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Relationships Between Snake River Paleofloods, Occupational Patterns and Archaeological Preservation at Redbird Beach Archaeological Site in Lower Hells Canyon, Idaho

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RELATIONSHIPS BETWEEN SNAKE RIVER PALEOFLOODS, OCCUPATIONAL PATTERNS AND ARCHAEOLOGICAL PRESERVATION AT REDBIRD BEACH ARCHAEOLOGICAL SITE IN LOWER HELLS CANYON, IDAHO

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by

Tabitha Trosper

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ABSTRACT

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The Snake River basin drains 282,000 km^2 of the northwestern U.S. and is the largest tributary to the Columbia River. Redbird Beach, an archaeological site located in the lower Hells Canyon reach of the Snake River, contains extensive vertical exposures of archaeological materials interbedded with Snake River flood sediments. Redbird Beach formed in the lee of the Redbird Creek debris fan, is composed of interfingering deposits from large floods on the Snake River and locally-derived alluvial sediments from Redbird Creek. Through stratigraphic analyses of slackwater deposits, this study compares the temporal and spatial patterns of human occupation at Redbird Beach with variations in the magnitude and frequency of floods from the Snake River. Results of this study will form a key component of a regional synthesis of floods and climate change in

the inland Northwestern U.S., and contribute to our understanding of the archaeological record along this major regional waterway.

ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

The geological reconstruction of paleoflood records is an important tool used to understand the hydrologic dynamics and evolution of a river system (Kochel and Baker, 1982). The stratigraphic record of slackwater flood sediments can also be used to understand the environmental context and potential influences of a river on human uses and timing of occupation and preservation of cultural materials at archaeological sites (Patton and Dibble, 1982; Vandal, 2007). The hypothesis of this study was that temporal and spatial patterns of human occupation and preservation of archaeological materials at Redbird Beach were influenced by floods from the Snake River and geomorphologic changes likely initiated by locally-derived debris from Redbird Creek and/or Snake River channel migration. The following objectives were implemented to test this hypothesis:

1) reconstruct the geomorphic history of Redbird Beach archaeological site;

2) establish a Snake River flood chronology for the last ~2300 years by describing and dating the slackwater deposits that compose the flood terrace at Redbird Beach;

3) reconstruct the timing of human occupancy and preservation of archaeological materials at the site;

4) document and describe the nature and potential causes of the bank erosion currently occurring along the edge of the site; and

5) compare the results of this study to other archaeological and paleoflood research sites on the Snake River to assess broader patterns in the timing of human occupation and flood events.

Regional Setting

The Snake River basin drains 282,000 km^2 of the northwestern United States, and is the largest tributary to the Columbia River (Fig. 1). In the 160 km reach from Oxbow Dam to the confluence with the Grande Ronde River, the Snake River flows northward through a steep narrow canyon called Hells Canyon. North of this point the terrain changes geologically and topographically, transitioning from the deep narrow walls of Hells Canyon to a shallower canyon and basalt-filled basin (Vallier, 1998). Although the Redbird Beach site lies 21 km downstream of this geologically-defined boundary of Hells Canyon (Fig. 1) the canyon walls are still steep and ~850 m high in this reach of the river. Redbird Creek is one of few access points from the highlands to the east, in Idaho, to the canyon bottom within this reach of the Snake River. This characteristic has made Redbird Creek an important passageway for humans and wildlife to access the Snake River canyon.

Geological and Geomorphological Context

The geologic origins of southeastern Washington and western Idaho begin in the Late Paleozoic. The Hells Canyon region is a conglomerate of exotic terrain, remnants of volcanic island arcs and oceanic crust transported across the ancestral Pacific Ocean and accreted onto the North American continent by way of subduction. Accretion is thought to have ceased by the Early Cretaceous, but regional uplift, related to the intrusion of the Idaho Batholith, took force during the Late Cretaceous. An erosional period of ~10 Ma

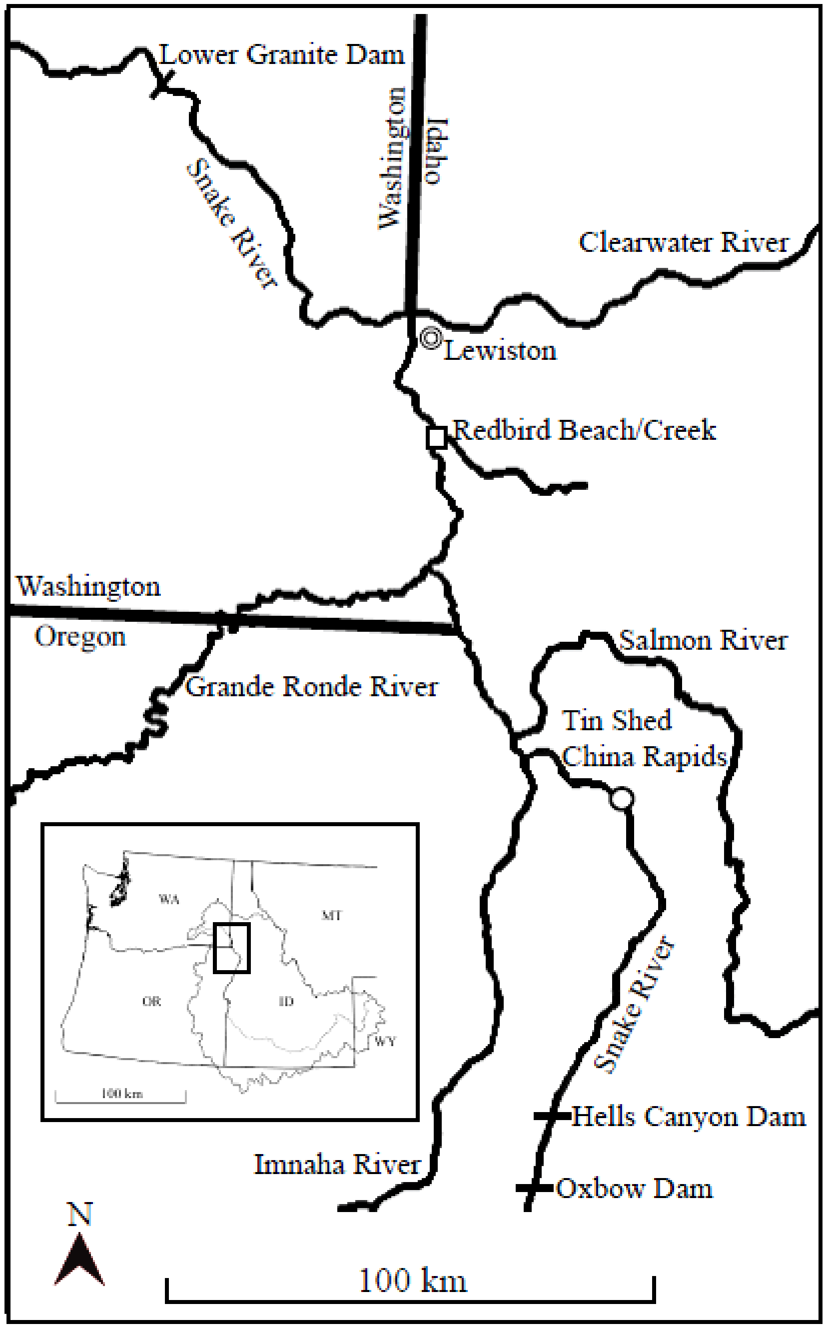

Figure 1. Regional location map of Redbird Beach archaeological site. The inset map shows the Snake River Basin boundaries. The open square on the inset map indicates the area shown in detail on the main map. Hells Canyon extends from the Oxbow Dam to the confluence of the Grande Ronde River. Redbird Beach (open square) is located on the Idaho border along the Snake River. Redbird Beach is 21 km downstream of the confluence of the Grande Ronde River and 23 km upstream of Lewiston, Idaho.

followed the uplift event and by the Late Miocene the Columbia River Basalt Group had engulfed much of western Idaho, Oregon and Washington states. The mountainous topography now observed in regions surrounding Hells Canyon has been attributed to tectonic uplift that ensued ca. 6 Ma, following the last basalt flows (Alt and Hyndman, 1995; Vallier, 1998). Wood and Clemens (2002) speculate that Lake Idaho, formed in the normal-fault bounded basin of the western Snake River Plain, drained into the ancestral Hells Canyon ~4 Ma. Overtopping of Lake Idaho at the spill point near Huntington and Weiser, Idaho is thought to have connected the Snake River to the Columbia-Salmon River system between 3.8 and 2 Ma. Wood and Clemens (2002) suggest that downcutting and deepening of Hells Canyon is a product of the final, relatively slow-draining (120m/Ma) of Lake Idaho. During the Quaternary the Snake River and its tributaries have since carved deep canyons that are the source of landslides, debris flows, and alluvial and fluvial deposition along the canyon river walls (Vallier, 1998).

Archaeological Context

In northwestern North America the Columbia and Eastern Plateau regions (Fig. 2) are defined by geographic boundaries and cultural adaptations (Chatters and Pokotylo, 1998). Both contain complex cultural records of late prehistoric hunter-gatherer societies (Prentiss et al., 2005). The Columbia Plateau covers a vast area extending south to Crater Lake in central Oregon, across northeastern Oregon, through Hells Canyon, up to the Northern Rocky Mountains in central and northern Idaho and finally, into eastern and central Washington covering the mid-Columbia River Basin (Ames et al., 1998). The Eastern Plateau consists of major drainages, such as the Clearwater and Salmon River in central and eastern Idaho and the Pend Oreille and Kootenai Rivers in northern Idaho and western Montana (Roll and Hackenberger, 1998). Redbird Beach archaeological site is located within the overlap between these cultural provinces (Fig. 2).

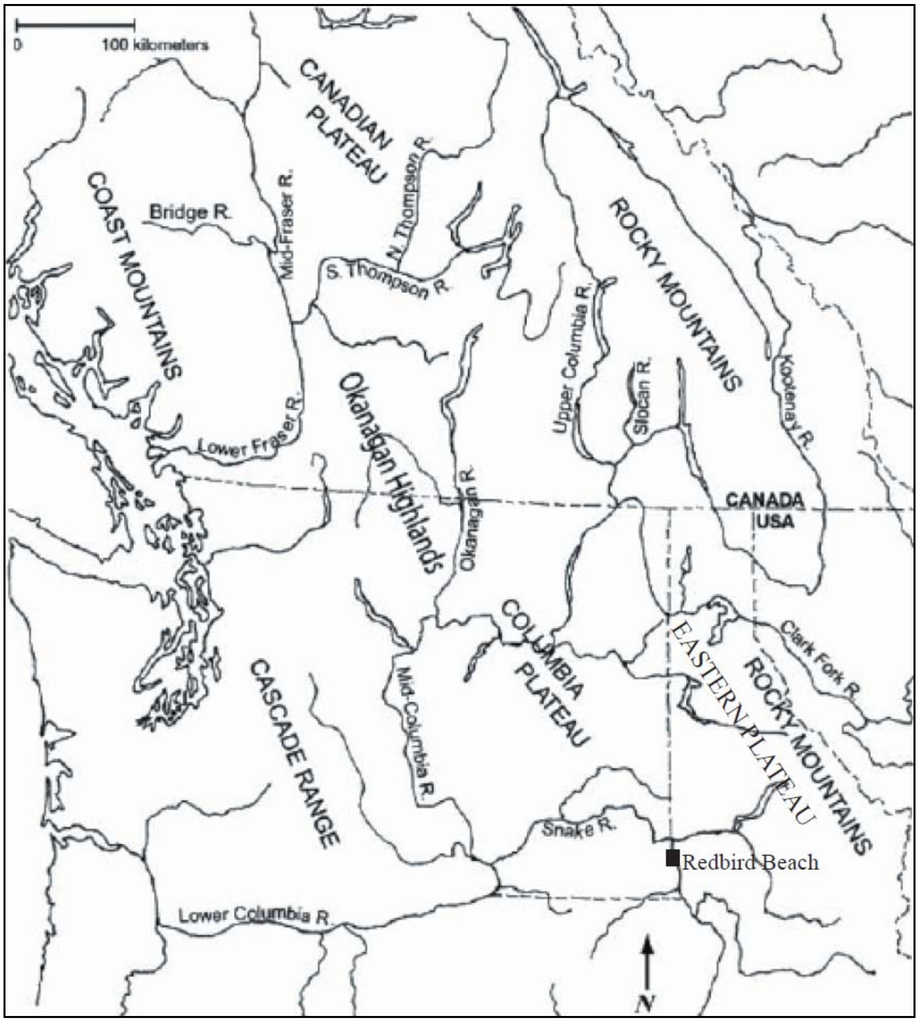

Figure 2. Map showing the Columbia Plateau. Redbird Beach is located where the Columbia and Eastern Plateaus over lap along the Washington-Idaho border. Modified from Prentiss et al (2005).

Cultural adaptations during the Holocene were likely influenced by the ecologically contrasting mountain and river-canyon environments found within the Eastern and Columbia Plateaus, respectively. Most subsistence patterns in these regions emphasized the harvest and storage of anadromous fish, edible roots and large ungulates. Settlements appeared to coincide with these subsistence patterns, and were characterized by a semi-sedentary settlement pattern in which the people utilized resources as they were available (Hammatt, 1977; Chatters and Pokotylo, 1998).

The prehistory of these plateau regions is generally divided into three major time periods: Early, 11,000-9,000 B.P.; Middle, 9,000-4,000 B.P.; and Late, 4,000 B.P.-A.D. 1720 (Chatters and Pokotylo, 1998). The definitions and temporal boundaries of these cultural time periods have evolved over time and continue to be modified depending on the author and subarea within the Plateau (Hammatt, 1977; Ames et al., 1998; Roll and Hackenberger, 1998; Prentiss et al, 2005; Davis, 2007).

