AN ABSTRACT OF THE THESIS OF

Steven A. Jenevein for the degree of Master of Arts in Interdisciplinary Studies in Applied Anthropology, Soil Science, and Geography presented on June 2, 2010.
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Abstract approved:

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Loren G. Davis

Locating archaeological sites that predate the arrival of modern sea level has been difficult along the Oregon coast. This is in part believed to be the result of geologic processes that have influenced the preservation, distribution, and visibility of sites within the Oregon coastal landscape. Because of these changes, researchers have a poor understanding of where sites that predate modern sea level are located within the modern landscape. Geoarchaeological techniques and concepts are well suited to address these types of questions and can help place the fragments of a once much larger paleocoastal landscape into a modern context. In this thesis I use a Geographic Information System (GIS) and geoarchaeological field and laboratory techniques and concepts to conceptualize, locate, and evaluate landforms located within both the paleo and modern central Oregon coastal landscapes.

Geoarchaeological investigations conducted as part of this project at the Neptune Site (35LA3) identified mid to late Holocene aged archaeological materials in addition to an erosional contact located between late Pleistocene and Holocene-aged deposits representing the loss of up to 11,400 years of stratigraphic time. To account for this loss of time, a model of landscape change that is occurring at 35LA3 is presented. Depositional sequences such as truncated late Pleistocene aged deposits that underlie mid to late Holocene

sediment that are observed at the Neptune Site are similar to, and have been associated with other early sites along the Oregon coast. The identification of these types of deposits and their associated erosional features may serve as key target horizons for future coastal researchers looking for landforms and archaeological deposits and date to the late Pleistocene to mid Holocene.

SEARCHING FOR EARLY ARCHAEOLOGICAL SITES ALONG THE CENTRAL OREGON COAST: A CASE STUDY FROM NEPTUNE STATE PARK (35LA3), LANE COUNTY, OREGON

by

Steven A. Jenevein

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Steven A. Jenevein, Author

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CHAPTER 1. INTRODUCTION

The archaeological record of Oregon's coastal zone is, in many ways, poorly understood. Although archaeological and ethnographic research suggests that the Oregon coastal landscape supported a thriving Native population during the mid-late Holocene, which continued into the historic period (Beckham et al. 1982a, 1982b), few sites predate the approximation of modern sea level (i.e., 6,000 radiocarbon years before present (RYBP; 6,843 ±20 cal BP[1]), and only one site has so far produced late Pleistocene-aged cultural components (Fairbanks1989; Davis et al. 2004; Davis 2009; Davis et al. 2009). This archaeological pattern is generally understood to be due by the operation of geological processes that influence the preservation, distribution, and visibility of sites in coastal settings.

The geoarchaeological context of coastal zones is among the most complex, due to the interactions of changes in relative sea level, neotectonic patterns, variances in waves, tides, currents, vegetation cover, soil formation, erosional patterns, and sediment flux, to name but a few potential vectors. The interaction of these abiotic and biotic processes have worked through time to create and modify coastal features such as the headlands, river valleys, bays, estuaries, tidal marshes, and extensive dunes currently present along Oregon's central coast (Wells 2001; Orr and Orr 1999). Despite the fact that geoarchaeological studies have focused on coastal zones elsewhere throughout the world (e.g., Waters 1992; 1999; Wells and Noller 1999), only a few have focused on

[1] Conversion from radiocarbon age to calibrated calendar years before present (cal BP) was performed using the CALIB version 6.1 conversion program (Stuiver and Reimer 1993). Radiocarbon ages with an unknown age uncertainty were assigned an arbitrary age uncertainty value of one.

Oregon's coast (e.g., Davis 2006; Punke 2001; 2006; Punke and Davis 2003; Hall 2000), and as such, we have a poor understanding of where archaeological sites of different ages are located in the modern landscape. From an anthropological standpoint, some of the most fundamental questions about the sociocultural aspects of Oregon's early coastal peoples cannot be answered without a more robust archaeological record to inform our perspectives. From a culture historical viewpoint, the coastal archaeological record is highly fragmented, particularly as it relates to the late Pleistocene and early Holocene (LPEH) periods. Thus, the current state of Oregon's early coastal archaeological record can be conceptualized as a fundamental geoarchaeological problem that requires basic research. In this thesis, I take up and explore the argument adopted in many coastal areas, that the lack of identified early sites along the Oregon coast is a product of archaeological site preservation, visibility, and identification, and that geoarchaeological techniques and concepts can help to find early sites that predate the arrival of modern sea level, including sites containing information about the First Americans. Armed with new geoarchaeological perspectives, I hope to move us closer to improving our knowledge of the early archaeology of Oregon's coast.

1.1. Coastal Research

Many archaeologists now favor the idea that the Pacific Coast probably served as a route of initial entry for the First Americans who migrated from western Beringia into the Americas during the late Pleistocene (Dillehay 2000; Dixon 1999). Previously, archaeological consensus held that early peoples bearing Clovis technology first entered north America through a unglaciated "ice-free" corridor in the North American continental interior that connected what is now the Yukon and the Great Plains at the end of the last glacial period (~11,500 RYBP; 13,348 ±40 cal BP), spreading southward and ultimately reaching the tip of South America (Flandmark 1979; Gruhn 1994; Mandryk et al. 2001). The

traditional view characterized the Clovis peoples as big game hunters who followed megafauna down into central North America (Cannon and Meltzer 2004). Modern research has showed that early Clovis peoples were in fact much less dependent on big game hunting and possessed a diversified tool kit that was used to exploit many plants and animal resources, as well as large game (Stanford 1991). In addition to this change in perception about the Clovis peoples, it is now generally accepted that the Clovis culture did not represent the first peoples that migrated into the New World (Goebel et al. 2008; Dillehay 1999).

Changing views about the origin and timing of people entering North America began to strengthen with findings of the Monte Verde Site located in Chile, which has been dated to ~12,500 RYBP (14,734 ±200 cal BP), a date approximately 1,000 years earlier than Clovis (Meltzer 1989; Bryan 1991; Dixon 1999). The discovery of new sites that predate Clovis and cutting-edge research on ancient human genetics continue to strengthen the case that initial human entry into the New World, possibly independent of Clovis, occurred along a Pacific coastal route (Goebel et al. 2008).

1.2. Early Coastal Sites

Finding archaeological sites that predate modern sea level (>6,000 RYBP; >6,843 ±20 cal BP) along Oregon's central coast has proven difficult for researchers. Multidisciplinary research has played a large and important role in the understanding the environmental context of the early coastal landscape since the last glacial maximum (LGM) (~21,000 RYBP (~25,000 cal BP)) (Gruhn 1994; Al-Suwaidi et al. 2006; Fedje 1997). Few sites that date older than >6,000 cal BP have been found along the Oregon coast and sites that date to the terminal Pleistocene have only been found in a few settings along the North American Pacific coastline (Davis et al. 2004; Davis 2006; Connolly and Tasa 2008). The

earliest sites known along the North American Pacific margin are found in environmental contexts that are different than that of the Oregon's central coast. A number of early sites have been found along the western coast of British Columbia, where postglacial isostatic rebound has progressively elevated coastal areas above rising sea levels. Other areas of the British Columbia coastline are within lower energy environments that help to preserve remnant archaeological deposits that date to the LPEH. Some of the earliest sites discovered on the Northwest Coast have been found in northern British Columbia on the island of Haida Gwaii. At the K1 Cave site, located on the island's west coast, the bases of two stemmed projectile points were found in association with the skeletal remains of a black bear that produced radiocarbon dates of 10,950 RYBP (12,807 ±80 cal BP) (Fedje and Mathewes 2005; Ramsey et al. 2004). At the Namu site located along the central coast of British Columbia, foliate bifaces, cobble and flake tools have been recovered within strata dating between 9,700 to 9,000 RYBP (11,173 to 10,196 cal BP) (Carlson 1996; Erlandson et al. 2008).

Other early sites such as Arlington Springs, Daisy Cave, and the Cardwell Bluffs have dated to as early as 13 - 12 ka cal BP have been found among the Channel Islands off the coast of Southern California (Erlandson et al. 2008). Optimal conditions such as limited burrowing animals and the remoteness of the Islands have contributed to the preservation of some of the earliest recorded sites found on the west coast of North America (Rick et al. 2006). One example is the Daisy Cave site that due to the steep drop-off at the mouth of the cave, allowed the site to be located a very short distance to the paleocoastline when the site was occupied at about 11,500 cal BP (Erlandson et al. 2008). The cave is located on San Miguel Island and contains a variety of well-preserved artifacts that include projectile points, bifaces, bone bipoints, fish gorges, cordage, woven items, shells, shell midden, and other faunal items. Radiocarbon dates from Daisy Cave extend back to 11,600 cal BP and continue through 8,500 cal BP and may represent one of the earliest long-term occupation sites within the Channel Islands.

Since so few sites currently exist that date to the terminal Pleistocene that might otherwise inform our perspectives, much of the modern archaeological research is being completed under the assumption that early coastal peoples would have used the coastal landscape in much the same way that coastal peoples did at the time of contact with Euro-American settlers. The use of analogy in an archaeological context, especially in a situation where much of the environment and associated archaeological remains have been destroyed can be very useful (Binford 1967). Caution must be used in this situation however, as many factors such as the past environmental conditions as well as cultural factors such the variability in the sociopolitical organization of early people may have been very different than that of the Native peoples that lived on the coast during historic times. Because no sites that date to the LPEH have yet to be found along the central Oregon coast, I assume that its early peoples employed coastally adapted forager strategies, based on other examples of sites located on the northern and southern Pacific coast. Paleolandscape modeling such as used in this project is important when working under assumptions of how early coastal peoples would have used the coastal landscape and allows researchers to conceptualize the many complex interactions possible between people and their environment.

1.3. Looking for Early Sites Along the Coastal Margin

Global sea level rose ca. 130 m since the LGM, following the deglaciation of Late Wisconsinan-era glaciers (Fairbanks 1989). This marine transgression significantly altered the coastal landscape by submerging much of the environment that would have been available for early coastal peoples. Locating archaeological sites within a submerged landscape or along the remaining portion of an ancient coastal setting is important not only for furthering knowledge about the timing and origin of the first people entering North America, but is also for the day to day management of cultural properties located along the coast.

For example, sites have been inadvertently found along the Oregon coast within submerged settings that potentially could be avoided through the construction and use of archaeological sensitivity models that would help land managers make decisions about the potential affects a project may have to unknown cultural resources (Minor and Nelson 2004). In these settings, techniques other than traditional archaeological survey must be used to find early sites. Traditionally, the most common methods for locating archaeological sites along the Oregon coastal margin involves pedestrian survey or sub-surface testing. This work is usually conducted within an area of the coast that has been previously defined, not due to its potential to contain early sites, but by a prescribed undertaking, typically associated with development activities. Unfortunately, when investigating the potential for early sites, much of the early landscape is unavailable and the remaining portion of the truncated landscape may not provide ideal survey conditions.

Attempts have been made on the west coast of North America and in coastal zones elsewhere to model paleoenvironmental conditions with the hopes of locating submerged sites along the continental margins. Projects within the Gulf of Mexico and along the Atlantic seaboard have proven successful at modeling and locating archaeological sites within a submerged setting (Stright 1990; Waters 1992). Most of these projects have been undertaken within low energy or coastal environments with high rates of sediment deposition. These areas differ from the west coast of North America, which is considered to be generally within an erosive or high-energy environment. Some projects off the west coast have experienced moderate success in modeling and locating submerged archaeological resources that date prior to modern sea level. Work by Canadian researchers off the coast of British Columbia employed a program of high-resolution digital terrain imaging and sea floor sampling to locate and date cultural material in water depth up to 53 meters (m) (Fedje and Christensen 1999; Fedje and Josenhans 2000). Work was accomplished by first identifying geomorphic features that have subaerial analogs in the modern landscape such

as alluvial fans or meandering river channels, then selecting targets and sampling areas of interest with a clam shell grab sampler. Results included the recovery of a flaked stone tool, which was dated to ~10,000 cal BP based on its position relative to estimated sea levels. This project is a good example of the methodology that would need to be employed to be successful for identifying additional archaeological materials within a submerged setting.

In 2003, a workshop entitled, “Linking the Disciplines of Marine Geology and Archaeology to Facilitate the Potential of Archaeological Discoveries on Submerged Continental Margins” was held in Oregon by an interdisciplinary team of archaeologists, marine scientists, oceanographers, and geophysicists (NOAA 2003; Robert W. Embley, personal communication 2009). The goal of the workshop was to explore multiple aspects related to the potential for discovering archaeological evidence of human habitation off the Oregon coast. One of the important next steps identified by the workshop was the need for developing a geoarchaeological model to explore the potential for submerged archaeological resources off the Oregon coast. Work by Davis et al. (2009) and this thesis project, arguably represent that “next step” by linking together theoretical concepts and known processes about archaeological resources and landscape change with seeking places in the modern environment where evidence of early coastal peoples may still exist.

1.4. Goals of Research

This thesis seeks to contribute new knowledge relating to the earliest archaeological period of Oregon’s coast by addressing three main questions: (1) how has the central Oregon coastal landscape changed since the LGM, (2) how would those changes affect the preservation and visibility of archaeological sites; and (3) equipped with an understanding of how the landscape has changed since the LGM, how might we locate sites of certain ages on the central Oregon coast?

To address these three primary questions, I will first review modern archaeological and ethnographic data about of how early coastal peoples were known to have used the central Oregon coastal landscape, in order to establish a social context of potential site distribution. I will then review the natural geomorphic processes that worked to shape Oregon's modern coastal landscape since the LGM. I will then discuss how these coastal processes may have influenced the spatial distribution of archaeological sites at landscape scales, and will also review the physical factors that could affect the preservation and visibility of pre-contact archaeological sites in a modern coastal setting. Armed with this basic understanding of cultural land use and landscape change along the central coast since the LGM, I will then utilize spatial information within a Geographic Information System (GIS) in an attempt to reconstruct the central Oregon coast paleolandscape and to make predictions about where archaeological sites of certain ages might be best preserved. Finally, I will conduct a limited assessment of the GIS predictive model's ability to identify the location of early sites by conducing archaeological test excavations at a high probability locale within Neptune State Park, which is positioned on the modern central Oregon coastal shoreline. The results of these archaeological and geoarchaeological investigations at Neptune State Park are reported in detail and used to evaluate the GIS model.

CHAPTER 2. BACKGROUND

2.1. Regional Setting

The primary study area is situated along a 160 kilometers (km) stretch of the central Oregon coast located between the towns of Lincoln City and Reedsport, Oregon (Figure 2.1). Field investigations for the project will cover a much smaller area of the central coast, centered within Neptune State Park, which is located 5 km south of the town of Yachats. The local setting of the Neptune State Park area will be characterized in more detail later in the report.

Common characteristic geomorphic features along this stretch of the central Oregon coast include a narrow, straight coastal plain that is bounded on the east by the sharply rising foothills of the Coast Range and the Pacific Ocean to the west. Numerous Rocky headlands divide this section of the coast that also includes shallow bays, estuaries, and expansive dune deposits (Orr and Orr 1999; Kelsey et al. 1996; Peterson et al. 2007). Medium to large tidally influenced rivers such as the Yaquina, Alsea, Siuslaw, and Umpqua, generally flow in an east to west direction and drain the Coast Range Mountains into the Pacific Ocean. The crest of the Coast Range averages 457 m (1,500 ft) above mean sea level (masl) but some of the interior peaks can reach heights to as much of 1,249 masl (4,097 ft) (Mary's Peak).

Climate along the central Oregon coast consists of mild wet winters and relatively dry cool summers with temperatures averaging between 7.2°C in the winter to 15°C during the summer months. Frequent fog and low clouds are common along the coast with the annual precipitation averaging close to 70 inches with most (50%) of the precipitation occurring during the winter months of December, January, and February (Franklin and Dyrness 1988; Western Regional Climate Center 2010).

