsini site is an attempt to identify both when the Tsini Tsini site could have first been occupied and what forces during the Late Pleistocene/early Holocene may have affected the context of the assemblage recovered there as well as the culture of the people responsible for the creation of that assemblage. Further, through a hypothesized reconstruction of the formation of the Tsini Tsini landform, an attempt has been made to present hypotheses as to the nature of the depositional context of the cultural material found at the Tsini Tsini site. Moreover, the proceeding represents at least an initial attempt at trying to integrate Nuxalk oral histories within the known paleoenvironmental and geomorphological history of the Bella Coola valley. Further archaeological and geoarchaeological research needs to be conducted on raised glaciomarine features within the upper reaches of fjords along the B.C. coast, as additional early coastal sites may be present in these areas.