REPORTS

CALIBRATED RADIOCARBON DATING AT KEATLEY CREEK: THE CHRONOLOGY OF OCCUPATION AT A COMPLEX HUNTER-GATHERER VILLAGE

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This paper provides an analysis of radiocarbon dates acquired during earlier and recent field seasons at the Keatley Creek site, southern British Columbia. Results indicate that early occupations predating 1900 cal. B.P. occurred, but were not likely associated with population aggregation and large housepits. The aggregated village appears to have emerged by approximately 1700 cal. B.P. and was abandoned at approximately 800 cal. B.P. A break in the occupational sequence is recognized at 1450–1350 cal. B.P. and one other short break may have occurred shortly after 1250 cal. B.P. Peak socioeconomic complexity appears to have been achieved between 1350 and 800 cal B.P. Climatic warming may have provided a selective environment favoring population aggregation and intensification during this time. The final abandonment of the Keatley Creek village appears to have been part of a regional phenomenon suggesting the possibility that climatic factors were important in this case as well.

Este reporte se presenta un análisis de fechas de radiocarbono que se obtuvieron en estudios previos y recientes en el sitio de Keatley Creek, localizado en Columbia Británica. Los resultados indican que hubo una ocupación temprana que data del año 1900 cal. A.P., pero que no puede asociarse esto con una agregación de la población y con grandes casas de piedra en hoyos. La aldea agregada aparece aproximadamente alrededor del año 1700 cal. A.P. y fue abandonada alrededor del año 800 cal. A.P. Hay una ruptura en la secuencia ocupacional entre 1450 y 1350 cal A.P. y hubo otra interrupción corta después del año 1250 cal. A.P. El mayor desarrollo socioeconómico y la mayor complejidad al parecer se alcanza entre 1350 y 800 cal. cal. A.P. Un calentamiento climático pudo constituir un ambiente favorable para la agregación y la intensificación poblacional durante este período. El abandono final de la aldea "Keatley Creek" parece haber sido parte de un fenómeno regional, lo cual sugiere la posibilidad de que los factores climatológicos también fueron importantes en este caso.

The late prehistoric archaeological record of the Mid-Fraser Canyon in south-central British Columbia offers enormous opportunity for expanding our understanding of the evolution and organization of complex hunter-gatherer communities (Arnold 1996, 2001; Cannon 1999; Hayden et al. 1985). Although important early excavation was conducted in the Mid-Fraser region (Sanger 1969, 1970; Stryd 1972, 1973, 1980; Stryd and Baker 1968; Stryd and Lawhead 1978), Hayden's (1997a, 2000a, 2000b) long-term excavation program at the Keatley Creek site (Figures 1 and 2) has offered the most comprehensive insight into this cultural pattern. Studies by Hayden's team (Hayden 1997a, 2000a, 2000b, 2000c, 2000d; Hayden and Spafford 1993; Hayden et al. 1996; Hayden and Schulting 1997; Lepofsky et al. 1996; Prentiss 2000a) support the contention that by its final phase of occupation, the Keatley Creek village[1] was composed of internally ranked corporate group households, with hereditary elites likely controlling non-elite labor, resource access, and exchange. The record from Keatley Creek has been used in concert with data from earlier excavations as a proxy marker of change throughout the Mid-Fraser region (Hayden and Ryder 1991).

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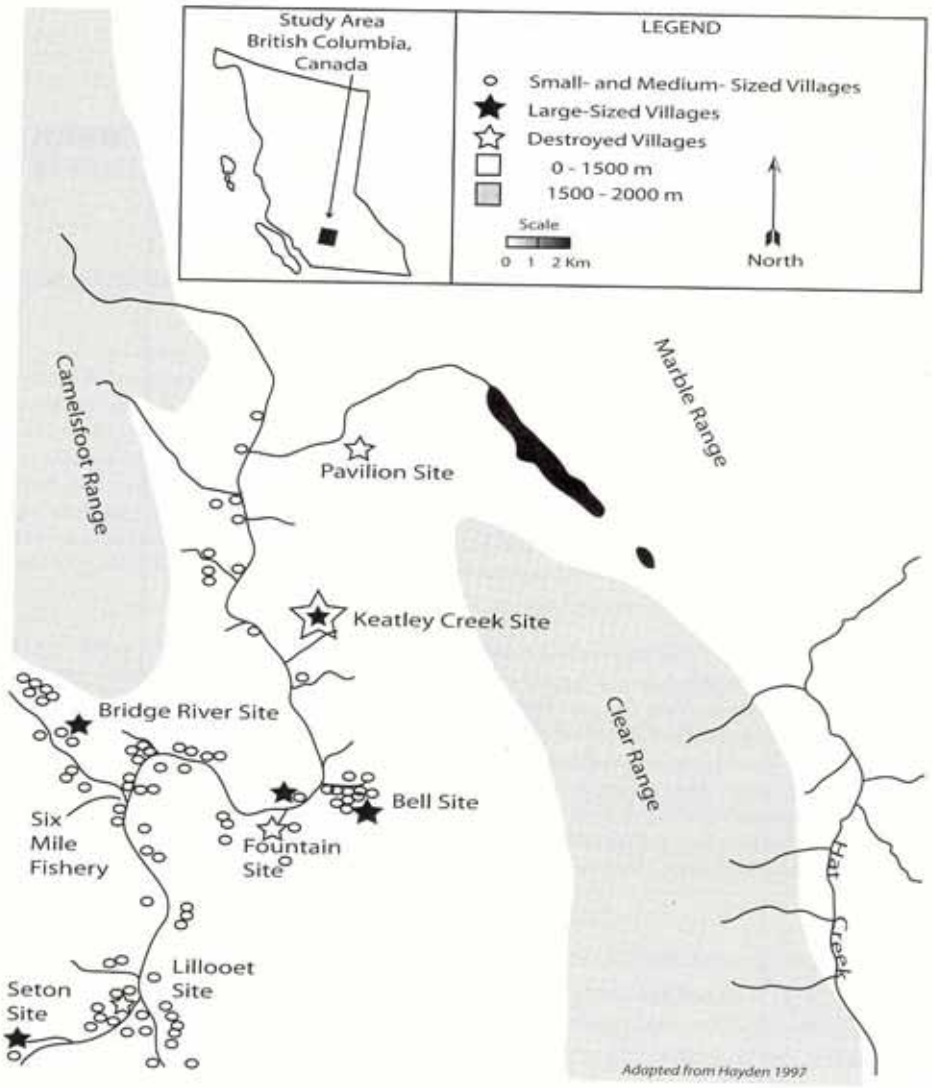

Figure 1. Middle Fraser Canyon area with associated large prehistoric villages (adapted from Hayden 1997a:Figure 1.2).

Although Hayden's excavations at Keatley Creek focused primarily upon inter-housepit variability, data were collected to explore the chronology of site occupations and thereby address the important issues of origin and decline in socioeconomic complexity in the Mid-Fraser (Hayden 2000d; Prentiss 2000b). Based upon its large size[2] and excellent stratigraphic record, Hayden focused particular (though not exclusive) attention on Housepit 7 (Figure 2) as an indicator of village chronology. Hayden (1997a, 1997b, 2000d) consequently postulated that the medium-to-large houses emerged in the late Shuswap horizon, prior to 2400 B.P., expanding to full size during the Plateau horizon, by 2160 B.P. (Housepit 7) and were abandoned in early Kamloops horizon times, at ca. 1000–1100 B.P. Smaller houses were occupied periodically between about 1100 and 1500 B.P. Hayden recognized several important implications of these dates. First, corporate groups had emerged shortly after the time when the size of salmon runs in the rivers of the Pacific Northwest had significantly expanded (Chatters 1995, 1998). If salmon were the primary support for the Mid-Fraser villages, then this suggested that optimal resource conditions were important preconditions for the emergence of complexity. Second, individual large houses appeared to have been occupied

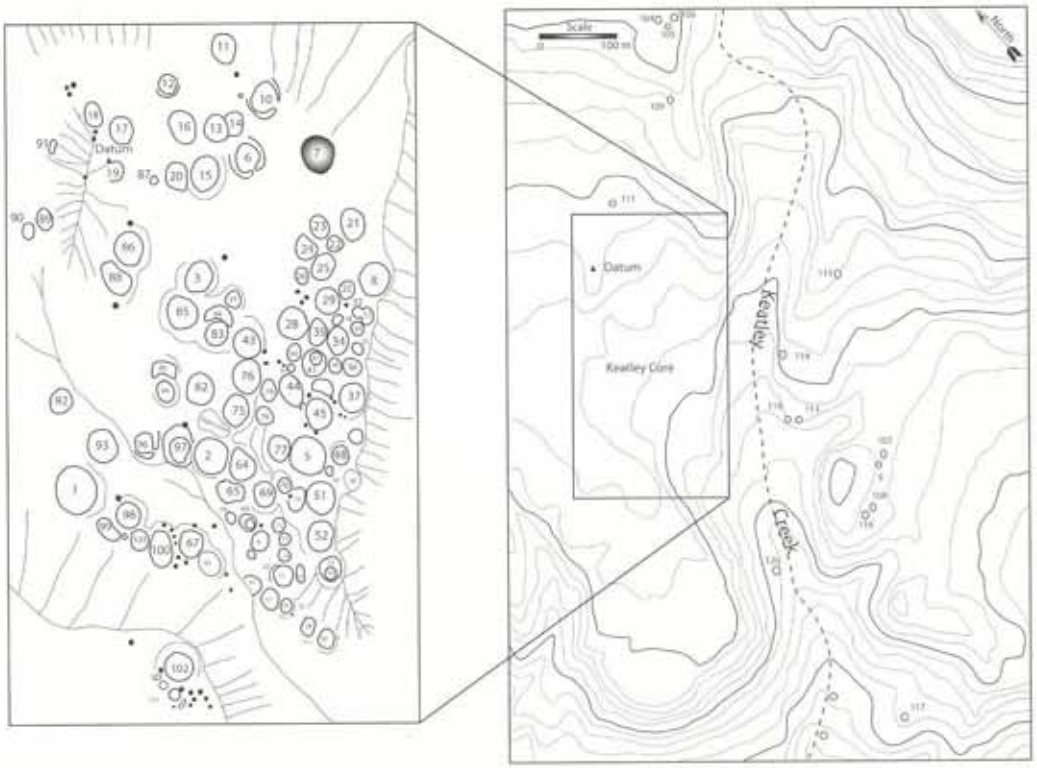

Figure 2. Map of the Keatley Creek site (adapted from Hayden 1997a:Figures 3.2 and 3.3).

without break or significant change for perhaps 1,600 years, implying in Hayden's words "the world's longest lived corporate group" (Hayden et al. 1996). Third, the village appeared to have been abruptly abandoned by 1000 B.P., implying some form of catastrophe since there were no signs of stress in the archaeological record prior to that event (Hayden and Ryder 1991).

