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PALEOSEISMICITY, ECOLOGICAL CHANGE, AND PREHISTORIC EXPLOITATION OF ANADROMOUS FISHES IN THE SALMON RIVER BASIN, WESTERN IDAHO, USA*

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ABSTRACT

By the middle Holocene, Native American groups developed semi-sedentary villages in the Columbia River basin of the Pacific Northwest. The economic basis for these villages is thought to have been predicated on the acquisition of bulk food resources, such as salmon and camas, for delayed consumption during the winter. In Idaho's lower Salmon River canyon, semi-sedentary pit house villages are absent until after 2000 ^{14}C yr BP. Floodplain geochronology shows channel incision and terrace formation occurred at ca. 2000 ^{14}C yr BP, caused by fluvial response to neotectonic displacement along a normal fault. The delayed appearance of pit house sites and other markers of the Winter Village Pattern in the canyon is argued to be directly related to neotectonically-induced changes in fluvial conditions after 2000 ^{14}C yr BP, which significantly improved aquatic habitats for anadromous fishes and led to the development of a predictable, productive salmon fishery.

INTRODUCTION

Archaeological records indicate that Native American societies of the Columbia River Plateau region of the Pacific Northwest developed a semi-sedentary lifeway

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during the latter half of the Holocene. The practice of this lifeway, commonly termed the *Winter Village Pattern*, provided Plateau hunter-gatherers with solutions to problems of seasonal resource imbalance through the development of several key adaptive strategies. The strategic hallmarks of the Winter Village Pattern include: an emphasis on the acquisition, processing, and storage of salmon and root/bulb crops (Ames and Marshall, 1980; Nelson, 1969); bulk resource extraction and storage for delayed consumption throughout the winter months (Schalk and Cleveland, 1983); increased use of ground stone technologies and the construction of substantial residential structures (e.g., semi-subterranean pit houses; Ames and Marshall, 1980); and seasonally scheduled settlement and logistical mobility patterns tied to collector-based exploitation of temporarily abundant food resources (Binford, 1980; Marshall, 1977; Walker, 1998).

Observing archaeological signatures at the site level that are associated with the Winter Village Pattern arguably reflect the presence of three interrelated factors. First, access to ecosystemic components that support a minimal resource base must be present in the surrounding area. This area can be thought of as an extended resource catchment, which encompasses riverine aquatic, riparian, slope, and uplands (cf. Schwede, 1966, 1970; Walker, 1967, 1998). These ecosystemic components must include multiple keystone resources in sufficient amounts for hunter-gatherers to acquire adequate stores to support bands of extended families during the low productivity late fall to early spring months. Second, hunter-gatherers require information on how to accomplish the Winter Village Pattern's primary components. Third, regional population density must have been high enough to allow groups of individuals to come together and work as coordinated task units in the labor intensive process of bulk resource acquisition, processing, transport, and storage. In regards to the question of when the Winter Village Pattern first appeared in the Columbia River Plateau of western North America, we must consider the status of each of these factors and how they may have represented obstacles or opportunities to hunter-gatherers through time.

Archaeological indicators of the Winter Village Pattern first appear at sites along the middle Columbia, lower Snake, and Clearwater rivers between ca. 5500 and 4500 ^{14}C yr BP (Ames, 1991; Ames et al., 1981; Ames et al., 1998; Brauner, 1976; Lucas, 2000), or perhaps even as late as 4200 Cal BP (3800 ^{14}C yr BP) (Prentiss and Chatters, 2003). Explanations for the appearance of the Winter Village Pattern also vary, but touch on some or all of the main factors described above. Ames and Marshall (1980) argue against the central role of salmon productivity as the driving mechanism behind the onset of semi-sedentary southeastern Plateau villages, and consider economic intensification of plant resource use as a more critical factor. Throughout the Plateau, it is generally believed that plant resources become more central to hunter-gatherer economic systems after ca. 5500 ^{14}C yr BP—a time that corresponds with a regional shift toward increased precipitation (Barnosky, 1985; Davis and Muehlenbachs, 2001; Mehringer, 1985; Wigand, 1987). Economically important plants like camas and cous thrive under mesic conditions, and would have greatly increased in range and abundance throughout the Plateau after the middle Holocene. Ames (1991) argues against increased environmental productivity (namely heightened camas production) as primary reasons for the development of sedentary settlements and instead, like Rafferty (1985), contemplates the dual roles of population growth and resource stress in driving these changes.

Archaeological excavations at site 45OK11 along the upper Columbia River revealed a long record of radiocarbon-dated pit house occupations beginning as early as 5200 ^{14}C yr BP (Lohse and Sammons-Lohse, 1986). Based on the absence of storage features in and between the houses, the wide range of subsistence resources, and their estimates of the seasonality of site occupation, Lohse and Sammons-Lohse (1986) argue that the occupants of 45OK11 practiced a semi-sedentary forager lifeway (cf. Chatters, 1989). This interpretation uncouples the link between semi-sedentism and the collector lifeway as requisite factors in the establishment of pit house settlements.

More recently, Prentiss and Chatters (2003:39) have argued that the disappearance of foraging and "early collector" adaptive systems and the subsequent appearance of the collector mode of logistical and economic organization coincides with a coast-to-interior spread of the Winter Village Pattern adaptive concept and/or the spread of peoples bearing these ideas after 4200–3500 cal BP. The appearance of this regional adaptive shift is linked to a shift toward cool, wet neoglacial paleoclimatic conditions (Prentiss and Chatters, 2003:Figure 1; cf. Chatters, 1995). According to the authors, the onset of neoglacial conditions triggered a catastrophic failure of preexisting foraging strategies throughout the region and favored the spread of better adapted collector-based resource management strategies that swiftly took their place (Prentiss and Chatters, 2003:43-44). Like Lohse and Sammons-Lohse (1986) before them, Prentiss and Chatters (2003) assume a period of semi-sedentary foraging, complete with pit house occupation, which precedes the appearance of their neoglacial collector onset across the Plateau.

Recent archaeological and geoarchaeological research in the lower Salmon River canyon (LSRC) of western Idaho reveals that pit houses, economic patterns of bulk resource acquisition, and other markers of the Winter Village Pattern appear only after 2000 ^{14}C yr BP and coincide closely with large scale changes in the fluvial behavior of the lower Salmon River. These changes in fluvial behavior closely follow neotectonic displacement along a large normal fault, which in turn triggered a series of geomorphic changes that served to improve anadromous fish habitat. In this article, I advance a hypothesis that the late appearance of the Winter Village Pattern in the LSRC is directly related to this neotectonic event and its effects on local riverine environmental conditions, which subsequently improved the canyon's salmon fishery. To present the basis for this hypothesis, I review archaeological and geological information from the LSRC and the larger Salmon River Basin and synthesize these datasets into a geoarchaeological perspective on human-environmental interaction through time.

GEOGRAPHIC AREA

The Salmon River is a tributary of the Snake River and Columbia River drainages, within the geographic limits of the southern Columbia River plateau region of the inland Pacific Northwest in Idaho (see Figure 1). The LSRC begins at the confluence of French Creek on the main stem of the Salmon River, about 20 miles upstream from Riggins, downstream to where it joins the Snake River. Above Riggins, the Salmon River is entrenched in narrow, steep-walled canyons cut into the granitic bedrock of the Idaho Batholith and adjacent metamorphic lithologies. Downstream from Riggins many portions of the canyon are cut through Columbia River basalts and are wider, with more gentle slope gradients; however, tight and narrow canyons can still be found in areas where metamorphic bedrock exists. Between Riggins and White Bird, the Salmon River flows through