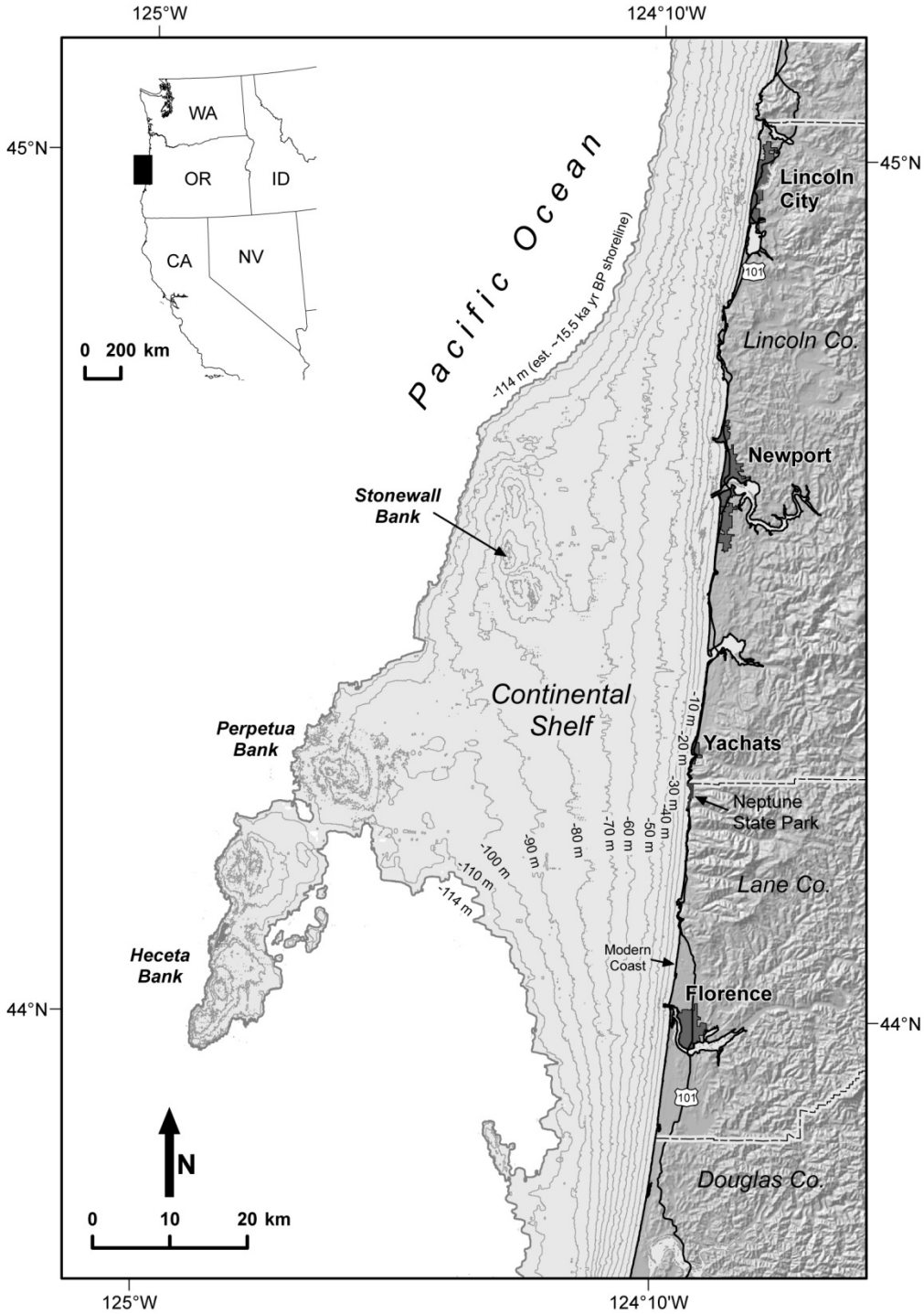

Figure 2.1. Regional map showing the location of the study area along the central Oregon coast.

The study area is situated within the Sitka spruce (*Picea sitchensis*) Vegetation Zone (Franklin and Dyrness 1988), which can be primarily characterized as a coniferous forest with common over story species including Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and beach pine (*Pinus contorta*). Common understory species include salal (*Gaultheria shallon*), western sword fern (*Polystichum munitum*), redwood-sorrel (*Oxalis oregana*), false lilly of the valley (*Maianthemum dilatatum*), Siberian springbeauty (*Claytonia sibirica*), foamflower (*Tiarella trifoliata*), evergreen violet (*Viola sempervirens Green*), largeflower fairybells (*Prosartes smithii*), red huckleberry (*Vaccinium parvifolium*), and rusty menziesia (*Menziesia ferruginea*) (Franklin and Dyrness 1988; Pojar and MacKinnon 2004; Unites States Department of Agriculture, Natural Resources Conservation Service 2010).

Other modern plant communities within the study area include Sand Dune and Strand, Tideland, and Herb- Shrub-dominated communities such as Headlands. Species common within the Sand Dune communities include American silvertop (*Glehnia leiocarpa*), largehead sedge (*Carex macrocephala*), silver bur ragweed (*Franseria chamissonis*) and salal (*Gaultheria shallon*). Species common within the range of tideland communities include seaside arrowgrass (*Triglochin maritimum*), cosmopolitan bulrush (*Scirpus pacificus*), Lyngby's sedge (*Carex lyngbyei*), tufted hairgrass (*Deschampsia caespitosa*), and Baltic rush (*Juncus balticus*). Species common within the Headland communities include giant horsetail (*Equisetum telmateia*), western buttercup (*Ranunculus occidentalis*), Common cowparsnip (*Heracleum lanatum*), and Mexican hedgenettle (*Stachys Mexicana*) (Franklin and Dyrness 1988; Pojar and MacKinnon 2004; Unites States Department of Agriculture, Natural Resources Conservation Service 2010).

2.2. Paleoenviromental Setting

Understanding the paleoenviromental setting of the central Oregon coast since the LGM is an important link to understanding how early coastal peoples may have moved throughout and utilized resources within the coastal landscape. As is true with modern fluctuations in atmospheric circulation and sea-surface temperatures, changing paleoclimatic conditions would likely have affected coastal populations by shifting biomes and by creating variability in the productivity of terrestrial, littoral and maritime resources (Waters 1992; Fedje and Christensen 1999).

From their analysis of pollen and plant macrofossil remains obtained from Little Lake, Oregon (located 40 km east of the study area), Worona and Whitlock (1995) provided a detailed record of climate and vegetation changes within the central Coast Range during the late Pleistocene. Climate during the full glacial period was generally colder and dryer then it is today with forest species mainly consisting of pine, fir, western and mountain hemlock. A shift to more temperate conditions occurred at 13,000 cal BP with a short period of cooling occurring between 12,400 cal BP and 11,000 cal BP coinciding with the Younger Dryas event (Grigg and Whitlock 1998). Forests during the early Holocene contained Douglas-fir, Red alder and bracken fern suggesting summer drought conditions and frequent fires. During the mid-Holocene (~5,500 cal BP), forests began the shift in response to a cool, moist climate to forest conditions similar to what we see today within the Coast Range. Indicators of climate change other than pollen and plant macrofossil remains have also been used in the central Oregon Coast Range. Personius (1993) attributes alluvial terrace aggradation in the Coast Range during the LPEH as a possible indicator of a warmer, drier climate. Increased sediment loads during the LPEH within most of the Coast Range rivers is probably due to an increased incidence of mass movement events due to vegetation changes, an increase in forest fires, and an associated rise in slope destabilization. The work of Worona and Whitlock (1995), Grigg and Whitlock

(1998), and Personius (1993) all support a characterization of a warmer, drier climate during the late Pleistocene to mid-Holocene, which exhibited summer drought and an increased frequency of forest fires as compared to the present-day cool, moist climate.

2.3. Geology and Geomorphology

Bedrock geology within the study area includes Eocene sandstone and both Miocene and Eocene-aged basalts (Orr and Orr 1999). In the northern portion of the study area, middle Miocene-aged basalts, which represent the distal ends of extruded lava flows, form many prominently visible headlands such as Yaquina Head. In comparison, Eocene-aged basalts form many of the prominent headland features in the southern portion of the study area, including Heceta Head, Devil's Elbow, and Sea Lion Cave. Extruded basalt flows and pyroclastic deposits from Eocene subaerial or submarine eruptions are visible along the central portion of the study area as well (Lund 1971). These volcanic breccias and stratified pyroclastics can be seen among many of the rocky outcrops features at Neptune State Park area (Lund 1971). These rocky coastal areas were used by Native coastal peoples for shellfish procurement (Barner 1982; Minor 1986; Tasa and Connolly 2001; Erlandson and Moss 1993). Eocene sandstone of the Tyee Formation was formed by the repeated infilling of sediment within an offshore forearc basin before being uplifted (Lund 1971; Orr and Orr 1999). Susceptible to erosion, this deposit underlies much of the surficial dune deposits that cover the southern portion of the study area surrounding the town of Florence.

Marine terraces are another prominent geologic feature that is visible along the central Oregon coast. Six distinct wave cut terraces were carved into bedrock during periods of interglacial and interstadial sea level standstill have been identified in the study area (Kelsey et al. 1996). Visibility and preservation

of each terrace is discontinuous and terrace widths vary from less than 100 m to up to 800 m. Depending on the terrace, their heights extend from sea level up to 150 masl. Terrace ages range between 80 ka cal BP (Newport terrace) to >200 ka cal BP (Alder Grove terrace). The Yachats terrace dates to ~125 ka cal BP (marine isotope stage 5e) and is the primary terrace in the main study area at Neptune State Park. The Yachats terrace is exposed at an elevation between 0 to 13 masl and is characterized by nearly vertical, stratified sea cliffs bearing basal conglomerate deposits that rise sharply above the modern beach (Kelsey et al. 1996; Lund 1972). Terrace cover sediments include a mix of late Pleistocene and Holocene-aged aeolian dune deposits, alluvium, and colluvial debris (Peterson et al. 2007; Beckstrand 2001).

2.3.1. Regional Tectonics

The central Oregon coast is situated within the central portion of the Cascadia Subduction Zone that spans the coastal region along the Pacific Coast of North America (Nelson et al. 1995) (Figure 2.2). In this area, the converging forces of the Juan de Fuca oceanic plate and the larger North American continental plate have the potential for producing large-scale earthquakes along this coastal margin (Atwater et al. 1995). Friction resulting from the Juan de Fuca plate being forced under the North American plate causes the overlying North American plate to bulge at the point of contact. Bulging associated with plate friction is termed interseismic uplift and can occur at variable rates along the coastline. Coastal features such as headlands and low lying areas are directly affected by local and regional faulting and respond differently to interseismic uplift longitudinally along the coastal margin. As interseismic uplift occurs, the elevation of the coastal margin increases in elevation. When tension at the point of contact between the two plates becomes too great, the plates slip or “rupture” releasing the energy in the form of an earthquake. As the overlying North American Plate relaxes after the earthquake, the surface will drop in elevation in a process called coseismic subsidence. The rupture location has a

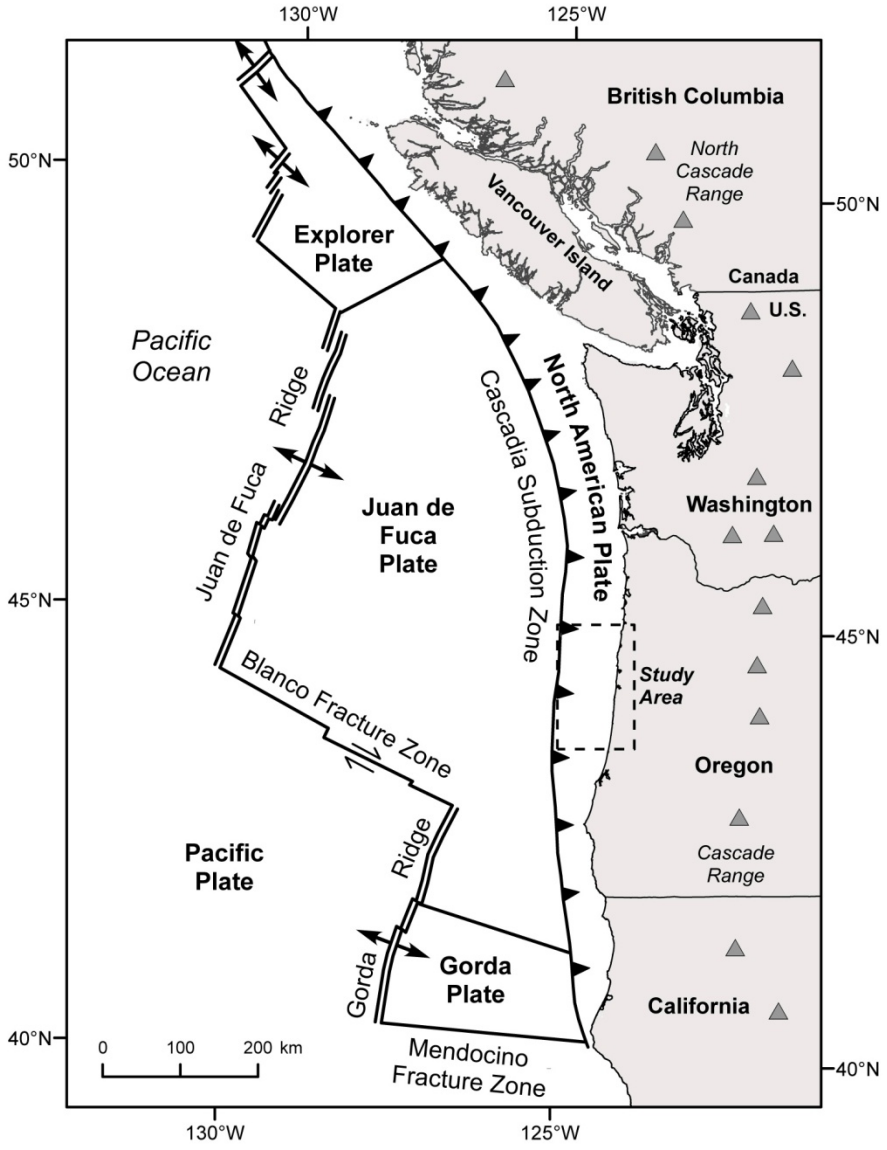

Figure 2.2. Map of the Cascadia Subduction Zone off the Oregon coast showing the location of the study area. Map based on work by Atwater et al. (1995).

major effect on the distribution of subsidence, and although a rupture would not be visible on the surface of the earth, it can be estimated by the extent of subsidence observed along the surface (Atwater et al. 1995). In addition to the initial destruction caused by a large magnitude earthquake, and subsequent tsunami, coseismic subsidence can dramatically alter and readjust the coastal landscape (Minor and Grant 1996; Cole et al. 1996; Losey et al. 2000; Minor and Nelson 2004; Becker 2008).

In addition to the long term repeating patterns of tectonic activity within the Cascadia Subduction Zone, shallow crustal bedrock structures experience neotectonic movements during large magnitude earthquakes and have also worked to modify the paleocoastal landscape since the LGM (Figure 2.3). For example, work conducted by Yeats et al. (1998) along the Stonewall anticline located southwest of Newport identified a remnant stream channel that could be the possible Pleistocene lowstand continuation of the Yaquina River. Shelf deformation since ~11,000 to 12,000 cal BP appears to have back-tilted the stream channel from the ridge of the anticline allowing Holocene mud to partially infill the channel. Sidescan sonar identified river terrace, riser, and side channels features associated with this paleostream feature, which has been significantly altered since the LPEH.