Recent research, however, has pointed to some potential ambiguities in these arguments. First, several researchers questioned the date of aggregated village emergence. Based upon several new radiocarbon dates, Prentiss et al. (2000, 2002) and Lenert (2001) suggested the possibility that Housepit 7 may not have been constructed until some time after 1600 B.P, perhaps even as late as ca. 1250 B.P. These suggestions fell in line with arguments made previously by Chatters and Pokotylo (1998), Fladmark (1982), and Richards and Rousseau (1987) that social complexity was a late prehistoric phenomenon limited to the period postdating 2000 B.P. Second, Kuijt (2001) questioned Hayden and Ryder's hypothesis regarding the nature of the collapse of the Mid-Fraser, asserting that the terraces of the Mid-Fraser had not been fully abandoned, thus implying a continuous sequence of occupation past the 1000 B.P. date at places like Keatley Creek. Taken together, these works suggest a late emergence of corporate group structures (post ca. 1600 B.P.), a brief fluorescence, and a subsequent shift to smaller residences within several hundred years. This implies that the occupational history of Keatley Creek was more like that of other briefly occupied large villages on the Plateau (e.g., Galm and Masten 1985; Prentiss et al. 2001; Schalk 1983) and that aggregation and emergent social complexity was more likely a short-term response to some extraneous factor such as competitive pressure from neighboring groups (e.g., Galm 1985) than a sustained adaptive strategy.

This paper provides a test of these opposing models using new stratigraphic data and calibrated radiocarbon dates from Housepit 7 at Keatley Creek. Excavations conducted in 2001 and 2002 demonstrate a more complex occupational history than supposed by previous researchers at this site. Analysis of radiocarbon dates also reveals occupation patterns not previously considered. Results

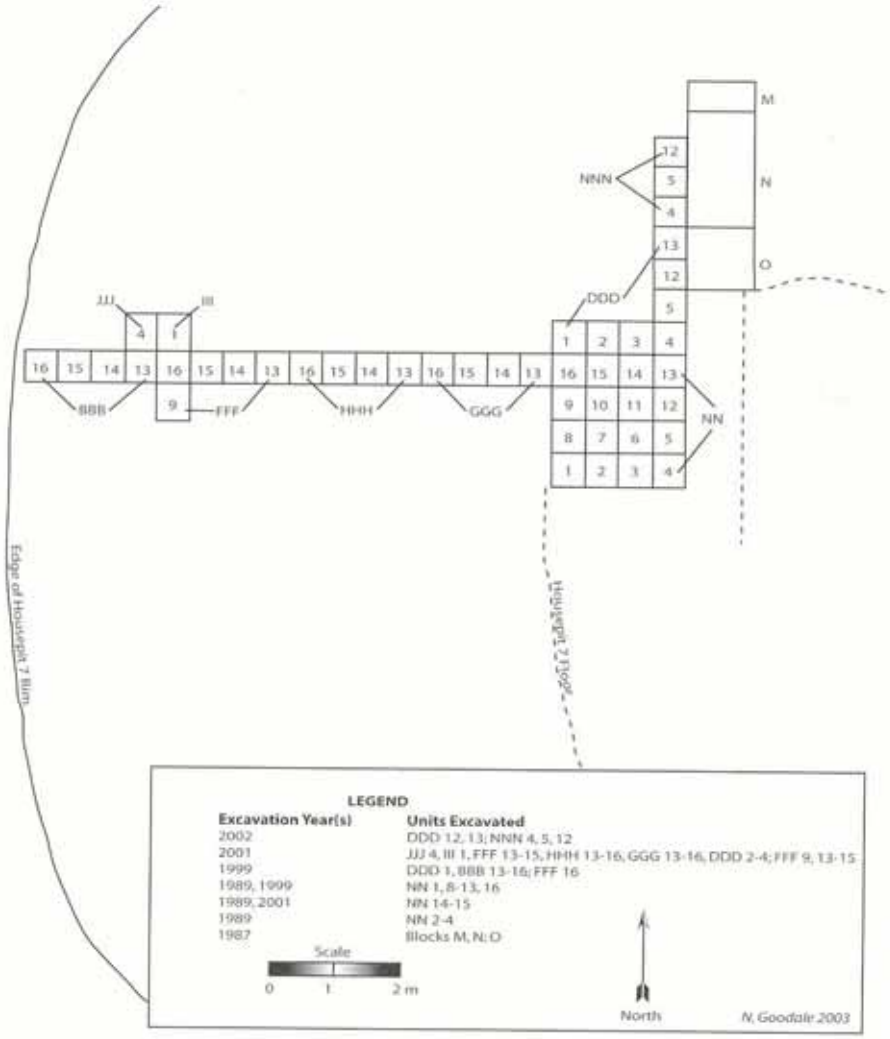

Figure 3. Excavation map, northwest quarter of Housepit 7.

of this assessment have important implications for our understanding of the origin, persistence, and decline of socioeconomic complexity at Keatley Creek and in the late prehistoric Mid-Fraser Canyon.

Archaeological Context

Northern Plateau winter housepits can be exceedingly complex from a stratigraphic standpoint. As illustrated by Hayden (1997a; see also Goldberg 2000) sedimentary layers result from complex use histories that include initial excavation of the housepit, establishment of roof timbers, creation of floors, occupation activities, burning and cleanout of old roof and floor material, and subsequent new construction upon reoccupation. When excavated, housepits typically have a final occupation floor and associated collapsed roof, surrounded by a ring of rim-midden deposits chronicling cycles of occupation, temporary abandonment, and reoccupation. This record can be made more complex if the original house was constructed over older archaeological materials that became incorporated into the later deposits via excavation of the house and various pits for cooking and storage.

Archaeologists from the University of Montana began excavations at Keatley Creek in 1999 with the goal of exploring small housepit floors buried beneath Housepit 7's floor and rim materials (Figures 3–7). A small block excavation was undertaken

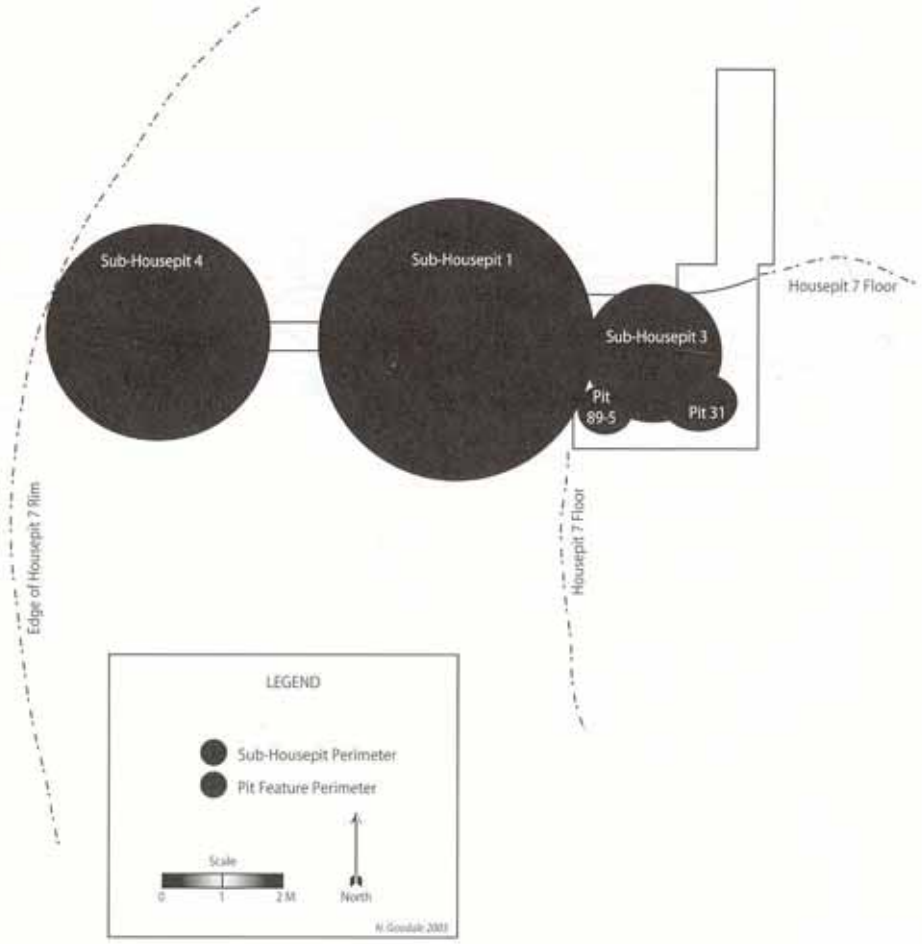

Figure 4. Idealized plan view of housepit floors and excavation area associated with the northwest quarter of Housepit 7.