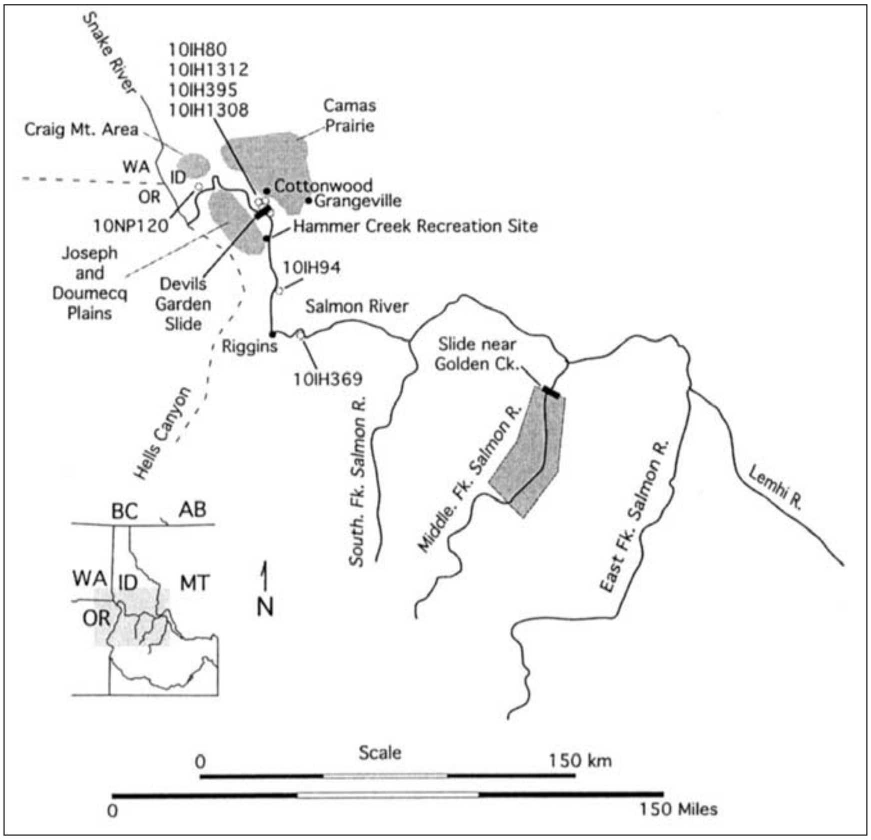


Figure 1. Area map showing sites, towns, and localities mentioned in text.

mountainous terrains adjacent to the Salmon River Mountains to the east and the Seven Devils Mountains complex to the west, which forms the divide between the Snake River. Downstream of White Bird, the Salmon River is flanked by large upland plateaus. The Camas Prairie lies to the north and east of the river, and the Joseph and Doumecq plains are located to the south and west. Near the lower portion of the Salmon River, close to its confluence with the Snake, high relief terrains of the Craig Mountain area rise up to the north.

Mean annual precipitation is varied in the basin. The bottom of the LSRC receives 42.7 cm (16.8") of rainfall and 18.8 cm (7.4") of snowfall, as measured at Riggins. Higher elevations receive greater amounts of precipitation. Warren, Idaho averages 67.3 cm (26.5") of rainfall and 418.8 cm (164.9") of snowfall annually, while an average of 57.1 cm (22.5") of rainfall and 85.9 cm (33.8") of snowfall is reported from Cottonwood. Mean maximum and minimum temperatures vary from 19.2E C (66.3E F) to 5.5E C (41.9E F) in lower elevations of the basin, and 10.9E C (51.4E F) to –6.2E C (21.0E F) in the higher elevations (Western Regional Climate Center, 2007).

Annual discharge of the Salmon River is largely controlled by the melting of accumulated snowpack in the upper reaches of the basin. Of greater influence than rainfall, the annual melting of the snowpack controls annual rates and timing of alluvial discharge values. As measured at the White Bird gauging station, the mean annual discharge of the river is 302.7 cubic meters per second (m^3/s) (10,690 cubic feet per second (cfs)). Maximum discharge has been placed at ca. 3681.6 m^3/s (ca. 130,000 cfs), while the lowest measured flow lies at 44.8 m^3/s (1,580 cfs). Averaging 1897.4 m^3/s (67,000 cfs), peak flow typically occurs between May and June as rising spring temperatures and rain-on-snow events melt the snowpack. By September, Salmon River discharge is at its lowest point. River flow remains subdued throughout the fall and winter months (United States Geological Survey [USGS], 2007). Today, the Salmon River has a relatively low sediment load and flows in a channel dominated by cobble to boulder gravels or exposed bedrock. Spring runoff and high intensity, short duration thunderstorms can introduce sediments and organic debris, temporarily increasing the river's sediment load over a period of days to weeks.

THE ARCHAEOLOGICAL DATASET

The archaeological data used in this study is drawn from multiple sites excavated in the LSRC since the 1960s (see Figure 2). B. Robert Butler conducted archaeological excavations at five sites in the LSRC between 1961 and 1964, including Weis Rockshelter (10IH66), McLaughlin Flat (10IH67), Picture Cave (10IH69), Cooper's Ferry (10IH73), and Double House (10IH80). The results of this work were published in several reports and monographs (Butler, 1962, 1965, 1968, 1969). Radiocarbon dates from Weis Rockshelter and Double House span the period 7340 ± 140 ^{14}C yr BP to 4650 ± 70 ^{14}C yr BP and 2040 ± 190 ^{14}C yr BP

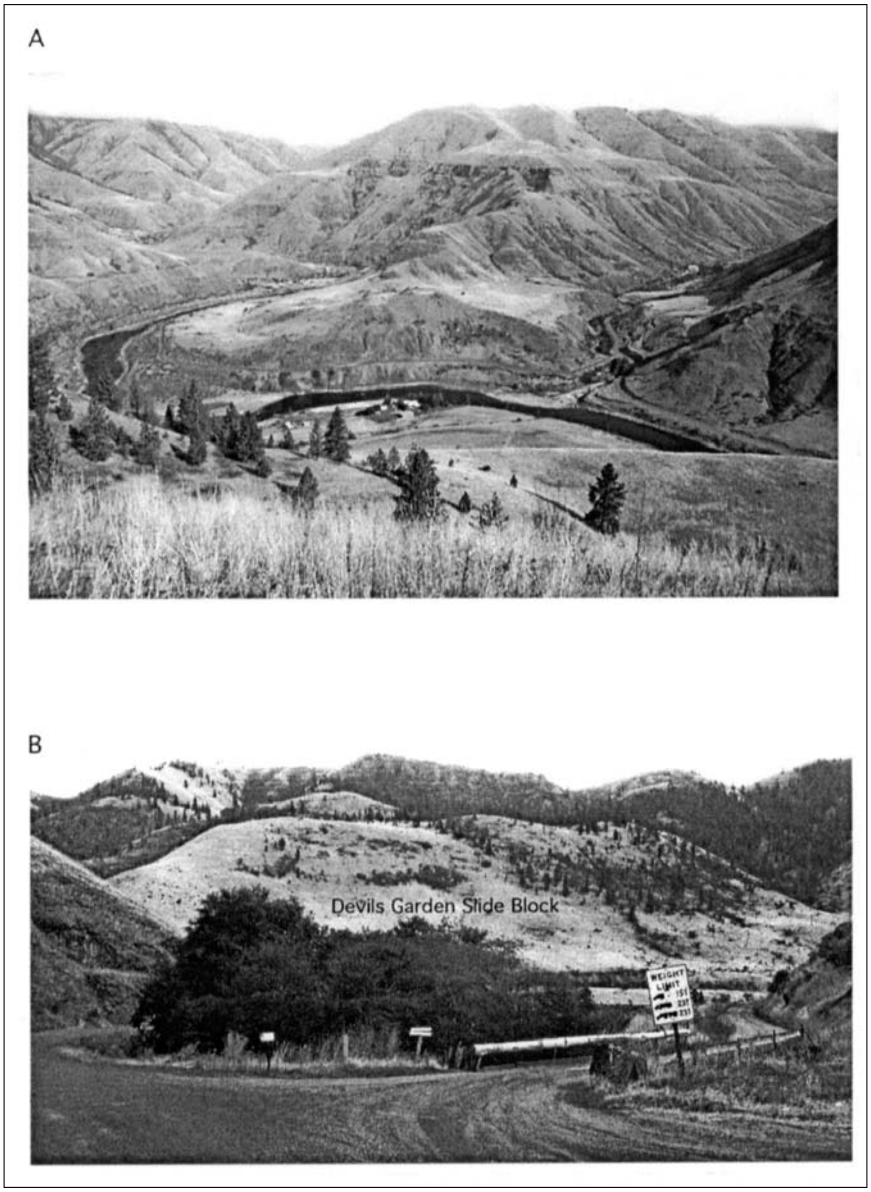


Figure 2. (A) Photographic overview of the lower Salmon River canyon. Perspective shows the Rock Creek–Salmon River confluence as viewed to the north from the top of the Devils Garden Slide block. (B) View from the mouth of Rock Creek Canyon looking south toward the Devils Garden Slide block. Top of slide block lies ca. 380 m (1247') above the Salmon River.

to 1 ± 57 ^{14}C yr BP, respectively. Oswald (1975) excavated a pit house feature at 10IH94 near Slate Creek, which was probably occupied at ca. 500 ^{14}C yr BP based on its associated artifact typology (cf. Davis, 2001a). Excavations at Russell Bar (10IH58) by Markos et al. (1990) revealed a cultural component dated at 300 ± 60 ^{14}C yr BP and 1330 ± 100 ^{14}C yr BP. Miss et al. (1990) conducted limited archaeological testing at Butcher Bar, producing two radiocarbon dates of 630 ± 90 ^{14}C yr BP from site 10IH1908 and a date of 1400 ± 90 ^{14}C yr BP from 10IH1957. Sappington et al. (1995) excavated a pit house site (10IH369) situated on a terrace immediately upstream of Island Bar, near the town of Riggins. The pit house feature was dated at 920 ± 45 ^{14}C yr BP. Miss (2001) reports the excavation of a prehistoric camp along the Little Salmon River, which was repeatedly occupied between ca. 850-800 ^{14}C yr BP. Archaeological investigations conducted at the Gill Gulch site (10IH1308) produced a record of prehistoric occupation on a dynamic alluvial fan surface, dating between 6110 and 300 ^{14}C yr BP, culminating with the construction of two house features (Davis, 2008).