2.3.2. Coseismic Subsidence and Tsunami

Coseismic subsidence and tsunami related to large magnitude Cascadia Subduction Zone earthquakes have the ability to very quickly and dramatically change the coastal landscape. It is expected that up to 0.5 m of subsidence will result from a major (>9.0 magnitude) offshore earthquake within the central coast region (Peterson et al. 2000). Numerous late Holocene examples of archaeological site burial and the subsequent abandonment associated with the effects of subsidence and tsunamis exist along the Pacific coastal margin

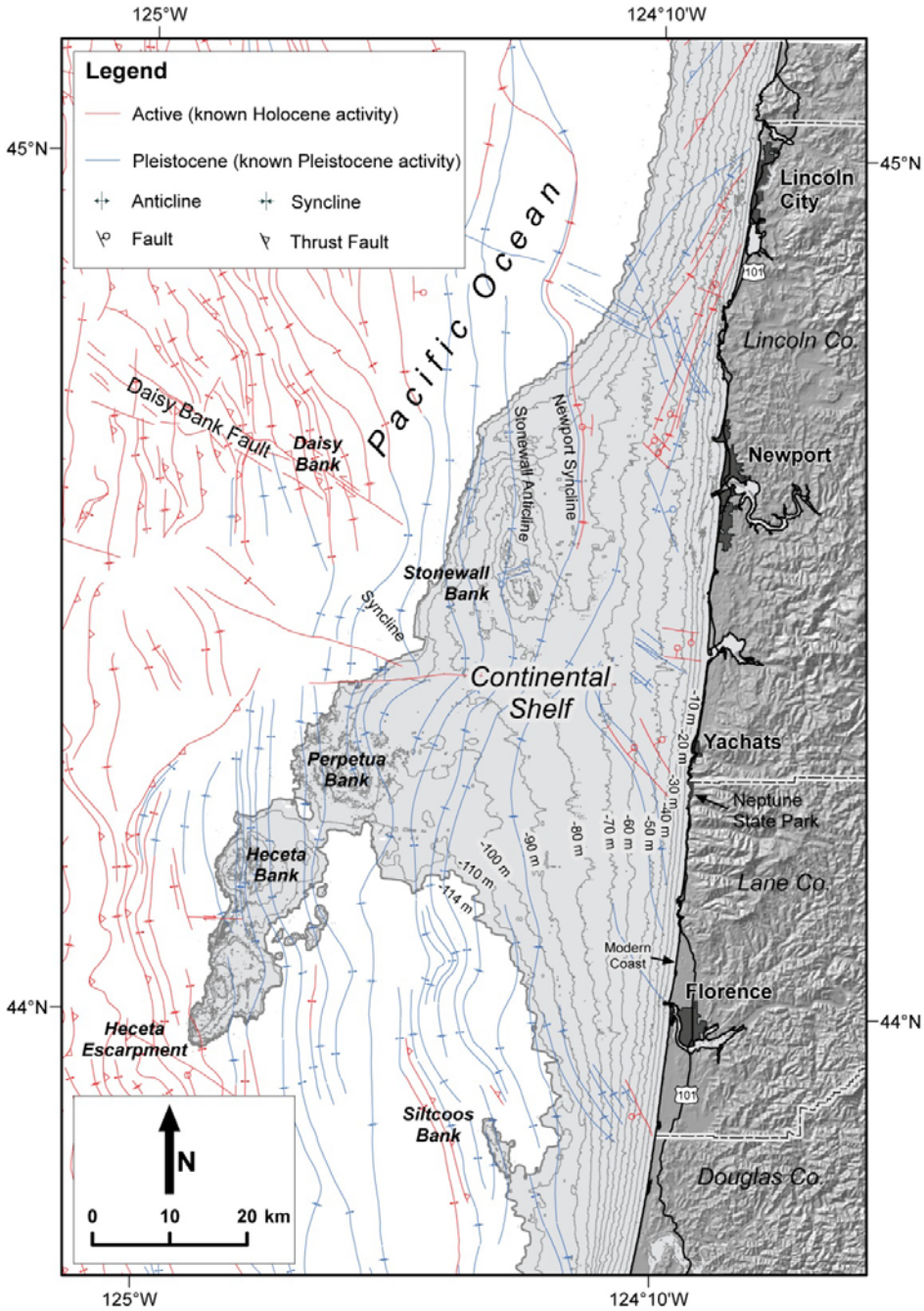

Figure 2.3. Neotectonic structures off the Oregon coast. Spatial data obtained from the Oregon Department of Geology and Mineral Industries, Portland. Open File Report O-92-4.

(Hutchinson and McMillan 1997; Hall 1995, 2000; Minor and Grant 1996; Cole et al. 1996).

As surface elevation drops during a coseismic subsidence event, low elevation landforms are inundated with seawater and are subsequently buried by mud, sand, and debris (Losey et al. 2000). Typical stratigraphy associated with this type of event would include buried soil that is covered with sand, which is in turn overlain with intertidal mud (Atwater et al. 1995; Minor and Grant 1996). Witter (1999) however cautions that bedded sediment deposited during a tsunami cannot be easily distinguished from bedded sediment deposited during a climatologically-induced event, such as an onshore surge of ocean waves during a strong winter storm. Although Witter's suggestion that climatological events may be responsible for some of the burial events and may affect the estimated recurrence interval for great earthquakes, it does not detract from the geomorphic severity of the seismic events when they do occur.

The environmental effects following a large scale earthquake, coseismic subsidence would have undoubtedly damaged food resources by eroding or burying intertidal shellfish beds, and introducing large amounts of sediment that choked streams necessary for anadromous fish (Hutchinson and McMillan 1997). Estuary margins and landforms that were once considered productive areas for resource procurement would quickly become unproductive. As estuary margins shift due to the environmental effects of tectonic events, so too would the spatial distribution of archaeological resources and the patterning of settlement by Native peoples (Byram and Witter 2000; Davis et al. 2009). As a result, coastal hazards could contribute significantly to the depopulation or reduced use of archaeological sites immediately after a tsunami and or coseismic subsidence event (Hutchinson and McMillan 1997). Once this inundation and burial occurs, the cycle of interseismic uplift would begin again, raising landforms, adjusting estuary margins to their previous levels, and changing the ecological context of the coast for its human foragers (Davis et al. 2009).

2.3.3. Eustatic Sea Level Change

Melting of glacial ice since the LGM caused eustatic sea level to rise ~130 m at a non-uniform rate, reaching the current modern level by ~3,000 cal BP (Fleming et al. 1998; Fairbanks 1989). Understanding the height and timing of sea level change since the LGM is a crucial first step for reconstructing the paleocoastal landscape (Davis et al. 2009). By estimating changes in ice volume, researchers have been able to reconstruct glacioeustatic sea levels during the last deglaciation (Fairbanks 1989).

Between 21 ka cal BP and 17 ka cal BP, marine transgression was relatively slow with sea levels rising only 6 m/ ka (Figure 2.4). Between 17 ka cal BP and 15.5 ka cal BP, sea level rise increased slightly to approximately 10 m/ ka. Between 15.5 ka and 13.5 ka cal BP, sea level rise slowed to 5 m/ ka and then increased between 13.5 ka and 11.5 ka cal BP to 16 m/ ka. At 11.5 ka to 11.25 ka cal BP sea level slowed to 8 m /ka marking the period during the Younger Dryas. From 11.25 ka to 7 ka cal BP, sea level rise increased again to 13 m/ ka. After 7 ka cal BP when sea level was at approximately -15 m, the sea level rose slowly at a rate of several meters / ka until reaching its current position at ~3,000 cal BP (Fleming et al. 1998; Fairbanks 1989; Davis et al. 2009).

In addition to melting glacial ice, the relative sea level curve can also be influenced by regional tectonic movement related to coseismic subsidence and interseismic uplift (Darienzo and Peterson 1990; Punke 2005). As described in the preceding pages, coseismic subsidence and interseismic uplift occurs at a non uniform rate and varies latitudinally along the Oregon coast. Interseismic uplift rates for the Oregon coast range from 0 - 5 mm per year and coseismic subsidence can range from 0 - 2 meters (Peterson et al. 2000). Coseismic subsidence rates estimated for the central coast bays range between 0 - 0.5 m (Peterson et al. 2000).

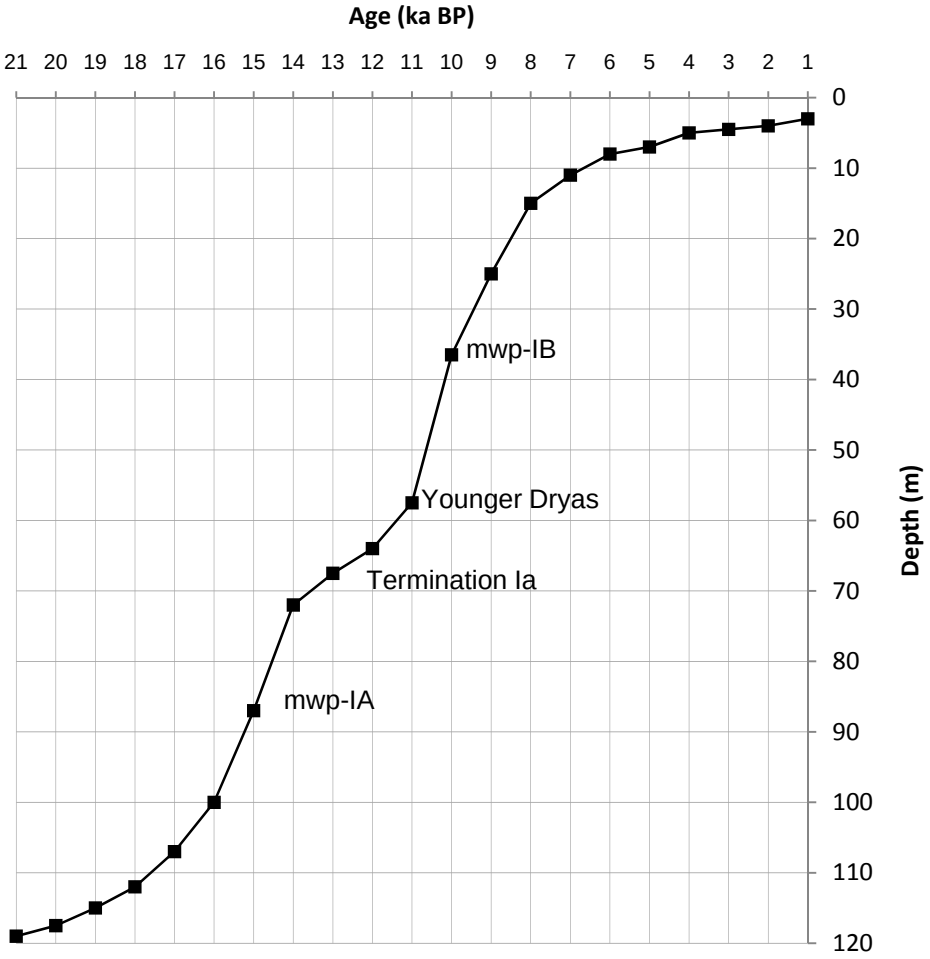

Figure 2.4. Late Quaternary eustatic sea level curve showing the timing of melt-water pulse-IA (mwp-IA), melt-water pulse-IB (mwp-IB), Termination Ia, and the Younger Dryas event (data estimated from Fairbanks 1989).

2.3.4. Sand Dunes, Sediment Source, Timing, and Emplacement

Coastal dune sheets are one of the primary landscape features along the central Oregon coast. Peterson et al. (2007) identified and named three major aeolian sand deposits within the study area, including the Lincoln City, Newport, and Florence dune sheets. A prominent geographic feature such as a rocky headland separates each dune sheet. The Florence dune sheet is the largest of the three and encompasses the southern portion of the study area. The Newport and Lincoln City dune sheets are smaller in size than the Florence dune sheet and decrease in both length and width with latitude (Peterson et al. 2007). Sediment that comprises the Coastal dune sheets within the study area have been sourced[2] to river sediment from southern Oregon and northern California. This sediment has been transported northward along the Oregon coast by littoral processes and trapped and stored by the Heceta, Perpetua, and Stonewall Banks.

Chronometric dating of the coastal dune sheets suggest two general periods of dune emplacement, with the first occurring during marine low-stand[3] conditions of the late Pleistocene (11 - 103 ka cal BP) and the second occurring during high-stand conditions of the mid-late Holocene (0.1 - 8 ka cal BP) (Peterson et al. 2007; Beckstrand 2001). During low-stand conditions, aeolian processes transported accumulated sediment south of the Heceta-Perpetua-Stonewall Banks across the continental shelf to form the late Pleistocene dune sheets. During high-stand[4] conditions, inner-shelf sand was remobilized and transported to the east by ocean currents. The lack of LGM-aged dune sand is attributed to climatic conditions that reduced onshore aeolian cross-shelf sand supply

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[2] Sourced is a tern use to describe the determination of a sediments geographic origin by means of micro or macro analysis.
[3] Low-stand is a term used to describe the lowest sea level elevation experienced during periods of glaciations.
[4] High-stand is a term used to describe the highest sea level elevation experienced during interglacial periods.

(Peterson et al. 2007). As a result, the coastal dune sheets along the central Oregon coast are primarily the result of the prominent Heceta-Perpetua-Stonewall Bank complex that has served as a low-stand sand depocenter[5] supplying the area sediment to be reworked and transported eastward throughout the late Pleistocene and Holocene.

2.3.5. Mass Movement

The term mass movement is used to describe the various degrees of landslide, debris flow, and creep behavior within the coastal region, which varies from slow moving soil creep to fast and violent debris flows (McDowell 1987). Mass movement is affected by a combination of many factors some of which include landscape position, material type, the nature of stratigraphic contacts, and the moisture content of the sediment (McDowell 1987; Personius 1993). Rapid mass movement is often triggered by saturated ground conditions that often follow periods of intense precipitation. Evidence of archaeological site burial by landslide debris has been documented in both the archaeological record and in oral history at Whaleshead Cove on the southern Oregon coast (Connolly et al. 2008). At this site, late Holocene shell midden deposits are visible within the cutbank, buried by landslide debris. Numerous landslide deposits have been observed within the study area. As a result of the narrow coastal plain that is situated adjacent to the sharply rising slope of the Coast Range, numerous examples of poorly sorted debris flows fans and landslide deposits are visible within the shoreline stratigraphy of the Neptune State Park area.

[5] Depocenter is geomorphological term used to describe the location of maximum sediment accumulation within a landscape.

CHAPTER 3. CULTURAL SETTING

Archaeological and ethnographic research has suggested that the Oregon coastal landscape supported an environment that was attractive and productive for Native peoples (Byram 2002). Most of the sites that have been identified along the Oregon coast date to the late Holocene and until more sites are found that date to the early and mid Holocene, the use of later period archaeological and ethnographic analogy will have to serve as the basis how we expect early Native people would have moved and utilized the coastal environment. A number of reviews have been published that list and evaluate early to mid Holocene-aged archaeological sites identified along the Oregon coast (Lyman and Ross 1988; Minor 1995; Moss and Erlandson 1998; Erlandson et al. 2008; Connolly and Tasa 2008). For this thesis I will not attempt to duplicate past review and syntheses. I will, however, discuss the few sites located along the Oregon coast that date to the late Pleistocene to mid-Holocene period (>6,000 cal BP). During the end of this period (>6,000 cal BP), sea level rise slowed upon reaching a depth of approximately -10 m until gradually rising to its modern level.

3.1. Early Sites Along the Oregon Coast

Five sites along the Oregon coast are reported to contain cultural deposits that date to the early to mid-Holocene (>6,000 cal BP), including the Devils Kitchen site (35CS9), the Blacklock Point Site (35CU75), and the Indian Sands Site (35CU67C), which are all located on the southern coast. The Tahkenitch Landing Site (35DO130), and the Neptune Site (35LA3) are located along the central Oregon coast and are within this project's study area. The Neptune Site is the focus of archaeological excavations associated with this project and will be covered in more detail later in the document.

Located south of the City of Bandon, the Devils Kitchen site (35CS9) includes lithic tools and debitage located within stratified deposits of aeolian sand and alluvial deposits (Hall et al. 2005; Davis et al. 2008). All tools and debitage were made from cryptocrystalline silicate (CCS) with the exception of one flake that was made of obsidian (Hall et al. 2005). Cultural deposits found in association with alluvial sediment were radiocarbon dated between 2,600 ±40 RYBP (2,739 ±20 cal BP) (Beta-189635) and 11,000 ±140 RYBP (12,859 ±130 cal BP) (Beta-189636). Site occupation is believed to have begun by at least the mid-Holocene, although interpolated sedimentation rates suggest that that date of initial occupation could be pushed back to possibly the early Holocene (Hall et al. 2005; Davis et al. 2008). The Devils Kitchen site represents an example of a mid-early Holocene coastal headland site with a primary emphasis on lithic tool production (Hall et al. 2005; Davis et al. 2008; Willis and Davis 2007).