in the northwest corner of the housepit interior (reopening Hayden's 1989 square NN) while a short trench was excavated on the outer northwestern rim (Figure 3). These excavations resulted in the recognition of three small housepit floors described herein as sub-housepits (SHP). Sub-housepits 1 and 4 were located beneath the northwestern rim (Figures 4, 6–7). Sub-housepit 3 was located directly beneath the Housepit 7 floor in square NN (Figures 4–6). Sub-housepit 2 was identified in the field as a thin sediment lens under the north rim, but has since been discarded as a potential house floor. Initial radiocarbon dating provided perplexingly late dates of 1270 ± 60 B.P. for SHP4 and 1580 ± 60 B.P. for SHP3 (Lenert 2001; Prentiss et al. 2000). Since these floors were buried by substantial amounts of floor, rim, and roof materials, this implied that Housepit 7 could not be any older than these dates. This contrasted substantially with Hayden's well-established argument that Housepit 7 had been first constructed around 2600 B.P.

In order to resolve the questions regarding chronology, additional field seasons were undertaken in 2001 and 2002. The goal of these excavations was, first, to formally establish the stratigraphic relationships between sub-housepits and overlying Housepit 7 sediments, and second, to confirm the dates acquired in 1999. In order to achieve this, the 1999 outer rim trench was expanded eastward to connect to the interior block excavation while the block excavation was also expanded to the north (Figure 3). In addition, Hayden's north rim trench, excavated in 1987 as squares M, N, and O, was reopened and seven 50-x-50-cm subsquares excavated to the south and west (Figure 3). Walls were drawn, resulting in intersecting

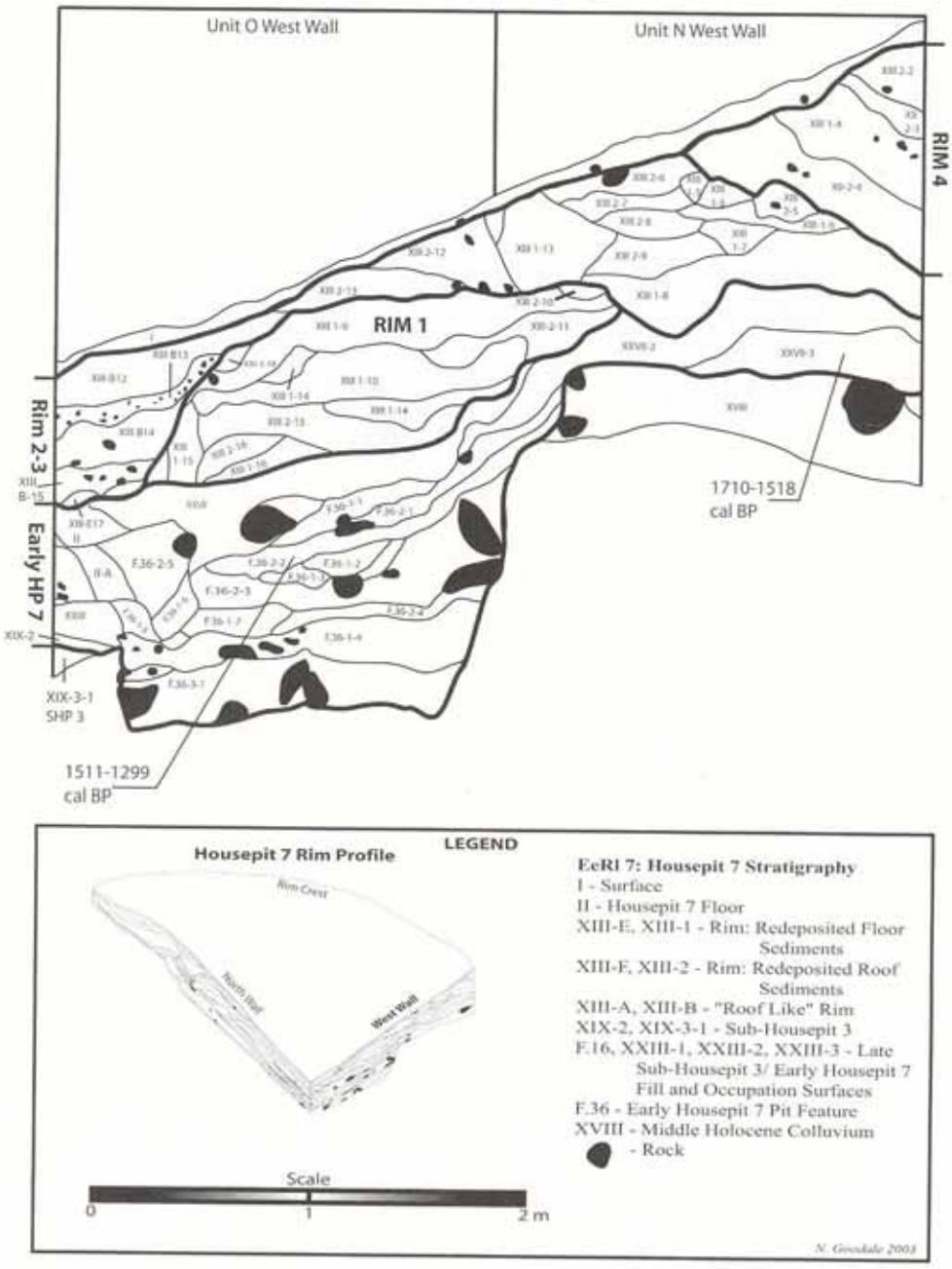

Figure 5. Profile of west wall, north trench (units N and O), Housepit 7 illustrating Middle Holocene colluvium (XVIII), Sub-housepit 3 (XIX-3-1, XIX-2), early Housepit 7 (II, XXIII, F 36, and XXVII), and Housepit 7 rims 1-4 (XIII).

stratigraphic profiles illustrating relationships between all floors and rim materials from the north and west sides of Housepit 7 (Figures 5–7).

Distinct stratigraphic layers including floor, rim, and roof material were identified using criteria developed by Hayden (1997a, 2000a, 2000e; Goldberg 2000). In brief, floors (profile layers II [HP 7 floor], XIX-1 [Sub-housepit 1 floor], XXIV [Sub-housepit 4 floor], XIX-3-1 (Sub-housepit 3 floor], and XXVII [early HP 7 floor extension]) are typified by well-sorted gray-brown sandy silt, containing broken and smeared charcoal and various

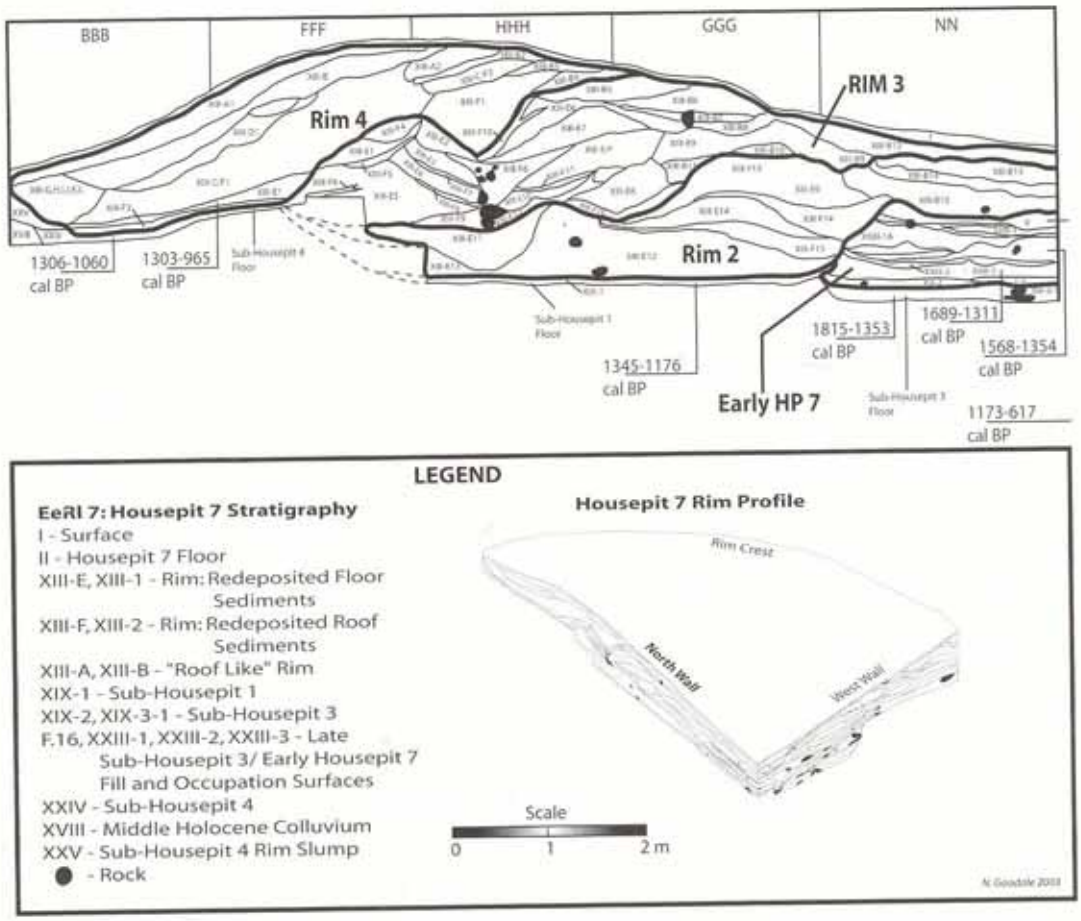

Figure 6. Profile of rim and housepit floors on northwest side of Housepit 7. This includes north walls from units BBB, FFF, HHH, GGG, and NN. It illustrates Housepit 7 rims 2-4 (XIII) and underlying floors from Housepit 7 (II) Sub-housepits 1 (XIX-1), 3 (XIX-3-1), and 4 (XXIV).