Between 1997 and 2001, Davis (2008) conducted excavations at six sites in the LSRC, including: American Bar (10IH395), Bug Slope (10IH1220), Cooper's Ferry (10IH73), Gill Gulch (10IH1308), McCulley Creek (10IH1160), and Rock Creek Mouth (10IH1312). The summary dataset of artifact and faunal frequencies from 50 discrete cultural components excavated at these sites is presented in Table 1. These excavations form the basis for past and ongoing published research dealing with issues of culture history (Davis, 2001a); human-environmental interaction at the late Pleistocene-early Holocene transition (Davis, 2001b); early cultural occupation in the canyon (Davis and Schweger, 2004); site formation processes and pit house construction (Davis, 2005); and the preliminary study of technological and logistical organization through time (Davis, 2008).

To date, 11 chronometrically dated pit house features have been excavated in the LSRC; six of which occur at the Double House site (10IH80) (dated between 2040 ± 190 ^{14}C yr BP to 1 ± 57 ^{14}C yr BP—the latter clearly indicating contamination of some sort), one at Island Bar (10IH369) (630 ± 90 ^{14}C yr BP), one at American Bar (10IH395) (1370 ± 40 ^{14}C yr BP), two at Gill Gulch (10IH1308) (460 ± 70 ^{14}C yr BP and 300 ± 70 ^{14}C yr BP), and another at site 10NP120 (328 ± 35 ^{14}C yr BP). In most cases, the pit house features appear to have been occupied for a limited time; however, Butler (1968: Figure 25) describes what appears to be a lengthy history of reoccupation at the Double House site: "Lower pair of houses date from the 1st Century B.C. to the 16th Century (A.D.). The upper pair of houses date from the 18th to 19th Century. In each period, the village was made up of two houses, one of a conical form—presumably a single family dwelling and the other an oblong form—a multiple family dwelling or community lodge." Many more unexamined pit houses are known to occur on landforms that post-date 2000 ^{14}C yr BP (Davis, 2001b), including Oswald's assessment of a pit house at Slate Creek (10IH94), which suggests that the total

Table 1. Cultural Component Assemblages from the LSRC Sorted by Temporal Period and Alphabetical Order

COMP	DEB	LAWL	BIF	BEAD	BLAD	BT	CT	CORE	GRST	HAM	MF	NWGT	PPT	UNI	FCR	BONE	FBON	MSH	SSH	PERIOD
AB1	194	0	1	0	0	0	0	0	0	0	1	0	0	0	0	35.6	0	22.3	0	LP
AB2	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.4	0	0.9	0	LP
CF1	1637	0	4	0	2	0	0	2	0	1	0	0	4	1	0	31.1	0	2.2	2.5	LP
CF2	4626	0	5	0	0	0	1	4	0	1	14	0	3	3	22	29.5	15	9	10.3	LP
AB3	195	0	2	0	0	0	0	0	0	0	1	0	0	0	0	7.9	0	37.7	0	EH
AB4	390	0	5	0	0	0	0	0	0	2	2	0	1	0	0	37.2	0	11	0	EH
AB5	529	0	7	0	0	1	0	0	0	2	10	0	4	2	0	31.8	0	44.7	6	EH
BS1	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	EH
CF3	4084	0	7	0	2	0	0	1	0	0	9	0	2	0	5736.6	27.1	7	7	8.5	EH
CF4	22095	0	39	0	6	0	2	8	2	3	65	0	5	12	938.5	367.2	126	295.9	19.6	EH
CF5	4302	0	12	0	6	0	0	0	0	0	13	0	3	0	0	68	41	25.8	2.5	EH
CF6	6718	1	20	0	5	0	0	1	0	0	11	0	2	2	0	167.9	44	58.2	1.1	EH
MC1	98	0	1	0	0	0	0	0	0	0	0	0	2	0	0	6.2	0	2.6	0	EH
GG1	8554	0	4	0	0	0	0	2	0	4	6	0	9	3	8233	384.7	0	1904.7	0	MH
MC2a	70	0	1	0	0	0	0	0	0	0	0	0	0	0	0	41.7	0	10.5	1.8	MH
MC2b	191	0	2	0	0	0	0	0	0	0	1	0	0	1	0	29.8	0	48.4	2.2	MH
MC3	111	0	1	0	0	0	0	0	0	0	0	0	1	0	0	9.8	0	30.1	1	MH/LH1
MC4	97	0	3	0	0	0	0	0	0	0	0	0	1	0	0	25.1	0	182	4.3	MH/LH1
MC5a	59	0	1	0	0	0	0	0	0	0	1	0	1	0	115.5	18	0	48.7	0	MH/LH1
MC5b	340	0	1	1	0	0	0	0	0	0	1	0	0	0	615.8	58.2	1	491.2	4.3	MH/LH1
BS3	224	0	2	0	0	0	0	1	0	0	2	0	0	0	0	0.9	0	3.5	3.5	LH1
BS4	88	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	LH1
GG2	7864	0	24	1	0	0	0	8	1	0	8	0	10	6	6298.4	470.7	3	891.6	0	LH1
GG3	6271	0	3	0	0	0	0	0	0	0	1	0	6	1	3575.5	224.7	3	267.3	0	LH1
GG4	4234	0	2	0	0	0	0	3	1	0	4	0	9	1	2536.5	207	5	111.2	0	LH1
MC6	560	0	1	0	0	1	0	1	0	0	2	0	1	0	9411.5	280.5	1	161	43.3	LH1
MC7	77	0	0	0	0	0	0	0	0	0	0	0	0	0	6930.4	65.5	0	11.1	302.3	LH1

RC1	212	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0.5	0	1.8	0	LH1
RC2	2902	0	5	1	0	0	0	1	0	0	5	0	2	0	3685.5	25.6	3	81.3	2.5	LH1
RC3	4467	0	13	0	0	0	0	4	0	0	5	0	5	1	12349.7	70	3	201.3	0	LH1
AB6	153	0	2	0	0	0	1	2	2	1	0	1	1	0	0	20.4	0	4.9	0	LH2
AB7	518	0	5	0	0	0	0	0	1	1	1	0	1	0	0	191.8	0	0	0	LH2
AB8	529	0	6	0	0	0	0	0	0	0	0	0	9	0	0	41.9	0	0	0	LH2
BS5	114	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0.1	0	0	0	LH2
BS6	40	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	LH2
GG10	625	0	3	0	0	0	0	1	0	0	4	0	2	2	79.8	15	0	82.1	0	LH2
GG5	715	0	7	0	0	0	0	0	1	1	2	0	2	4	141.6	39.9	0	264.8	0	LH2
GG6	1773	0	2	0	0	0	0	0	0	1	0	0	1	0	4196.2	21.3	0	44.3	0	LH2
GG7	3305	0	11	0	0	0	1	3	3	1	4	0	5	4	8945.6	97.5	0	769.3	0	LH2
GG8	500	1	1	1	0	0	0	1	0	1	1	0	1	0	3416.3	49	0	33	0	LH2
GG9	475	0	0	0	0	0	0	0	0	0	1	0	1	0	480.5	63	0	395.5	0	LH2
MC10	1194	0	1	0	0	0	0	1	0	0	0	0	5	1	30002.4	223.4	0	76.1	0	LH2
MC11	576	0	0	0	0	0	0	0	0	0	0	0	2	2	10329.8	90.4	0	123.5	0	LH2
MC12	831	0	0	0	0	0	0	0	0	1	0	0	5	0	2573.9	162.6	2	27.7	0	LH2
MC8		0	2	0	0	0	0	0	0	0	0	0	2	0	1590.6	27	0	218.4	0	LH2
MC9	1724	0	10	0	0	1	0	1	0	1	1	0	17	3	20995.8	472.2	0	617.9	1.3	LH2
RC4	3857	0	6	0	0	0	0	2	0	0	3	0	4	2	10802.5	48.9	0	340.3	3	LH2
RC5	5321	0	19	0	0	1	0	6	0	0	7	0	7	3	28266.1	110.7	1	328.8	3.9	LH2
RC6	8459	0	27	0	0	0	0	3	0	2	20	0	13	5	73127.7	260.1	2	1277.7	7.4	LH2
RC7	6292	0	21	3	0	0	0	4	1	1	11	0	11	4	34569.3	250.7	0	618.5	0.2	LH2