Located within Floras State Park along the southern Oregon coast, the Blacklock Point Site (35CU75) is situated on an uplifted marine terrace in a dark sandy loam overlying consolidated fine sands. Cultural materials include a large collection of lithic tools and debitage but no shell remains (Minor 1993; Davis et al. 2008). Cultural deposits at the site have been dated between 2,750 ±55 RYBP (2,831 ±50 cal BP) (DIC-1911) and 7,560 ±80 RYBP (8,367 ±60 cal BP) (Beta-62391), suggesting an occupation spanning much of the Holocene. Stratigraphic unconformities observed at the site suggest a landscape evolution history that includes erosion and the reworking of sediments at the site that is a common occurrence on Oregon coastal headland sites (Davis et al. 2008). The Blacklock Point Site represents a well-documented mid-Holocene-aged headland site with a primary emphasis on lithic tool production.

Located within Samuel H. Boardman State Park along the southern Oregon coast, the Indian Sands Site (35CU67C) is situated on a coastal headland within stratified late Pleistocene to Holocene-aged aeolian dune deposits (Davis et al. 2004, 2008; Davis 2006; Willis 2004, 2005; Davis 2009). Cultural deposits

recovered during excavations consist of a collection of lithic tools, debitage, and fire cracked rock (FCR) (Davis et al. 2004). Most of the lithic material (91.9%) was made from CCS, although a small percentage (5.9%) was made from obsidian, and the remaining (2.2%) was made from metamorphic rock. Radiocarbon and thermoluminescence dating has placed these cultural deposits within the late Pleistocene to mid-Holocene with a radiocarbon date of 10,430 ±150 RCBP (12,322 ±210 cal BP) (Beta-170406) associated with cultural material within a buried paleosol (Davis et al. 2004; Davis 2009). Artifacts also include debitage, cores, flaked cobbles, burned rock, whereas faunal remains were observed within deflated deposits at the site and were associated with surficial marine shells that returned radiocarbon ages between 7,790 ±70 RYBP (8,572 ±60 cal BP) (Beta-73004) and 8,250 ±80 RYBP (9,221 ±100 cal BP) (Beta-66891) (Moss and Erlandson 1998); however, doubts about the archaeological integrity of these deflated deposits have been recently voiced (Davis 2009; Davis and Willis 2010). Site stratigraphy suggests episodes of wind erosion and deflation, in some areas, throughout the site's history. Cultural materials present at the site suggest its primary cultural use was for procuring raw lithic materials and manufacturing lithic tools, possibly when the ocean shoreline was located further to the west (Willis 2004, 2005; Davis et al. 2008).

The Tahkenitch Landing Site (35DO130) is a stratified shell midden located on the western shore of Tahkenitch Lake, which is situated along Oregon's central coast (Minor and Toepel 1986). Tahkenitch Lake was once an open estuary that was blocked by shifting dunes at ~3,000 cal BP, after which the lake shifted to a fresh water system. Recovered cultural materials include faunal remains from marine fish species, birds, and both marine and terrestrial mammals. After ~3,000 cal BP, marine species are absent within the archaeological record and are replaced with fresh water varieties. Radiocarbon dates have placed site deposits to be between 4,340 ±80 RYBP (4,911 ±70 cal BP) (Beta-14868) and 7960 ±90 RYBP (8,850 ±130 cal BP) (Beta-14870). This site provides an example of how landscape change, due to shifting sand dunes,

can significantly alter the economic function of the site, and as a result, those environmental changes are reflected and visible within the archaeological record. This site provides a good example of how cultural use of the landscape can change in response to evolving coastal environments.

Each of the four sites reviewed have similarities in common that are important to note when evaluating coastal sites that predate modern sea level. Although some of the sites were located at the boundaries of different landscape settings, such as situated on coastal headlands or associated with an estuary environment, they all are similar in the fact that they were subject to significant landscape changes since the early-mid Holocene. In the cases of the headland sites (35CS9, 35CU75, and 35CU67C), erosion and deflation of sediment can remove or bury cultural deposits complicating stratigraphic and temporal relationship between cultural materials and the under or overlying sediment. In the case of the estuary environment (35DO130), shifting environmental conditions can abruptly alter site function, potentially isolating the site from its current environmental context.

3.2. Archaeological Site Types and Spatial Distribution in a Coastal Landscape

In 1992, a multi-year project began to survey, radiocarbon date, and evaluate archaeological sites located within State Parks lands along the Oregon coast (Moss and Erlandson 2008). As a result of the project, 89 sites were nominated for listing on the National Register of Historic Places (NRHP) in 1996. As part of that 1996 NRHP Multiple Property Documentation Form, a Statement of Historic Contexts, Section E was completed that discussed Native American property types identified during the State Parks inventory. Although the study area of this current project considers lands located both within and outside of Oregon State Parks, the site type classification provided by Moss and Erlandson

is a useful summation of general site types that can be applied throughout the Oregon coastal setting (Moss and Erlandson 2008).

Moss and Erlandson (2008) identify eight different Native American site types within the Oregon coast region, including shell middens, lithic sites, villages, ethnographic/ethnohistorical places, burial sites, intertidal fishing structures, quarries, and rock art sites (Table 3.1). These eight site types represent different cultural activities or functions that were specific to a particular part of the landscape. It is possible that multiple cultural activities could have occurred within a single site, such as a village that contains both shell middens, and intertidal fishing structures (Moss and Erlandson 2008). In addition to a site's activity or function, a property type can also be classified by its particular coastal setting, as reflected in its specific depositional or environmental context. As would be expected, archaeological site types are not found randomly within the landscape but are connected to various environmental zones where these activities or resources occur.

The next chapter will consider the archaeological preservation potential of each of the different site types proposed by Moss and Erlandson (2008) within different environmental zones located throughout the coastal landscape. Ethnographic/ethnohistorical places will not be included as part of this study due to the potential that some ethnographic/ethnohistorical places may not include archaeological remains and that many ethnographic/ethnohistorical places that would contain archaeological remains are likely be included within the other seven categories.

Table 3.1. Correlation table between hypothetical coastal site types and environmental zones.

		Environmental Zone					
		Maritime	Littoral	Estuary	Coastal plain and headland	Alluvial valley and upland	Montane and headwaters
Site Types	Shell middens		x	x	x		
	Lithic sites				x	x	x
	Villages		x	x	x	x	
	Burial sites			x	x	x	x
	Intertidal fishing structures			x			
	Quarries				x	x	x
	Rock art sites				x	x	x

CHAPTER 4. A MODEL OF COASTAL LANDSCAPE CHANGE

The physical and biological context of the modern central Oregon coast is the result of a complex mixture of terrestrial and marine processes that have been at work for thousands of years shaping the landscape into what we see today (Wells 2001; Orr and Orr 1999). Understanding these processes is an important first step when considering how Native peoples may have utilized coastal resources and moved throughout the landscape. Considering coastal processes, what types of resources or places were important to early coastal peoples, and where in the paleoenvironment those resources would be located will help researchers to evaluate in what conditions or site formation scenarios would archaeological remains be preserved in the coastal landscape (Davis et al. 2009).

4.1. Environmental Zones Within a Coastal Landscape

Within a coastal landscape, multiple environmental zones exist and these can be associated with different types of human activities (Waters 1992; Davis et al. 2009). Six environmental zones are conceptualized to extend from near the Pacific Ocean's shoreline to the headwaters of the Coast Range and include: maritime; littoral; estuary; coastal plain and headland; alluvial valley and upland; and montane and headwaters areas. Because they offer different resources and other natural attractions, they are variously associated with the eight primary archaeological site types previously identified within the central Oregon coast. Thus, we should expect that different kinds of archaeological sites, bearing different material signatures associated with specific activities, should be found in association with the different environmental zones. This cultural-environmental relationship is fundamental to a more complete understanding of site type distribution in a changing coastal landscape.

Listed below is a brief description of the physiographic extent of each of the environmental zones, a summary of site types that are expected at each of the zones, and a description of the resulting hypothetical archaeological record and resulting stratigraphy that could be expected. Assumptions about the location of site types within the landscape and any possible resulting stratigraphy are based on ethnographic and or archaeological analogy of known or presumed environmental conditions present within the study area during the late Pleistocene. It must also be expected that significant variability can occur among site types found within each of the six environmental zones. The hypothetical archaeological record and resulting stratigraphy associated with each site type and depositional context of different each environmental zones could also vary widely.

4.1.1. Maritime Environmental Zone

For the purposes of this model, the maritime environmental zone includes areas of open water extending to the base of the intertidal zone that are solely accessed with watercraft. Because the maritime zone is located exclusively within deeper, open water, no terrestrial sites or stratigraphy are expected to exist. Depending on the proximity of a site to the open ocean, archaeological remains from maritime zone activities could be expected to appear at sites within the littoral, estuary, or coastal plain and headland zones. As sea level rises, many sites and their associated submerged landscapes are eventually incorporated into the maritime environmental zone.

4.1.2. Littoral Environmental Zone

The littoral environmental zone includes areas located along both open and protected coastlines from the base of the intertidal zone up to the high tidewater line (Wells 2001). This zone includes rocky and sandy beaches, rock exposures, and mudflats that are not partially protected within bays. Site types expected

within the littoral environmental zone include shell middens and villages. The littoral zone is generally considered a high-energy geomorphic environment with low preservation potential for stratified terrestrial deposits (Wells 2001). However, the “late-Holocene buried forest scenario” presented by Hart and Peterson (2006) and site burial by landslide are two examples where stratified cultural deposits could be preserved in a littoral setting. In the case of the “late-Holocene buried forest scenario”, late Holocene-aged forests that were growing on marine terraces located adjacent to the beaches were overrun and buried with dune deposits that were then protected and preserved by the sand. Subsequent wave erosion and the retreat of the sea cliffs exposed the buried forest deposits and possibly any potential cultural deposits they might contain. The second preservation scenario could occur when a cave that was once utilized by humans is buried by colluvium thereby encasing and preserving any cultural deposits. Remaining archaeological materials in this zone could include deposits that have been previously deposited and subsequently reworked in place by wave action or materials that have been eroded and transported to the present location from a nearby deposit possibly within the coastal plain and headland zone. Stratigraphy that is representative of a “late-Holocene buried forest scenario” would include sorted, coarse-grain beach deposits (sand to cobbles) overlying terrestrial forest soil deposits. Representative stratigraphy associated with the second scenario, potentially including the burial of cave features, should include fine-grained, well-sorted beach or aeolian deposits that are overlain by poorly sorted colluvium.

4.1.3. Estuary Environmental Zone

The estuary environmental zone includes tidal flats and inlets extending up to the highest point reached by high tide (Huggett 2003). The estuary environmental zone will always include a mixture of both fresh and salt water that is at least partially by open water and always open to the ocean. The primary site types expected within the estuary environmental zone include intertidal fishing structures. As a result of coseismic subsidence, burial by earthquake

induced tsunamis deposits, or sediment deposited by storm events, other site types may also be present in a buried context within this zone (Witter 1999; Cole et al. 1996; Minor and Grant 1996; Losey et al. 2000). Potentially buried site types could include shell middens, lithic sites, villages, burial sites, and intertidal fishing structures. Stratigraphy representative of this zone could include one or more sequences of buried marsh or forest soil (subsidence), buried layers of sand overlying forest soil (tsunami or storm events), or sand extruded into and extruded onto buried soil (liquefaction) (Atwater et al. 1995; Witter 1999). Cultural material could be found on the presently exposed ground surface or on any buried surface or surfaces within the stratigraphic sequence.

4.1.4. Coastal Plain and Headland Zone

The coastal plain and headland zone includes those areas extending from the eastern limit of beaches that are unaffected by tidal influence up to and including all low lying land adjacent to the shoreline and uplifted headlands that often overlook the shoreline (Orr and Orr 1999). Many areas of low-lying land or low terraces adjacent to the shoreline within the study area have been identified as late Pleistocene-aged wave cut terraces (Kelsey et al. 1996; Lund 1972; Orr and Orr 1999). Expected site types within the coastal plain and headland zone include shell middens, lithic sites, villages, burial sites, quarries, and rock art sites. Coastal plain cover sediments within the study area typically include coarse-grain sediment that represent the deposition of higher energy nearshore marine deposits, which underlie a sequence of consolidated Pleistocene age dune deposits, which are in turn capped by Holocene-aged aeolian sand (Kelsey et al. 1996; Ticknor 1993). Within the study area, a soil chronosequence has been developed for marine terraces, based on properties such as the depth to oxidized parent material, the thickness of the Bt horizon, estimated percent of clay, and degree of clay skin development (Kelsey et al. 1996). This relative chronosequence is useful for identifying time dependent soil properties in the field. Debris flow deposits and alluvial facies are also common in some parts of

this environmental zone and have the potential to introduce great variability in the depth and longitudinal extent of its deposits (Kelsey et al. 1996).

Four site formation scenarios have been developed for coastal headland sites located on the southern Oregon coast that can also be applied to the central Oregon coastal landscape (Davis et al. 2008). In scenario one, no new deposition of sediment occurs during the late Pleistocene to early Holocene, the surface is altered pedogenically and then subsequently occupied by humans but produces a cultural deposit with no stratigraphic resolution. Later, middle to late Holocene aeolian deposition occurs, capping the older deposits with sediment and stratified cultural deposits. In scenario two, stratified cultural deposits develop during the late Pleistocene and Holocene but is later eroded resulting in a lagged[6] surface containing a mixture of artifacts of all ages. In scenario three, both late Pleistocene and Holocene-aged aeolian sediments accumulate and are pedogenicaly altered suggesting some surface stability but contain erosional unconformities. In the fourth and final scenario, late Pleistocene and Holocene-aged alluvial and aeolian sediments accumulate exhibiting both pedogenic development and erosional unconformities (Figure 4.1).

4.1.5. Alluvial Valley and Upland Zone

The alluvial valley and upland zone includes all moderate gradient valleys, floodplains, and terraces, associated with fluvial processes. The zone also includes areas of moderate gradient slope representative of the footslope and low backslope of the Coast Range (Schaetzl and Anderson 2005). Site types that could be expected in this zone include lithic sites, villages, burial sites, quarries, and rock art sites. Representative stratigraphy of the alluvial valley could include alluvial channel facies and associated fining-upwards sequences of floodplain sediments showing both vertical and lateral accretion. Cultural

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[6] Lagged is a geologic term used to describe the accumulation of unconsolidated rock left behind after the erosion the surrounding finer-grained material.