botanical remains and frequent small flakes and faunal remains. Roof sediments, in contrast, are darker in color due to large amounts of charcoal; poorly sorted, containing substantial quantities of rock in size ranges from granule to cobble; and contain relatively frequent artifacts reflecting roof-top activities (e.g., flintknapping), but also resulting from household dumping of debris resulting from interior household activities. Rim sediments (layer XIII in profiles) vary substantially, including layers containing redeposited housepit floor material (XIII E and XIII 1) and loose layers (XIII C, F and 2) containing extraordinarily high quantities of ash, fire-cracked rock, lithic artifacts, and, particularly, burned and unburned wood and mat fragments. The latter sediments likely reflect old burned and collapsed roof superstructures, later deposited on the rims. Sediments near the surface of the rim (XIII A and XIII B) tend to have relatively abundant rocks, but substantially fewer botanical materials and faunal remains. Hayden (2000e) has described these layers as roof-like rim since these sediments may have been frequently moved around as roof insulation resulting in substantial destruction of plant and animal remains. Limited disturbance in the form of occasional krotovinas has been found in some upper rim deposits (XIII-C/F and XIII-F in particular) and to a far lesser degree on floors. Other than these minor disturbances, the floor, roof, and rim deposits are entirely anthropogenic in origin.

The 2001 excavations resulted in the complete exposure of SHP3 within the square NN block excavation. Sub-housepits 1 and 4 were fully bisected by the east-west rim trench (Figure 4). Rim sediments above these floors (Figures 6 and

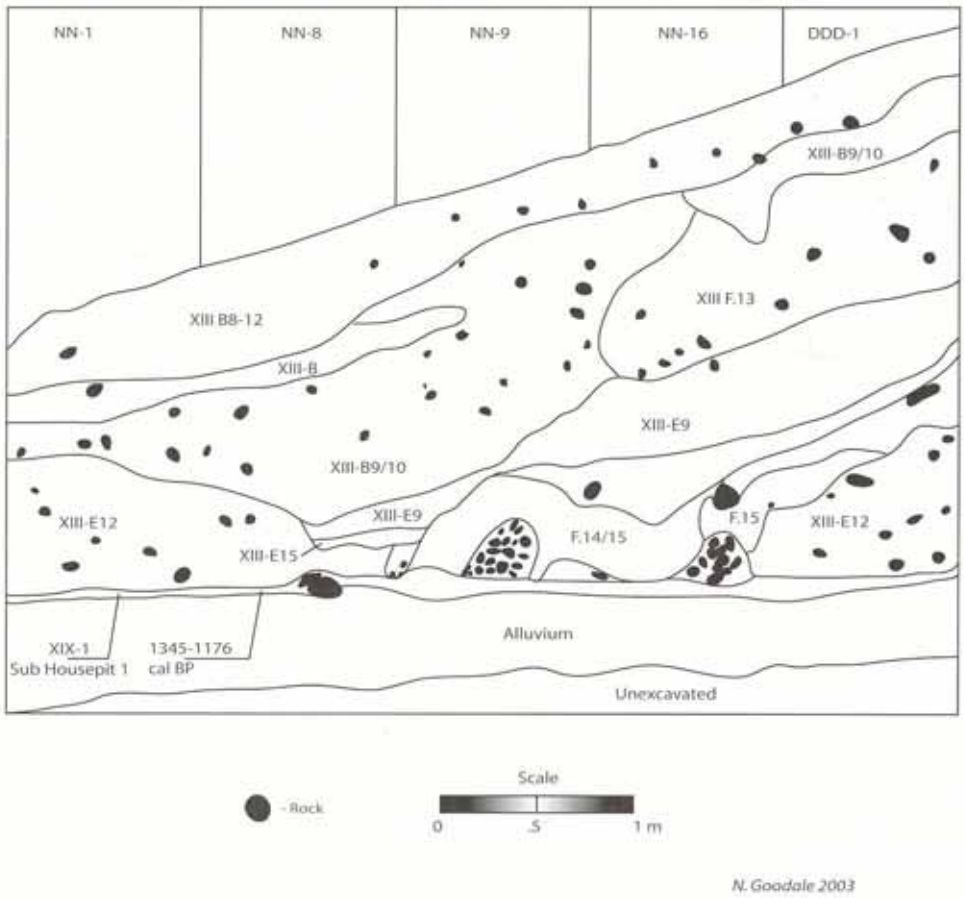

Figure 7. Profile of square NN west wall illustrating Sub-housepit 1 (XIX-1) floor and rim fill (XIII).

7) were exposed producing data reflecting on the history of life in Housepit 7 since they are a consequence of household reoccupation patterns that periodically required cleanout and discard of old roof and floor materials on the housepit rims. These excavation results, combined with Hayden's extensive earlier excavation materials, provide the means to reconstruct the occupational chronology of Housepit 7 and the Keatley Creek village.

Radiocarbon Dating and Chronology Building

Charcoal for radiocarbon dating was collected during the 1999, 2001, and 2002 excavations from *in situ* hearth and posthole features where possible, though on occasion, large fragments of charcoal were retrieved from floors. Seventeen radiocarbon dates were obtained and analyzed in conjunction with other dates from Housepits 3, 7, 12, 90, 104, 105, 106, and 109, previously published by Hayden (2000d). Dates from floor and pre-floor sediments at Housepits 1 and 5 (1970 ± 60 B.P. and 2160 ± 70 B.P., respectively) were excluded due to their problematic association with incongruous artifacts linked either to natural root-burns (Housepit 1) and, possibly, recycling of old wood at Housepit 5 (Hayden 2000d). One anomalously old date from the Housepit 7 rim (6470 ± 90) is also excluded from this analysis since it is clearly outside of the range of housepit occupations on the Canadian Plateau (Hayden 2000d). All dates were calibrated using the Calib 4.3 program (Stuiver et al. 1999). Table 1 presents both conventional dates expressed in ^{14}C years B.P. ± 1σ and calibrated date ranges at 2σ. Figure 8 shows calibrated means and 95 percent confidence intervals for all these dates.

Table 1. Calibrated Radiocarbon Dates from Keatley Creek.

Lab #	Standard Age B.P.	Calibrated Mean B.P.	2σ Range B.P.	Housepit Association	Provenience	Ref.	Arbitary I.D.
Beta 125907	220 ± 50	215	429–1	109	Roof beam on Upper floor	1	1
Beta 106611	220 ± 70	228	456–0	106	Pine Bark on floor	1	2
CAMS 35105	250 ± 60	237	472–2	104	Basket Fragment on floor	1	3
SFU 641	270 ± 55	239	474–3	105	Wood on floor	1	4
AA51439	398 ± 38	418	516–319	7	Feature 50 hearth	4	5
SFU 742	740 ± 70	747	877–617	7	Roof beam on floor	1	6
SFU 720	900 ± 65	812	926–695	7	Roof beam on floor	1	7
SFU 796	1000 ± 85	939	1166–712	7	Populus branch on floor	1	8
SFU-*	1080 ± 85	984	1173–795	7	Roof beam on floor	1	9
SFU 1001	1080 ± 85	984	1173–795	3	Wood charcoal on Floor	1	10
T-15205A	1236 ± 71	1134	1303–965	7	Feature 34 hearth in Rim 4	3	11
Beta 139441	1270 ± 60	1176	1292–1060	SHP 4	Feature 14 hearth on floor	2	12
A11796	1305 ± 50	1197	1306–1088	SHP 4	Feature 14 hearth on floor	3	13
SFU 722	1330 ± 60	1217	1347–1087	3	Plank fragments on floor	1	14
T-15208A	1332 ± 41	1241	1306–1176	SHP 1	Feature 41 hearth on floor	3	15
T-15202A	1360 ± 44	1263	1345–1181	SHP 1	Feature 38 Hearth on floor	3	16
T-15207A	1361 ± 41	1263	1345–1181	SHP 1	Charcoal on floor	3	17
T-15204A	1489 ± 41	1405	1511–1299	7	Feature 36A Wood in Posthole	3	18
SFU 721	1550 ± 60	1429	1546–1312	12	Roof beam on floor	1	19
A-11792	1545 ± 40	1436	1525–1347	SHP 3	Feature 33 wood in Posthole	3	20
A-11793	1590 ± 45	1461	1568–1354	SHP 3	Feature 24 hearth on upper floor	3	21
Beta 139440	1580 ± 60	1470	1607–1333	SHP 3	Feature 16 hearth	2	22
SFU 723	1410 ± 60	1475	1623–1330	90	Roof beam on floor	1	23
A-11794	1580 ± 80	1500	1689–1311	SHP 3	Feature 16 hearth	3	24
SFU-*	1590 ± 70	1522	1688–1315	7	Wood charcoal in rim deposits	1	25
T-15203A	1636 ± 67	1528	1703–1353	SHP 3	Feature 25 hearth on floor	3	26
A-12475	1695 ± 45	1614	1710–1518	7	Feature 53, hearth in rim base	4	27
T-15206A	1710 ± 71	1628	1818–1438	SHP 3	Feature 17, hearth on floor	3	28
A-11795	1745 ± 50	1677	1815–1539	SHP 3	Charcoal on floor	3	29
SFU-*	2080 ± 50	2099	2295–1902	7	Wood Charcoal in rim deposits	1	30
Beta 25181	2140 ± 110	2115	2349–1880	7	Wood charcoal in rim deposits	1	31
CAMS 35105	2160 ± 60	2164	2326–2001	7	Bone in Pit 31	1	32
SFU-*	2620 ± 50	2673	2850–2496	7	Wood charcoal in rim deposits	1	33

*lab numbers not provided in reference publication

References: 1. Hayden (2000d), 2. Prentiss et al. (2000), 3. Prentiss et al. (2002), 4. Prentiss et al. (2003).