Note: Column headings include: COMP = component; DEB = debitage; LAWL = lithic awl; BIF = biface; BLAD = blade; BT = bone tool; CT = cobble tool; GRST = groundstone; HAM = hammer stone; MF = modified flake; NWGT = fishing net weight; PPT = projectile point; UNI = uniface; FCR = fire cracked rock; FBON = fish bone (reported as NISP); MSH = mussel shell; SSH = snail shell; LP = late Pleistocene (> 10,000 BP); EH = early Holocene (9,950-7,500 BP); MH = middle Holocene (7,450-5,000 BP); LH1 = late Holocene 1 (4,950-2,000 BP); LH2 = late Holocene 2 (1,950-200 BP). All data shown as quantities (n) except for FCR, BONE, MSH, and SSH categories, which are reported as weights (g). Cultural component abbreviations relate to associated sites: AB = American Bar (101H395); BS = Bug Slope (101H1220); CF = Cooper's Ferry (101H73); GG = Gill Gulch (101H1308); MC = McCulley Creek (101H1160); RC = Rock Creek Mouth (101H1312).

number of post-2000 ^{14}C yr BP pit houses is actually much greater than the available population.

Elsewhere in the Salmon River basin upstream of the LSRC, Hackenberger (1988:276) reports 13 ^{14}C dates from pit house features excavated at five sites along the Middle Fork Salmon River (Hackenberger, 1985; Holmer and Ross, 1985; Leonhardy, 1987 (cited in Hackenberger, 1988); Wylie et al., 1981). These ^{14}C-dated pit houses indicate a series of house occupations between ca. 1250-570 Cal BP. Hackenberger (1988) attributes the appearance of pit houses in the Middle Fork Salmon River basin during the late Holocene to an improvement of large ungulate populations triggered by a period of climatic amelioration. Based on this interpretation, Hackenberger (1988:282) sees the appearance of pit houses as signaling the presence of foragers who possessed an emphasis on large game hunting, instead of collectors employing the Winter Village Pattern with a seasonally scheduled hunter-gatherer-fisher economic mode. Climatic conditions, he argues, restricted salmon fishing, and a collector-based Winter Village Pattern:

> During such warm, dry conditions it is predicted that ungulate population totals would increase and benefit winter human settlement. Such conditions would probably more generally benefit foragers, as compared to collectors. . . Foragers may have relied more greatly on ungulate hunting in all seasons. Collectors may have depended on salmonid runs, and storage and these practiced (*sic*) may not have been as profitable in warm, dry periods.
>
> If the above scenario holds, then it is most likely that the study area house settlements reflect winter residential camps of relatively mobile foragers and not multi-seasonal residential bases of collectors.

Adjacent to the Salmon River basin in nearby Hells Canyon, pit houses are unknown before they appear in the Knight Creek site at 2450 ^{14}C yr BP (Hackenberger, 1993). Although the relatively late appearance of pit houses in Hells Canyon is believed to be an artifact of archaeological sampling (Reid, 2001), typologically distinct artifacts of the Tucannon phase—a cultural phase that dates between ca. 5000–2500 ^{14}C yr BP and is associated with pit houses elsewhere in the Plateau (e.g., Leonhardy and Rice, 1970)—have been found in Hells Canyon suggesting humans were using the area in some way at the time (Lucas, 2000; Reid and Gallison, 1996). Until pit houses first appear at Knight Creek, Hells Canyon sites appear to reflect small, mobile hunter-gatherers exploiting a wide range of food resources and storing little if any in the canyon. After 2400 ^{14}C yr BP, a clear pattern of seasonal sedentism in pit house "villages" can be seen at key Hells Canyon localities, mainly established up tributary canyons of the Snake River (Reid, 2001). Why the Winter Village Pattern appears in Hells Canyon only after 2450 ^{14}C yr BP has not been adequately explained.

Based on the currently available sample of excavated archaeological sites in the LSRC, a clear demarcation in cultural patterns exists between sites older and younger than 2000 BP. Sites in the LSRC older than 2000 ^{14}C yr

BP lack key aspects that are seen in many of the sites that post-date 2000 ^{14}C yr BP. These missing aspects include: evidence of substantial shelters, such as semi-subterranean pit house features or above ground mat lodge floor features; an associated geologic matrix of organic- and charcoal-rich, black, greasy sediments which are typically created by bone marrow and bone grease processing and bulk plant food roasting (Vern, 1991; Wildesen, 1982); relatively high proportions of fire cracked rock; relatively high proportions of ground stone artifacts; fishing equipment; and anadromous fish remains. These differences signal a shift to new cultural activities in the LSRC after 2000 ^{14}C yr BP. The potential reasons for this shift will be explored next.

PALEOENVIRONMENTAL CONDITIONS

As stated at the beginning of this article, the appearance of the Winter Village Pattern in the LSRC closely follows a major reorganization of the alluvial system, triggered by the reactivation of a local fault. To fully understand the relationship between changing alluvial conditions and hunter-gatherer cultural patterns in the LSRC, we must embrace an extended view of the canyon's geologic history. This history will be examined in terms of events and conditions prior to and following 2000 ^{14}C yr BP—the timing of the appearance of the Winter Village Pattern in the LSRC—and draws heavily from the geologic studies reported in Davis (2001b).

Fluvial conditions prior to 2000 ^{14}C yr BP

At some time prior to ca. 350-450 ka, tectonic movement along the Rock Creek Fault triggered the failure of a 1.5 km^2 portion of the canyon wall that fell into the bottom of the canyon and spread landslide debris across the landscape near the confluence of the Salmon River and Rock Creek (see Figure 3). The debris from what is known as the Devils Garden Slide event, introduced a substantial canyon fill that exerted significant influence on fluvial geomorphology of the Salmon for a distance of ca. 65 km upriver of the slide block. By the early Holocene, finely textured alluvial deposits began to accumulate near and upriver of the Devils Garden Slide. The sedimentary qualities of these alluvial sediments—designated as Qal4 by Davis (2001b)—reflect the presence of a low energy depositional environment wherein silt- and clay-dominated alluvium was deposited across the riparian landscape during relatively quiescent flood events. By 2000 ^{14}C yr BP, the Salmon River had built an extensive floodplain of alluvium several meters thick in the area adjacent to Devils Garden Slide block and in areas upstream of the landslide. Based on studies of lower Salmon River floodplain sedimentology (Davis, 2001b, 2005; Davis and Schweger, 2004) and pedogenic carbonate stable isotope geochemistry (Davis et al., 2002), the pre-2000 ^{14}C yr BP canyon probably held a muddy, slow-moving stretch of heavily vegetated riparian floodplain,