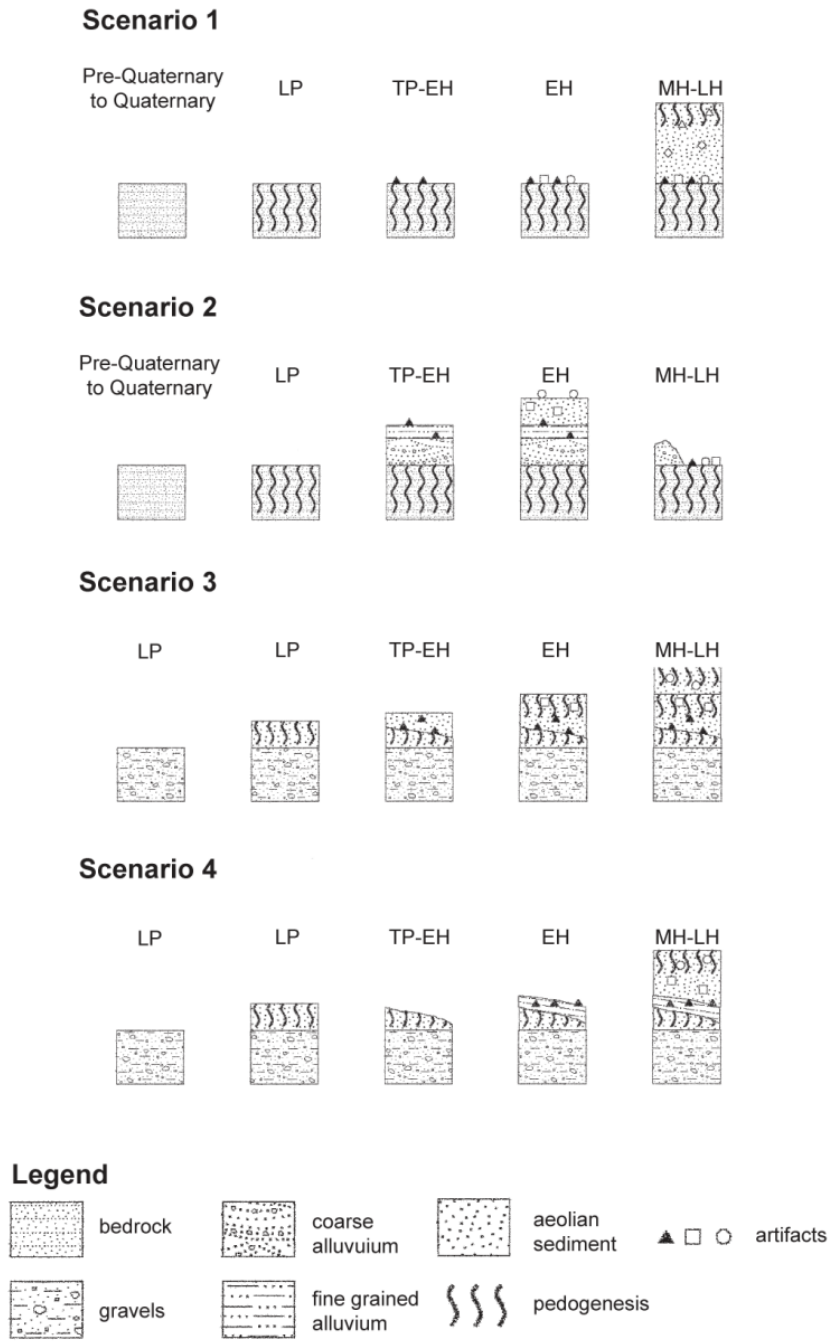

Figure 4.1. Four scenarios of coastal headland site formation taken from Davis et al. (2008). LP = late Pleistocene; TP = terminal Pleistocene; EH = early Holocene; MH = middle Holocene; LH = late Holocene.

materials could accumulate on stable surfaces as would be indicated by soil development. Overlying sediment could include both alluvium and or colluvial deposits possibly to thicknesses greater than 30 m (Waters 1992; Brown 1997; Punke and Davis 2003, 2006).

4.1.6. Montane and Headwaters Zone

The montane and headwaters zone includes all areas of high gradient that includes the upper backslope, shoulder, and summits of the coastal landscape (Schaetzl and Anderson 2005). Site types expected in this zone could include lithic sites, burial sites, quarries, and rock art sites. Representative stratigraphy of the montane and headwaters zone would include shallow to moderately deep soils formed within colluvium and residuum.

4.2. Spatial Distribution of Sites in a Changing Landscape

As reviewed in Chapter 2, many dynamic geomorphic processes are continually working to alter the coastal landscape at variable scales of space and time. Only by first identifying what site types are represented within a coastal landscape, and then by determining where those sites types would most likely be located, are we then able to then ask the important question of how has the central Oregon coastal landscape change since the LGM affected the preservation and visibility of archaeological sites?

Post-glacial relative sea level rise is one of primary factors responsible for modifying the paleocoastal landscape and the spatial and temporal distribution of archaeological sites (Waters 1992). As sea level rose after the LGM, the Oregon coastline was progressively displaced eastward and these shifting conditions would have correspondingly displaced early coastal peoples. As a result of the eastward compression within the coastal landscape, sites that were once located

within the littoral zone during the late Pleistocene and early Holocene would now be displaced eastward to occupy the coastal plain and headland zone (Figure 4.2). This is expected to produce a stratigraphic record consisting of coastal plain deposits comprised of consolidated Pleistocene age dune deposits (terrestrial) containing archaeological evidence of upland resource orientation, capped by a shell midden layer, reflecting littoral environmental use. Similarly, early cultural activities centered on the estuary environmental zone would be displaced up stream to a higher position within the alluvial system. In this example, a hypothetical stratigraphic record would consist of river terrace deposits containing a cultural assemblage including fresh water and terrestrial resources that underlie sediments and faunal resources reflecting brackish to brackish-marine conditions, representing a later development of tidal flats, marsh facies (Punke 2006).

4.3. Primary Factors Affecting Site Preservation in a Coastal Setting

Outlined below are four of the primary factors affecting archaeological site preservation within a coastal setting. Although numerous processes are present within a coastal landscape that have the ability to preserve, alter, and destroy cultural deposits, most can be placed within one of these four primary factors to include: marine transgression, tectonic uplift, erosion, and post depositional disturbance.

4.3.1. Marine Transgression

As mentioned earlier in the chapter, relative sea level rise or marine transgression is one of primary factors responsible for modifying the paleocoastal landscape (Waters 1992). As sea levels rose, environmental zones and any archaeological sites associated with those areas would have been displaced eastward towards the Coast Range. At that time, the width of the exposed

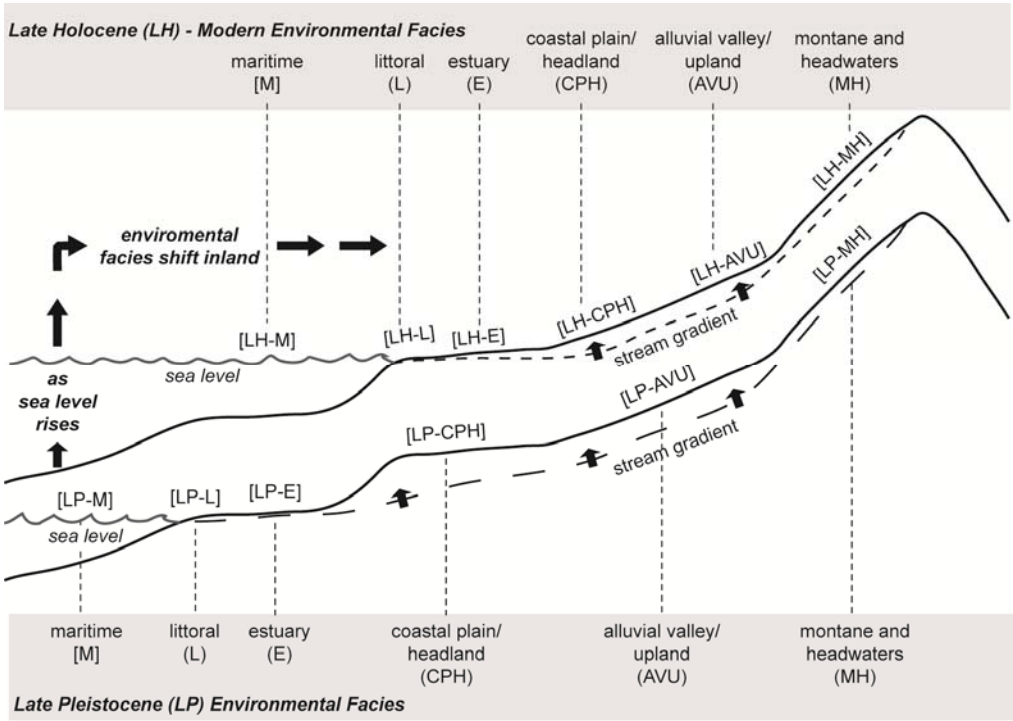

Figure 4.2. Model showing predictions of environmental zones and site functions as a result of shifting environmental conditions. Figure based on Davis et al. (2009).

continental shelf within the study area would have ranged from ~15 - 60 km (Davis et al. 2009). As a result of marine transgression, coastal sites that date to pre-modern sea levels would be submerged and possibly buried by Ocean sediments. Today, the central Oregon coast is considered to be a “high-energy” erosional environment due to the unrelenting geomorphic force of wind-driven waves (Wells 2001). In this environmental setting, it is difficult to imagine that ancient coastal landforms or any archaeological materials within them that would have been present prior to inundation would be preserved.

In other parts of the world, archaeological sites that predate modern sea level have been found within a submerged context where the coastal environment is considered to be “low-energy”, or within a depositional environment that receives a net gain of new sediment (Waters 1992). A recent GIS paleogeographic reconstruction of the central Oregon coast by Davis et al. (2009) shows that prior to 11,250 cal BP, when sea level was -70 m, the Oregon shoreline appeared very differently than today. The shoreline was not straight like the modern coastline but contained large bays and was sheltered by a large northeast - southwest trending coastal ridgeline that progressively became islands as sea level rose. Portions of this paleocoastal landscape would have been located within “low energy” environments with extensive dune deposits (Beckstrand 2001; Peterson et al. 2007). Extensive dune deposits present on the continental shelf during the late Pleistocene could have potentially deeply buried and preserved archaeological materials, protecting them from the erosive forces of rising sea levels. This situation could occur when an incised river valley and its associated river terraces would be overrun by shifting dunes, allowing for the quick and deep burial of potential terrestrial soil and archaeological materials. The effects of marine transgression have undoubtedly been a major factor in the destruction of archaeological sites within a coastal setting. There are however situations within the study area that preservation of sites within a submerged context could occur.

4.3.2. Tectonic Uplift

Acting at variable scales of space and time along the Oregon coast, tectonic uplift has the ability to contribute to both the preservation and destruction of archaeological sites. Tectonic uplift that is often associated with marine headlands or terraces along the Oregon coast is generally considered a key factor contributing to site preservation (Davis et al. 2008). These features are generally geomorphically stable and in some cases have had time to accumulate sediment throughout the late Pleistocene. Many of the earliest sites that date to the early-mid Holocene recorded along the Oregon coast have been located on uplifted landscape features (Davis et al. 2008; Connolly and Tasa 2008). The abundance of sites found on uplifted headlands may be as much of a product of a landform's accessibility and visibility by the modern archaeological surveyor as it is to an apparent preference for use by early native peoples (Davis et al. 2008). The margins of many uplifted marine terraces and headlands have areas of reduced vegetation, exposed stratigraphic sequences that are easily accessible and aid the surveyor in identifying buried cultural materials.

Just as tectonic uplift has the ability to elevate and preserve some coastal features; it can also have the opposite effect by lowering and destroying others. On the southern Oregon coast, Punke and Davis (2006) explored how upper-plate deformation has modified fluvial systems by laterally displacing drainages preserving some late Pleistocene-aged deposits and destroying or deeply burying others. Their study showed that the preservation of late Pleistocene-aged terrestrial deposits are partly related to tectonic processes that, once understood, can be used to focus survey efforts onto those parts of the coastal landscape that could contain well preserved deposits of the right age.

4.3.3. Erosion

Much of the cover sediments found within the study area consist of aeolian sand and loess (Kelsey et al. 1996). Although deposits of residuum and alluvium are common within the study area, the primary parent material is aeolian sand, silt, and clay that were deposited during the late Pleistocene and Holocene (Beckstrand 2001; Peterson et al. 2007). As a result of the weathering process, dune deposits that have been altered by pedogenesis generally become more stable with time (Kelsey et al. 1996; Langley-Turnbaugh 1995; Schaetzl and Anderson 2005). Throughout the study area, numerous paleosols are visible within the with dune deposits that represent periods of landscape stability (Peterson et al. 2007; Davis et al. 2009).

Dune deposits that blanket the surfaces of many marine terraces and headland sites along the central Oregon coast are continually subjected to the erosional effects of the wind, surficial water, and the wave action of the Pacific Ocean (Soil Survey Staff 1993). Many stratigraphic exposures observed along the coast show evidence of unconformable surfaces that are the result of erosion by geomorphic agents (Davis et al. 2009; Waters 1992). Some of these contacts appear as varying degrees of contrasting parent material, truncated bedding structures, abrupt smooth boundaries, or as geomorphic features such as infilled alluvial channels. Geoarchaeological investigations along the Oregon coast have revealed characteristic stratigraphic patterns at different sites in which the upper portion of the solum within a buried soil has been eroded, leaving behind a truncated, highly weathered Bs horizon (Davis et al. 2008; Davis 2006). Areas such as headlands and the outer margins of marine terraces are also affected by the Pacific winds that continually erode and create areas of blowouts and lagged lithic pavements making it difficult to date or to demonstrate association of artifacts in those areas (Davis et al. 2004; Hall et al. 2005).

Erosion from coastal shoreline retreat is another major factor affecting the integrity of sites along the central Oregon coast (Minor 1986; Erlandson and Moss 1993; Ruggiero 2008). This process has undoubtedly been in effect along the Oregon coast throughout time, eroding coastal features, and reworking and redepositing sediment back into the ocean (Wells 2001). Many of the late Holocene-aged archaeological sites located along the central Oregon coast contain shell middens that form distinct stratigraphic sequences that often are exposed high above the beach surface (Minor 1986; Erlandson and Moss 1993). These “hanging” deposits illustrate the ongoing erosion that is occurring from shoreline retreat. Sites that are now located many meters above the shoreline were once connected to the beach by dune ramps that have since eroded leaving these sites seeming now removed from the ocean (Minor 1991; Hart and Peterson 2007). Although the ongoing process of coastal erosion along the modern beachline will persist until the next glaciation, it is important for archaeologists working in a coastal setting to understand the source of disturbance and the potential effects erosion has and will have to archaeological sites and the materials they contain.

4.3.4. Post Depositional Disturbance

Previous chapters reviewed some of the geomorphic processes and primary factors affecting archaeological site preservation within the central Oregon coastal landscape. Although not as dynamic as rising sea levels, post depositional disturbances have the ability to alter the character or visibility of archaeological sites and their contents. For this study, the use of the term “post depositional disturbance” implies large-scale natural processes that have the ability to destroy, significantly alter, or affect the visibility of archaeological sites at the scale of coastal landscapes. These processes should not be confused with the numerous intersite cultural and natural disturbances that can occur to archaeological materials after they were originally discarded (Schiffer 1987; Stein 2001). It is important for archaeologists working within a coastal setting to be

able to identify the site level post-depositional processes that are the result of both cultural modifications and natural processes. Some of these natural processes include the vertical and horizontal displacement of artifacts through means of bioturbation (faunalturbation, floralturbation), graviturbation, deformation, chemical alteration by soil and groundwater, and pedoturbation (Schiffer 1987; Johnson and Watson-Stegner 1990; Waters 1992; Stein 2001; Surovell et al. 2005).

Landscape-scale post depositional site disturbance processes identified within the study area include deep burial by aeolian and alluvial sedimentation, direct and indirect effects of fire, deep burial or destruction by mass wasting, landform destruction by wind and water-driven erosion, floralturbation, and modern anthropogenic impacts related to coastal development and other activities. Both Grigg and Whitlock (1998) and Personius (1993) describe that between 13,500 and 11,000 cal BP that the LPEH paleoclimate of the central Oregon coastal region as being warmer and drier than modern conditions, with summer drought and frequent fires. Large wildfires have the ability to reduce surface vegetation, which in turn increases erosion during periods of heavy precipitation following a fire. Increased sediment loads within the river systems of the central Coast Range would also translate into additional sediment being deposited on the coastal plain that could then be mobilized by wind as dune sand and/or loess. Under the climatic conditions described by Grigg and Whitlock (1998) and Personius (1993), early archaeological sites could be deeply buried within the landscape by mass wasting events, or by aeolian or alluvial deposition (Hall et al. 2005). Additional factors to consider include the inability of archaeological surveyors to locate surface artifacts or features obscured by dense vegetation. Many of the sites located on the coast are within headland settings or areas with some subsurface exposures that are provided either by rodent disturbance, modern development (e.g., road cuts), or natural exposures along the faces of cutbanks (Davis et al. 2009; Minor 1986; Erlandson and Moss 1993). Modern impacts related to human coastal development could have a

significant effect on the visibility and preservation of sites within all coastal environmental zones.

CHAPTER 5. METHODOLOGICAL APPROACHES TO PALEOLANDSCAPE RECONSTRUCTION ALONG THE CENTRAL OREGON COAST

The spatial distribution and preservation of archaeological sites within Oregon's coastal landscape has undoubtedly undergone considerable change as a result of marine transgression and other environmental processes since the LGM (Davis et al. 2009; Lyman 1991). Acknowledging this, researchers interested in elucidating the archaeological record of Oregon's coastally adapted peoples must first understand the complexity of processes occurring within the dynamic coastal landscape (Waters 1992).