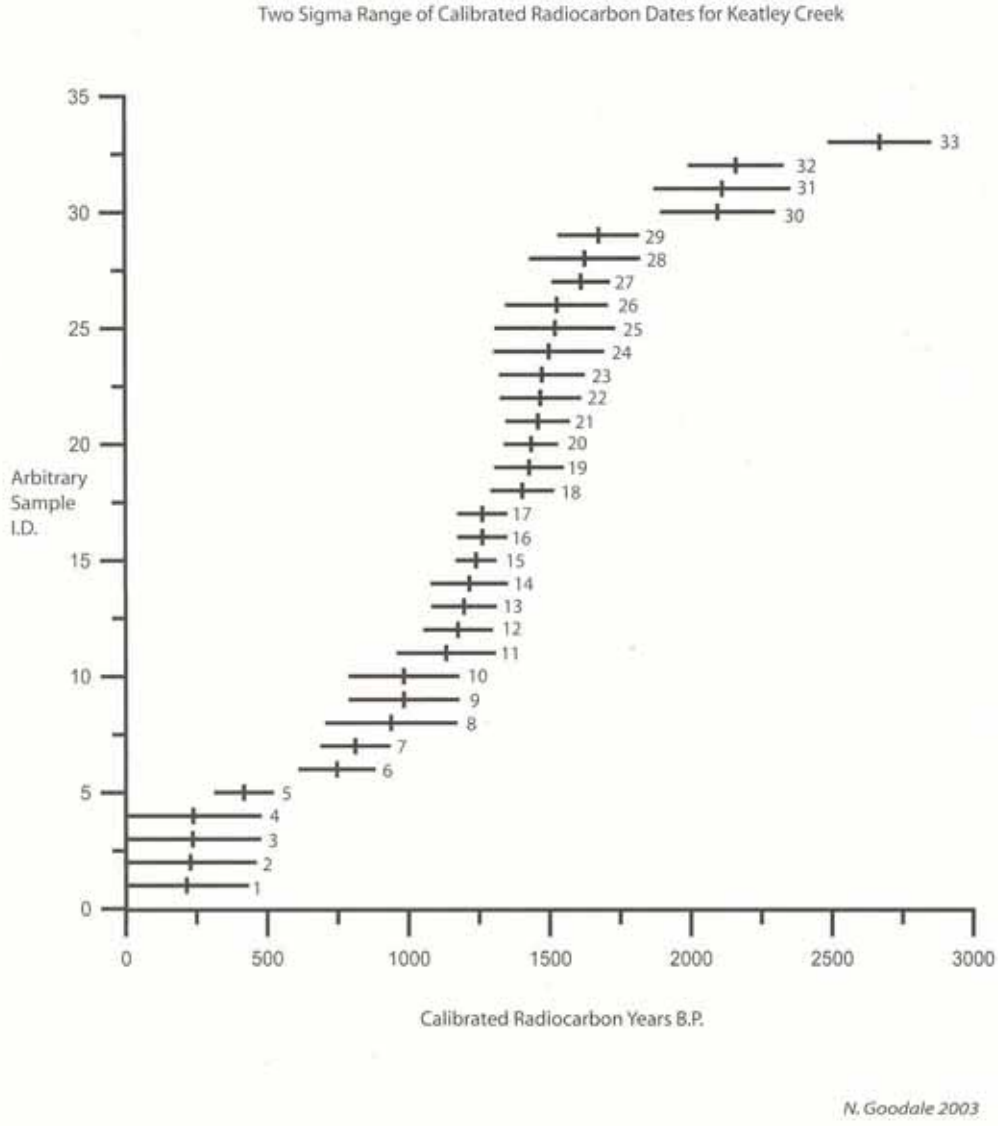

Figure 8. Plot of 2σ calibrated radiocarbon date ranges from Keatley Creek.

Analysis of Uncalibrated Dates

The uncalibrated dates were first analyzed in order to develop an initial chronology with a focus on recognition of evidence for breaks in the occupation sequence. In most archaeological instances, the first step in comparing dates is to determine whether all sample means are estimates of a common underlying population mean and the investigator performs an ANOVA followed by multiple comparisons to determine where the differences among the means were occurring (Aliaga and Gunderson 2003:717). The second level of analysis, in particular, is "one of the most vital and controversial within statistics" (Klockars and Sax 1986:8). However, since our goal was determine the contemporaneity of two adjacent dates, independent of other comparisons, a simple use of Students *t* is the most appropriate statistic for our analysis.

Most adjacent dates are not significantly different (30 dates or 5.5 percent), although most (515 or 94.5 percent) comparisons of nonadjacent dates yield *t* values > 1.96 and are therefore significantly different at the 95 percent confidence interval. However, these data do suggest several potential radio-

Table 2. Student's *t* Scores Significant at .05 Level Indicating Potential Breaks in the Housepit 7 Chronology.

	Table 1 ID Number/Housepit				
Table 1 ID Number/Housepit	5/7	7/HP7	17/SHP1	29/SHP3	32/HP7
7/7	2.065				
11/7		3.4905			
19/7			2.2076		
30/7				4.7376	
33/7					5.8897

carbon breaks in the chronology (Table 2). First, there is a break between Hayden's early dates from the rim (2620 and 2160 B.P.) and a second major break between the latest of these early rim dates and the earliest SHP3 date (2080 and 1745 B.P.). Two additional breaks are evident within the Housepit 7 rim sequence. There is a separation between the 1489 ± 41 B.P. date on the early Housepit 7 posthole and the 1361 ± 41 B.P. date of SHP 1. Although the Housepit 90 date of 1410 ± 60 B.P. lies between these dates, it still suggests a possible break in the Housepit 7 chronology. Next, there is a break between the Feature 34 rim hearth date at 1236 ± 71 B.P. and the younger dates from the last floor of Housepit 7. Finally, a separation exists between one of the last dates from the final Housepit 7 floor and the earliest dates from later occupations elsewhere at Keatley Creek. Overall, these data indicate a discontinuous sequence for the site spanning 2620 ± 50 to after 398 ± 38 B.P. This analysis suggests the possibility that Housepit 7 may not have been continuously occupied throughout its lifespan. Further analysis is necessary, however, to determine the initial construction date of Housepit 7 and to verify the potential breaks in the chronology. This is accomplished in the following analysis of stratigraphy and calibrated dates.

Analysis of Calibrated Dates

The use of calibrated dates is fundamentally important in identifying the timing of cultural events since it permits direct evaluation of actual time spreads by aligning the radiocarbon time scale with that of the calendar (Bartlein et al. 1995; Little 2002). Major disjunctions in the 2σ calibrated radiocarbon record are used as markers of potential occupation breaks in the Keatley Creek chronology (Figure 8).

Early Phase Housepit 7. The earliest Housepit 7 rim date collected by Hayden is located deep in the north rim and falls at 2850–2496 cal B.P. A second, slightly later date (2349–1880 cal B.P.), also collected by Hayden, was derived from the same context. Hayden obtained a second group of dates from slightly higher north rim strata and from a dog bone in a pit (P31) located beneath the northwestern floor (Square NN) of Housepit 7 (Figure 4). Taken together, this group spans 2326–1902 cal B.P. All of these dates are derived from materials excavated in unconsolidated rim or pit fill that by definition are in secondary contexts (Hayden 2000d).

The next group of dates is derived from hearth features and charcoal from the Sub-housepit 3 floor, covering 1815–1353 cal B.P. (Figure 8). These dates and those that follow are statistically independent of the former dates at 95 percent confidence suggesting the strong possibility of a short break between the earlier events and the establishment of Sub-housepit 3. A second set of dates, from 1689–1347 cal B.P., is derived from cultural sediments that include fill layers (XXIII 1 and 3) and two later occupation surfaces (XIX-2/Feature 16 and XXIII-2) within the Sub-housepit 3 depression.

A similar range of dates was extracted from features in sediments at the base of the Housepit 7 north rim. A date of 1710–1518 cal B.P. was extracted from hearth material in the bottommost sediments (XXVII-3) of the north rim (Figure 5). Because these sediments are homogeneous and fine-grained, containing a small hearth, charcoal staining, and occasional small flakes and bone fragments, we interpret them to represent a humanly created living surface resembling a floor associated with early life in Housepit 7. A slightly later date of 1511–1299 cal. B.P. was taken from preserved wood in a posthole placed in the upper fill of a large and early cache pit (Feature 36; Figure 5). Feature 36 is capped by Strata XXVII-1 and 2; layers that are very similar to XXVII-3 and which may have

formed in a similar way. Stratum XXVII-1 is covered by the first mound of rim-midden sediments (Rim 1; Figure 5).