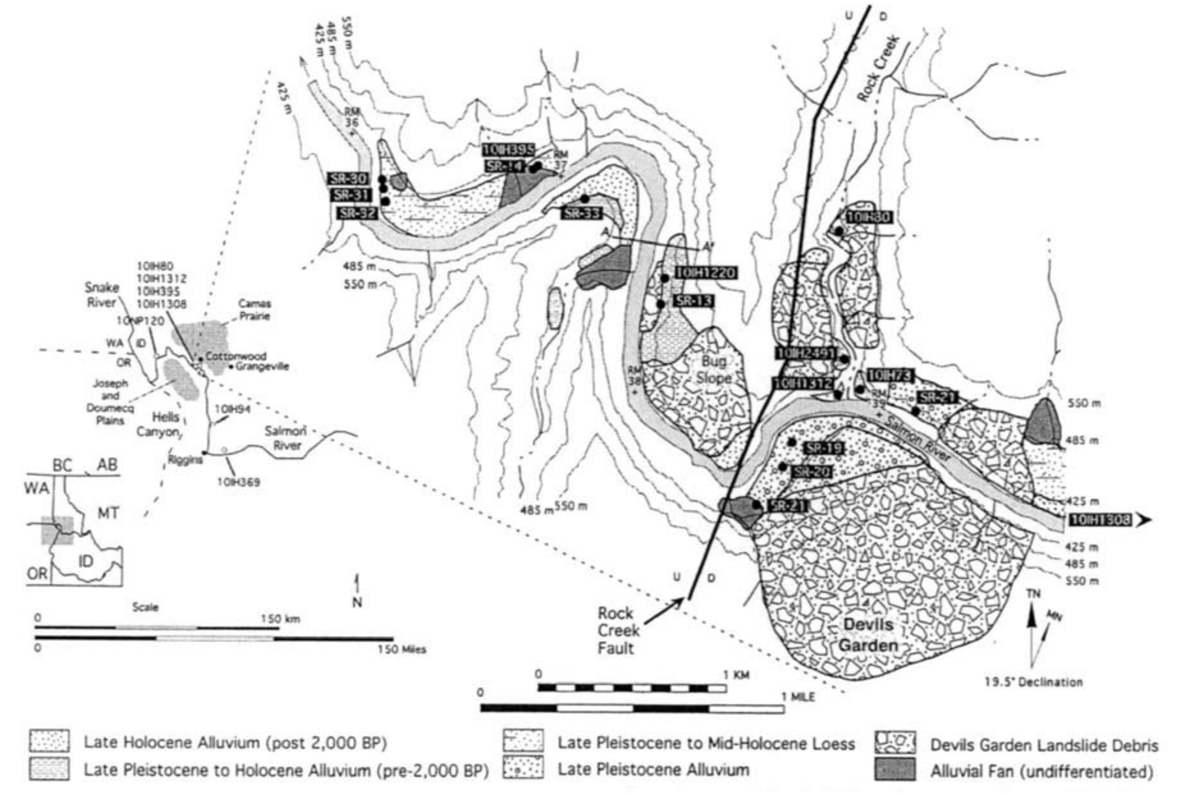


Figure 3. Surficial geology in the vicinity of the Devils Garden Slide at the rock Creek–Lower Salmon River confluence.

which was subject to extensive seasonal flooding that frequently blanketed the landscape with fresh, organic rich alluvium.

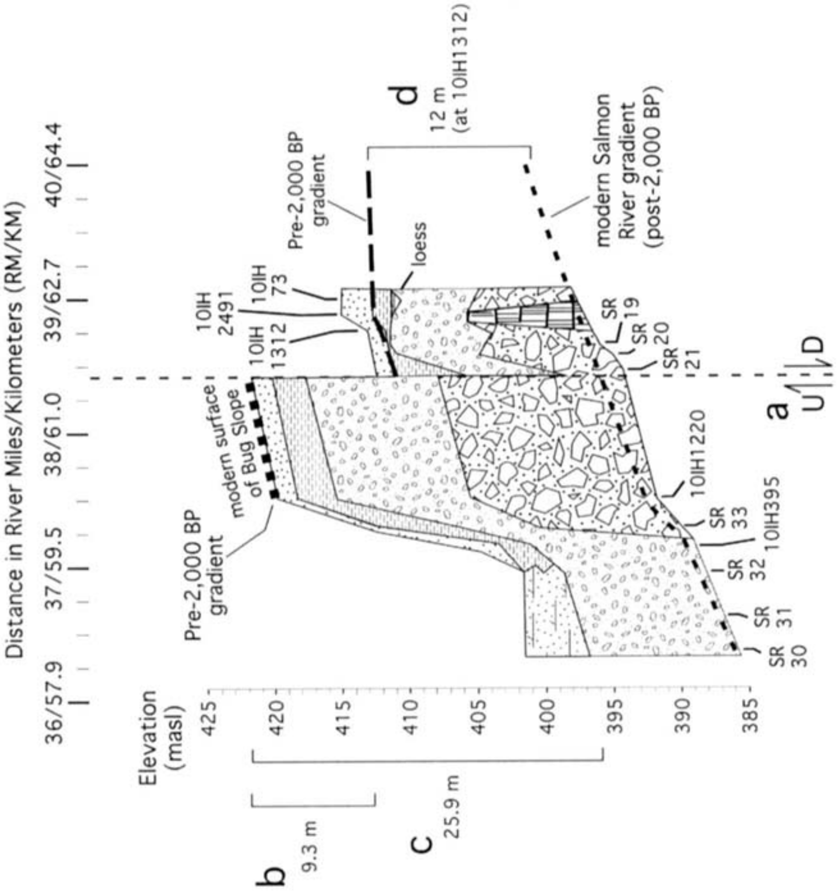
Fluvial conditions since 2000 ^{14}C yr BP

At ca. 2000 ^{14}C yr BP, the Salmon River cut through its Holocene-age Qal4 floodplain and the underlying Devils Garden Slide debris that had occupied the LSRC near the Rock Creek-Salmon River confluence since the middle Pleistocene. The cause of this 2000 ^{14}C yr BP erosional episode is attributed to vertical displacement along the Rock Creek Fault, which has been identified as a normal fault (Gaston and Bennett, 1979). Based on surveyed elevations of Qal4 floodplain deposits in the vicinity of the fault, an area of the canyon landscape appears to have been thrust upwards about 9.3 m (30.5’) on the downstream side of the Rock Creek Fault (see Figure 4). Although significant in its own right, this vertical displacement appears to have triggered even more extensive erosion from the Salmon River. In the area of Bug Slope, the relict Qal4 floodplain surface is 25.9 m (85’) above the position of the modern Salmon River channel, whereas the Qal4 floodplain upstream of the fault lies 12 m (39’) above the river. This difference in elevation indicates that the 2000 ^{14}C yr BP neotectonic event not only caused the river to erode beyond the distance uplifted, but caused the channel to erode through the Devils Garden Slide debris that had previously occupied the bottom of the canyon. This erosional event was rapidly transmitted upriver, causing an extensive abandonment of the Qal4 floodplain in the lower Salmon River canyon (see Figure 5). This erosional event undoubtedly served as a catalyst for the reorganization of the lower Salmon River alluvial system and its aquatic and riparian ecosystem.

Post-2000 ^{14}C yr BP alluviation is largely restricted to point bar development with more extensive floodplain construction occurring only at the Hammer Creek Recreation Site. Stratigraphic exposures in the modern floodplain at Hammer Creek reveal a late Holocene-age series of horizontally bedded, fining-upwards depositional units, which are interpreted as periodic large-scale flooding events (Davis, 2001b). Compared to the older Qal4 alluvial deposits, post-2000 ^{14}C yr BP alluvial sediments are coarser, dominated by sands and gravels, and are restricted to small, discontinuous point bars and sandy beaches. The modern channel contains coarse clastic materials, largely free of fine sediments, and occasionally is composed of bare bedrock. This post-2000 ^{14}C yr BP change in alluviation style represents a shift toward fluvial patterns that are characteristic of the modern Salmon River hydrological system.

Fluvial conditions elsewhere in the Salmon River Basin

Meyer and Leidecker (1999) report on the discovery of geologic deposits related to a late Holocene-age landslide that impounded the Middle Fork Salmon River upstream of RM 13.2, near Golden Creek (see Figure 1). Radiocarbon dated


Distance in River Miles/Kilometers (RM/KM)
36/57.9
37/59.5
38/61.0
39/62.7
40/64.4
Elevation (masl)
425
420
415
410
405
400
395
390
385
b
9.3 m
c
25.9 m
d
12 m (at 10IH1312)
a
U
D
Pre-2,000 BP gradient
modern surface of Bug Slope
Pre-2,000 BP gradient
loess
modern Salmon River gradient (post-2,000 BP)
10IH 1312
10IH 2491
10IH 73
SR 19
SR 20
SR 21
10IH1220
SR 33
10IH395
SR 32
SR 31
SR 30