5.1. Visualizing Ancient Landscapes in a Modern Context

To help visualize the coastal landscape that existed in the study area prior to modern sea level, a paleolandscape reconstruction of the central Oregon coast was created using a Geographic Information System (GIS). The following section provides a technical overview of this visualization process. Modern hydrographic survey data obtained from the National Geophysical Data Center (NGDC) at (http://www.ngdc.noaa.gov/mgg/bathymetry/hydro.html) were used to modify an integrated 1/3 arc-second (~10 m grid) bathymetric-topographic Digital Elevation Model (DEM) also obtained from the NGDC for the central Oregon coast (http://nctr.pmel.noaa.gov/). The NGDC DEM was supplemented with additional hydrographic survey data obtained from the NGDC online National Ocean Service (NOS) hydrographic database (http://www.ngdc.noaa.gov/mgg/bathymetry/hydro.html) in order to extend topographic coverage beyond the -114 masl contour (i.e., the 15,500 cal BP shoreline (Fairbanks 1989)). Hypothetical shelf hydrography was modeled using Hydro Tools within ArcGIS software and exported to a feature data set. For this conceptual model, only those streams that currently flow into the Pacific Ocean were extended onto the shelf to the -114 masl bathymetric contour. Figure 5.1 shows the resulting paleolandscape

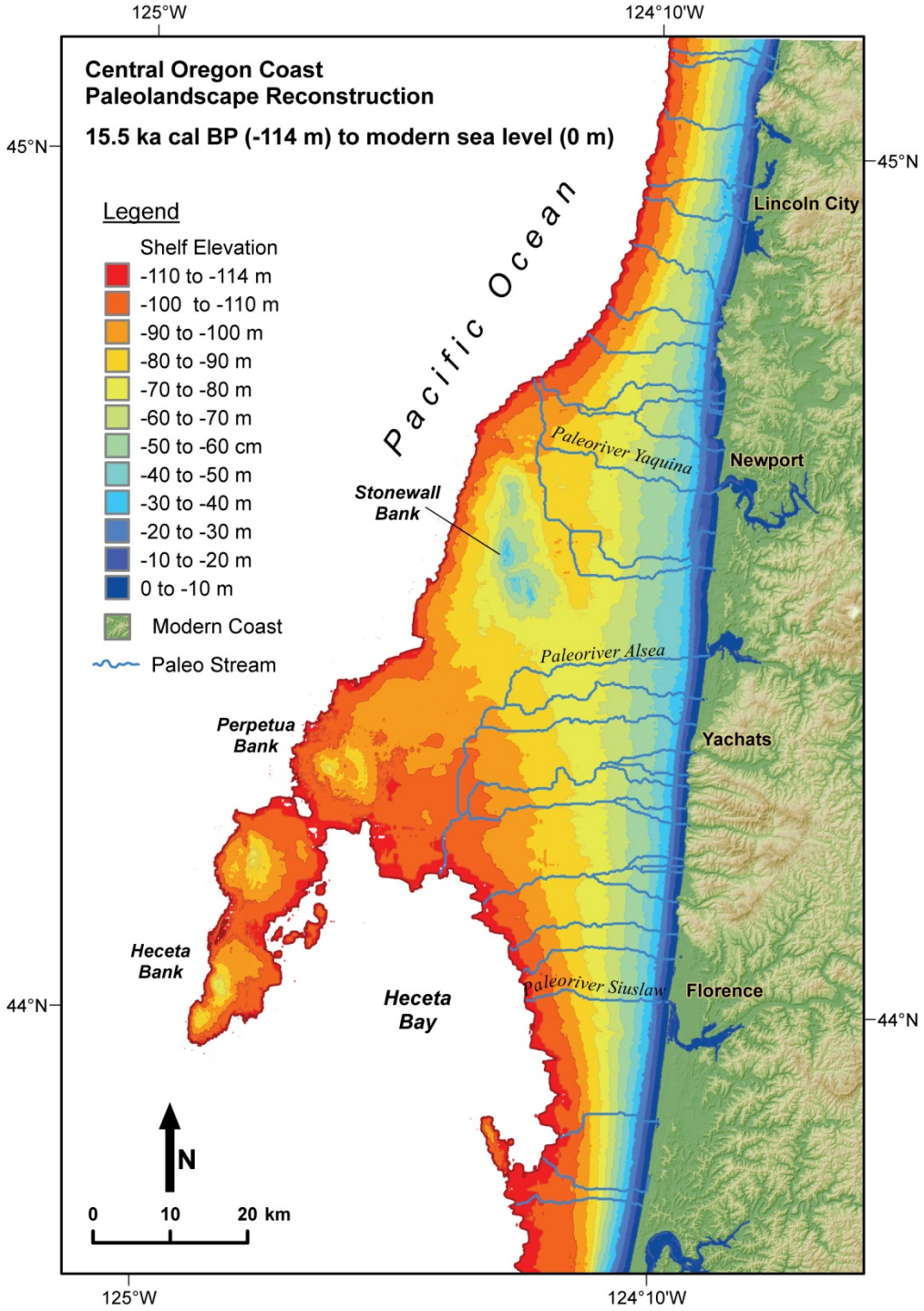

Figure 5.1. GIS paleolandscape reconstruction of the central Oregon coast.

reconstruction of the central Oregon coast modeled from -114 masl to 0 masl below sea level.

This model does not account for known post LGM tectonic deformation along the near shore shelf zone (Yeats et al. 1998). Due to the current lack of quantitative data related to rates and extents of offshore neotectonic movements within the study area since the LGM, paleoshorelines and paleolandscapes are modeled solely from current bathymetric configurations and post-LGM eustatic rates of marine transgression based on Fairbanks (1989), and as a result, the accuracy of this GIS model may be incorrect to some unknown degree. Therefore, this model is intended to serve as a general heuristic tool in order to visualize probable coastal paleolandscapes and is not presented as a precise landscape reconstruction.

By combining the GIS paleolandscape model of the central Oregon coast with estimations of sea level rise since the LGM, we may better understand diachronic changes to the coastal environment and the potential effects it would have had on the redistribution of archaeological sites within the coastal landscape. Davis et al. (2009) used a paleolandscape reconstruction similar to the one applied in this study to theorize about post-LGM landscape change along the central Oregon coast. In the following section, I will review and add to the observations made by Davis et al. (2009), detailing synchronic landscape changes within the central Oregon paleocoastal environment during four time periods: 15.5 ka cal BP(-114 masl), 12.5 ka cal BP (-90 masl), 11.25 ka cal BP (-70 masl), and 6 ka cal BP (-10 masl).

At 15.5 ka cal BP, when sea level was at -114 masl, the coastal landscape looked very different then it does today (Figure 5.2a). The now submerged northeast to southwest trending ridgeline comprised of the Hecata, Perpetua, and Stonewall banks formed an emergent peninsula that extended ~35 km south

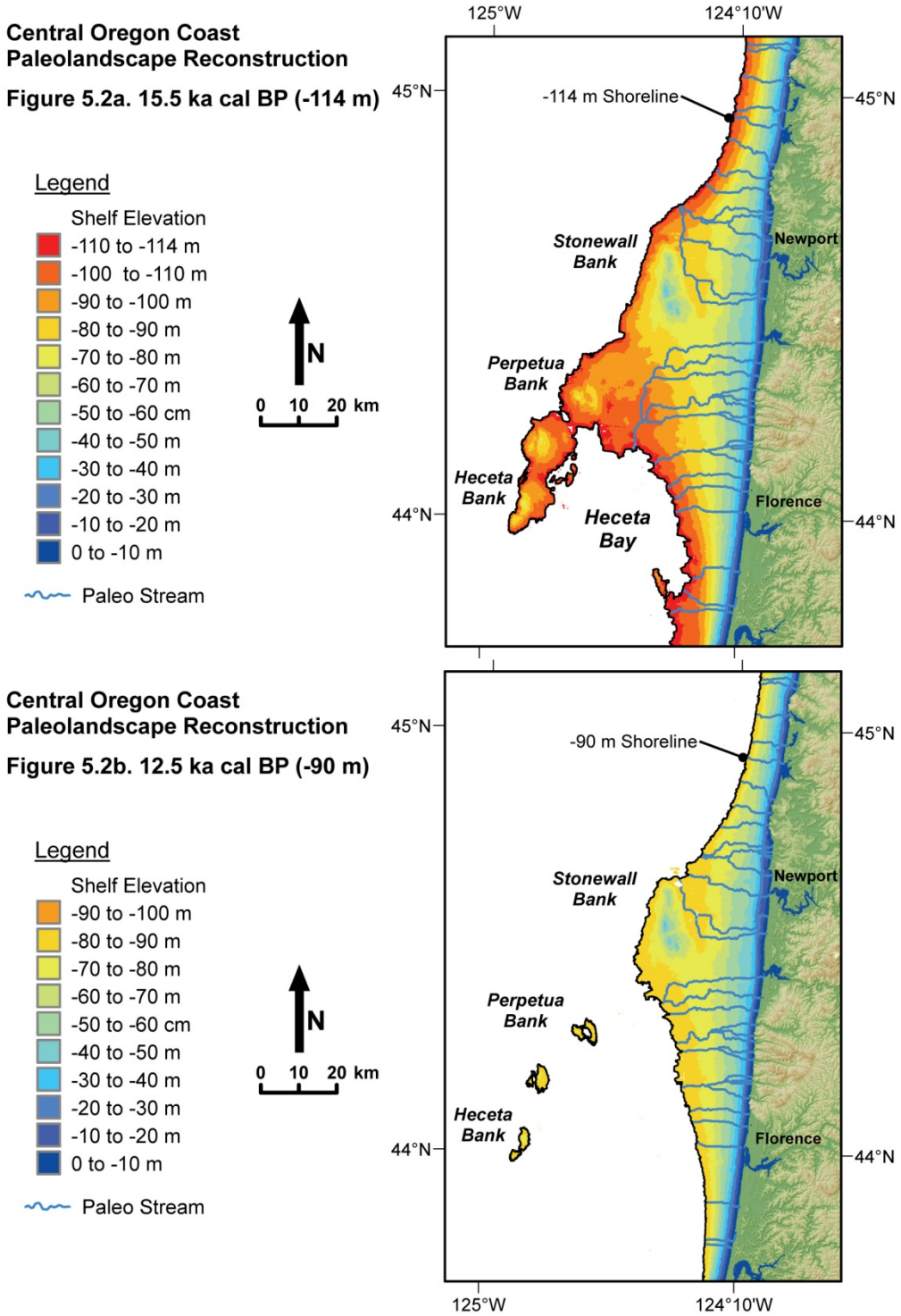

Figure 5.2a,b. Synchronic GIS paleolandscape reconstruction of the central Oregon coast shown at 15.5 ka cal BP (-114 m), and 12.5 ka cal BP (-90 m).

from the mainland, and rose ~30 m above its coastline. Modern shelf deposits along the outer western coast and the eastern bank of the peninsula have been classified as rocky (Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences, Oregon State University 2009, http://pacoos.coas.oregonstate.edu), and may have been a productive area for littoral resource procurement that was sheltered from northern and western winds. A large bay, which I term “Heceta Bay”, existed at the southern end of the study area, measured over 30 km wide at its mouth and extended inland for another 30 km, and undoubtedly offered a wide range of resources that would have been available to early coastal peoples. Rocky shorelines that formed the eastern shore of the peninsula may also have been a productive and favorable location for early coastal peoples. Sixteen modeled rivers, including the Paleoriver Alsea and Paleoriver Siuslaw, would have flowed onto the coastal plain and converged into six larger rivers that ultimately emptied into ancient Heceta Bay. A vast, low gradient coastal plain extended between 14 km and 50 km inland, and rose only 114 m in elevation to the footslope of the Coast Range. At this time, the central Oregon coastal landscape that is now submerged below modern sea level measured 444,997 hectares (ha) in area (1,099,612 acres).

By 12,500 cal BP, the Pacific Ocean moved to -90 m and the central Oregon coastal landscape had changed significantly (Figure 5.2b). At this time, only the Stonewall Bank remained connected to the mainland. The low ridge that once connected to the mainland disappeared, and the ridgeline summits of Hecata and Perpetua Bank now appeared as islands. The modern lithology surrounding Stonewall Bank is classified as rocky but most other areas of this landscape are identified as sandy or muddy primarily within the area of the now inundated Heceta Bay (Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences, Oregon State University 2009, http://pacoos.coas. oregonstate.edu). Although Heceta Bay was inundated by this time, the paleoshoreline possessed more physiographic variability than the modern coast, and probably contained numerous pocket bays and sheltered inlets, some

possibly extending several kilometers inland. Many of the modeled rivers that would have flowed onto the coastal plain did not converge with other rivers but appear to have run independently into the Pacific Ocean. At this time, the coastal landscape measured 279,501 ha in area (690,662 acres).

At 11.25 ka cal BP when sea level was at -70 masl, the coastline took on a rather straight appearance, reminiscent of its modern form (Figure 5.3a). The previous summits of Hecata and Perpetua Bank were submerged; Stonewall Bank was located more than 7 km offshore, and the width of the coastal plain averaged between 5 km and 13 km. Modern sediment covering this area of the shelf is classified primarily as being sandy. At this time, the coastal landscape that is now submerged below modern sea level measured 147,005 ha in area (363,257 acres).

By 6 ka cal BP when sea level was at -10 masl, the coast would have looked much as it does today (Figure 5.3b). The coastline was straight and possessed a narrow coastal plain averaging less than 1 km in width. Stonewall Bank became fully submerged and all rivers flowed directly into the ocean instead of across a broad coastal plain. At this time, the coastal landscape that is now submerged below modern sea level would have measured 16,531 ha in area (40,849 acres).

5.2. Approaches to Finding Early Sites Within the Modern Coastal Landscape

In the previous chapters, I reviewed some of the geomorphic processes and primary factors affecting archaeological site preservation within the central Oregon coastal landscape. I also discussed how marine transgression and associated environmental changes displaced coastal resources and undoubtedly altered the spatial distribution of archaeological sites within the coastal landscape

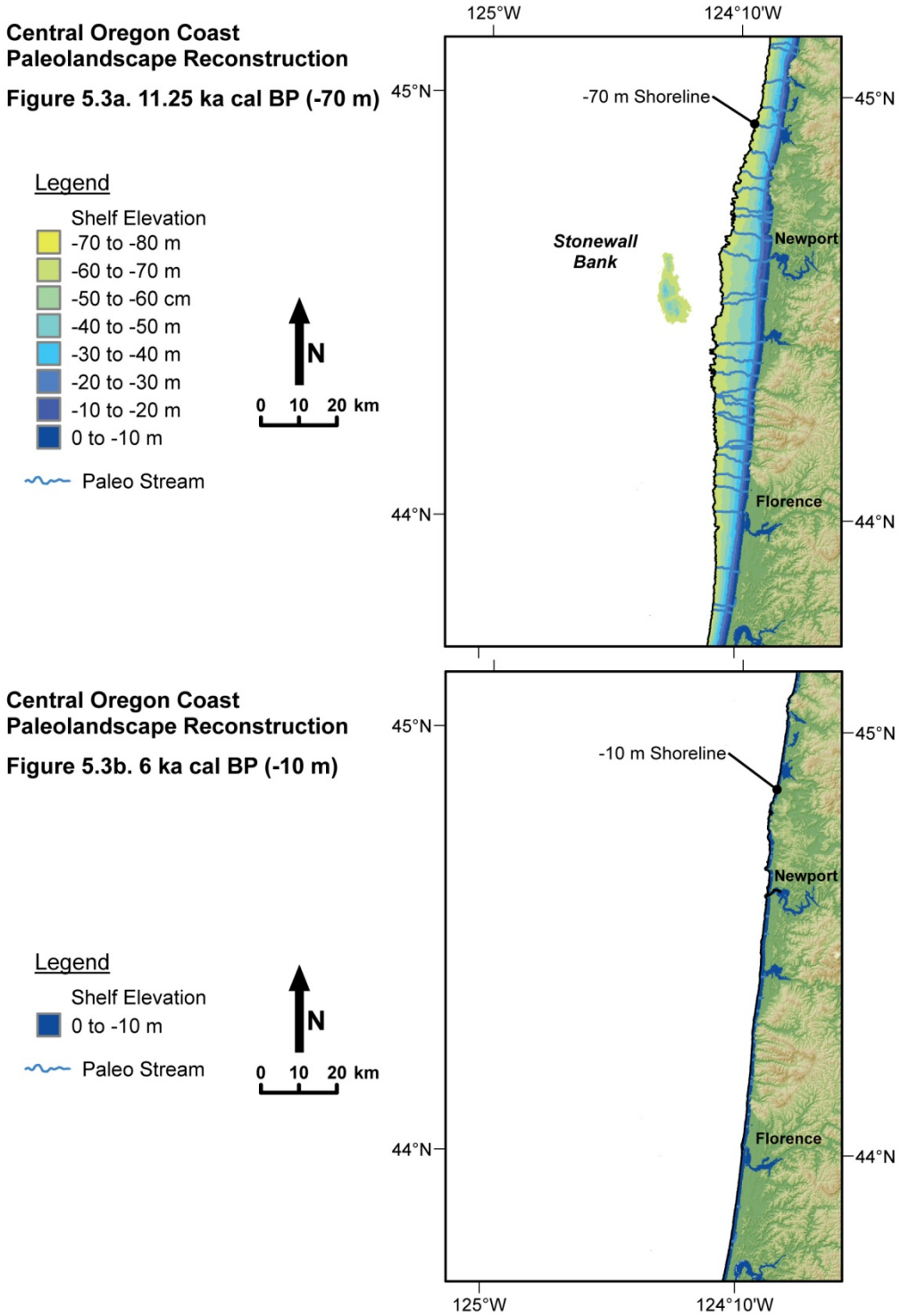

Figure 5.3a,b. Synchronic GIS paleolandscape reconstruction of the central Oregon coast shown at 11.25 ka cal BP (-70 m), and 6 ka cal BP (-10 m).

since the LGM. Building on this knowledge, we can turn to the question of how one might find early archaeological sites within the current coastal landscape.