Previous studies and archaeological surveys at Redbird Beach archaeological site (10NP55) would suggest that prehistoric and historical occupation occurred during the Late period (4,000 B.P.-A.D. 1720). The site was originally recorded as an extensive prehistoric habitation by the Idaho State College Museum in 1970, and was assigned to the Nez Perce National Register District. In 1984 Idaho State Archaeologist, Thomas Green, visited Redbird Beach and wrote a memo documenting that there was "severe, on-going bank erosion that was destroying the integrity of the deposits" (Root and Ferguson, 1999). Since Green's observations were made, status updates of the archaeological site have continued, but Redbird Beach has not been excavated. More recently, Kenneth Kvamme (2009) conducted a geophysical survey using magnetic gradiometry, electrical resistance, ground-penetrating radar, soil conductivity and electromagnetic induction to detect possible locations of archaeological features within the terrace. The data showed evidence for 23 anomalies thought to represent both prehistoric and historic archaeological features, such as house floors, hearths and pits, as well as geomorphic features within the terrace (Kvamme, 2009). The anomalies detected in Kvamme's study have not been confirmed, though the extensive vertical exposures along the terrace at Redbird Beach continue to expose archaeological materials. Erosion along the cut bank also persists, contributing to the loss of cultural materials and the geomorphic and paleoflood history of the site. Documentation of the geomorphology of the site, in this study, is an important step toward understanding the relation of the prehistoric occupation of the site with the timing of Redbird Creek alluvial deposition and Snake River floods before the geomorphic and archaeological records are lost to bank erosion.

Regional Paleoflood History

Syntheses of modern floods and paleofloods have discussed magnitudes and frequencies of extreme floods in relation to geography and climate in the western United States (Ely, 1997; O'Connor et al., 2002; O'Connor & Costa, 2004). In the Pacific Northwest paleoflood studies have largely focused on the catastrophic Bonneville flood (O'Connor, 1993) and Missoula floods (Bretz, 1969; O'Connor & Baker, 1992; Smith, 1993). Late Holocene paleoflood studies have been conducted in the Columbia River Basin (Chatters & Hoover, 1986, 1992; Orth, 1998; Rhodes, 2000; Hosman, 2001; Hosman et al, 2003) addressing paleoclimatic and paleoenvironmental changes, but few Holocene flood studies have been conducted on the Snake River (Rhodes, 2000).

Along the Hells Canyon reach of the Snake River, Rhodes (2000) used geological evidence to identify more than 20 floods over a 5000-yr period at Tin Shed and China Rapids study sites, 90 km upstream from Redbird Beach (Fig. 1). Redbird Beach is an ideal site for comparing and extending these Snake River flood records. Flood records from multiple sites at different points on a river are useful to fully characterize the long-term flood record, as a single site may not preserve evidence of all flood events. This study will extend the flood record and provide a missing piece of the Holocene flood record of this reach of the Snake River not seen at Tin Shed or China Rapids. This study will also contribute to a regional database of Holocene floods and climate change in the inland Northwestern U.S. (Orth, 1998; Rhodes, 2000; Hosman, 2001; Hosman et al, 2003; Vandal, 2007).

Paleoflood studies conducted at archaeological sites have used cultural materials as a chronological tool for dating paleoflood deposits (Patton and Dibble, 1982; Enzel et al., 1994; Ely, 1997; Rhodes, 2000; Vandal, 2007), but few have directly examined the relationship between the geomorphic and paleoflood records and temporal patterns of human occupation at a single site (Huckleberry, 1995; Vandal, 2007). Redbird Beach archaeological site is an excellent location to explore how the site geomorphology and flood events may have influenced the occupational patterns of prehistoric and historic humans along the Snake River. This study hypothesizes that the preservation of cultural materials at archaeological sites might be enhanced by slackwater flood deposition.

Paleoflood Hydrology and Slackwater Deposits

Paleoflood hydrology, the study of past flood events, has adopted two widely-used and accepted approaches to reconstructing paleoflood records: 1) the estimation of mean hydrologic conditions achieved through physical analysis of paleochannels (Kochel & Baker, 1988; O’Connor and Webb, 1988); and 2) the characterization of individual flood events, specifically, frequency and magnitude, determined by various techniques applied to the depositional environment and flood deposits (Baker, 1987; Kochel &

Baker, 1988; Baker, 2008). The analysis of slackwater deposits is an example of the latter technique that can provide abundant and accurate data for estimating the frequency and magnitude of large flood events in some circumstances. Slackwater deposits are fine-grained sand and silt that settle out of suspension from flood waters in backwater areas of quiet water such as irregular margins along canyon walls, back-flooded tributaries, and in bedrock canyon alcoves or in the lee of large bedrock obstructions (Ely & Baker, 1985; Kochel & Baker, 1988; O'Connor & Webb, 1988). Because slackwater sites are areas of passive deposition rather than active erosion, a single site can accumulate sediments from multiple floods over periods of thousands of years (Kochel & Baker, 1988; Ely, 1997).

CHAPTER II

METHODS

Stratigraphic Analysis

Kochel and Baker (1982) differentiate the slackwater deposits associated with discrete flood events by identifying abrupt stratigraphic breaks, variations in sedimentation patterns, evidence of subaerial exposure at stratigraphic boundaries and variations in color. During the summer 2010 field season six profiles were selected along the Snake River terrace at Redbird Beach based on the geomorphic changes observed along and within the terrace, and the proximity to culturally-rich sections of the cut bank. Each profile was described from the terrace surface downward. The fine-grained Snake River overbank fluvial sediments along the exposed cut bank were described and individual depositional units were characterized based on their color, grain-size, stratigraphic boundaries, depth and location within the terrace. Cultural horizons within the flood stratigraphy were also used to delineate the boundaries between flood deposits. Select sediment samples were collected for grain-size analysis. Appendix A contains detailed field descriptions of each profile.

Geochronological Analysis

The passive and protective depositional nature of the flood deposits at Redbird Beach has enabled the preservation of archaeological materials and other datable organic materials of the site. Interbedded in the Snake River flood deposits are cultural horizons containing *in situ* artifacts, detrital charcoal and freshwater bivalve shells. Detrital charcoal fragments and shells (sp. *Margaritifera falcate*) were collected for accelerator mass spectrometry (AMS) radiocarbon dating to constrain the ages of specific flood events and periods of occupation at Redbird Beach (Appendix B). In the more deeply buried fluvial sand deposits, samples were collected for optically stimulated luminescence (OSL) dating, but were not submitted for dating analysis.

Charcoal dates can be ambiguous, in an archaeological context, as their origin and residence time on the surface or in the fluvial system is unknown. Uncertainties in wood/charcoal dates are commonly attributed to: 1) the lack of knowledge of the part of a tree that the sample originally came from; 2) where within a drainage basin the wood was collected or transported from; 3) biological processes including human placement, later burial by woodrats, root growth and decay; and 4) how long the wood source has been dead, particularly in semi-arid environments where decomposition may be prolonged (Kochel and Baker, 1982; Osterkamp et al., unpublished report).

Dating shells also includes complications that stem from the incorporation of old carbon from the river water, but a calibration scheme developed for radiocarbon analysis of shell samples from the Hells Canyon reach of the Snake River has increased the dating accuracy for cultural contexts (Osterkamp et al., unpublished report). Differences in radiocarbon ages between coupled shell and charcoal samples from archaeological sites along the Snake River is attributed to isotopic variations of carbon in ground-water discharges. Bivalve shells can reflect the isotopic composition of the waters in which they lived, for instance, a shell living in a river environment where recharge is dominated by subsurface sources can result in a ^{14}C-deficiency, due to processes of dissolution and radioactive decay that occur during the long periods of ground-storage and transport. In this scenario the bivalve shell will yield ^{14}C ages that exceed the true age. Charcoal paired with shells, has been used to standardized a shell calibration and define the reservoir effect for different reaches of the Snake River. Two regression equations of coupled wood/charcoal and shell pairs have been implemented to adjust shell ages in the Snake River (Osterkamp et al., unpublished report). They are highly dependent upon the geographical location and ground-water or tributary contributions to the Snake River. The following regression equations (1 and 2) are applied to Snake River sites:

$$D_a = [0.862D_c - 2197] \text{ yr} \qquad (R^2 = 0.9599; SE = 294 \text{ yr}) \qquad (1)$$

$$D_a = [1.049D_c - 2739] \text{ yr} \qquad (R^2 = 0.9905; SE = 296 \text{ yr}) \qquad (2)$$

where D_c is the conventional ^{14}C shell age and D_a is the adjusted age. Regression equation 2 was used on the wood/charcoal and shell pair collected for analysis from Redbird Beach archaeological site.

Radiocarbon samples were analyzed at The University of Georgia, Applied Isotope Studies Laboratory (laboratory results are in Appendix B). All radiocarbon ages obtained from detrital charcoal samples were converted to calendar years and reported in the two sigma range using CALIB Radiocarbon Calibration (Stuiver and Polach, 1977; Stuiver et al., 2005). The one freshwater bivalve shell date was corrected for the reservoir effect by Waite Osterkamp, U.S. Geological Survey in Tucson, AZ.

Archaeological Analysis and Mapping Methods

Archaeological test investigations and mapping of the site were conducted by students from the Department of Anthropology and Resource Management at Central Washington University (CWU) under the direction of Dr. Steven Hackenberger and Dr. Kenneth Reid (Idaho State Archaeologist). During the summer 2010 field investigations test excavations were conducted along the terrace cut bank. Students also mapped the terrace from the canyon wall to the shoreline under the direction of Marc Fairbanks (CWU, Resource Management Program). An inventory of archaeological features and artifacts observed in the cut bank wall were recorded and mapped. In addition to the GIS data collected at Redbird Beach, LiDAR data from the Army Corp of Engineers were also utilized to construct maps of the site. Maps were constructed in ArcGIS by Marc Fairbanks.

CHAPTER III

DATA AND RESULTS

Analysis of slackwater and coarser-grained fluvial sediments from the Snake River terrace at Redbird Beach provided spatial and temporal chronologies for both the flood and occupational records of the site. Here the geomorphology of Redbird Beach is described, as well as the stratigraphy of profiles RB-1 through RB-6 (Appendix A), radiocarbon dates (Appendix B), cultural and flood chronologies.

Geomorphology of Redbird Beach

Redbird Beach is composed of two key geomorphic features: 1) the Snake River flood terrace; and 2) the Redbird Creek alluvial fan (Fig. 3). Redbird Creek flows from east to west down through the Eastern Plateau of eastern Idaho, and into the Snake River. It is the source for debris accumulated on the alluvial fan. The Snake River flood terrace has formed in the lee of the Redbird Creek alluvial fan, and is composed of accumulated slackwater flood deposits and coarser-grained fluvial sediments.

The Snake River terrace study area extends ~155 m along the river and gradually decreases in elevation from north to south (240.5 to 239.5 m above sea level; Fig. 3 and 4). The highest bench along the flood terrace at Redbird Beach is at an elevation of ~240 m at the northern end of the site, where profiles RB-1, RB-2 and RB-3 were described (Figs. 3 and 4). The elevation for profiles RB-4 to RB-6 gradually decreases from north to south along the terrace surface, and each profile represents a distinct, progressively younger stratigraphic inset.

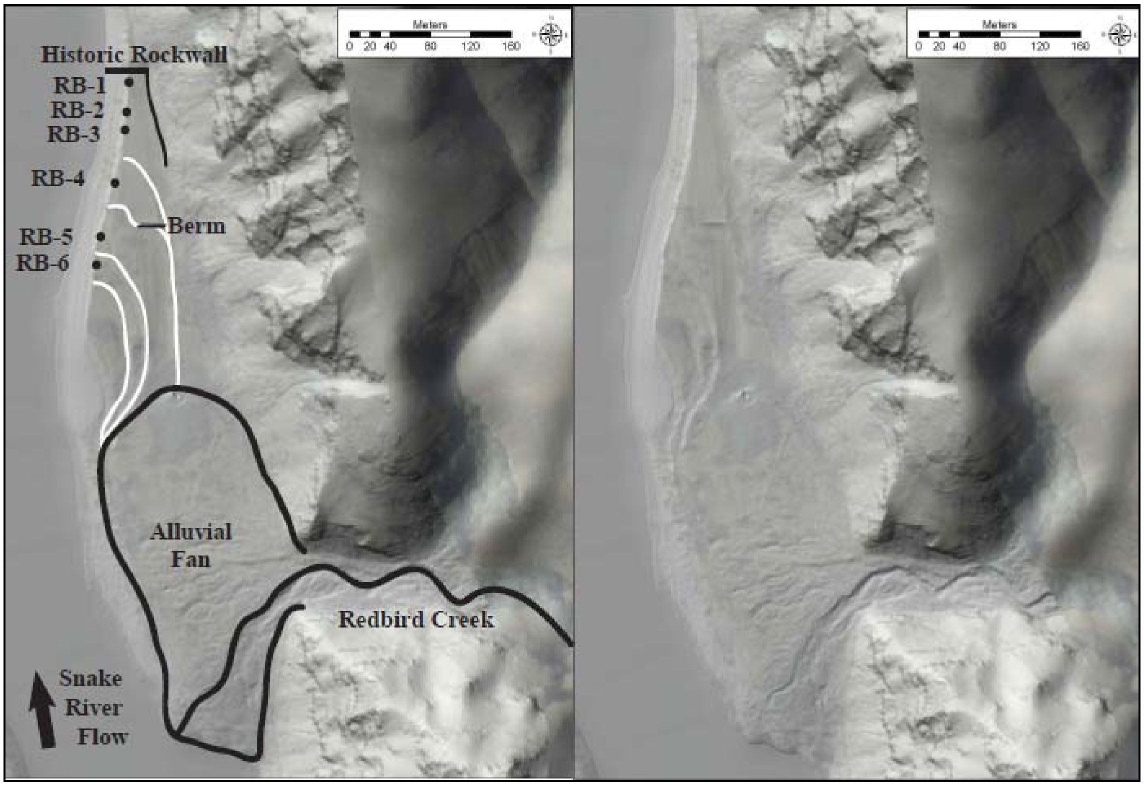

Figure 3. Geomorphic map of Redbird Beach archaeological site. The Snake River flood terrace has formed in the lee of the Redbird Creek alluvial fan and is the primary study site (RB-1-RB-6 are the profiles described in the study). The inferred paleochannels and insets for profiles RB-4, RB-5 and RB-6 are noted by the white lines. Within inset RB-5 linear features run from north to south, perpendicular to an earthen berm developed during historic occupation. Modified map constructed by Marc Fairbanks, 2011.