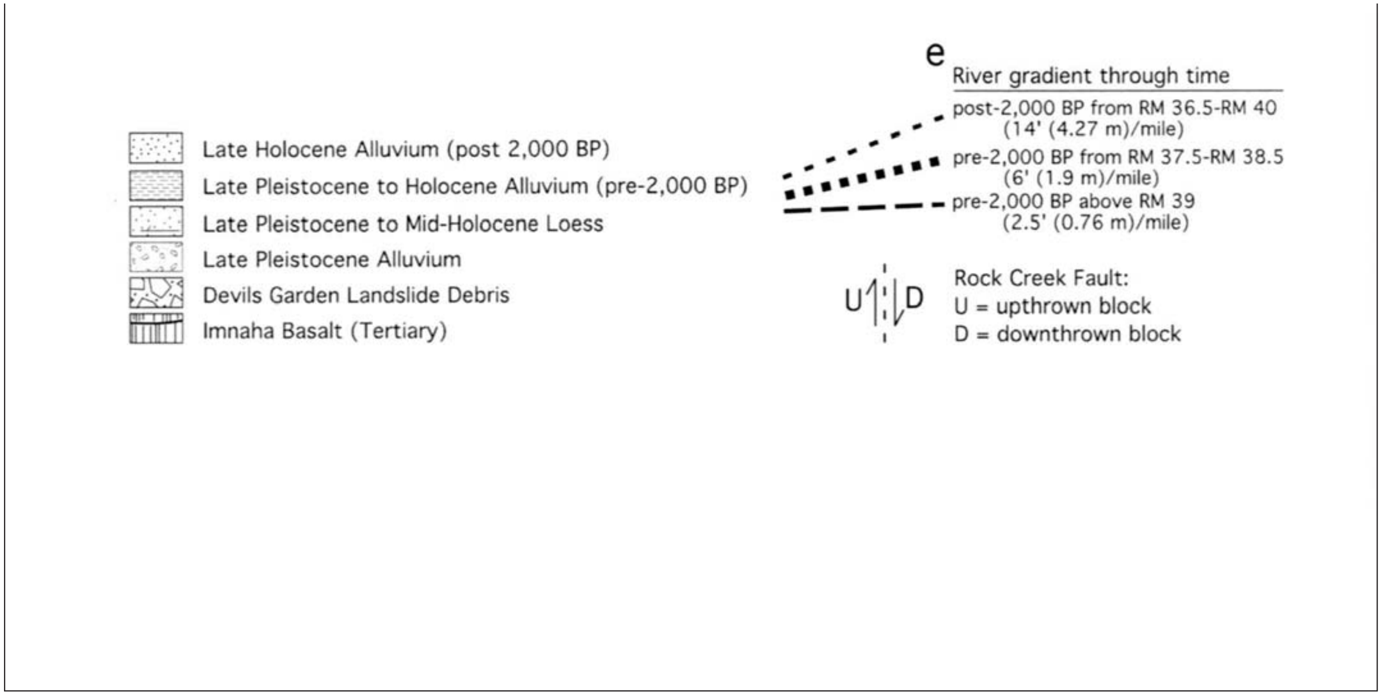


Figure 4. Projection of lower Salmon River gradients before and after 2,000 BP as reconstructed from surficial deposits observed in stratigraphic profiles (e.g., SR-21, 10IH73) in the immediate area upstream and downstream of the Rock Creek Fault line (a). Degree of vertical displacement of the pre-2,000 BP floodplain (9.3 m) at the Rock Creek Fault line is shown at (b). Amount of post-2,000 BP incision of the Salmon River at Bug Slope (25.3 m) and near the mouth of Rock Creek (is shown at (c), and (d), respectively. Variance in lower Salmon River channel gradients during the Holocene is shown in (e).

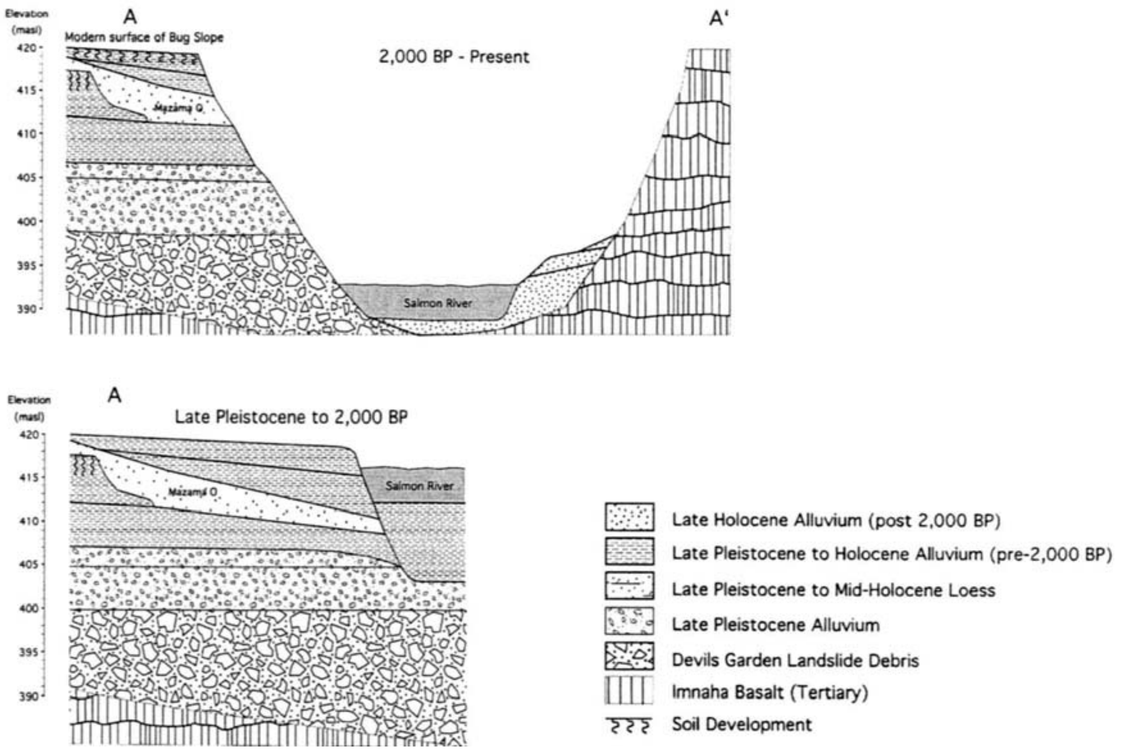


Figure 5. Stratigraphic cross section of canyon surficial deposits and reconstructed channel elevation in the vicinity of Bug Slope along transect A–A′ (Figure 4) before and after 2,000 BP. Horizontal perspective not to scale.

marl sampled near the top of alluvial sediments that accumulated behind the landslide dam returned a ^{14}C age of 1845 ± 45 ^{14}C yr BP. The authors estimate that 24 m of alluvial fill may have accumulated behind the dam for tens to hundreds of years prior to 1845 ^{14}C yr BP. This evidence indicates the presence of a significant obstruction to river flow prior to the appearance of ^{14}C-dated pit house features along the Middle Fork Salmon River (Hackenberger, 1985; Holmer and Ross, 1985; Leonhardy, 1987; Wylie et al., 1981). Although Meyer and Leidecker (1999) cannot be certain of the timing of fluvial down cutting through the landslide dam, pit house features first appear in the Corn Creek site at ca. 1250 ^{14}C yr BP (Holmer and Ross, 1985). Whether or not these natural and cultural events are related will be discussed later.

FLUVIAL CONDITIONS AND ANADROMOUS FISH ECOLOGY

A great deal of literature is dedicated to the study of anadromous fish ecology in the Pacific Northwest and describes a range of environmental conditions that negatively influence salmon populations. The critical elements of freshwater habitats include: suitable channel substrate for construction of redds; moderate discharge rates during spawning; stability of spawning gravels and their eggs during floods; lack of fine sedimentation that might inhibit the proper operation of the hyporheic zone causing suffocation of eggs or an insufficient exchange of nutrients; connectivity of instream habitats; appropriate channel morphology to avoid overcrowded spawning grounds during low streamflow; absence of dramatic fluctuation in water temperatures; insufficient discharge during droughts; presence of open gravels of suitable size for young fish survival; and presence of deep pools to hold adults (Gregory and Bisson, 1997; Hicks et al., 1991; Liss et al., 2006; Schalk, 1997; Stanford et al., 2006). Physical obstructions to upstream travel, such as dams or great waterfalls are known to exclude anadromous fishes from portions of a river basin causing local hunter-gatherers to seek these fishes elsewhere (Walker, 1967). Exogenous sources of disturbance, such as large landslides in constricted canyons, can be expected to trigger periods of extensive channel/floodplain aggradation and, ultimately, degradation due to their sediment storage potential (Liss et al., 2006: Table 3.1). Moreover, these particular effects might appear beyond the reach scale in a drainage basin and show influence at larger segment scales in a constrained alluvial setting like the LSRC. More recent studies illustrate how variance in oceanic conditions may serve to influence the productivity of anadromous fish populations (Liss et al., 2006; Pearcy, 1992; Mantua et al., 1997). Ultimately, variability in the productivity of anadromous fish runs may be caused by degradation of habitat elements in riverine or oceanic contexts, at different stages in the life cycle. Just as we have only more recently begun to fully appreciate the influence of oceanic conditions on anadromous fishes, little is known about the variance of oceanic habitats throughout the archaeological time scale. Regardless of the fact that detailed knowledge of late Pleistocene to

Holocene oceanic conditions and their influence on anadromous fish ecology is largely absent at this time, we must remember that river basins play a most critical role—a point succinctly explained by Gregory and Bisson (1997:279): "It is impossible to ensure the survival of the stocks of anadromous salmonids of the Pacific coast without providing high-quality freshwater habitat for spawning, rearing, and passage of juvenile fish, and migration of returning adults."