We suggest that Sub-housepit 3 was established as the result of brief occupation(s) immediately prior to the first construction of Housepit 7, most likely in the upper range of 1438–1815 cal. B.P., perhaps around 1700 cal. B.P. Extensive cultural debris including hearths, hearth-associated activity areas, and stored salmon (Prentiss et al. 2000, 2002) suggests that the earliest floor of Sub-housepit 3 represents an independent occupation with a relatively full compliment of normal housepit activities. Housepit 7 was first constructed between 1710 and 1299 cal B.P. (most likely in the 1600–1700 cal. B.P. range), and the Sub-housepit 3 depression was filled in by its occupants (ca. 1450–1600 cal. B.P.). During this early phase occupants also dug, used, and filled large cache pits (Feature 36) and, later, accumulated the first rim midden (Rim 1). Housepits 12 and 90 also appear to have been established and abandoned within this time frame (Table 1, Figure 8).

While there were housepit occupations at Keatley Creek before 1710 cal. B.P. (Hayden 2000d), there is little to suggest that they were associated with large houses or substantial population aggregations. The early dates (pre-1900 cal. B.P.) from the north rim of Housepit 7 come from pieces of charcoal in secondary deposits. While they provide tantalizing hints of earlier occupations, it is currently impossible to know their ultimate origin. The early dog bone (2326–2001 cal. B.P.) from Pit 31 cannot be reconciled with the current chronology either since the pit in which the bone was found bisects all of the Sub-housepit 3 sediments and was clearly created after 1525 cal. B.P. (upper date for final deposits in the SHP 3 pit). Therefore, this bone must also be a secondary or tertiary deposit of much earlier materials. Thus, the north rim basal deposits, dated 1710–1299 cal. B.P., represent the beginnings of the early phase in the history of the aggregated village at Keatley Creek.

Middle Phase Housepit 7. The analysis of uncalibrated dates suggested a break between the posthole date from Feature 36 and that of Sub-housepit 1. Examination of calibrated date distributions (Table 1, Figure 8) suggests a disjuncture at this point as well, although there is a small (33-year) overlap in date ranges. With a similarly small overlap (46 years), Housepit 90 may also have been abandoned prior to the construction of Sub-housepit 1 (Table 1, Figure 8). Sub-housepit 1 (SHP1) reflects a small room excavated on the northwest side of Housepit 7, dating 1345–1176 cal B.P. This is undoubtedly a room and not an independent housepit predating Housepit 7 since the SHP1 floor cuts through early Housepit 7 sediments (Figures 6 and 7). It is also buried by a second phase of rim development (layers XIII E-13 to XIII B-13 in Figure 6). The room appears to have had a domestic function with an occupational pattern little different from other house floors at Keatley Creek, containing an extremely thin floor layer, hearths reflecting high heat (ash concentrations and oxidized surrounding sediments), debitage, and occasional faunal remains. Occupation of this room was brief as Sub-housepit 4 was established to the west at 1306–1060 cal B.P. Sub-housepit 1 appears to have been filled in by rim material at this point, converting it, first, to a possible side entrance for Housepit 7. The NN west-wall profile illustrates layers of fill (XIII E-12) on the north and south sides of the XIX-1 floor (SHP 1) forming the shape of a passageway (Figure 7). The north-south downward trend of XIII E-12 in subsquares DDD-1 and NN-16 was apparent throughout the trench excavated west from NN-16 (Figure 3). Later dumping filled in the passageway (layers XIII F14 to XIII B12 on Figure 7).

Rim accumulation over SHP 1 was substantial and appears to have occurred over a relatively brief period (layers XIII E13 to XIII F4 on Figure 6). After this phase of rim development, a small housepit (Sub-housepit 4) was constructed on the outer edge of the rim at 1306–1060 cal. B.P. Like Sub-housepit 1, Sub-housepit 4 contains indicators of domestic activities with similar patterns in features, fauna, and lithics.

Late Phase Housepit 7. Following abandonment of Sub-housepit 4, a layer of rim material was deposited (XIII E-1 on Figure 6) within which was placed a hearth, dating 1302–965 cal B.P., containing the highest diversity in faunal and floral remains (salmon, bighorn sheep, mountain goat, dog, beaver, deer, blueberry, Saskatoon berry, pine nut) of any hearth at Housepit 7 (Prentiss et al. 2002). Since this feature is located on the outer rim it may reflect an outdoor ceremony of some form perhaps involving feasting. The radiocarbon record suggests a possible

occupational disjuncture after the abandonment of this hearth feature. However, it is also possible that occupation continued, forming Rim 4 and leading to the final dated floor of Housepit 7.

Following cessation in use of the "feast hearth," rim material on the northwest side of Housepit 7 again accumulated rapidly (Figure 6) until the point of abandonment. Various dates have been collected in association with the final floor and roof of Housepit 7 (Table 1, Figure 8). Uncalibrated dates of 1080 ± 70 from Housepits 7 and 3 are considered by Hayden (2000d; Hayden and Ryder 1991) to mark the final occupation of Keatley Creek before the catastrophic abandonment. Later dates (900 ± 65 and 740 ± 70) from the Housepit 7 floor were not considered accurate for various reasons including old wood issues, root burns, and variability in laboratories (Hayden 2000d). We suggest that a more likely explanation is variation in the radiocarbon reservoir. The 1080 ± 70 dates calibrate to an extraordinarily wide range (1173–795 cal B.P.). This is due to intersections with the radiocarbon curve at three reversal points, thus placing the potential abandonment date at some time within a 378-year range (assuming old wood is not a serious problem [Hayden 2000d]). The 2σ spread on the later Housepit 7 dates actually intersects within the latter distribution (926–695 and 877–617 cal B.P. respectively). If the intersection point marks the most likely range, then the abandonment probably occurred between 877 and 795 cal B.P.

The Reoccupation of Keatley Creek. The final housepit occupations at Keatley Creek fall in the range of 0 to 516 cal B.P. (Figure 8). The most recent dates (less than 300 B.P.) are considered unreliable for various reasons primarily due to recent changes in ^{14}C in the atmosphere (Taylor 1997). However, the upper range dates in this group can be used to demonstrate a period of abandonment at Keatley Creek spanning a substantial interval (at least 279 years) between the final dates of the large houses and the reoccupation of the site in the form of significantly smaller housepits. Only two other Mid-Fraser sites provide dates that occur entirely within the post-abandonment period. Site EeRl40 dates to 544–295 cal B.P., while EeRl36 falls in the range of 660–329 cal B.P. This suggests that following the abandonment of the large houses at Keatley Creek, people may not have occupied the Mid-Fraser for over 100 years.

Discussion

Data presented in this paper suggest that although the Keatley Creek site had been intermittently occupied by mobile peoples (Hayden 2000e; Prentiss et al. 2000) and early housepit users (Hayden 2000d; Prentiss et al. 2002), the dense concentration of small, medium, and large houses in the village core probably did not really begin to take shape until approximately 1700 cal. B.P. (Figure 9). Immediately prior to the first construction of Housepit 7, a very small housepit (SHP3) was created and occupied for a brief time. Then, Housepit 7 came to life with a pattern of increasingly intense occupations and new constructions spanning ca. 1700 to 800 cal B.P. We can divide the chronology of Housepit 7 into several major phases that likely characterize the history of the entire aggregated village (Figure 9). The most significant aspects of this history include rapid population increase and an early achievement of wide diversity in housepit sizes and presumably social groups, a later process of household consolidation whereby small households declined while larger houses expanded, and a pattern of periodic abandonment, including a late one that lasted nearly 300 years (ca. 800–500 cal. B.P.).

The emergence of the Keatley Creek village and others in the Mid-Fraser area (Lenert 2001) at 1700 cal. B.P. comes at a time of significant climatic warming indicated in southern British Columbia by rising fire frequency and changes in vegetation associated with increasingly xeric conditions (Hallett and Walker 2000; Hallett, Lepofsky, Mathewes and Lertzman 2003; Hallett, Mathewes, and Walker 2003). It is well known that warm and dry conditions can cause reductions in salmon populations (Chatters et al. 1995; Chavez et al. 2003; Mann et al. 1998). If places like the Mid-Fraser provided above-normal returns for investments in salmon fishing (Hayden 1992; Kennedy and Bouchard 1992; Kew 1992; Romanoff 1992), then it would not be surprising to see population packing occur under conditions of climatic warming as groups sought to protect access to an increasingly precious resource base (Kuijt and Prentiss 2003).