Stratigraphic exposures visible along Oregon's modern coastline reveal portions of ancient landscapes that have been truncated by marine transgression and the arrival of modern sea level (Davis et al. 2009). Because of their position relative to their ancient paleolandscape context, early sites that would be found in today's modern coastal environment will reflect cultural activities associated with inland terrestrial and aquatic environments that lay east of ancient coastlines (Figure 4.2). Thus, efforts to find early archaeological sites within the modern coastal landscape must focus on identifying upland areas that were used by early coastal peoples and not on shell middens, which reflect marine or littoral adaptations in areas long-since submerged beneath the ocean. As discussed previously, many factors and processes have been at work since the LGM to obscure, alter, and destroy what may be left of these early sites. One of the most potentially effective means of identifying elusive early sites in a coastal landscape is to identify sedimentary deposits that remain within parts of the modern landscape that date to the period of interest (Waters 1992; Hall et al. 2005). This is best accomplished through the use of geoarchaeological techniques and approaches that; (1) identify sediments and landforms that date to the period of interest, (2) identify the cultural and natural factors responsible for site formation and post depositional alteration, and (3) reconstruct the coastal landscape that existed near a site or area of interest.

5.3. Central Oregon Coast Archaeological Site Modeling

5.3.1. Background

Archaeological predictive models are tools that allow researchers to make informed guesses about where archaeological sites may or may not be found

within a modeled landscape (Gibbon 2000; Kvamme 2006). The general theoretical basis for archaeological predictive models is that environmental attributes such as slope or proximity to a permanent water source can be correlated with archaeological site locations (Gibbon 2006). This is grounded in the theoretical assumption that past human behavior was not random and that site locations were chosen, in part, based on the spatial distributions and patterning of key resources within their landscape. Therefore, it is expected that certain landscape features associated with resources or places preferred by native peoples are more likely to contain the archaeological remains of those activities than are other places. Two general types of predictive models exist, including inductive or "correlative" models and deductive models (Kvamme 2006; Gibbon 2000). Inductive models use statistical methods to select variables or more appropriately "estimating" approximate weights for theoretically derived variables. Deductive models use a researcher's *a priori* knowledge to select meaningful variables, based on certain knowledge of the study area, previous work experience, and theoretical background for the area being modeled. For this study, a deductive model will be used due to the lack of available data for both site locations and the paleoenviromental conditions present within the study area during the period of time being modeled.

5.3.2. The Central Oregon Coast Paleolandscape Model

In a effort to answer the three basic research questions posed by the project--how has the central Oregon coastal landscape changed since the LGM?, how would those changes affect the preservation and visibility of archaeological sites?, and how might we locate sites of certain ages on the central Oregon coast?--a GIS model of the central Oregon coast was created in order to help visualize concepts of landscape change and archaeological site preservation for a landscape that existed prior to the arrival of modern sea level. The developed model is grounded in deductive reasoning that is informed by our current

understanding of past cultural patterns and environmental variables within the central Oregon coastal landscape.

5.3.3. Data Quality and Error

The central Oregon coast GIS model is not intended to mirror other archaeological predictive or sensitivity models in its application or complexity. This model, although quantitative in nature, includes several assumed numerical values and was developed as heuristic tool to conceptualize past human activities within a paleolandscape that no longer exists. This model is based on assumptions about the past paleoenviromental context and or cultural preferences that existed along the central Oregon coast. Preferences related to site and resource selection by early native peoples is grounded in our current understanding of the modern coastal landscape. In this case, ethnographic analogy and our current knowledge of the coastal landscape is the best tool to conceptualize the spatial patterning or resources and the foraging potential of those areas throughout paleolandscape. Specifics about the size and quantity of potential resource patches or the foraging potential of these areas by early coastal peoples is all assumed based on these understandings about the LPEH environment. These assumptions intrinsically relate to the archaeological site spatial distribution, the position of key resources such as streams, past environmental conditions to include climate, and finally, human behavior (Kvamme 2006; Punke 2001).

Significant error is inherent in any attempt to turn modern bathymetric conditions into predictions of what the actual subareal landscape may have been like. For example, work conducted along the Stonewall anticline by Yeats et al. (1998) showed that a feature interpreted as a remnant stream channel associated with an LGM-aged extension of the Yaquina River might have been altered since the LGM by neotectonic shelf deformation. Crustal warping from the Stonewall anticline appears to have tilted the hypothesized remnant stream

channel towards the east resulting in the infilling of the eastern side of the channel with mud (Yeats et al. 1998). Hydrological modeling produced in this thesis, which is based on modern bathymetry, projects the Paleo Yaquina River as flowing northwest along the Newport syncline, and not within the hypothesized paleochannel identified by Yeats et al. (1998). Differences in paleolandscape modeling like these have significant implications for predicting the spatial distribution of early sites, and ultimately must be accounted for if more detailed analysis is conducted for a particular area in the future. Identifying and accounting for all such errors within the study area is beyond the scope of this current project. Despite known discrepancies such as the one just described, the goal of producing the GIS paleocoastal landscape model was to relate elements of the fragmentary ancient coastal landscape that exists along Oregon's modern coastline with submerged landscape features as a means of generating a more holistic paleolandscape perspective. The resultant model serves well for the stated purposes of this thesis, but caution must be exercised when attempting to use it for more detailed analyses.

A key requirement of any predictive model is that its accuracy can be tested; however, testing can be very difficult is the case with the current thesis project where most of the coastal landscape that dates to pre-modern sea level has been displaced and compressed eastward and is now expressed in fragmentary stratigraphic remnants within a narrow fragmented strip of modern coastline. No prehistoric sites predating 6,000 cal BP have yet been located offshore along the Oregon coast and very few sites that predate the arrival of modern sea level have been found within the terrestrial environment.

In the absence of more information about the distribution of Oregon's early coastal sites, GIS may be further employed to generate a predictive model of early site locations, based on the foraging potential of different parts of the modeled ancient coastal landscape. Without known sites to compare and test the model for accuracy, the model will remain a deductive conceptual tool based

on theoretical assumptions about the central Oregon paleocoastal environment and its Native peoples. The model was also not intended to produce an output prediction for each map unit of either “site present” or “site absent” that is common with archaeological predictive models. The final map unit output was based on a cumulative score of the sum of the combined environmental attributes included within the analysis with higher values hypothesized as more attractive to coastal foragers than areas with lower values.

5.3.4. Procedures

In order to build a model that predicts site location based on the distribution of favorable environmental elements in Oregon’s ancient coastal landscape, key data were assembled, including an estimate of the paleocoastal landscape’s surficial geology based on recent efforts to map regional sea floor sediments, GIS-based hydrological projections of streams along the shelf surface, and finally, slope and calculated solar insolation values that were derived from modern bathymetric DEM data. These data, which represent environmental characteristics of the study area’s paleolandscape, were assigned arbitrary quantitative values in order to highlight their relative resource potential for early coastal foragers.

Spatial data representing the shelf’s surficial lithologic or sedimentary characteristics within the study area were obtained from Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences, Oregon State University (http://pacoos.coas.oregonstate.edu). The data represents a modern representation of a best estimate of the most abundant surficial deposits present on the sea floor. Data classes from the SGH_lith1 field, which is the primary surficial lithologic category, include rock, sand, mud, gravel, shell, and cobble. These shelf feature data were converted to a 10 m square raster grid file and values were assigned to each of the six lithologic classes to include: rock = 50, sand = 30, mud = 40, gravel = 20, shell = 10, and cobble = 15. Each score

represents a relative and heuristic environmental value that the substrate would have provided. For example, rocky and muddy substrates are known to provide more productive habitats for a range of intertidal and estuarine vertebrate and invertebrate organisms, than do landforms comprised of sandy, gravelly, shelly, or cobbly sediments, and were subsequently given higher scores to reflect their relative foraging potential.

An integrated 1/3 arc-second (~10 m grid) bathymetric-topographic DEM was obtained from the National Geophysical Data center (NGDC) of the central Oregon coast and was used as a source to create other project data for the study (http://nctr.pmel.noaa.gov/). The NGDC DEM was supplemented with hydrographic survey data obtained from the NGDC online National Ocean Service (NOS) hydrographic database (http://www.ngdc.noaa.gov/mgg/bathymetry/hydro.html). Using Hydro Tools, a flow accumulation raster was created from the integrated DEM. Grid values >5,000 were reclassified to 1 and values <5,000 were assigned a value of 0. The flow accumulation raster was converted to a polyline feature and stream order was assigned to the modeled streams using the Strahler system (Huggett 2005). Streams were buffered according to the assigned stream order converted to a polygon feature file (Stream order (SO) /buffer, SO1=10 m, SO2=30 m, SO3=50 m, SO4=75 m, SO5=100 m, and SO6=150 m). The stream order polygon feature was converted to a raster grid with 10 m cells. Grid cell values were reclassified based on stream order to equal SO1=5, SO2=25, SO3=40, SO4=65, SO5=80, and SO6=100). Numerical values assigned to streams are used to represent the assumed value of associated riparian zones.

A slope raster in degrees was created from the DEM using the slope function of the Spatial Analyst extension in ArcGIS. The slope raster was reclassified to reflect desired slope values to equal 0 - 2° = 50, 2° - 5° = 30, and >5° = 5. The solar radiation analysis tool within the Spatial Analyst extension of ArcGIS was then used to determine the amount of radiant energy that was received from the

sun for each grid square included within the DEM. This function was used in place of the “aspect” function that calculates the downslope direction of grid squares where a value is assigned by the operator, which corresponds to the expected amount of radiant energy that particular aspect would receive. Before running the solar radiation analysis tool, the integrated DEM was re-sampled to a grid cell size of 100 m to reduce the file size and processing time. Solar insolation was calculated for the winter solstice and classified into 7 standard deviation (STD) levels to include: STD 1 = 408 - 476, STD 2 = 476 - 481, STD 3 = 481 - 487, STD 4 = 487 - 492, STD 5 = 492 - 497, STD 6 = 497 - 503, STD 7 = 503 - 568 (values rounded to the nearest whole number). Winter solstice was used to represent the low end of values expected within an annual insolation pattern of each cell being sampled. The seven classes were then reclassified into grid values equaling STD 1 = 0, STD 2 = 5, STD 3 = 25, STD 4 = 40, STD 5 = 65, STD 6 = 80, STD 7 = 100. The 100 m grid was then resampled back to a 10 m cell size for analysis.

All project calculations were performed using ESRI ArcMap 9.2 (ESRI Inc., Redlands, California) GIS mapping software with the Spatial Analyst, Arc Scene, and Arc Hydro extensions. Data was projected in World Geodetic System (WGS) 1984 UTM Zone 10N in meters. Vertical datum of the NGDC DEM was converted from mean high water (MHW) to mean sea level (MSL) in meters (-0.972 as estimated at the South Beach tide station #9435380).

5.3.5. GIS Analysis

As previously stated, one of the goals of constructing the central Oregon coast GIS model was to develop a GIS-based model to help conceptualize a paleolandscape that no longer exists. The second goal was to begin to investigate the potential spatial distribution of environmental attributes that would have been considered attractive areas for early coastal foragers, as a means of predicting site distribution in the ancient coastal landscape. Achieving this

second goal involved a GIS-based analysis that combined the arbitrary values assigned to modern shelf lithology (surface), hydrological projections of streams along the shelf surface (stream), slope (slope), and calculated solar insolation (solar) to produce a quantitative measure of paleoenvironmental resource productivity. The calculation is as follows:

$$\text{Sum} = ([\text{SURFACE}] + [\text{STREAM}] + [\text{SLOPE}] + [\text{SOLAR}])$$

5.3.6. Analysis Results

The final projection of the central coast paleolandscape resource productivity model is calculated at the scale of 10-meter grid squares. Analysis results displayed for the entire study area is shown in Figure 5.4. Detail GIS analysis for the study area located within Neptune State Park is shown in Figure 5.5.

5.4. Landscape Reconstruction at Neptune State Park

Based on the results of the predictive model presented in Figure 5.4, the coastline near Neptune State Park was identified as a potentially productive location that is accessible within the modern landscape. Due to the generally uniform topographic relief of the near shore environment and limited available data relating to shelf surficial deposit lithology, high cell values are rather concentrated along modeled stream courses, potentially highlighting the importance of riparian ecosystems in the ancient coastal landscape. In the area of Neptune State Park, high value resource potential cells were identified as a result of the current analysis. The high value cells extended off shore of the modern coastline extending from Cummins Creek in the area of 35LA5 and continuing north to Gwynn Creek and site 35LA3 until extending west away from the shoreline (Figure 5.5). These cells followed the outlets of modern drainages that would be considered productive locations for both early and late Holocene

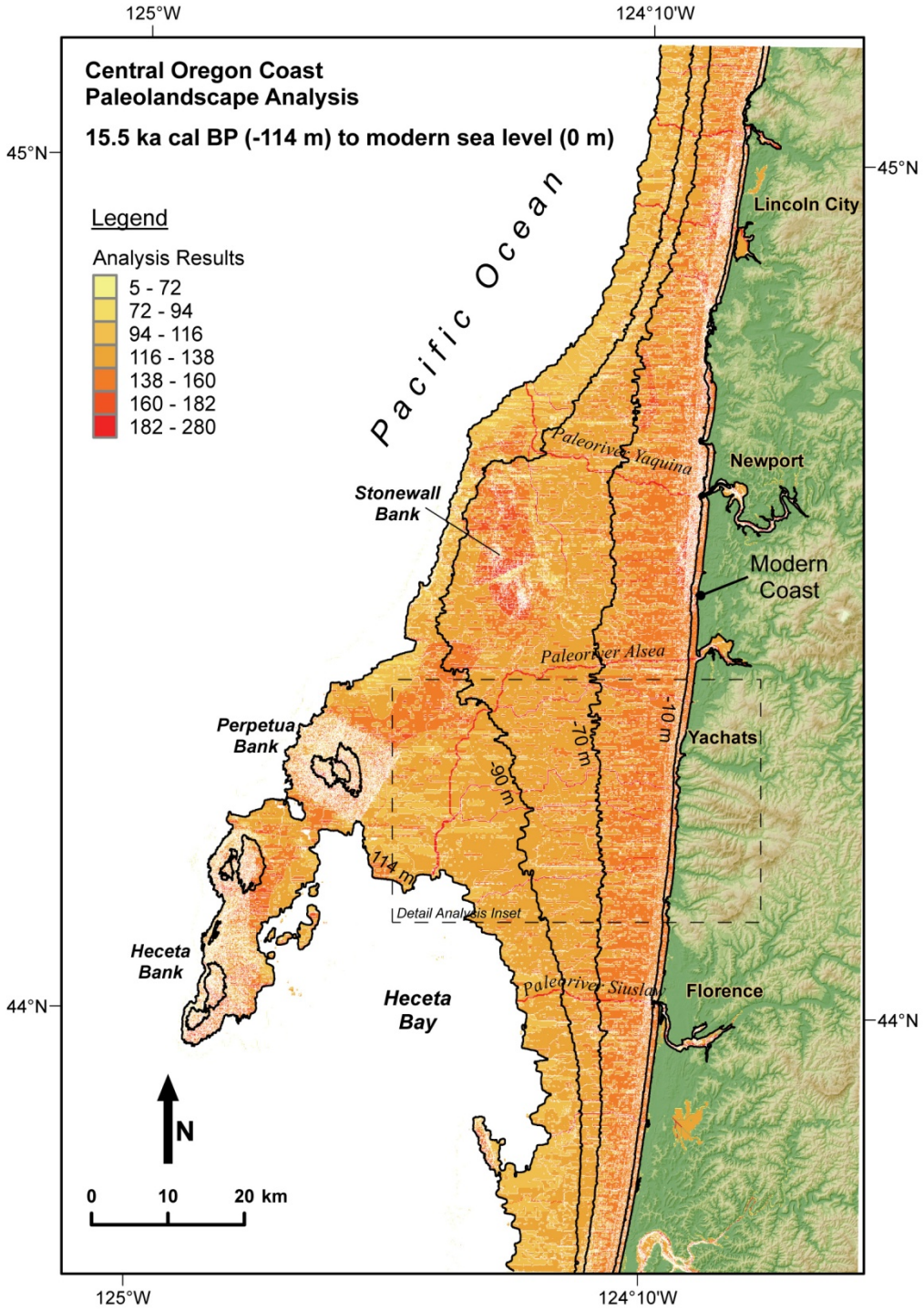

Figure 5.4. Central Oregon coast paleolandscape GIS model analysis results.