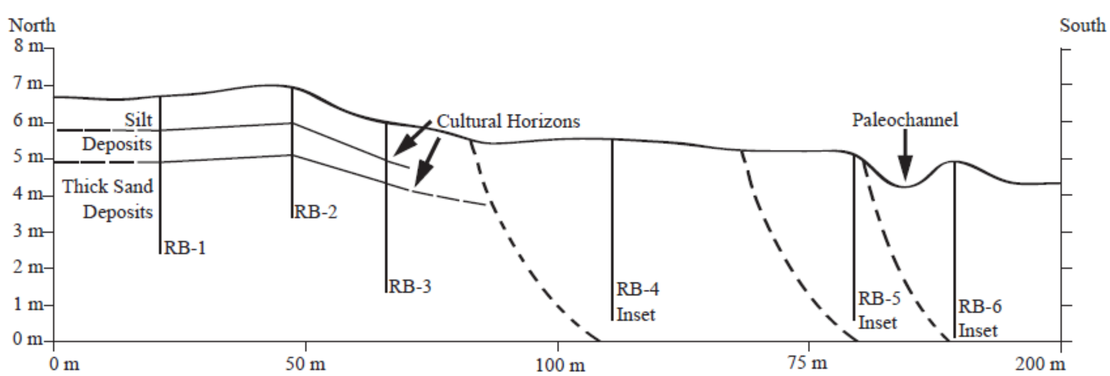

Figure 4. Snake River terrace profiles in cross-section. Profiles RB1 through 6 are represented along the terrace cut bank from north to south. Insets are indicated by the dashed lines between profiles RB3-6.

Geomorphic features and anomalies were detected on the terrace surface, in Kvamme's geophysical investigation at Redbird Beach (Kvamme, 2009). The features noted by Kvamme were also detected on the LiDAR imagery in this study (Fig. 3). During historical occupation of the site an orchard was planted and an earthen berm was emplaced. Linear features run perpendicular to the berm and are also visible in the LiDAR imagery. The extent of modifications to the terrace surface are not known and may have obscured evidence that could have led to a better understanding of how the terrace insets containing profiles RB-4, RB-5 and RB-6 were formed.

Stratigraphy

The Snake River flood terrace is composed of accumulated slackwater and coarser-grained fluvial deposits from the Snake River. The alluvial fan deposits at the southern end of the terrace were not described in this study. Tables 1-6 in Appendix A provide a detailed description of each stratigraphic layer recorded in the six profiles studied at Redbird Beach, which are summarized below.

Profiles RB-1, RB-2 and RB-3 contain correlative stratigraphic units and are composed of the oldest Snake River flood deposits. In the subsequent section these three profiles are summarized together. Profiles RB-4, RB-5 and RB-6, located south of profiles RB-1, RB-2 and RB-3, represent inset stratigraphic sections that become progressively younger from north to south along the terrace cut bank (Fig. 4). Those profiles are described individually below, as each inset represents a different stratigraphic sequence. All six of the profiles are shown in the correlated stratigraphy of the Snake River terrace, illustrated below in Fig. 5.

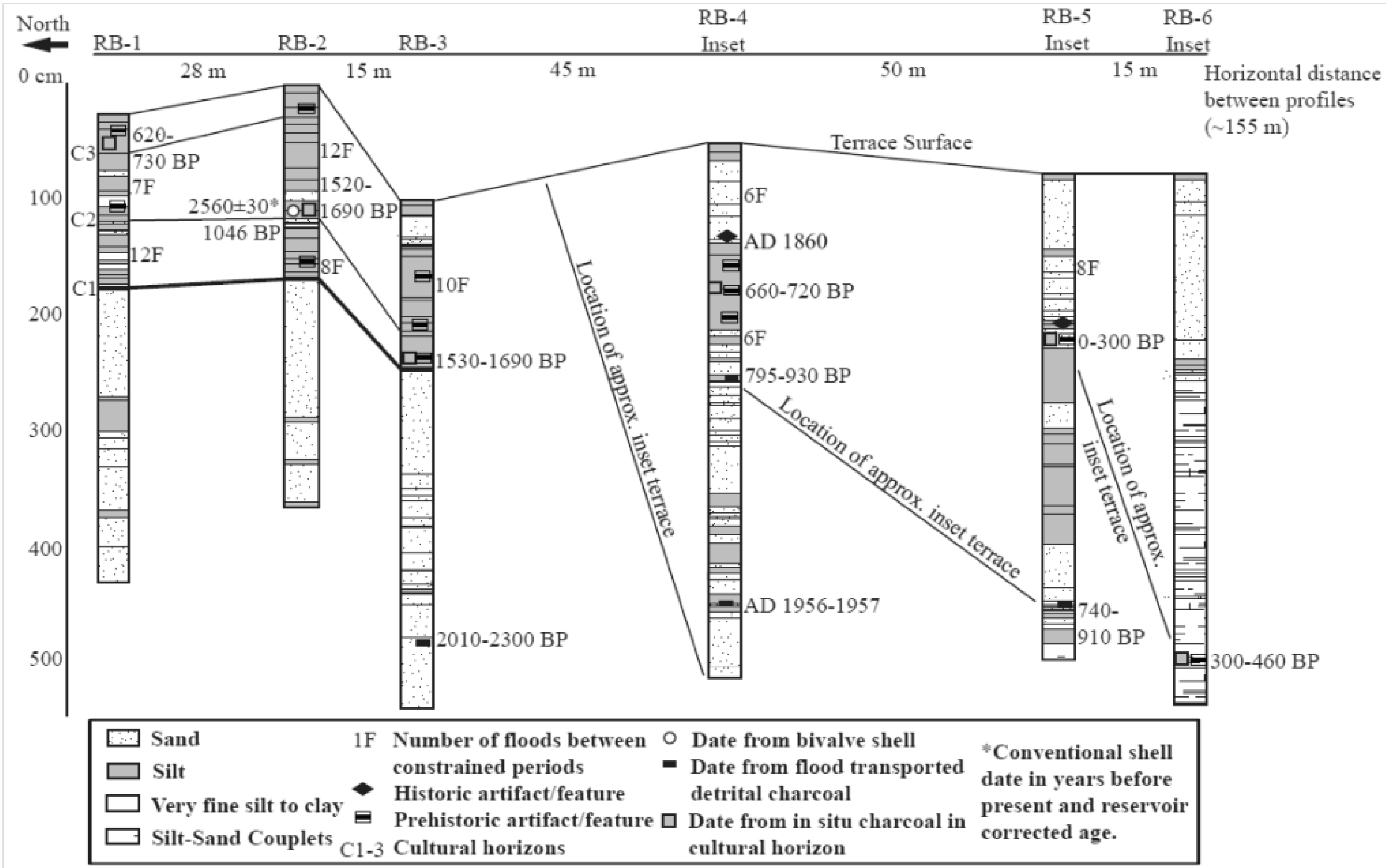

Figure 5: Correlated Snake River terrace stratigraphy. From left to right profiles illustrate cut bank stratigraphy of the terrace from north to south. Flood deposits are generally silt to sand with massive sands dominating the lower depths of each profile. RB-1, RB-2, and RB-3 all exhibit similar flood deposition and contain correlative cultural horizons, most notably from 0 cm to ~175 cm depth. Profiles RB-4, RB-5 and RB-6 are younger, inset flood deposits that accumulated within Snake River paleoflood channel(s) or were laterally accreted, as indicated by the terrace morphology (Figs. 3 and 4).

RB-1, RB-2 and RB-3

RB-1 is located at the northern end of the Snake River terrace. A total of 34 units were distinguished and described in a 425-cm vertical profile (Figs. 3, 4 and 5). RB-2 is located 28 m south of RB-1. The profile contains 24 units within a total depth of 360 cm (Figs. 3, 4 and 5). Profile RB-3 is located 15 m south of RB-2. The profile contains 31 units within 460 cm depth (Figs. 3, 4 and 5). The sedimentology of the three profiles is composed of coarse to fine grain sand in the lower depths (from ~175 to 460 cm) of the profiles, and fine sand, silt and clay in the upper depths (from ~175 to the terrace surface) (Fig. 5). Each depositional layer was distinguished and described based on their color, grain-size, stratigraphic boundaries, depth and location within the terrace. The following descriptions are examples of typical layers found in the lower coarse grain (1) and upper finer-grained (2) deposits observed in the Snake River terrace at Redbird Beach (Appendix A):

1) Profile: RB-1. Unit 28. Depth 287-293 cm. Color: 10 YR 6/3 pale brown. Texture: very fine sand. Unit is massive, contact at the upper boundary is sharp and irregular and the lower contact is sharp and wavy.

2) Profile: RB-2. Unit 16. Depth 138-151 cm. Color: 10 YR 5/2 grayish brown. Texture: fine silt. Unit is massive and bioturbated with some red colored staining (oxidation?). The upper and lower contacts are sharp and irregular.

The boundaries between individual units were determined by visible, physical changes between units, such as subtle differences in sediment color and grain size. Abrupt or sharp contacts between layers of varied sedimentology were used to delineate units.

Sedimentary structures within the deposits were usually very weakly developed, cross-bedding, grading and laminations were occasionally observed in coarse sand to coarse silt deposits, but layers generally lacked a defined structure. Evidence of subaerial exposure between depositional events was elucidated by the presence of cultural materials, bioturbation caused by animal and insect burrowing or root growth and oxidation.

A prominent change in the sedimentation pattern occurs in the stratigraphic columns of RB-1, RB-2 and RB-3 at a depth ranging from 152-175 cm (depending on the location along the cut bank wall). The observed depositional change is defined by a sharp contact between older underlying massive, coarse to fine sands and younger overlying silty-clay, silts and fine sand deposits. The boundary that marks this distinct transition from coarser- to finer-grained deposits coincides with the earliest dated cultural materials at Redbird Beach, dating to 1530-1690 cal B.P. (Fig. 6).

From profile RB-3, at 275 cm depth, a flood-transported detrital charcoal fragment yielded a minimum age of 2,100-2300 cal B.P. for the Redbird Beach archaeological site. Additional ages were obtained from samples collected from within cultural horizons. Cultural horizons, as described in this study, were defined by the following set of shared sedimentological characteristics: silt to clay grain-size, dark brown color, sharp layer boundaries, and a higher density of visible charcoal fragments within the layer. Cultural horizons also had a lateral component, containing archaeological materials at multiple points within the same stratigraphic horizon along the cut bank wall. In profile RB-3, charcoal was collected from unit 16 at 150 cm, dating to 1530-1690 cal B.P (Figs. 5 and 6). A second set of ages for the northern end of the terrace was collected from profile RB-2: an *in situ* charcoal and shell pair, radiocarbon dated to 1046 cal B.P. (shell) and 1520-1690 cal B.P (charcoal) (Figs. 5 and 6).