The first corporate groups may have emerged with the construction of large houses such as Housepit 7 and there is nothing so far to suggest that they did not remain the dominant force in the

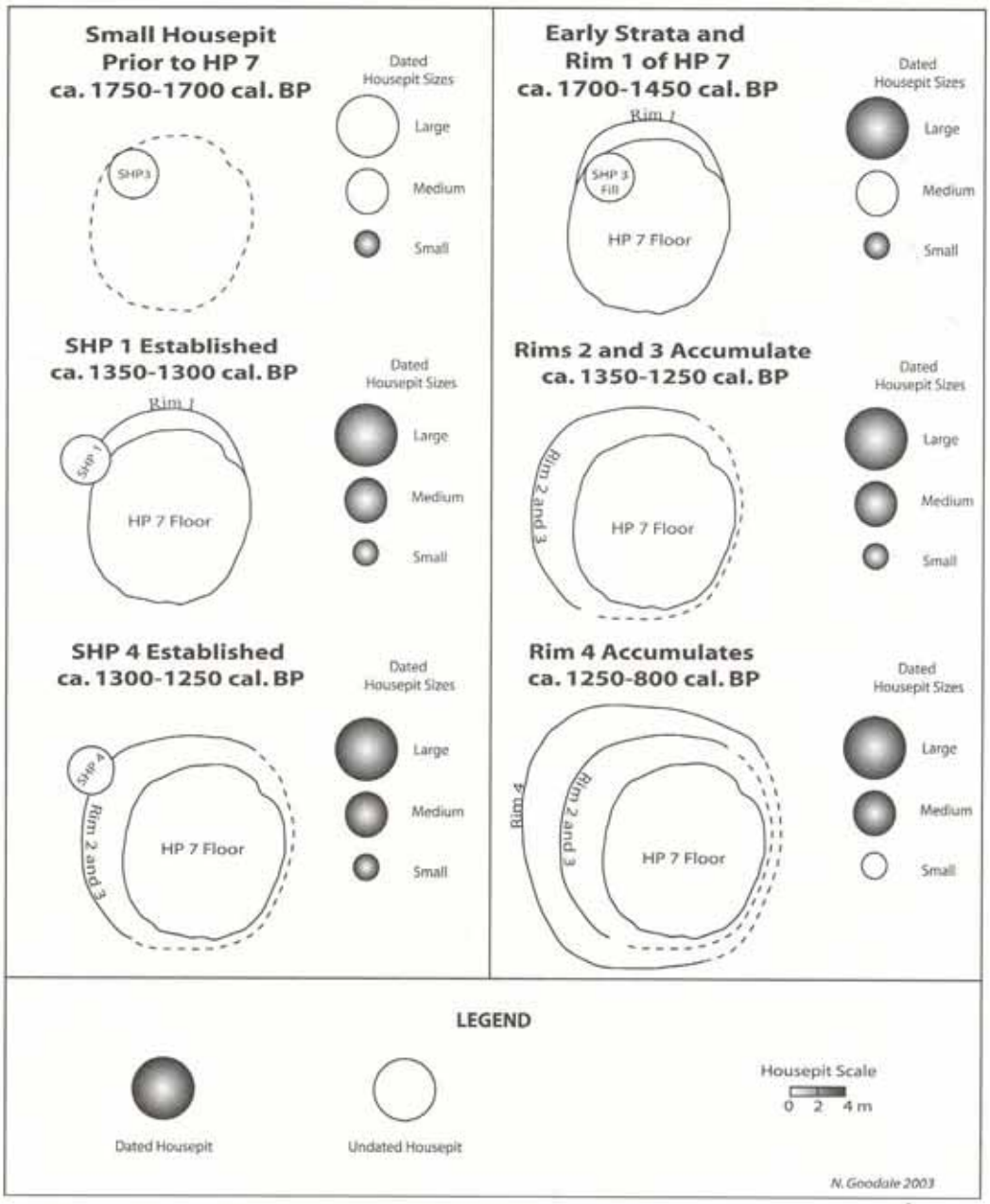

Figure 9. Model of change in pattern of occupations at the Housepit 7 locality and housepit sizes at the Keatley Creek site. Dotted line at ca. 1750-1700 cal. B.P. denotes location of Housepit 7 once constructed.

village until its abandonment at ca. 800 cal. B.P. (Hayden et al. 1996). These same corporate groups may also have absorbed members of less-powerful smaller houses such as 90 and 12, marked by the creation of rooms at Housepit 7. This could reflect control of non-kin labor as expected by Hayden (1992) and Arnold (1993).

The abandonment appears to have occurred a little later than asserted by Hayden and Ryder (1991) and Kuijt (2001). Calibrated data strongly support abandonment of the Keatley Creek site and the Mid-Fraser region for over 100 years. Indeed, it took 200–300 years for human groups to return to Keatley Creek. Interestingly, however, it suggests that the abandonment of Keatley Creek and the

other Mid-Fraser villages (Lenert 2001) coincides with a similar pattern of abandonments elsewhere on the Fraser-Thompson and Columbia Plateaus (e.g., Chatters 1995; Galm and Masten 1985; Goodale et al. 2002; Kuijt 2001; Prentiss et al. 2001; Schalk 1983). This does not eliminate the possibility that catastrophic landslides affected Fraser River salmon stocks as posited by Hayden and Ryder (1991, 2003). However, it also suggests that an important regional process was also underway perhaps associated with the droughts of the Little Climatic Optimum.

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References Cited

Aliaga, M., and B. Gunderson
2003 *Interactive Statistics*. 2nd ed. Prentice Hall, Upper Saddle River, New Jersey.

Arnold, J. E.
1993 Labor and the Rise of Complex Hunter-Gatherers. *Journal of Anthropological Archaeology* 12:75–119.
1996 The Archaeology of Complex Hunter-Gatherers. *Journal of Archaeological Method and Theory* 3:77–126.
2001 *The Origins of a Pacific Coast Chiefdom*. University of Utah Press, Salt Lake City.

Bartlein, P. J., M. E. Edwards, S. L. Schafer, and E. O. Barker
1995 Calibration of Radiocarbon Ages and the Interpretation of Paleoenvironmental Records. *Quaternary Research* 44:417–424.

Cannon, A.
1999 Archaeology of North American Hunter-Gatherers. In *The Cambridge Encyclopedia of Hunter-Gatherers*, edited by R.B. Lee and R. Daly, pp. 31–35. Cambridge University Press, Cambridge.

Chatters, J. C.
1995 Population Growth, Climatic Cooling, and the Development of Collector Strategies on the Southern Plateau, Western North America. *Journal of World Prehistory* 9:341–400
1998 Environment. In *Plateau*, edited by D.E. Walker Jr., pp. 29–48. Handbook of North American Indians, Volume 12, William C. Sturtevant, general editor. Smithsonian Institution Press, Washington D.C.
2003 Safety in Numbers: Conflict and Village Settlement on the Plateau. In *Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities on the Plateau of Northwestern North America*, edited by W. C. Prentiss and I. Kuijt. University of Utah Press, Salt Lake City, in press.

Chatters, J. C., V. L. Butler, M. J. Scott, D. M. Anderson, and D. A. Neitzel
1995 A Paleoscience Approach to Estimating the Effects of Climatic Warming on Salmonid Fisheries of the Columbia Basin. *Canadian Special Publication in Fisheries and Aquatic Sciences* 21:489–496.

Chatters, J.C., and D.L. Pokotylo
1998 Prehistory: Introduction. In *Plateau*, edited by D.E. Walker Jr., pp. 73–80. Handbook of North American Indians, Volume 12, William C. Sturtevant, general editor.Smithsonian Institution Press, Washington D.C.

Chavez, F. P., J. Ryan, S. E. Lluch-Cota, M. Niquen C.
2003 From Anchovies to Sardines and Back: Multidecadal Change in the Pacific Ocean. *Science* 299:217–221.

Fladmark, K. R.
1982 An Introduction to the Prehistory of British Columbia. *Canadian Journal of Archaeology* 6:95–156.

Galm, J. R.
1985 The Avey's Orchard Site in Regional Perspective. In *Avey's Orchard: Archaeological Investigation of a Late Prehistoric Columbia River Community*, edited by J.R. Galm and R.A. Masten, pp. 321–334. Eastern Washington University Reports in Archaeology and History 100-61, Cheney.

Galm, J. R., and R. A. Masten (editors)
1985 *Avey's Orchard: Archaeological Investigation of a Late Prehistoric Columbia River Community*. Eastern Washington University Reports in Archaeology and History 100-61, Cheney.

Goldberg, P.
2000 Micromorphological Aspects of Soil Formation at Keatley Creek. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden, pp. 81–94. Archaeology Press, Burnaby, British Columbia.

Goodale, N. B., W. C. Prentiss, and I. Kuijt
2003 Cultural Complexity: A New Cultural Chronology of the Upper Columbia Drainage Area. In *Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities from the Plateau of Northwestern North America*, edited by W.C. Prentiss and I. Kuijt. University of Utah Press, Salt Lake City, in press.

Hallett, D. J., and R. C. Walker
2000 Paleoecology and its Application to Fire and Vegetation Management in Kootenay National Park, British Columbia. *Journal of Paleolimnology* 24:401–414.

Hallett, D.J., D.S. Lepofsky, R.W. Mathewes, and K.P. Lertzman
2003 11,000 years of Fire History and Climate in the Mountain Hemlock Rainforests of Southwestern British Columbia based on Sedimentary Charcoal. *Canadian Journal of Forest Research*, in press.

Hallett, D.J., R.W. Mathewes, and R.C. Walker
2003 A 1000-Year Record of Forest Fire Drought and Lake Level Change in Southeastern British Columbia. *The Holocene* 13, in press.