In an archaeological application, Butler and Schalk (1986:243-245) present several hypotheses regarding the productivity and structure of Holocene anadromous fish resources in the upper Columbia River basin, based on the autecological requirements of salmon and the effects of generalized environmental conditions on their habitats. According to the authors, between 13,000 and 10,000 ^{14}C yr BP, salmon populations were possibly absent at worst and unpredictable and of low productivity at best in the sediment-laden glacier-fed waters of the upper Columbia River. From 10,000 to 5000 ^{14}C yr BP, Chinook and steelhead runs would occur during several months of the year, representing important resources for hunter-gatherers. Because of the extended presence of salmon throughout much of the year, the authors hypothesize that human groups would not require large quantities of salmon for storage, but likely consumed salmon as they were caught. Between 5000 and 2000 ^{14}C yr BP, salmon runs were probably restricted to only a few months of the summer season. This situation potentially acted as an impetus for storing large amounts of salmon for consumption during the less-productive winter months. Butler and Schalk (1986) hypothesize that salmon runs of the last 2500 ^{14}C years most resembled historic records of fish populations and provided an important delayed-subsistence resource for Plateau peoples.

Considering the habitat requirements of anadromous fishes, a review of the geologic and paleoenvironmental records from the LSRC suggest that suboptimal conditions for salmon and steelhead spawning and rearing probably persisted in the canyon until after 2000 ^{14}C yr BP. Success of spawning and survival of salmon smolts is hypothetically lower under these pre-2000 ^{14}C yr BP conditions as they correspond with conditions commonly cited as detrimental for anadromous fish ecology: reduced alluvial discharge, increased sediment input, and greater sediment storage in a low-energy floodplain, which probably raised water temperatures due to an inherent albedo effect.

DISCUSSION

Based on the research presented above, geologic events may have created alluvial conditions that were detrimental for the spawning and rearing of anadromous fishes in the Salmon River Basin throughout much of the Holocene. After 2000 ^{14}C yr BP, the alluvial system changed in the lower Salmon River canyon, bringing about the development of more favorable habitat conditions for anadromous fishes. Along the Middle Fork Salmon River, similar improvements in anadromous fish habitat may have been further delayed by the effects of a landslide event prior to 1865 ^{14}C yr BP. Considering the close timing between geological and archaeological datasets, the post-2000 ^{14}C yr BP appearance of the Winter Village Pattern in the Salmon River basin is considered to be more than a simple coincidence. Instead, the late onset of the Winter Village Pattern may be the direct product of local hunter-gatherers choosing to practice the economic behaviors associated with the Winter Village Pattern's semi-sedentary lifeway only after certain key environmental conditions were firmly established in the basin. This model of LSRC alluvial environments and anadromous fish ecology is presented in a dichotomous manner, with conditions seen as either good or bad for anadromous fishes. Clearly, intermediary states of anadromous fish productivity between high and low levels probably occurred in the Salmon River basin before 2000 ^{14}C yr BP; however, these intermediary states of productivity may not have provided hunter-gatherers with local runs of salmonids that were stable and abundant enough to warrant a shift to the Winter Village Pattern, which corresponds to overt archaeological patterns. Therefore, measuring intermediary states of productivity and use from the archaeological record should prove challenging.

Consideration of the geoarchaeological and archaeological data at hand leads to the inductive formulation of two hypotheses that describe prehistoric patterns of hunter-gatherer settlement in the Salmon River basin:

1. The timing of the Winter Village Pattern's appearance in the LSRC was caused by the amelioration of anadromous fish habitat conditions and the subsequent improvement of local fisheries through significant fluvial reorganization at ca. 2000 ^{14}C yr BP;
2. Establishment of Winter Village Pattern occupations along the Middle Fork Salmon River was initially delayed due to downstream fluvial conditions in the LSRC, but ultimately postdated removal of a more localized landslide obstruction sometime between 1,865-1,250 ^{14}C yr BP.

While these hypotheses offer possible explanations for the archaeological patterns emerging from the Salmon River basin, they are at odds with the other models described earlier that seek to explain the appearance of the Winter Village Pattern in the Plateau. Because the LSRC lies within the southeastern Plateau physiographic province and is flanked by productive prairies, there is no reason to believe that economically important plants would not have become more productive on the slopes and uplands surrounding the LSRC after ca. 5500 ^{14}C yr BP. Thus, while the resource was theoretically available in abundance on nearby Camas Prairie, Joseph Plains, and Doumecq Plains before the late Holocene, a shift toward the intensified use of key plant foods does not appear to have been enough to cause LSRC hunter-gatherers to embrace a semi-sedentary Winter Village Pattern lifeway before 2000 ^{14}C yr BP.

If Lohse and Sammons-Lohse's (1986) interpretation that semi-sedentary foragers lived along the upper Columbia River beginning in the middle Holocene is applicable to other canyons in the Plateau region, we should expect to see pit house structures in the LSRC well before 2000 ^{14}C yr BP in association with local foragers; however, this model is difficult to fully evaluate for several reasons. First, the authors mainly infer a foraging lifeway among the occupants of 45OK11 on the basis of the absence of storage pit features. Considering what is known about how pit house structures were designed and how their interior floor space was used by Plateau peoples (Ames et al., 1981; Ames et al., 1998; Brauner, 1976; Brauner and Stricker, 1990), it is entirely unclear how the occupants of a pit house could manage to store their bulk food resources (not to mention their equipment) in subfloor facilities while one or more families lived in the house.

Unlike Northwest Coast plank houses, which in some cases were designed to facilitate subfloor storage beneath sturdy, moveable wooden floor planks (e.g., Ames and Maschner, 1999), Plateau pit houses did not incorporate such substantial flooring that might simultaneously enable extensive subfloor storage (e.g., hundreds of pounds of plant foods and dried fish (Hewes, 1998; Walker, 1967)) and occupation by one or more families. Descriptions of storage facilities in Plateau ethnography indicate that materials were commonly stored outside of the house in bark/matting bundles or baskets placed in pits or in grass-lined pits dug into well-drained soils or talus slope deposits (Walker, 1967, 1998). Moreover, this issue of determining the existence of a collector strategy mainly based on the presence of in-house storage features that is raised by Lohse and Sammons-Lohse (1986), Chatters (1989), and later by Prentiss and Chatters (2003) only seems to be relevant to early pit house occupations. The absence of in-house storage features at well-known late Holocene-age Harder Phase (Leonhardy and Rice, 1970) pit house sites like Alpowa (Brauner, 1976) is not interpreted to represent the presence of semi-sedentary foragers, but is taken to signal the practice of the Winter Village Pattern in the lower Snake River canyon. On this basis, the assumption that the absence of subfloor storage pits indicates a lack of bulk resource acquisition for delayed consumption, *ergo* the absence of a collector-based economic orientation, is very tenuous and must be reconsidered. Logically, archaeological observations on the absence of storage features from the interior of pit houses can only be taken to indicate a lack of storage within occupational structures—not a total lack of storage activities within the society. Chatters (1989) offers an interesting alternative to this problem by considering evidence of "geographically displaced" or "seasonally displaced" food resources such as salmon bones or camas bulbs as a better proxy indicators of collector-like patterns; however, reliance on these indices as ultimate measures of the forager or collector patterns must account for taphonomic processes that bias faunal and floral records in Plateau sites.

The other half of Lohse and Sammons-Lohse's (1986) argument regarding the identification of semi-sedentary foragers comes from their interpretation of faunal and floral remains as seasonality indicators. The authors argue that the presence of hunter-gatherers at site 45OK11 during the summer months indicates an absence of the Winter Village Pattern. Their interpretation of summer occupation is based on the presence of marmots and turtle (species unspecified) remains in the faunal assemblage. Reconstructions of solar radiation variability for the Northern Hemisphere indicate significant differences in seasonal solar input over the past 6,000 years (Kutzbach, 1983). Because Northern Hemisphere climates of the middle Holocene period exhibited warmer average temperatures than today, it is incorrect to assume that the presence of certain species in the faunal record of sites indicate seasonality indicators directly comparable to today. Moreover, Lohse and Sammons-Lohse (1986) seem to underestimate how long marmots and turtles could be potentially exploited in the area of 45OK11. Depending on the microclimatic particularities of their local habitat, Pacific Northwest marmots enter hibernation as late as November and some turtles, such as the Western Painted Turtle (*Chrysemys picta bellii*), are able to delay hibernation into the fall months due to their greater tolerance of colder temperatures (Committee on the Status of Endangered in Wildlife in Canada [COSEWIC], 2006). Also, both of these animals emerge from hibernation during the early spring months, further expanding their annual availability. Considering these facts, an alternative interpretation of the faunal assemblage from 45OK11 could easily place hunter-gatherers away from the site during the summer months, which is consistent with the Winter Village Pattern. These alternative interpretations of the site's faunal record also cast doubt on the presence of a year-round occupation at 45OK11.