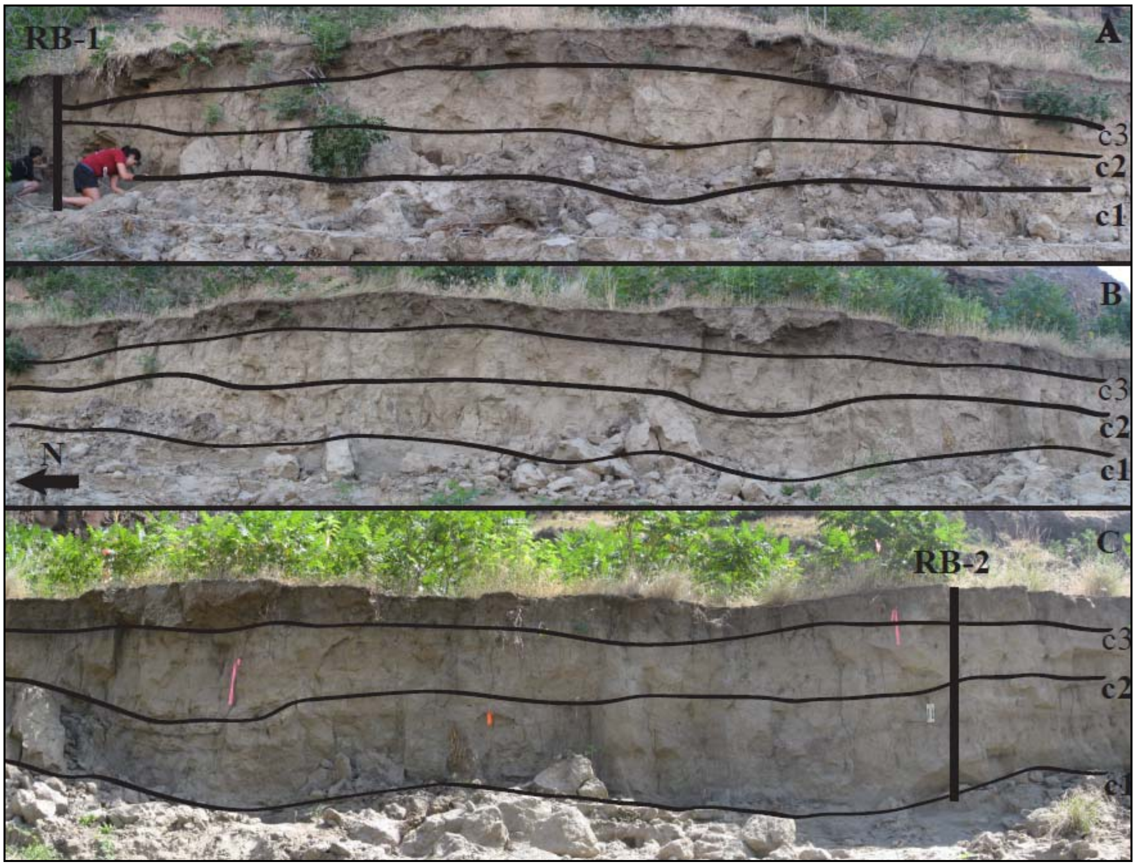

Figure 6. Photographs of the Snake River terrace cut bank. Highlighted profiles RB-1 (photo A) and RB-2 (photo C). The distance between RB-1 and RB-2 is 28 m (photo B). The black lines mark the approximate locations of three horizons containing cultural materials: c1, ~1500-1700 B.P.; c2, ~1000 B.P.; c3, ~600-700 B.P. Note: the photographs are not the same scale and overlap does occur between photos A/B and B/C.

An *in situ* charcoal fragment found under a fire cracked rock feature exposed at 30-65 cm depth, located 1 m south of RB-1, yielded the youngest age constraining deposits within the highest bench of the terrace, at 620-730 cal B.P. (Figs. 5 and 6).

RB-4 Inset

RB-4 is an inset profile, 45 m south of RB-3, which contains 46 units within a 485 cm profile (Figs. 3, 4 and 5). RB-4 contains a stratigraphic sequence that exhibits sedimentological characteristics similar to the northern profiles described at Redbird Beach. The stratigraphic section comprises fluvial overbank deposits of fine silt to medium sand. Silt colors are brown (Munsell 10 YR 4/2 to 6/3) and sands are more gray (Munsell 2.5 Y 5/2 to 6/3). Layer boundaries are sharp and irregular between units (Appendix A).

The earliest date obtained from RB-4, 795-930 cal B.P., was radiocarbon dated from a detrital charcoal fragment collected from unit 17 at 213 cm depth. A second date of 660-720 cal B.P. was obtained from an *in situ* charcoal fragment collected from an extensive cultural horizon, unit 10, at 145 cm depth. Farther up in the profile, 86 cm from the surface of the terrace, a historical glass bottle was recovered. This artifact provides a relative historical occupational age at Redbird Beach of A.D. 1860 (Fig. 7). The relative age of the bottle was determined based on the known timing of historical occupation at Redbird Beach and the design of the bottle (pers. comm. Kenneth Reid, 2010).

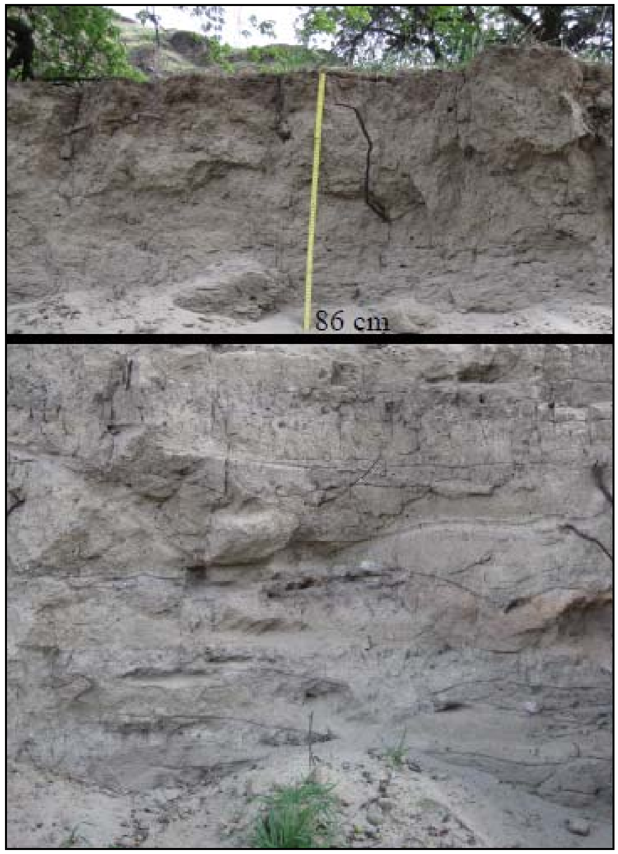

Figure 7. Photograph of the terrace cut bank adjacent to RB-4. Black line denotes the location where the historical artifact was exposed at 86 cm depth.

RB-5 Inset

RB-5 is the second inset profile identified at Redbird Beach, located 50 m south of RB-4. The stratigraphic section described at profile RB-5 contains 17 units and was described to 440 cm depth (Figs. 3, 4 and 5). The stratigraphy in RB-5 provides a third, younger stratigraphic sequence at Redbird Beach archaeological site. RB-5 is composed of fluvial overbank deposits of fine silt to coarse sand. The sediment color is largely grayish brown (Munsell 2.5 Y 4/2-6/2) and layer boundaries are generally sharp and irregular, as described in profiles RB-1, RB-2, RB-3 and RB-4 (Appendix A). In profile RB-5 coarser-grained sand deposits occurred more frequently and exhibited increased grading and sand-silt couplet deposition throughout the section, compared to profiles RB-1, RB-2, RB-3 and RB-4.

Two radiocarbon dates were obtained from RB-5 stratigraphy: from near the base of the profile a flood-transported detrital charcoal fragment was dated 740-910 cal B.P.; and the second date, 0-300 cal B.P., was obtained from an *in situ* charcoal fragment collected from within a cultural horizon containing both prehistoric and historic artifacts and features (Fig. 5). The sedimentary sequence of deposits in RB-5 is generally consistent with the silt to sand-size deposits observed in the other profiles at Redbird Beach, with the exception of a couplet-bearing horizon near the base of profile RB-5, containing multiple sets of sand (<1 cm) topped by silt (1-3 mm) from 440-308 cm.

RB-6 Inset

RB-6 is located 15 m south of RB-5. The stratigraphic section described at RB-6 contains 15 units and extends 480 cm depth (Figs. 3, 4 and 5). Profile RB-6 is the southernmost inset profile described from the Snake River terrace cut bank at Redbird Beach. RB-6 represents the fourth, youngest inset and exhibits different sedimentological characteristics from the other profiles recorded at Redbird Beach. Deposits are predominantly composed of fine to coarse sands with fewer substantial silt layers. Boundaries between deposits vary by grain size: contacts between sand and silts are sharp and irregular, and contacts between sands of coarse to fine grain size are gradational. The sediment is mainly grayish brown but the thicker sand deposits have a yellowish hue (Munsell 2.5 Y 5/2 to 6/3) (Appendix A). The section of the profile from 480-187 cm contains as many as 182 silt-sand couplets (Fig. 8). The additional 9 sedimentary layers from 187 cm to the terrace surface are composed of silt to coarse sand-size fluvial and

Figure 8. Photograph of silt-sand couplets in profile RB-6.

aeolian deposits. One radiocarbon date was obtained from RB-6; *in situ* charcoal fragments were collected from the edge of a fire-cracked rock near the base of the profile, with an age of 300-460 cal B.P.

Radiocarbon Dates

Radiocarbon dates were acquired through the analysis of ten charcoal and one freshwater bivalve shell (sp. *Margaritifera falcate*) samples. Table 1 (below) lists each sample number, type of material analyzed, ^{14}C age in years before present (B.P.), calibrated radiocarbon age, sampling location within the stratigraphy (Fig. 5), and context from which each sample was collected. These dated samples are also given in uncalibrated ages in the original lab reports in Appendix B.

Samples RB-7-21-10-R6 (charcoal) and RB-7-21-10-R7 (shell) have an age discrepancy that is likely attributed to the ambiguities in charcoal sampling, often associated with uncertainties regarding the origin of the wood source of that sample (as discussed in the Methods section). In contrast, according to Osterkamp et al.

Table 1: Radiocarbon dates, Redbird Beach

Sample No.	MATL	^{14}C age, yrs BP	Cal BP (2 Sigma)	Unit	Depth (cm)	MATL Context
RB1-7-21-10-R6	C	1663 ± 25	1520-1690	10	120	CA
RB1-7-21-10-R7	SH	3608 ± 26	1046	10	120	CA
RB3-8-18-10-R4	C	1677 ± 23	1530-1690	16	150	CA
RB3-8-18-10-R1	C	2136 ± 24	2010-2300	21	275	CT
RB4-8-19-10-R7	C	956 ± 26	795-930	17	213	CT
RB5-8-20-10-R1	C	147 ± 23	0-300	8	143	CA
RB5-8-20-10-R7	C	902 ± 23	740-910	17	390	CT
RB6-8-21-10-R4	C	313 ± 23	300-460	15	455	CH
RB1-2-16-11-R1	C	764 ± 22	670-730	6	65	CH
RB4-8-20-10-R10	C	741 ± 22	660-720	10	145	CA
RB4-8-19-10-R4	C	AD 1956-1957		41	411	Root?

Notes: C charcoal, SH shell, CA *in situ* charcoal in horizon containing cultural materials, CT flood transported charcoal, CH *in situ* charcoal in hearth.

(unpublished report), bivalve shells are durable, easily identified and stable. In the Snake River canyon bivalve shells are an abundant, datable resource commonly found in refuse piles and pit-house floors of archaeological sites. Therefore, a standardized calibration scheme for bivalve shells recovered from archaeological sites can increase the accuracy in establishing cultural chronologies (Osterkamp et al., unpublished report). In this study Osterkamp applied the calibration scheme used at other sites on the Snake River, to a charcoal and shell pair from Redbird Beach. Both the charcoal and shell ages are reported (Table 1, Appendix B) and recorded in the stratigraphy of profile RB-2 (Fig. 5), the corrected shell age, 1046 B.P., is most representative of the timing of human occupation of the site. Sample RB4-8-19-10-R4 was collected from profile RB-4 at 411 cm depth, the results from this sample came back modern creating an inversion in the profile chronology. The sample was reported (Table 1, Appendix B) and recorded in the stratigraphy of profile RB-4 (Fig. 5) but was not considered in the chronological analysis of the site because it conflicted with the abundant evidence indicating an older age for this stratigraphic layer.. The sample collected appeared to be detrital charcoal, but was probably an exposed root from a younger plant.

Cultural Features

Cultural features were identified and mapped by the CWU archaeological team along the exposed cut bank wall of the Snake River terrace. Prehistoric and historic cultural features identified in the cut bank (Fig.5) include: fire-cracked rock, fragments of chert, shell, shell/charcoal features (Fig. 9D), cobble core/tool, bone, and historical artifacts including a glass bottle and seed beads. A test excavation, called Feature 1 (Fig. 9E), was conducted north of inset profile RB-5. Feature 1 contained both prehistoric and historic artifacts. South of inset profile RB-5 historic cooking features and refuse were also observed. Ages derived from detrital charcoal fragments, shell and artifacts collected from horizons containing archaeological materials are (from earliest to most recent): 1500-1700 cal B.P., 700-900 cal B.P., 600-700 cal B.P., 300-460 cal B.P., 0-300 cal B.P. and A.D. 1860.

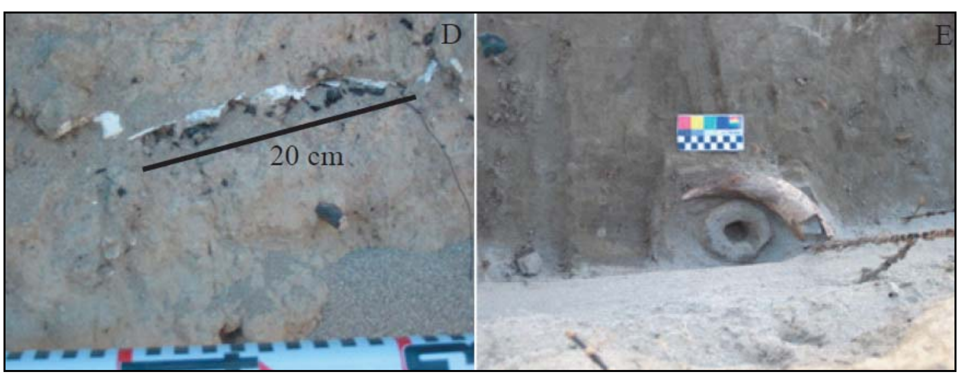

Figure 9. Photographs of cultural materials identified in the cut bank wall. D: a charcoal and shell feature exposed at 130 cm depth and located south of inset profile RB-4. E: test excavation, called Feature 1, located north of inset profile RB-5, centrally located in the photograph is a cow-size horn sheath surrounding a doughnut-formed cobble.

CHAPTER IV

DISCUSSION

Paleoflood Chronology

The stratigraphy and geomorphology gleaned from the Snake River terrace provide evidence for an active fluvial history. The stratigraphic record at Redbird Beach extends over a minimum of ~2300 B.P to post A.D. 1950. Flood deposition at Redbird Beach archaeological site appears to be heavily influenced by the geomorphology of the site, as observed by the number of inset profiles along the Snake River terrace.