Hayden, B.
1992 Introduction: Ecology and Culture. In *A Complex Culture of the British Columbia Plateau*, edited by B. Hayden, pp. 3–46. University of British Columbia Press, Vancouver.
1997a *The Pithouses of Keatley Creek*. Harcourt Brace College Publishers, Fort Worth.
1997b Observations on the Prehistoric Social and Economic Structure of the North American Plateau. *World Archaeology* 29:242–261.
2000a The Opening of Keatley Creek: Research Problems and Background. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden pp. 1–34. Archaeology Press, Burnaby, British Columbia.
2000b Socioeconomic Factors Influencing Housepit Assemblages at Keatley Creek. In *The Ancient Past of Keatley Creek, Volume II, Socioeconomy*, edited by B. Hayden, pp. 3–28. Archaeology Press, Burnaby, British Columbia.
2000c Prestige Artifacts at Keatley Creek In *The Ancient Past of Keatley Creek, Volume II, Socioeconomy*, edited by B. Hayden, pp. 189–202. Archaeology Press, Burnaby, British Columbia.
2000d Dating Deposits at Keatley Creek. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden, pp. 35–40. Archaeology Press, Burnaby, British Columbia.
2000e Site Formation Processes at Keatley Creek. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden, pp. 299–336. Archaeology Press, Burnaby, British Columbia.

Hayden, B., E. Bakewell, and R. Gargett
1996 The World's Longest Lived Corporate Group: Lithic Analysis Reveals Prehistoric Social Organization Near Lillooet, British Columbia. *American Antiquity* 61:341–356.

Hayden, B., and A. Cannon
1982 The Corporate Group as an Archaeological Unit. *Journal of Anthropological Archaeology* 1:132–158.

Hayden, B., M. Eldridge, and A. Eldridge
1985 Complex Hunter-gatherers in Interior British Columbia. In *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity*, edited by T.D. Price and J.A. Brown, pp. 181–199. Academic Press, New York.

Hayden, B., and J. Ryder
1991 Prehistoric Cultural Collapse in the Lillooet Area. *American Antiquity* 56:50–65.
2003 Cultural Collapses in the Northwest: A Reply to Ian Kuijt. *American Antiquity* 68:157–160.

Hayden, B., and J. Spafford
1993 The Keatley Creek Site and Corporate Group Archaeology. *BC Studies* 99:106–139.

Hayden, B., and R. Schulting
1997 Plateau Interaction Sphere and Late Prehistoric Cultural Complexity. *American Antiquity* 62:51–85.

Kennedy, D. I. D., and R. T. Bouchard
1992 Stl'atl'imx (Fraser River Lillooet) Fishing. In *A Complex Culture of the British Columbia Plateau*, edited by B. Hayden, pp. 266–354. University of British Columbia Press, Vancouver.

Kew, M.
1992 Salmon Availability, Technology, and Cultural Adaptation in the Fraser River Watershed. In *A Complex Culture of the British Columbia Plateau*, edited by B. Hayden, pp. 177–221. University of British Columbia Press, Vancouver.

Klockers, A., and G. Sax
1986 *Multiple Comparisons*. Quantitative Applications in the Social Sciences 61. Sage Publications, Beverly Hills.

Kuijt, I.
2001 Considering the Cause of Cultural Collapse in the Lillooet Area of British Columbia, Canada: A Geoarchaeological Perspective. *American Antiquity* 66:692–703.

Kuijt, I., and W. C. Prentiss
2003 Villages on the Edge: Pithouses, Cultural Change, and the Emergence of Complex Forager-Fishers. In *Complex Hunter-Gatherers: Evolution and Organization of prehistoric Communities on the Plateau of Northwestern North America*, edited by W.C. Prentiss and I. Kuijt. University of Utah Press, Salt Lake City, in press.

Lenert, M.
2001 Calibrated Radiocarbon Dates and Culture Change: Implications for Socio-complexity in the Mid-Fraser Region, British Columbia. *Northwest Anthropological Research Notes* 35:211–228.

Lepofsky, D., K. Kusmer, B. Hayden, and K. Lertzman
1996 Reconstructing Prehistoric Socioeconomies from Paleobotanical and Zooarchaeological Data: An Example from the British Columbia Plateau. *Journal of Ethnobiology* 16:31–62.

Little, E. A.
2002 Kautantouwit's Legacy: Calibrated Dates on Prehistoric Maize in New England. *American Antiquity* 67:109–118.

Mann, D. H., A. L. Crowell, T. D. Hamilton, and B. P. Finney
1998 Holocene Geologic and Climatic History around the Gulf of Alaska. *Arctic Anthropology* 35:112–131.

Prentiss, W. C.
2000a The Formation of Lithic Debitage and Flake Tool Assemblages in a Canadian Plateau Winter Housepit Village: Ethnographic and Archaeological Perspectives. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden, pp. 213–230. Archaeology Press, Burnaby, British Columbia.
2000b An Analysis of Lithic Artifacts from the Rim Deposits at HP 7. In *The Ancient Past of Keatley Creek, Volume I, Taphonomy*, edited by B. Hayden, pp. 251–266. Archaeology Press, Burnaby, British Columbia.

Prentiss, W. C., M. Lenert, and H. Stelton
2000 *Report of the 1999 University of Montana Investigations at the Keatley Creek Site (EeRl7)*. Report on file, Archaeology Branch, Department of Small Business, Tourism and Culture, Province of British Columbia, Victoria.

Prentiss, W. C., I. Kuijt, N. Goodale, and M. Burns
2001 *Report of the 2000 Investigations at the Slocan Narrows Village (DkQi1 and DkQi2)*. Report on file, Archaeology Branch, Department of Small Business, Tourism

and Culture, Province of British Columbia, Victoria.

Prentiss, W. C., M. Burns, T. Schlegel, L. Harris, and N. B. Goodale
2002 *Report of the 2001 University of Montana Investigations at the Keatley Creek Site (EeRl7)*. Report on file, Archaeology Branch, Department of Small Business, Tourism and Culture, Province of British Columbia, Victoria.

Prentiss, W. C., L. Harris, S. Mandelko, J. Adams, C. A. Dietz, B. Lyda, and M. Lenert
2003 Report of the 2002 University of Montana Investigations at the Kently Creek Site (EeR17). Report on file, Archaeology Branch, Department of Small Business, Tourism, and Culture, Province of British Columbia, Victoria.

Richards, T. H., and M. K. Rousseau
1987 *Late Prehistoric Cultural Horizons on the Canadian Plateau*. Publication Number 16. Department of Archaeology, Simon Fraser University.

Romanoff, S
1992 The Cultural Ecology of Hunting and Potlatches among the Lillooet Indians. In *A Complex Culture of the British Columbia Plateau*, edited by B. Hayden, pp. 470–505. University of British Columbia Press, Vancouver.

Sanger, D.
1969 Cultural Traditions in the Interior of British Columbia. *Syesis* 2.
1970 The Archaeology of the Lochnore Nesikep Locality, B.C., *Syesis* 3, Supplement 1.

Schalk, R. F.
1983 *The 1978 and 1979 Excavations at Strawberry Island in the Mcnary Reservoir*. Project Report 1. Laboratory of Archaeology and History, Washington State University, Pullman.

Stryd, A.
1972 Housepit Archaeology at Lillooet British Columbia: The 1970 Field Season. *BC Studies* 14:17–46.
1973 The Later Prehistory of the Lillooet Area, British Columbia. Ph.D. dissertation, Department of Archaeology, University of Calgary, Calgary, Alberta.
1980 A Review of Recent Activities Undertaken by the Lillooet Archaeological Project. *The Midden* 122:5–20.

Stryd, A., and J. Baker
1968 Salvage Excavation at Lillooet, British Columbia. *Syesis* 1:47–56.

Stryd, A., and S. Lawhead (editors)
1978 *Reports of the Lillooet Archaeological Project No. 1*. National Museum of Man, Mercury Series No. 73, Ottawa.

Stuiver, M.P., P.J. Reimer, and R. Reimer
1999 CALIB Radiocarbon Calibration HTML Version 4.3. Quaternary Isotope Laboratory, University of Washington, Seattle.

Taylor, R.E.
1997 Radiocarbon Dating. In *Chronometric Dating in Archaeology*, edited by R.E. Taylor and M.J. Aitken, pp. 65–96. Plenum Press, New York.

Notes

1. The term "village" is rarely defined in Plateau archaeology. In this paper we follow Chatters (2003) in defining a village as groups of three or more simultaneously occupied housepits. By aggregated village we mean far more extensive numbers of simultaneously occupied houses perhaps in the range of 20–100. Hayden (1997a) estimates that at peak population size, at least 25 percent of the smaller housepits at Keatley Creek were occupied and perhaps a higher percentage of larger houses. This could mean that as many as 30 or more houses were simultaneously occupied at Keatley Creek during its peak occupation. There have not been enough houses dated at Keatley Creek to provide a detailed assessment of changes in frequencies of dated houses during the different phases of occupation discussed in this paper. The widest range of house sizes was created and occupied in the early phase (Housepits 7, 12, and 90 dated ca. 1700–1450 cal. B.P.), but there are indications that larger houses may have grown to accommodate people from the smaller houses later in the life of the village. This may suggest that the number of simultaneously occupied housepits peaked early. Human populations may also have increased rapidly in the early phase. It is currently unknown whether they continued to increase later, remained stable, or declined slightly prior to the major abandonment at ca. 800 cal. B.P.

2. House sizes at Keatley Creek span 2.5 to over 23 m in diameter. We rely on Stryd's (1973) original housepit size classification that included small (0–10 m), medium (10–15 m), and large (greater than 15 m). Housepits discussed in this paper include all Sub-housepits, and Housepits 12, 90, 104, 105, 106, and 109 in the small class; Housepit 3 in the medium class and Housepits 1, 5, and 7 in the large class. Floors from the larger houses (1, 3, 5, 7) provide the best evidence for corporate group organization (Hayden 1997a). We assume that the shift from exclusive reliance on small dwellings to the construction of medium and large houses marks a change in residence patterns from single families to multifamily units organized as socioeconomic units or corporate groups (Hayden and Cannon 1982).

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