Notwithstanding the factual and conceptual shortcomings embedded in the Prentiss and Chatters (2003) model, which at a minimum requires us to disregard the appearance of what has been widely interpreted as a collector-based semi-sedentary settlement system much earlier than the appearance of their supposed neoglacial environmental catastrophe (e.g., Ames, 1991; Ames et al., 1998; Brauner, 1976; Lucas, 2000) based largely on the absence of in-house storage features, their argument is not useful for explaining the late onset of the Winter Village Pattern in the LSRC, Hells Canyon, or elsewhere in the Plateau.

Archaeological and geoarchaeological research in the LSRC points to the consideration of more comprehensive hypotheses that accounts for the timing of the Winter Village Pattern that can be applied both locally and regionally: the decision to practice the seasonally scheduled collector pattern of bulk resource procurement for delayed consumption in the context of semi-sedentary winter villages followed the development of key fluvial conditions that promoted the establishment of a productive and predictable anadromous fishery. In the absence of these key fluvial factors—an environmental situation that typified the manifestation what has been called the *Oasis Effect* in the LSRC (Davis et al., 2002)—anadromous fisheries were of low quality and the local resource base insufficient to support the practice of the Winter Village Pattern.

Considering the hypothesized proximate cause of the pre-2000 ^{14}C yr BP absence and later presence of a salmon-dependent Winter Village Pattern described in this article, what kinds of empirical tests could be devised to measure the productivity of anadromous fisheries through time? The recent study by Butler and Campbell (2004) illustrates one kind of approach to the measure of prehistoric fisheries, wherein the number of individual bones of salmonids are quantified and compared against the frequency of other faunal species. In their study, Butler and Campbell attempt to evaluate the relative economic importance of salmoninds from large archaeological collections originating from the Chief Joseph Reservoir of the middle Columbia River basin of eastern Washington and Puget Sound lowlands of western Washington. The rationale underlying their faunal analysis is that the number of identified specimens (NISP) of salmonids and multiple species NISP ratio statistics of salmonids and nonsalmonids represent direct measures of the relative economic importance of various faunal species. On the basis of their zooarchaeological analysis, Butler and Campbell conclude that salmonids were not intensively exploited through specialized use, relative to other species, at any time in the prehistoric past in the Pacific Northwest. This conclusion is surprising, given the numerous historic and ethnographic accounts of Native Americans that describe an economic focus on highly productive salmon fisheries in the Columbia River basin (e.g., Hewes, 1947; Lewis and Clark, 1814; Smith, 1979; Walker, 1967). Based on these records, Smith (1979:5) describes regional contact period salmon use lucidly: “When white settlers arrived in the Columbia River basin at the beginning of the nineteenth century, the Indians already relied heavily on the river’s salmon runs. A Native American population of 50,000 caught an estimated 18 million pounds of Columbia River salmon each year. This figure is based on an average daily consumption of one pound of salmon per person.”

Regardless of ethnographic and historic viewpoints, it is understandable how a case for nonintensive exploitation of salmon could be made if one interprets species frequencies in zooarchaeological datasets as a literal representation of past salmon abundance and intensity of use. Given the numerous taphonomic agents that are expected to have been in operation throughout the prehistoric period that would work to dramatically reduce the visibility of salmonind remains during the formation of the archaeological record (cf. Schiffer, 1987; Lyman, 1994), we should not be surprised to find few salmon bones in sites. A generalized list of natural transforms would include fluvial entrainment and transport of remains away from a site, physical weathering, animal scavenging, microbial digestion, and chemical dissolution in pedogenic contexts. Cultural transforms of the salmonid faunal record could easily include off-site disposal of filleted carcasses, on-site feeding of salmon parts to dogs, and secondary processing of skeletal elements (e.g., roasting, boiling, pounding) for culinary variety. Thus, it seems unlikely that a clearly representative picture of prehistoric salmon use, based on quantification of salmon bones, would ever emerge from Plateau sites.

How, then, should we proceed to evaluate salmon productivity and use in the archaeological past? Like most Plateau river systems, archaeological sites in the Salmon River basin have not produced large quantities of salmonid bone. It is difficult to know whether this situation is meaningful due to the aforementioned operation of site formation processes that bias the zooarchaeological record. In order to avoid this larger skeletal taphonomic problem, two research directions may be pursued that hold promise for testing the productivity of anadromous fisheries in the Salmon River basin: ancient DNA and stable nitrogen isotopes. Recent advances in the recovery and identification of ancient DNA (aDNA) proteins dispersed in sediments have successfully revealed the presence of animals in cases where an associated macrofossil record is absent (Haile et al., 2007; Willerslev et al., 2003). Where natural and cultural site formation processes might filter out the skeletal record of anadromous fishes, aDNA from tissues and bodily fluids may be introduced and preserved in a site's stratigraphy. Although aDNA provides presence and absence measures of species, it unfortunately does not clarify the relative quantities of various animals present at any one time. Regardless, samples taken across a site could provide important insights into the association of anadromous fishes with various features, especially pits, and use areas of camps and larger settlements. Because the δ^{15}N values of marine animals (including anadromous fishes) are generally higher than among terrestrial animals, studies of ^{15}N/^{14}N ratios in different sources may reveal the relative contribution of organic matter by anadromous fishes in the Salmon River basin. After spawning, anadromous fishes die, decompose, and contribute their organic matter into the river. Uptake of this organic matter, and the ^{15}N signature it holds, will occur in a wide range of biotic and abiotic reservoirs including plants, riverine animals, terrestrial animals, and clays (Hoefs, 1997; Hoering, 1955; Scholten, 1991; Williams et al., 1995). Studies of δ^{15}N in Alaskan lake sediments reveal high-resolution records of salmon productivity (Finney et al., 2000) and could also be viewed as a proxy measure for the relative size of salmon runs in alluvial basins. Measuring the *^{15}N of freshwater river mussel shell and floodplain sediments through time are potentially useful means of testing of the productivity of anadromous fisheries in the Salmon River basin during the prehistoric period.

CONCLUSION

I have attempted to offer hypotheses that present explanations for the archaeological and geoarchaeological evidence related to the late appearance of the Winter Village Pattern in the Salmon River basin of western Idaho. If my dataset is representative of the larger archaeological record of the basin, and if my interpretation of the evidence is correct, hunter-gatherers of the LSRC and farther upstream may have been faced with greater environmental constraints than in other Plateau river basins, which limited their opportunities to practice economic and settlement strategies such as the Winter Village Pattern.

Throughout the southern Plateau, the development of and decision to apply the Winter Village Pattern's practices was probably determined in large part by ecological factors particular to the different river systems of the Plateau. In his examination of the roots of pit house village life in the interior Pacific Northwest, Ames (1991:128) says as much: “On the Intermontane Plateau, changes in residential patterns were a regional phenomenon produced by a complex web of regional and local causes.” Stochastic variables, such as landslides and neotectonic behavior of local bedrock structures played a strong role in shaping the natural history of the Salmon River basin and were surely influential elsewhere in the region. The ecological reorganization produced by large-scale forcing functions like climate changes or earthquakes, which might include vegetation shifts and hydrological reorganization, are more relevant to the study of human-environmental interaction than the original mechanisms that triggered the change. Also, the degree and timing of ecological reorganization in the past should be both complex and contextually dependent (e.g., predicated on local scale variables), just as we are accustomed to expect in modern environments. Thus, the assumption that prehistoric hunter-gatherers of the Plateau were equally influenced by regional scale events, such as broad ecosystemic reorganization driven by climate change (Chatters, 1995; Prentiss and Chatters, 2003), is an oversimplification that encourages us to ignore or downplay the importance of behavioral variability at local scales of space and time. In order to work toward detailed interpretations of humanenvironmental interaction in the Plateau, we must continue to apply archaeological and geoarchaeological approaches that are designed to elucidate contextual perspectives at the scale of alluvial basins and subbasins (e.g., Davis, 2001b; Davis and Muehlenbachs, 2001; Davis et al., 2002; Davis and Schweger, 2004; Fadem, 2004; Hammatt, 1976; Mierendorf, 1984). Clearly, large scale interpretative syntheses have a place in Plateau archaeology; however, in the absence of detailed knowledge on human-environmental interaction at smaller spatial scales, such interpretations are surely premature and overlook critical information on ecological contexts and evolutionary contingency—factors that undoubtedly influenced the decisions prehistoric peoples made through time.

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