While Snake River paleoflood deposits before 1530-1690 cal B.P. are present in profiles RB-1, RB-2 and RB-3, the deposits are thicker and composed of coarser-sand sediments than the fine sand and silt deposited after this date. The coarser sand sediments found in the lower depths of RB-1, RB-2 and RB-3 imply that higher velocity waters flowed across that portion of the site prior to ~1500 years B.P. The present beach, located between the Redbird Creek alluvial fan and the southern end of the Snake River terrace (Fig. 3), is a possible modern analogue for what the lower depths of RB-1, RB-2 and RB-3 may have looked like when these sands were being deposited in a higher velocity depositional environment. Slackwater flood deposits at Redbird Beach archaeological site began accumulating post-1530-1690 cal B.P. (Fig. 5), indicating deposition by lower velocity overbank flood waters. The present day geomorphic setting (Fig. 3) provides evidence for a possible explanation of the change in the nature of these fluvial deposits. The Snake River probably shifted laterally, creating a change in the local depositional environment in this part of the site. One possibility, although unconfirmed, would be that a large depositional event from Redbird Creek could have increased the size of the alluvial fan. This event could have caused the Snake River to migrate, and develop an eddy that would have enabled the subsequent change in the depositional environment and sedimentation patterns of the site. Further field research on the alluvial fan would be necessary to confirm or negate this scenario.

The descriptions from the cut-bank stratigraphy (Appendix A) and geomorphic interpretations made from LiDAR imagery (Fig. 3) indicate that the Snake River terrace has at least four progressively younger flood-bearing sections: the highest bench containing profiles RB-1, RB-2 and RB-3; inset RB4; inset RB-5; and inset RB-6. Each inset is hypothesized to be either the filling of a Snake River paleochannel or laterally accreted flood sediments that built onto the side of the higher bench at the northern end of the terrace. Slackwater sediments can be deposited and accumulate in a cut bank along the river's edge while still actively eroding during or after new flood deposition, thus even inset flood packages are not expected to contain complete or continuous records. Furthermore, agricultural work conducted during a period of historical occupation at Redbird Beach introduced modifications to the terrace surface that likely altered preexisting geomorphic features, such as evidence for paleochannels.

The slackwater sediments at Redbird Beach accreted vertically and thus the minimum threshold elevation that must be exceeded by the flood waters in order to leave a deposit is slightly higher for each successive flood event. Because the depth of the water above its associated deposit is unknown, the resulting stratigraphy does not necessarily indicate a successive increase in the flood magnitude, as any flood might have been centimeters or even meters above the top of the preexisting sediments. However, fewer floods would be large enough to exceed the threshold toward the latter part of the record than in the earlier stages when preexisting surface was lower. Deposits from floods that do not exceed the threshold of preservation would either be laterally accreted onto the edge as insets, or would not be preserved.

Based on the depositional nature of the flood deposits recorded at Redbird Beach, the oldest events as well as the largest, later flood events were recorded in RB-1, RB-2 and RB-3, at the northern end of the terrace, with each inset representing deposits from younger, lower-magnitude events that laterally accreted onto the terrace (Fig. 5). Evidence of flooding in June of 2010 was observed at the southern end of the site, overtopping the lowest elevations along the terrace, though this flood does not appear to have reached the profiles in this study, it is possible that other recent, large floods were recorded at the site.

In profiles RB-1, RB-2 and RB-3, as many as 19 floods were recorded between 1530-1690 cal B.P. and 620-730 cal B.P. During the past 620-730 cal B.P. evidence for only three flood events reached the highest bench marks of the two most northern profiles (Fig. 5). The stratigraphy recorded in profiles RB-1, RB-2 and RB-3 is generally correlative but not all discrete flood events appear in each of the profiles. The absence of flood deposits may be attributed to varied flood magnitude or destruction of parts of the stratigraphy from increased cultural activity, bioturbation or other processes. In profile RB-4 as many as 30 individual flood events were distinguished: at least 6 events were recorded between 660-720 cal B.P. and 795-930 cal B.P., and an additional 6 flood events have been recorded since early historical occupation of the site in ~A.D. 1860. In RB-5, approximately 11 distinct flood events appear to have been recorded over 740-910 cal years B.P. Profile RB-6 is composed of ~200 silt-sand couplets, with each silt layer representing an overbank inundation event since 300-460 cal B.P. The profile location, number of flood deposits and age of this section would suggest that this set of flood packages most likely represents annual flood events that were just large enough to overtop the beach. The flood chronologies recorded in profiles RB-4, RB-5 and RB-6 provide evidence to show that the frequency of flooding increases as the elevation decreases along the southern edge of the terrace. While the frequency of flood events recorded along the southern edge of the terrace increased, the magnitudes of these events were probably lower, as the elevation of the lower depths of the southern profiles is ~1-2 m lower than that of the higher bench along the northern extent of the terrace. Now the active beach lies between the southern reaches of the Snake River terrace and the Redbird Creek alluvial fan, where fluvial sediments are actively re-shaping the edge of the alluvial fan and new flood deposits are beginning to accumulate at lower, more southerly points along the terrace and site.

Cultural Chronology

Dates collected from *in situ* charcoal fragments, shell and relative dates from artifacts indicate that at least five periods of prehistoric and historic occupation occurred at Redbird Beach: 1500-1700 cal years B.P., 700-900 cal years B.P., 300-460 cal B.P., 0-300 cal years B.P. and A.D. 1860. The earliest evidence of occupation was dated to ~1500-1700 years B.P. from *in situ* charcoal fragments found adjacent to archaeological materials on the boundary between the coarse and fine grain flood deposits along the northern edge of the terrace. It is not likely a coincidence that among the oldest flood deposits identified was the presence of the earliest human occupation of the site. This relationship suggests that an early geomorphic setting at Redbird Beach, more conducive to either habitation or preservation of cultural materials, or both, was situated at the northern end of the site at that time. The cultural materials associated with human occupation of the site are found interbedded in flood deposits along the cut bank, and like the flood deposits, these dated cultural horizons also become progressively younger down terrace. The distribution and density of archaeological materials throughout the cut bank indicate that occupation occurred at multiple points along the terrace, but further excavations into the terrace are necessary to develop a better understanding of the extent and spatial distribution of occupation at the site during different time periods. Evidence of historical occupation at Redbird Beach, 0-300 cal B.P. and A.D. 1860, are seen at shallow subsurface depths along the cut bank and on the terrace surface extending from the canyon wall to the river's edge. In future archaeological studies at Redbird Beach a combination of the data and results found in Kvamme's geophysical investigation (2009) and the stratigraphic and geomorphic analysis conducted in this study could be used to select areas within the terrace to conduct more informed excavations of the site.

Implications of Flooding on Human Occupation and Preservation of Archaeological Materials

The sedimentary deposits at Redbird Beach appear to have affected the preservation of the archaeological materials at the site in several ways. Cultural materials and features were observed in the terrace cut bank, lying between fine-grained fluvial sediments. Occupational evidence between flood deposits provides evidence for subaerial exposure at stratigraphic boundaries. If spatial occupational patterns at Redbird Beach were impacted, it would appear as though the geomorphology of the site would have played a more significant role than flooding. The geomorphic features observed in the cut bank stratigraphy, such as swales in the topography between profiles RB-1 and RB-2, contained fewer artifact-bearing areas, compared to the flatter and slightly higher regions around profiles RB-3, RB-4 and RB-5 which contained a much higher density of archaeological materials and features.

The cultural horizons tend to be concentrated between the fine-grain slackwater flood sediments. These fine-grained sediments protect and preserve the interbedded archaeological materials through rapid burial during individual flood events in an area of low-velocity inundation and passive deposition. The flood deposits serve to separate the cultural periods in the stratigraphic record. Burial of the cultural materials by several centimeters of sediment in a single flood episode also protects them from bioturbation and disturbance by late human activities. It appears that the occasional floods did not prevent humans from reoccupying the same portions of the site afterward.

In contrast, today the geomorphology and sedimentology of the flood deposits also appear to be a primary factor contributing to the active erosion observed along the cut bank of the terrace. The less consolidated, coarse sands in the lower portions of the profiles along the Snake River terrace, particularly RB-1, RB-2 and RB-3, are topped by well-consolidated silts and fine sands. However, undercutting and/or seepage of the permeable underlying sands is now causing large blocks of the overlying, artifact-bearing sediments to slump and erode, contributing to the ongoing loss of cultural materials and the occupational history of Redbird Beach. Cultural materials that were formerly located within the flood-deposit stratigraphy now litter the sloping beach at the base of the cut bank. Observations of the cut bank position between October, 2009 and February, 2011 revealed evidence of newly slumped material on multiple occasions, particularly over the course of the winter seasons. Additional evidence for erosion of the cut bank at Redbird Beach is marked by a stone wall that was built across the northern property boundary. The wall runs from the talus slope of the canyon wall, across the terrace, and along the beach. The rocks that made up the wall along the beach are now scattered, and the length of fence erosion from the cut bank to the river marks a minimum of 10 m of historic erosion of the site (Root and Ferguson, 1999).

Regional Comparison

Many large floods that have affected regions of the Snake River have also been observed throughout the Pacific Northwest (Table 2). Gauging stations along the Snake River near Asotin and Anatone, Washington, downstream of Redbird Beach, have recorded large floods that have also been recorded upstream in the Hells Canyon reach of the Snake River, near Rhodes' (2000) study sites. The paleoflood study conducted at Tin Shed and China Rapids by Rhodes (2000) is the only other Late-Holocene record in the region with which to compare the record from Redbird Beach. The Snake River terrace at Redbird Beach provides a paleoflood record for a time period not recorded in the paleoflood record at Tin Shed and China rapids, 90 km upstream (Rhodes, 2000; Fig. 1). Two major periods of paleofloods were recorded at Rhodes' (2000) sites: ~5130-1960 B.P. and ~320 B.P. to post-A.D. 1950. The Redbird Beach paleoflood chronology, extending from ~2300 B.P. to post A.D. 1950 provides a record that overlaps the late period of flooding recorded at Tin Shed and China Rapids sites. The frequency of the largest flood events at Redbird Beach, recorded at the northern end of the site in profiles RB-1, RB-2 and RB-3, is ~1flood/100 years. The frequency of flooding at Rhodes' study sites over a 3700 year period is <1flood/100 years, however, extreme flooding is ~1flood/100 years, similar to the rate observed over a 1500 year period at Redbird Beach. Floods recorded at lower elevations along the southern end of the terrace at Redbird Beach occur more frequently, ~2 floods/100 years. The frequency of flooding and their Late-Holocene paleoflood records most likely reflect the differing hydraulic conditions at each of these sites. Major historical flood events that have likely contributed to the flood terraces of Redbird Beach, Tin Shed and China Rapids study sites include events that were recorded at gauging stations during the following years: June 1894, Winter 1955-1956, and Winter 1974 (Table 2).

Table 2: Major Floods in the Pacific Northwest

Date	**Areas Affected**	**Recurrence Interval** (yrs)ţ
Feb. 1996*	Pacific Northwest	
May and June 1984*	Eastern and central Idaho	50 to >100
April 1978	Eastern Oregon	<50
June 1976	Eastern Idaho	unknown
June 1974	Main-stem Columbia River, Snake River at Asotin, Washington and Salmon River at Riggins, Idaho	30, >100
Jan. 1974*	Eastern Oregon and Idaho (statewide)	25 to >100
March 1972	Eastern, OR	25
Dec. 1965-Jan. 1966	Pacific Northwest	
Dec.1964-Jan. 1965*	Pacific Northwest	30 to 100
May 1957	Snake River at Asotin, Washington	
Dec. 1955-Jan. 1956	Columbia River, Snake River and Salmon River	10 to 50
May-June 1948	Main-stem Columbia River, Northern and western Idaho	30, 20 to 50
April 1904	Snake River at Asotin, Washington	
June 1894#	Columbia River Basin and Idaho (statewide)	100, unknown
Dec. 1861-Jan. 1862	Pacific Northwest	100

Note: Table reconstructed from tables from Thomas, Broom and Cummans (1963); Paulson et al. (1991); Williams, J.R. (1992); Rhodes (2000)
*Caused by rain on snow event
#Largest flood event observed on the Columbia River
ţ Recurrence interval in years = 1/probability of occurrence in any given year

Regional cultural chronologies indicate that the Columbia and Eastern Plateaus were inhabited prior to 10,000 years B.P. Pit-house sites and/or semi-sedentary winter villages in the Lower Snake River and Hells Canyon region appear ~2500 years B.P. (Hammatt, 1977; Roll & Hackenberger, 1998; Prentiss et al., 2005). Evidence of occupation at the Redbird Beach archaeological site appears later than regional cultural chronologies, with the first appearance of any cultural evidence at Redbird Beach ~1530-1690 B.P. A confirmed explanation for the later date of the earliest evidence of human presence at Redbird Beach would require additional site research. However, the lack of evidence could be attributed to the geomorphic setting of the site, which might not have been habitable prior to ~1500-1700 years B.P. It is also possible that the site was habitable but that evidence of human occupation at the site was not preserved or that the evidence remains buried in unexcavated portions of the terrace.

CHAPTER V

CONCLUSIONS

The geomorphology of the Redbird Beach archaeological site has strongly influenced the depositional environment and preservation of the site. Two major sedimentation patterns were observed in the oldest portion of the Snake River flood terrace at the northern end of the site (RB-1, RB-2 and RB-3). Fluvial sediments deposited prior to ~1500-1700 years B.P. are composed primarily of coarse grain sands, which accumulated in a depositional environment under moderate flow velocity. After 1500-1700 years B.P., fine-grained fluvial sediments were deposited by low-velocity backwater flooding of the Snake River. The boundary between the coarse sands and overlying silts and fine sands marks a significant depositional change at Redbird Beach. This change probably indicates an alteration of the Snake River channel that resulted in a lower flood velocity reaching the northern end of the site, such as a slight lateral shift of the channel. The three successively younger insets toward the south each tend to record an increasing number of lower magnitude floods. In profiles RB-1, RB-2 and RB-3, ~20 floods were recorded from ~2300-600 years B.P., but only three floods were recorded in the past 600 years. The flood deposits observed in the inset profiles RB-4 and RB-5 began accumulating prior to ~700-900 years B.P. and those in RB-6 began accumulating prior to 300-460 years B.P.

Results from stratigraphic and geochronological analysis of the flood deposits and cultural materials suggest that humans reoccupied the same portions of the site between flood inundations from the Snake River. The occupation did not appear to be directly influenced by Snake River floods, but by geomorphological changes at Redbird Beach archaeological site. At least five periods of prehistoric and historical occupation were recorded at Redbird Beach: 1500-1700 cal years B.P., 700-900 cal years B.P., 300-460 cal B.P., 0-300 cal years B.P. and A.D. 1860. The archaeological materials exposed in the cut bank at Redbird Beach are preserved within the fine-grained slackwater deposits. As the coarser-grained sandy sediments that make up the lower depths of the Snake River terrace are undercut and eroded away, the overlying, artifact-bearing fine-grained deposits slump to the base of the bank and eventually erode, contributing to the loss of cultural materials and the occupational history or Redbird Beach. Thus the stratigraphic configuration that preserved and separated the cultural materials through rapid burial by flood sediments is now one of the major factors in the ongoing erosion of the site.

Future geologic and archaeological investigations at Redbird Beach would benefit from a thorough investigation of the Redbird Creek alluvial fan to determine the age and frequency of events on the fan and how they relate to the geomorphology of the associated Snake River terrace at Redbird Beach. The northern (downstream) end of the site shows the greatest potential for preservation of older and higher slackwater flood deposits inland from the cut bank and could be the most promising location for future archaeological investigations of the oldest cultural materials. The middle and southern (upstream) portions of the site would be most likely to preserve materials from the early contact and historical cultural periods.

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APPENDIXES

Appendix A

Stratigraphic Profile Descriptions

Table A1: Description of stratigraphic profile RB-1, located at the northern end of Snake River terrace.

Unit (flood)[f]	Depth (cm)	Description
1[f]	0-7	Color: 10 YR 3/2 very dark grayish brown. Texture: very fine sand to coarse silt. Unit is root bioturbated, lower contact is sharp, wavy. Top 1 cm is duff covered.
2[f]	7-13	Color: 10 YR 4/2 dark grayish brown. Texture: coarse silt. Unit contains thin root bioturbation, and a basal silt <1 mm thick.
3[f]	13-35	Color: 10 YR 5/2 grayish brown. Texture: silt. The unit is massive, bioturbated.
4[f] C3	35-50	Cultural horizon. Color: 10 YR 5/3 brown. Texture: silt. The unit is massive, bioturbated. Unit fines upward. Contacts are irregular and sharp. Unit contains fire cracked rock (fcr) and cultural materials that extend laterally. Radiocarbon dated: 620-730 cal B.P.
5[f]	50-56	Color: 10 YR 6/3 pale brown. Texture: sandy silt. Unit is bioturbated and contains (~1cm diameter) pockets of finer silts. Rocks from a possible hearth sit at the unit 4 (above) and 5 (upper boundary of this unit) contact.
6[f]	56-68	Color: 10YR 5/3 brown. Texture: silt. The unit is massive with minimal evidence of bioturbation. Unit fines upward and contains (<1cm diameter) pockets of finer grain silt.
7[f]	68-73	Color: 10 YR 6/2 light brownish gray. Texture: silt. The unit is bioturbated, silt dominated and contains some lenses of sand.
8[f]	73-83	Color: 10 YR 5/3 brown. Texture: silty clay loam. Color: 10 YR 6/3 pale brown. Texture: silt. Silt unit contains three silty clay loam interbeds. Interbeds contain some charcoal staining and laterally correlate to culturally impacted layers.
9[f]	83-91	Color: 10 YR 5/3 brown. Texture: silt. Unit contains small charcoal fragments. North of the profile, within the same layer, is a 30 cm (diameter) lens of *in situ* charcoal and lithic fragments, likely associated with cultural occupation.
10[f] C2	91-96	Cultural horizon. Color: 10 YR 6/3 pale brown. Texture: sandy silt. Massive, contains charcoal staining and ~1 mm charcoal fragments, probably cultural/occupational related deposition. Radiocarbon dated: 1520-1690 cal B.P. (charcoal); conventional date 2560±30 B.P. and 1046 B.P. (shell).
11[f]	96-99	Color: 10 YR 6/2 light brownish gray. Texture: sandy silt. Unit is massive with charcoal staining and charcoal fragments.
12[f]	99-104	Color: 10 YR 5/3 brown. Texture: sandy silt. Unit is densely packed, upper and lower contact boundaries are sharp and wavy.
13[f]	104-109	Color: 10 YR 5/3 brown. Texture: sandy silt. Sand and silt lenses interfinger within unit.
14[f]	109-119	Color: 10 YR 5/3 brown. Texture: silty clay. Unit is massive, minimal evidence of bioturbation, contains few detrital charcoal fragments. Bivalve shells are present in a correlative layer, to the south of the profile.

Table A1 Continued

Unit (flood)[f]	**Depth** **(cm)**	**Description**
15 [f]	119-125	Color: 10 YR 6/3 pale brown. Texture: sandy silt. Unit is massive, upper and lower contacts are sharp and irregular.
16 [f]	125-131	Color: 10 YR 6/2 light brownish gray. Texture: silty clay. Upper and lower contacts are sharp and irregular. Unit contains detrital charcoal fragments and may be the top of a single flood event, underlying silt unit appears to grade into this silty clay layer.
17	131-135	Color: 10 YR 5/3 brown. Texture: silt. Unit is massive, upper and lower contacts are sharp and irregular, and contain detrital charcoal fragments.
18 [f]	135-139	Color: 10 YR 5/3 brown. Texture: silty clay. Upper and lower contacts are sharp and irregular. Unit fines upward.
19 [f]	139-141	Color: 10 YR 5/3 brown. Texture: silty clay. Upper and lower contacts are sharp and irregular. Unit fines upward.
20 [f]	141-144	Color: 10 YR 5/3 brown. Texture: silt. Upper and lower contacts are sharp and irregular. Unit fines upward.
21 [f]	144-148	Color: 10 YR 5/3 brown. Texture: sandy silt. Upper and lower contacts are sharp and irregular. Unit fines upward and may be the lower portion of a single flood event.
22 [f]	148-154	Color: 10 YR 5/3 brown. Texture: sandy silt. Unit is massive, contains (~1mm-1cm diameter) silty clay nodules and upper and lower contacts are gradational and irregular. Evidence of root oxidation present.
23 [f] C1	154-162	Cultural horizon. Color: 10 YR 5/3 brown. Texture: silty clay. Unit is massive, upper and lower contacts are gradational and irregular. Presence of reddish brown streaks (seen in the overlying unit) may be from root oxidation. Lower boundary is sharp and is a major marker between lower coarse and upper fine-grained deposits observed in profiles RB-1, RB-2 and RB-3 (marked by thick dark line at boundary). Radiocarbon dated: 1530-1690 cal B.P.
24	162-256	Color: 10 YR 5/2 grayish brown. Texture: fine sand (represents depth ~162-212 cm). Color: 10 YR 5/3 brown. Texture: medium sand (represents depth ~212-256 cm). Unit is massive, contains some fine laminations approx. mid-section. Upper boundary is sharp and is a major marker between lower coarse and upper fine deposits observed in profiles RB-1, RB-2 and RB-3.
25 [f]	256-259	Color: 10 YR 5/3 brown. Texture: very fine sand to coarse silt. Massive, bioturbated, contains white (~1mm-1cm diameter) silty nodules. Upper contact is sharp and irregular. Lower contact is gradational and irregular.
26	259-262	Color: 10 YR 6/2 light brownish gray. Texture: very fine sand to coarse silt. Very similar to the overlying unit, contacts are gradational and irregular. Unit also contains root oxidation.
27 [f]	262-287	Color: 10 YR 5/3 brown. Texture: very fine sand to coarse silt. Massive, contains white (~1mm-1cm diameter) silty nodules and (1cm diameter) pockets of sand. Upper and lower contacts are sharp and irregular.
28 [f]	287-293	Color: 10 YR 6/3 pale brown. Texture: very fine sand. Unit is massive, contact at the upper boundary is sharp and irregular and the lower contact is sharp and wavy.
29	293-302	Color: 2.5 Y 5/3 light olive brown. Texture: medium sand. Coarse sand at the base gradually fines upward. Upper and lower contacts are both sharp and wavy.
30 [f]	302-319	Color: 10 YR 5/2 grayish brown. Texture: medium-fine sand. Unit gradually fines upward. Upper and lower unit contacts are sharp and wavy. Color was more difficult to identify due to two contrasting sediment grain compositions.

Table A1 Continued

Unit (flood)[f]	Depth (cm)	Description
31	319-358	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. Unit is massive from ~319-335 cm, underlying are three ~8 cm thick couplets that contain ~5 cm of fine sand over ~3 cm coarse sand.
32 [f]	358-365	Color: 10 YR 5/3 brown. Texture: very fine sand to coarse silt. Unit is massive, upper and lower contacts are sharp and irregular.
33	365-404	Color: 10 YR 4/3 brown. Texture: fine-very fine sand. Unit contains 8 coarsening upward couplets. Upper and lower contacts are sharp and wavy. At the base of the couplets is a massive coarse sand layer.
34	404-425	Color: 10 YR 5/2 grayish brown. Texture: medium silt. Unit is massive, and contains small (<1 mm) detrital charcoal fragments.

Table A2: Description of stratigraphic profile RB-2, located 28 m south of RB-1.

Unit (flood)[f]	Depth (cm)	Description
1 [f]	0-7	Color: 10 YR 4/2 dark grayish brown. Texture: fine-medium silt. Unit is bioturbated, lower contact is sharp. Top 1 cm is duff covered.
2 [f]	7-20	Color: 10 YR 4/3 brown. Texture: fine silt. Unit is massive, densely compacted and the upper and lower contacts of the unit are sharp and irregular. Unit also contains lithic fragments.
3 C3	20-28	Cultural horizon. Color: 10 YR 4/2 dark grayish brown. Texture: fine silt. Unit is massive, the upper and lower contacts are distinct (not sharp) and irregular. Radiocarbon dated: 620-730 cal B.P.
4 [f]	28-35	Color: 10 YR 5/2 grayish brown. Texture: very fine silt. Unit is massive, upper and lower contacts are visible and irregular.
5 [f]	35-43	Color: 10 YR 5/2 grayish brown. Texture: medium silt. The upper contact of the unit is visible and irregular but the lower contact is sharp. This unit also contains three coarsening upward couplets, appearing to represent three flood events.
6 [f]	43-52	Color: 10 YR 5/3 brown. Texture: coarse silt. The unit is massive and the upper contact is sharp and the lower contact is visible and irregular.
7 [f]	52-74	Color: 10 YR 5/2 grayish brown. Texture: course silt to very fine sand. Unit is massive and bioturbated. The upper contact of the unit is visible and irregular and the lower contact is sharp.
8 [f]	74-86	Color: 10 YR 6/2 light brownish gray. Texture: very fine silt. The unit contains alternating silts, the darker colored silt of the two is less compact. Upper and lower contacts are sharp.
9 [f]	86-95	Color: 2.5 Y 5/2 grayish brown. Texture: very fine sand. Unit is massive and the upper and lower contacts are sharp.
10 [f]	95-105	Color: 10 YR light brownish gray. Texture: fine-very fine silt. Unit is massive with a thin, dark silty layer in the upper section of the unit. Both upper and lower contacts are sharp.
11 [f]	105-113	Color: 10 YR 6/3 pale brown. Texture: coarse silt to very fine sand. Unit is massive, the upper contact is sharp and the lower, sharp and irregular.
12 C2	113-120	Cultural horizon. Color: 10 YR 5/3 brown. Texture: coarse silt to very fine sand. The unit is massive, bioturbated and charcoal stained. Unit contains small pockets of silt. The upper contact is sharp and the lower is visible but more irregular. Radiocarbon dated: 1520-1690 cal B.P. (charcoal); conventional date 2560±30 B.P. and 1046 B.P. (shell).

Table A2 Continued

Unit (flood)[f]	**Depth (cm)**	**Description**
13 [f]	120-125	Color: 10 YR 5/3 brown. Texture: very fine silt to clay. Unit is massive with fragments of detrital charcoal. Upper and lower contacts are visible and irregular.
14 [f]	125-129	Color: 10 YR 4/3 brown. Texture: medium to coarse silt. Unit is massive with sharp and irregular upper and lower contacts.
15 [f]	129-138	Color: 10 YR 5/3 brown. Texture: fine-medium silt. The unit is bioturbated and contains light colored silt nodules (~1mm in diameter). Upper and lower contacts are sharp and irregular.
16 [f]	138-151	Color: 10 YR 5/2 grayish brown. Texture: fine silt. Unit is massive and bioturbated with some red colored staining. The upper and lower contacts are sharp and irregular.
17 [f]	151-157	Color: 10 YR 4/2 dark grayish brown. Texture: medium-coarse silt. The unit is massive, bioturbated and contains detrital charcoal fragments (<1mm in diameter). The contacts on the upper and lower boundaries of the unit are visible and irregular.
18 [f]	157-162	Color: 10 YR 5/2 grayish brown. Texture: coarse silt to very fine sand. The unit is massive with some evidence of root bioturbation and contains charcoal fragments. Upper and lower contacts are irregular but the lower is more visible.
19 [f]	162-168	Color: 10 YR 5/3 brown. Texture: medium-coarse silt. Unit contains very small (<1mm in diameter) fragments of detrital charcoal. The upper and lower contacts are visible and irregular. Unit coarsens upward.
20 [f] C1	168-175	Cultural horizon. Color: 10 YR 5/2 grayish brown. Texture: medium silt. Unit is massive, contains lithic and charcoal fragments at the lower contact of the unit. The upper and lower contacts are sharp. Lower boundary is a major marker between lower coarse and upper fine-grained deposits observed in profiles RB-1, RB-2 and RB-3 (marked by thick dark line at boundary).Radiocarbon dated: 1530-1690 cal B.P.
21	175-190	Color: 10 YR 5/2 grayish brown. Texture: medium sand. This unit is massive and a major marker bed for the northern terrace stratigraphy. Upper boundary is sharp and is a major marker between lower coarse and upper fine deposits observed in profiles RB-1, RB-2 and RB-3.Unit contains cultural materials at the upper boundary.
22 [f]	190-286	Base of unit contains ~4 cm of silt that grades upward into medium to coarse sand.
23 [f]	286-323	~4 cm of silt that grades upward into medium-coarse sand.
24 [f]	323-360	~4 cm of silt that grades upward into medium-coarse sand.

Table A3: Description of stratigraphic profile RB-3, located 15 m south of profile 2.

Unit (flood)[f]	**Depth (cm)**	**Description**
1 [f]	0-4	Color: 10 YR 4/2 dark grayish brown. Texture: fine silt. This is the top of the profile, it is covered with grasses and other vegetation and is root bioturbated. The lower contact of the unit is sharp.
2 [f]	4-13	Color: 10 YR dark grayish brown. Texture: medium silt. The unit is massive and densely packed. Root bioturbation extending from the overlying unit is evident. Both upper and lower contacts are sharp and irregular.

Table A3 Continued

Unit (flood)[f]	**Depth (cm)**	**Description**
3 [f]	13-32	Color: 10 YR 5/2 grayish brown. Texture: fine-very fine sand. Unit is massive and bioturbated (high density of insect burrows on the surface of this unit). The upper and lower contacts are sharp.
4	32-34	Color: 10 YR 5/2 grayish brown. Texture: fine-very fine sand. Unit is massive and densely packed but discontinuous laterally, this may be a culturally impacted unit. The upper and lower contacts of the layer are sharp, irregular and discontinuous.
5 [f]	34-39	Color: 10 YR 5/2 grayish brown. Texture: very fine sand. Unit contains a thin light colored band of silt. The upper and lower contacts of the unit are sharp.
6 [f]	39-41	Color: 10 YR 4/2 dark grayish brown. Texture: medium-coarse silt. Unit is thin and massive, also contains detrital charcoal fragments. Both contacts are sharp.
7 [f]	41-43	Color: 10 YR 5/2 grayish brown. Texture: medium silt. The upper and lower contacts are sharp.
8 [f]	43-49	Color: 10 YR 4/1 dark gray. Texture: fine-medium silt. Unit is massive and bioturbated, with charcoal staining. The upper and lower contacts are sharp and irregular.
9 [f]	49-50	Color: 10 YR 4/2 dark grayish brown. Texture: coarse silt. Upper and lower contacts are sharp but laterally the unit is discontinuous.
10 [f]	50-87	Color: 10 YR 4/1 dark gray. Texture: fine-medium silt. Unit is massive and contains cultural materials (found lateral to the profile). Sediment also contains light colored silt nodules (~1mm in diameter). The upper and lower contacts are sharp and highly irregular.
11	87-90	Color: 10 YR 5/2 grayish brown. Texture: medium silt. The upper and lower contacts are sharp and highly irregular.
12	90-105	Color: 10 YR 5/2 grayish brown. Texture: medium-coarse silt. Unit is massive and heavily bioturbated. This unit may be mixed with two of the underlying units, as they exhibit similar color, texture and evidence of burrowing that would have caused mixing of the three units. The upper and lower contacts are highly irregular.
13 [f]	105-110	Color: 10 YR 6/2 light brownish gray. Texture: fine silt. Contacts are both faint and irregular.
14 C2	110-118	Cultural horizon. Color: 10 YR 5/2 grayish brown. Texture: coarse silt to very fine sand. Unit is massive and heavily bioturbated. This unit appears to be mixed with the two overlying units, as they exhibit similar color and texture. Evidence of burrowing is also present. Upper and lower contacts are highly irregular. Radiocarbon dated: 1520-1690 cal B.P. (charcoal); conventional date 2560±30 B.P. and corrected 1046 B.P. (shell).
15	118-122	Color: 10 YR 5/2 grayish brown. Texture: medium silt. Unit is massive, densely packed and discontinuous laterally along the cut bank. The contacts are faint and irregular.
16 C1	122-152	Cultural horizon. Color: 10 YR 5/2 grayish brown. Texture: fine silt. Unit is massive and densely packed. To the north and south of the profile the unit contains cultural materials (fcr, bivalves, detrital charcoal and bone fragments). Upper and lower contacts are visible and somewhat irregular (cultural impact?). Lower boundary is sharp and is a major marker between lower coarse and upper fine-grained deposits observed in profiles RB-1, RB-2 and RB-3 (marked by thick dark line at boundary).Radiocarbon dated: 1530-1690 cal B.P.

Table A3 Continued

Unit (flood)[f]	**Depth (cm)**	**Description**
17	152-247	Color: 2.5 Y 5/2 grayish brown. Texture: medium-coarse sand. The composition of this layer appears to be from two distinct sources and is difficult to Munsell color to. The unit is massive and generally coarsens upward. Upper boundary is sharp and is a major marker between lower coarse and upper fine deposits observed in profiles RB-1, RB-2 and RB-3.
18 [f]	247-261	Color: 2.5 Y 5/2 grayish brown. Texture: fine-medium sand. Unit is massive and fines upward. Upper and lower contacts of the unit are sharp and irregular.
19	261-267	Color: 2.5 Y 4/2 dark grayish brown. Texture: medium-coarse sand. The unit is massive and the upper and lower contacts are sharp and irregular.
20	267-272	Color: 2.5 Y 5/2 grayish brown. Texture: medium-coarse sand. The unit is massive and contains a high density of (~1mm in diameter) shell fragments. Both the upper and lower contacts of the unit are sharp and irregular.
21	272-287	Color: 2.5 Y 5/2 grayish brown. Texture: medium sand. The unit is generally massive but does gradually coarsen upward. The upper and lower contacts are sharp and irregular and the upper section of the layer contains detrital charcoal fragments.
22	287-295	Color: 2.5 Y 5/3 light olive brown. Texture: fine sand. Unit is massive with scattered, finer grain, light colored nodules and possible charcoal staining. Upper and lower contacts are sharp and irregular.
23	295-318	Color: 2.5 Y 5/2 grayish brown. Texture: medium sand. The unit is massive, the upper contact of the layer is sharp and irregular and the lower boundary is visible (not sharp) and also irregular.
24	318-335	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. This unit is massive with a visible upper boundary and sharp lower contact but both are irregular.
25 [f]	335-347	Color: 2.5 Y 5/2 grayish brown. Texture: very fine-fine sand. This unit is massive, containing laterally extensive nodules (or possible root casts?) and detrital charcoal fragments. Layer contacts are sharp and irregular.
26	347-352	Color: 2.5 Y 5/3 light olive brown. Texture: very fine sand. Unit is massive with sharp and irregular upper and lower layer boundaries.
27 [f]	352-355	Color: 2.5 Y 6/2 light brownish gray. Texture: coarse silt to very fine sand. Unit is massive with a clay-like textural feel. Upper and lower contacts are sharp and irregular.
28	355-366	Color: 2.5 Y 5/2 grayish brown. Texture: fine-medium sand. This layer is massive. The upper boundary of the unit is sharp and irregular and the lower contact is sharp but discontinuous and irregular.
29 [f]	366-367	Color: 10 YR 6/3 pale brown. Texture: medium-coarse silt. Unit is thin and massive with sharp, irregular and discontinuous upper and lower contacts.
30	367-396	Color: 2.5 Y 4/1 dark gray. Texture: coarse sand. This sand unit is massive but contains thin discontinuous clay lenses towards the top of the unit. Upper contact is sharp and irregular and the lower boundary is less sharp but visible and wavy.
31	396-460	Color: 2.5 Y 4/2 dark grayish brown. Texture: medium-coarse sand. The unit is massive, containing pockets of coarser grain sediment. The upper contact is sharp and irregular, the lower boundary of the unit was not reached.

Table A4: Description of stratigraphic profile RB-4, located ~45 m south of RB-3.

Unit (flood)[f]	**Depth (cm)**	**Description**
1[f]	0-8	Color: 10 YR 4/2 dark grayish brown. Texture: medium-fine silt. This is the top of the profile, it is covered with grasses and other vegetation and is root bioturbated. The lower contact of the unit is sharp.
2[f]	8-15	Color: 10 YR 4/2 dark grayish brown. Texture: medium silt. The unit is massive and bioturbation appears to be largely caused by root growth from the overlying unit. The upper and lower contacts of the unit are sharp and irregular.
3[f]	15-34	Color: 2.5 Y 5/2 grayish brown. Texture: very fine sand. The unit is massive and bioturbated. The upper and lower contacts of the unit are sharp and irregular.
4[f]	34-55	Color: 10 YR 5/3 brown. Texture: very fine sand to coarse silt. The unit is massive and bioturbated, the upper contact is faint and irregular. The lower boundary of the unit is sharp and irregular.
5[f]	55-66	Color: 2.5 Y 5/2 grayish brown. Texture: medium sand. The unit is massive, bioturbated, and more poorly sorted than other units previously observed in profile. The upper boundary is sharp and wavy and the lower contact of the unit is sharp and irregular.
6[f]	66-86	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. The upper 8 cm of the unit are massive and bioturbated, from 74-86 cm depth the sediment is cross-bedded. The upper contact is sharp and wavy and the lower is sharp and irregular. Relative date: A.D. 1860, determined from a wine bottle.
7[f]	86-89	Color: 10 YR 5/2 grayish brown. Texture: very fine sand. Unit is massive, densely packed and oxidized (by roots?). Upper and lower contacts of unit are sharp and irregular.
8	89-99	Color: 10 YR 4/2 dark grayish brown. Texture: coarse silt. The unit is bioturbated and composed largely of silt, and contains thin interbeds of coarser grained sediments. Charcoal fragments are present. The upper and lower contacts of the unit are sharp and irregular.
9	99-131	Color: 10 YR 5/3 brown. Texture: medium silt. The unit is heavily bioturbated with roots of varied sizes. *In situ* charcoal fragments, and fcr are noted within unit. The upper and lower contacts of the unit are faint and irregular.
10	131-168	Color: 10 YR 5/2 grayish brown. Texture: coarse silt. The unit is massive and heavily bioturbated. Impacts of cultural occupation are evident by dense concentrations of detrital charcoal, shell, bone fragments and fcr. The upper and lower contacts of the unit are sharp and irregular. Radiocarbon dated: 660-720 cal B.P.
11[f]	168-175	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand. The unit is largely massive but contains small (~1 cm in diameter) lenses of silt and detrital charcoal fragments. The upper and lower contacts of the unit are visible and irregular.
12	175-182	Color: 10 YR 5/2 grayish brown. Texture: coarse silt. Unit is bioturbated and contains small (~1cm in diameter) lenses of sand. Upper and lower contacts of unit are sharp and irregular.
13[f]	182-188	Color: 2.5 Y 5/3 light olive brown. Texture: fine-very fine sand. This unit coarsens upward and the upper and lower contacts of the unit are sharp.
14[f]	188-194	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. Unit coarsens upward. Upper and lower contacts are sharp.

Table A4 Continued

Unit (flood)[f]	**Depth** **(cm)**	**Description**
15 [f]	194-197	Color: 10 YR 4/2 dark grayish brown. Texture: fine silt. The unit is massive, bioturbated and is charcoal stained. The upper and lower contacts of the unit are sharp and irregular.
16 [f]	197-210	Color: 2.5 Y light olive brown. Texture: very fine sand. The unit coarsens upward and the upper and lower contacts of the unit are sharp and irregular.
17 [f]	210-216	Color: 10 YR 4/2 dark grayish brown. Texture: very fine sand to coarse silt. The unit is massive, bioturbated and is charcoal stained. The upper and lower contacts of the unit are sharp. Radiocarbon dated: 795-930 cal B.P.
18	216-221	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. Unit coarsens upward and the upper and lower contacts are sharp.
19 [f]	221-228	Color: 2.5 Y 5/3 light olive brown. Texture: fine-very fine sand. The unit coarsens upward and the upper and lower contacts of the unit are sharp.
20 [f]	228-231	Color: 2.5 Y 6/2 light brownish gray. Texture: very fine sand. The unit coarsens upward and the upper and lower contacts of the unit are sharp.
21 [f]	231-237	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine-fine sand. The unit coarsens upward and the upper and lower contacts of the unit are sharp.
22 [f]	237-249	Color: 2.5 Y 6/3 light yellowish brown. Texture: fine sand. Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand. The unit has minor bioturbation, coarsens upward, and the upper and lower contacts of the unit are sharp and irregular.
23 [f]	249-260	Color: 2.5Y 6/2 light brownish gray. Texture: medium sand. The unit is massive and the upper and lower contacts of the unit are sharp and irregular.
24 [f]	260-264	Color: 2.5 Y 5/2 grayish brown. Texture: fine-very fine sand. The unit is charcoal stained and appears to have some root oxidation. The upper and lower contacts of the unit are sharp and highly irregular.
25	264-269	Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand. The unit is oxidized and the upper and lower contacts of the unit are visible (not sharp) and irregular.
26	269-274	Color: 2.5 Y 5/2 grayish brown. Texture: fine-medium sand. The unit is massive and the upper and lower contacts of the unit are sharp and irregular.
27	274-317	Color: 2.5 Y 6/2 light brownish brown. Texture: medium sand. The unit coarsens upward. Upper and lower contacts of the unit are sharp and irregular and both ends of the units have detrital charcoal fragments.
28 [f]	317-329	Color: 10 YR 6/3 pale brown. Texture: coarse silt. The unit is massive, bioturbated and contains detrital charcoal fragments. The upper and lower contacts of the unit are sharp and irregular. The side walls of the pit extended out (to the west or toward the river) of the profile displaying an easterly down-dipping angle.
29	329-333	Color: 2.5 Y 6/2 light brownish gray. Texture: very fine sand. The unit is massive, bioturbated and the upper and lower contacts of the unit are sharp and irregular.
30 [f]	333-336	Color: 10 YR 5/3 brown. Texture: very fine sand to coarse sand. The unit has charcoal staining. The upper and lower contacts of the unit are sharp and irregular.
31	336-337	Color: 2.5 Y 5/2 grayish brown. Texture: medium-fine sand. The unit is discontinuous along the cut bank and the upper and lower contacts of the unit are sharp and irregular.

Table A4 Continued

Unit (flood)[f]	Depth (cm)	Description
32 [f]	337-341	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand. The unit massive, bioturbated and contains some charcoal staining. The upper and lower contacts of the unit are sharp.
33 [f]	341-347	Color: 2.5 Y 6/2 light brownish gray. Texture: fine-very fine sand. The unit is largely sand and contains interbeds of finer grain sediment with detrital charcoal fragments (< 1 mm in diameter). The upper and lower contacts of the unit are sharp and highly irregular.
34 [f]	347-355	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand to coarse silt. The unit is massive, bioturbated and contains detrital charcoal fragments. The upper and lower contacts of the unit are sharp and irregular.
35 [f]	355-363	Color: 2.5 Y 5/3 light olive brown. Texture: fine-very fine sand. The unit is bioturbated and has pockets of coarser grain sand. The upper and lower contacts of the unit are sharp and irregular.
36 [f]	363-381	Color: 2.5 Y 5/3 light olive brown. Texture: coarse silt. The unit is massive, bioturbated and contains pockets of silty clay sediment as well light colored densely packed nodules. The upper and lower contacts of the unit are visible and irregular.
37	381-385	Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand. The unit is massive and the upper and lower contacts of the unit are visible and irregular.
38 [f]	385-390	Color: 2.5 Y 6/2 light brownish gray. Texture: coarse silt. The unit is massive and charcoal stained. The upper and lower contacts of the unit are faint and irregular.
39	390-396	Color: 2.5 Y 6/2 light brownish gray. Texture: very fine sand. The unit is massive, bioturbated and charcoal stained. The upper and lower contacts of the unit are faint and irregular.
40	396-408	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. The unit is heavily bioturbated, containing brownish-red vertical streaks possibly caused by root oxidation. Within the layer are small detrital charcoal fragments, and the upper and lower contacts of the unit are visible.
41 [f]	408-417	Color: 2.5 Y light brownish gray. Texture: very fine sand to coarse silt. The unit is heavily bioturbated and contains minimal detrital charcoal fragments. The upper and lower contacts of the unit are visible. Radiocarbon dated: A.D. 1956-1957, date is inverted and not included in chronological analysis (modern root sample?).
42	417-419	Color: 2.5 Y 6/2 light brownish gray. Texture: fine-medium sand. The upper and lower contacts of the unit are sharp but discontinuous.
43 [f]	419-424	Color: 2.5 Y 6/3 light yellowish brown. Texture: coarse silt. The unit is densely packed and charcoal stained. The upper and lower contacts of the unit are sharp and irregular.
44	424-429	Color: 2.5 Y 5/2 grayish brown. Texture: medium sand. The unit is massive with vertical root oxidation. The upper boundary of the layer is sharp and irregular and the lower is visible, irregular and discontinuous.
45 [f]	429-431	Color: 2.5 Y 6/2 light brownish gray. Texture: fine-very fine sand. The upper and lower contacts of the unit are sharp, irregular and discontinuous.
46	431-485	Color: 2.5 Y 5/2 grayish brown. Texture: medium-coarse sand. The unit is massive with silty clay lenses that contain detrital charcoal fragments within them. The lower contact was not reached and the upper contact of the unit is sharp and irregular.

Table A5: Description of stratigraphic profile RB-5, located ~50 m south of RB-4.

Unit (flood)[f]	Depth (cm)	Description
1 [f]	0-5	Color: 10 YR 4/2 dark grayish brown. Texture: fine sand. This is the top of the profile, it is covered with grasses and other vegetation and is bioturbated. Lower unit contact is sharp.
2 [f]	5-67	Color: 2.5 Y 6/2 light brownish gray. Texture: fine-medium sand. The unit is massive and root bioturbated. Grain size varies throughout the unit, from the base the layer coarsens upward, then mid-unit begins to fine to the top of the unit. The upper and lower contacts of the unit are sharp and irregular.
3 [f]	67-73	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand to coarse silt. Unit is massive and contains a charcoal lens. Upper and lower contacts are sharp and highly irregular.
4 [f]	73-87	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. The unit coarsens upward. The upper contact is sharp and the lower contact is sharp and wavy.
5 [f]	87-133	Color: 2.5 Y 5/2 grayish brown. Texture: medium-coarse sand. The unit is massive with some grain size variation. The upper contact is sharp and wavy and the lower is sharp and irregular.
6 [f]	133-136	Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand to medium silt. The unit contains lenses of both grain sizes. The upper and lower contacts of the unit are sharp and irregular.
7 [f]	136-140	Color: 2.5 Y 5/2 grayish brown. Texture: coarse silt. The unit is massive and contains cultural materials possibly associated with the contact period. The upper and lower contacts of the unit are sharp and irregular.
8 [f]	140-158	Color: 2.5 Y 5/2 grayish brown. Texture: very fine sand. The unit is massive and contains detrital charcoal lenses. The upper contact is sharp and irregular and the lower contact is sharp and wavy. Radiocarbon dated: 0-300 cal B.P.
9	158-207	Color: 2.5 Y 6/3 light yellowish brown. Texture: medium-fine silt. Color: 2.5 Y 4/2 dark grayish brown. Texture: fine silt to clay. The unit is massive, bioturbated and may be culturally impacted. The upper and the lower contact are highly irregular.
10 [f]	207-230	Color: 2.5 Y 6/3 light yellowish brown. Texture: medium-fine silt. The unit is massive with possible root staining. The upper and lower contacts are sharp and irregular.
11 [f]	230-236	Color: 2.5 Y 6/3 light yellowish brown. Texture: medium-fine silt. The unit is massive and may contain some possible root staining. Upper and lower contacts are sharp and irregular.
12	236-244	Color: 10 YR 5/2 grayish brown. Texture: coarse-medium silt. The unit contains lenses of detrital charcoal fragments (<1mm in diameter) and possible root oxidation. The upper and lower contact are visible (not sharp) and irregular.
13	244-263	Color: 2.5 Y 6/2 light brownish gray. Texture: fine silt. The unit contains minimal detrital charcoal fragments. The upper and the lower contacts are faint and irregular.
14	263-301	Color: 2.5 Y 6/3 light yellowish brown. Texture: fine silt (sample from discontinuous interbed). Color: 2.5 Y 6/2 light brownish gray. Texture: coarse silt. The unit is massive with lenses of finer grain sediment and discontinuous clay-rich interbeds (~2mm thick). The upper contact is faint and gradational and the lower is gradational.

Table A5 Continued

Unit (flood)[f]	Depth (cm)	Description
15	301-308	Color: 2.5 Y 6/3 light yellowish brown. Texture: medium silt. The unit is massive and upper and lower contacts are gradational.
16	308-336	Color: 2.5 Y 5/2 grayish brown. Texture: coarse silt. The unit is composed of interfingering silts and fine-grained sand. Upper contact is gradational and lower contact is sharp and irregular.
17 [f]	336-440	Color: 2.5 Y 6/3 light yellowish brown. Texture: very fine sand. Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand. The unit contains 5 individual fining upward sequences and also contains detrital charcoal fragments, with no direct correlation to occupation. Upper contact is sharp and irregular, lower contact was not reached. Radiocarbon dated: 740-910 cal B.P.

Table A6: Description of stratigraphic profile RB-6, located 15 m south of RB-5.

Unit (flood)[f]	Depth (cm)	Description
1 [f]	0-5	Color: 10 YR 3/2 very dark grayish brown. Texture: very fine sand to coarse silt. Top of the profile is covered with vegetation. Lower contact is sharp.
2 [f]	5-25	Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand. Unit coarsens upward. Upper and lower contacts are sharp and irregular.
3 [f]	25-37	Color: 2.5 Y 6/2 light brownish gray. Texture: very fine sand. Unit coarsens upward. Upper and lower contacts are sharp and irregular.
4	37-150	Color: 2.5 Y 6/3 light yellowish brown. Texture: coarse sand. Color: 2.5 Y light brownish gray. Texture: medium sand. Unit gradually coarsens upward from 150 to 100 cm and is cross-bedded from100-37 cm. Upper contact is sharp and irregular, lower is gradational.
5	150-168	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. Unit is massive with a gradational upper contact and sharp, irregular lower contact.
6 [f]	168-173	Color: 2.5 Y 5/3 light olive brown. Texture: fine silt. Unit is massive, bioturbated and oxidized. Upper and lower contacts are sharp and irregular.
7 [f]	173-177	Color: 2.5 Y 6/3 light yellowish brown. Texture: coarse silt to very fine sand. The unit is massive and oxidized. The upper and lower contacts are sharp and irregular.
8	177-180	Color: 2.5 Y 5/2 grayish brown. Texture: very fine sand. The upper and lower contacts are sharp and irregular.
9 [f]	180-182	Color: 2.5 Y 5/2 grayish brown. Texture: coarse silt. The unit is massive and the upper and lower contacts are sharp and irregular.
10	182-187	Color: 2.5 Y 6/2 light brownish gray. Texture: fine sand. The unit is massive with a sharp and irregular upper contact. The lower contact is gradational and wavy.
11	187-269	Color: 2.5 Y 6/2 light brownish gray. Texture: coarse sand. Unit contains ~25 couplets of coarse to fine sand, where couplets are not visible the unit is weakly bedded. Upper contact is gradational and wavy, the lower is sharp and wavy.
12 [f]	269-382	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. This unit is composed of ~115 couplets of coarser sand topped by a fine-grained sand. The angle of the exposed sediments along the profile it walls may suggest that these sediments were deposited on the lee side of a beach dune. The upper and lower contacts of the unit are sharp and wavy.

Table A6 Continued

Unit (flood)[f]	**Depth (cm)**	**Description**
13 [f]	382-385	Color: 2.5 Y 5/2 grayish brown. Texture: fine sand. The upper and lower contacts are sharp and wavy to irregular.
14 [f]	385-448	Color: 2.5 Y 6/2 light brownish gray. Texture: medium sand. From 410 to 440 cm depth there are ~42 couplets of coarse sand topped by fine sand. The lower contact of the unit sits directly over a cultural feature containing detrital charcoal fragments, shell, bone, fcr and seeds. The upper and lower contacts are sharp and irregular.
15 [f]	448-480	Color: 2.5 Y 5/2 grayish brown. Texture: coarse silt. The unit is massive, bioturbated and contains lenses of clay-rich sediment. At the upper contact of the unit cultural artifacts were noted (and described above). The upper contact is sharp and irregular and this unit marks the base of the profile. Radiocarbon dated: 300-460 cal B.P.

Appendix B—Radiocarbon Laboratory Reports

The University of Georgia

Center for Applied Isotope Studies

RADIOCARBON ANALYSIS REPORT

UGAMS #	Sample #	Material	$\delta^{13}C$,‰	^{14}C age, uncorr.	±	^{14}C age, years BP	±
7237	RB-7-21-10R7,120cm	shell	-7.5	3608	26	2560	30
7238	RB-7-21-10R7,120cm	charcoal	-22.7	1663	25		

UGAMS#	Sample #	Material	$\delta^{13}C$,‰	^{14}C age, years BP	±
8210	RB3-8-18-10-R4	charcoal	-23.3	1677	23
8211	RB4-8-19-10-R7	charcoal	-24.6	956	26
8212	RB3-8-18-10-R1	charcoal	-24.7	2136	24
8213	RB5-8-20-10-R1	charcoal	-29.8	147	23
8214	RB5-8-20-10-R7	charcoal	-24.6	902	23
8215	RB6-8-21-10-R4	charcoal	-25.0	313	23

UGAMS#	Sample ID	$\delta^{13}C$,‰	^{14}C age, years BP	±	pMC	±
8829	RB1-2-16-11-R1	-23.9	764	22	90.92	0.26
8830	RB4-8-19-10-R4	-27.3	modern		106.37	0.29
8831	RB4-8-20-10-R10	-24.56	741	22	91.19	0.25