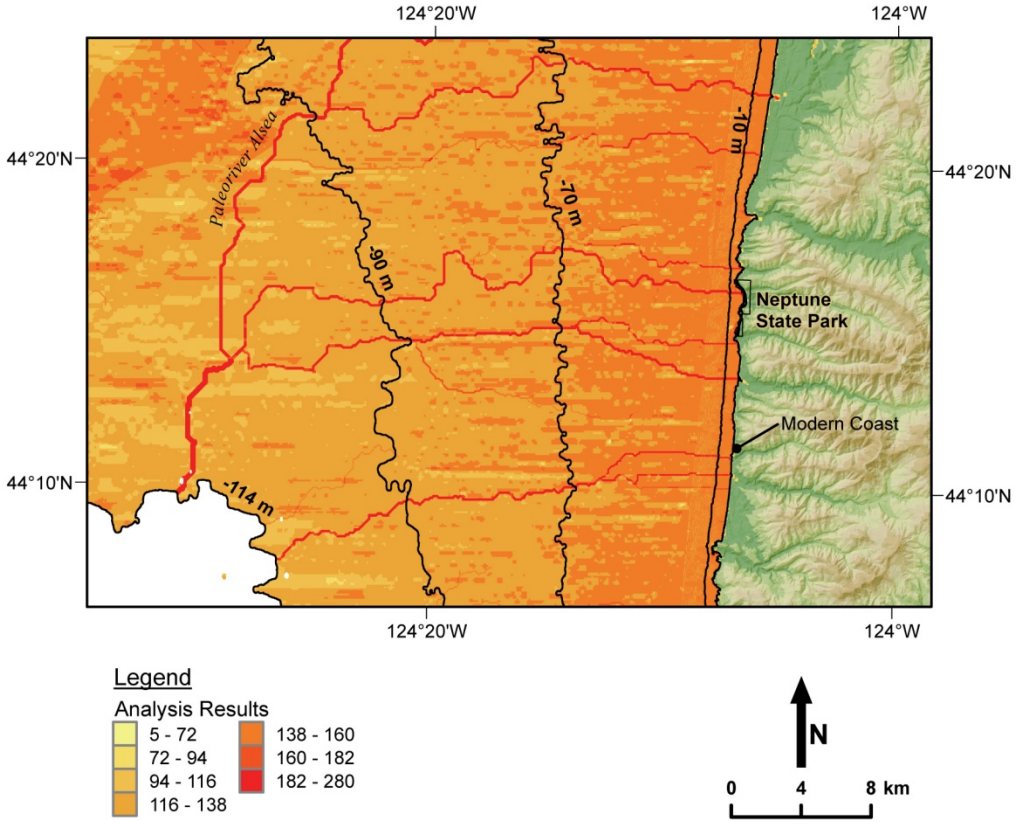

Figure 5.5. Detail analysis of the central Oregon coast paleolandscape GIS model. Neptune State Park is located in the center right of the figure.

coastal peoples. Today, Neptune State Park retains a small portion of a previously larger coastal plain and headland that is located at the footslope of the Coast Range. Because this area represents a portion of the past landscape that is now condensed and preserved within a narrow strip of land, evidence of early human use may be easier to identify then in other more open landscape settings. Archaeological sites that date to the late Holocene have been recorded within this area of Neptune State Park and large cutbank exposures related to shoreline erosion that provide good visibility make the Neptune State Park an ideal location for geoarchaeological study.

Based on the previously discussed model of shifting environmental zones related to marine transgression, LPEH stratigraphic deposits expected in the area of Neptune State Park would include alluvial or aeolian sediment overlying Pleisotcene-aged marine terrace deposits. We might expect that the surface of the LPEH deposits could show evidence of soil development or erosional unconformities depending on the type and amount of post depositional processes and any sediment containing archaeological material dating to the LPEH in this area of the landscape would represent inland terrestrial uses. It is expected that Holocene aged alluvial and or aeolian deposited sediments will overly the LPEH deposits. If archaeological materials are currently present within these younger deposits they would be expected to be related to marine or littoral activities as a result of the site's close (<1 km) proximity to the Oregon coast during the past 6,000 cal BP. The archaeological site predictive model shows a cluster of high values cells in the vicinity of Gwynn Creek, which is adjacent to a known archaeological site (35LA3) at Neptune State Park. The distance along Gwynn Creek to the Pacific coastline would have varied from 40 km at 15.5 ka cal BP (-114 m), 21 km at 12.5 ka cal BP (-90 m), 11 km at 11.25 ka cal BP (-70 m), and 1 km at 6 ka cal BP (-10 m). In order to evaluate the predictive ability of the archaeological site model, excavations were conducted at Neptune State Park. In the following chapters, I will describe the results of geoarchaeological

investigations at site 35LA3 and evaluate the models effectiveness based on the results of the investigations.

CHAPTER 6. GEOARCHAEOLOGICAL INVESTIGATIONS AT NEPTUNE STATE PARK (35LA3)

6.1. Introduction

Since the 1970s, the Neptune site (35LA3) has been a place of great interest for Oregon archaeologists. The Neptune site is just one example of several well-documented late Holocene-aged archaeological sites located along the rocky shoreline within Neptune State Park on Oregon's central coast. Despite past excavations and radiocarbon dating, key questions surrounding the antiquity of the site still remain unanswered (Erlandson and Moss 1993; Minor 1995). These questions are mainly focused on the interpretation of a single radiocarbon date (8,310 ±110 RYBP (9,343 ±110 cal BP), WSU-1644) that was obtained by Richard Ross during excavations in 1970s from a organically stained layer that contained lithic materials but no shellfish, all of which was located immediately below a late Holocene-aged shell midden (320 ±45 RYBP (349 ±50 cal BP) DIC-1399) (Ross 1979). Since this discovery, questions have been raised in the archaeological community about whether the early radiocarbon date represents archaeological evidence of early Holocene-age inland use of the Neptune site, or whether the date represents non-cultural charcoal that became associated with artifacts that were transported downward from the overlying shell midden (Erlandson and Moss 1993; Minor 1995; Davis et al. 2008). Based on the possibility that an early Holocene-aged cultural component might be present at 35LA3, OSU archaeologist Loren Davis obtained a permit in 2010 to conduct limited archaeological and geoarchaeological investigations at the site in order to more fully evaluate the site's stratigraphic context and its potential for holding LPEH-aged archaeological components. This author assisted in all aspects of the 2010 investigations at 35LA3 and reports the results of this site study here.

Research goals for the 2010 excavations at Neptune State Park included: (1) to test the effectiveness of the central Oregon coast GIS-based paleolandscape

model presented in this thesis by evaluating the Neptune State Park area for intact sediment and landforms dating to pre-modern sea level, and (2) to clarify questions about past dating and stratigraphy by carefully evaluating the temporal and stratigraphic association between deposits at the Neptune site and to correlate cultural bearing strata found during the excavations with other similar deposits within the central Oregon coastal landscape.

6.2. Geomorphic Setting

Site 35LA3 is located along the central Oregon coast within the boundaries of Neptune State Park, 5 km south of the town of Yachats, within Lane County, Oregon (Figure 2.1). The study area focuses on one section of coastline within Neptune State Park that encompasses site 35LA3 and extending south along the coastline from Gwynn Creek for approximately 100 m (Figure 6.1). The site area is situated at an elevation of 10 masl on the remnant back edge of the 125 ka Yachats Bench (Kelsey et al. 1996). The Yachats Bench is one of the more prominent landscape features along this reach of the central Oregon coastline, ranging in elevation between 0 and 13 m. The bench is identifiable by its characteristic nearly vertical sea cliffs that rise sharply above the modern beach that bear late Pleistocene-aged marine conglomerate representing high-energy near-shore deposits that overlie a nearly level wave-cut platform cut into Miocene basalt (Kelsey et al. 1996; Lund 1972). Late Pleistocene-aged dune deposits of varying thickness commonly cover the conglomerate, which are both in turn often capped by Holocene-aged aeolian dune deposits. Considerable variability exists within different areas of the bench that represent varying alluvial facies, multiple dune sequences with paleosol development, organics representing ancient stream channel infilling and marsh deposits, and colluvium derived from landslide events originating in the adjacent footslope of the Coastal Range mountains (Peterson et al. 2007; Kelsey et al. 1996; Lund 1972).

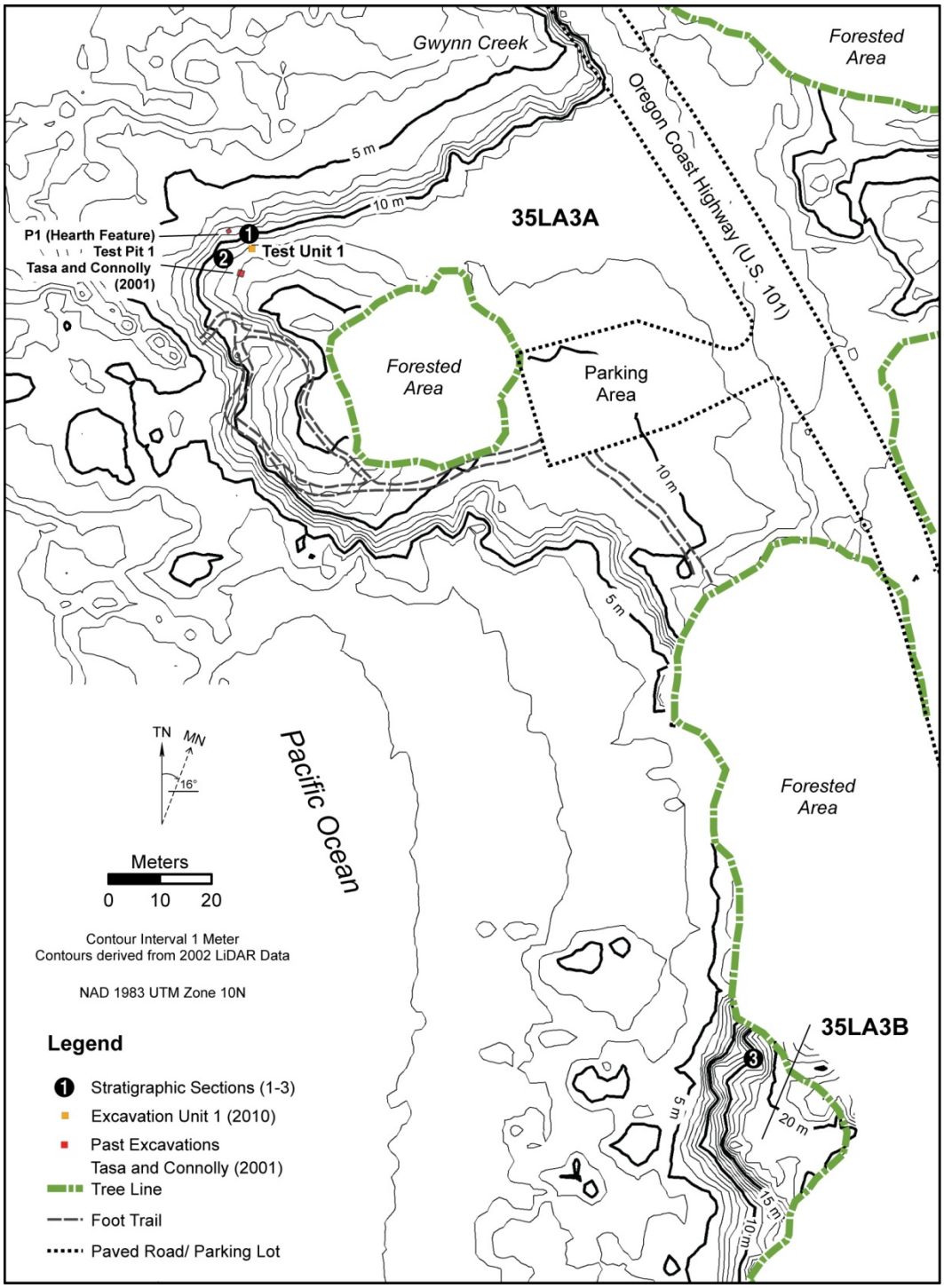

Figure 6.1. Geoarchaeological Investigations at Neptune State Park (35LA3A and B), Excavation Site Map, created in January 2010.

Typical climate along the central Oregon coast consists of mild, wet winters and relatively dry, cool summers with temperatures averaging between 7.2°C in the winter to 15°C during the summer months. Frequent fog and low clouds are common along the coast with the annual precipitation averaging close to 70 inches with 50% of the annual precipitation occurring between the winter months of December, January, and February (Franklin and Dyrness 1988; Western Regional Climate Center). Site 35LA3 is situated along an exposed portion of the coast that is continually subjected to coastal winds and salt spray moisture (Pojar and MacKinnon 2004).

Neptune State Park is situated within the Sitka spruce (*Picea sitchensis*) Vegetation Zone (Franklin and Dyrness 1999). The Picea sitchensis zone can be characterized primarily as a coniferous forest with common overstory species including Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and beach pine (*Pinus contorta*). Common understory species include salal (*Gaultheria shallon*), western sword fern (*Polystichum munitum*), redwood sorrel (*Oxalis oregana*), false lilly of the valley (*Maianthemum dilatatum*), Siberian springbeauty (*Claytonia sibirica*), foamflower (*Tiarella trifoliata*), evergreen violet (*Viola sempervirens Green*), largeflower fairybells (*Disporum smithii*), red huckleberry (*Vaccinium parvifolium*), and rusty menziesia (*Menziesia ferruginea*) (Franklin and Dyrness 1988; Pojar and MacKinnon 2004; Unites States Department of Agriculture, Natural Resources Conservation Service 2010). On-site vegetation includes a dense mat of beach strawberry (*Fragaria chiloensis*) and salal (*Gaultheria shallon*).

6.3. Previous Research

Since archaeological sites were first recorded in Neptune State Park in the 1950s, the area has been the focus of large-scale block excavations, mitigative

archaeological testing projects, the subject of two masters' theses, multiple re-recordings, and site monitoring visits. As a result, the work history at the site is complex and confusing, and that confusion is reflected in some of the past reporting. Provided below is a brief summary of the archaeological work history of site 35LA3, Areas A and B (The Neptune Site), that hopefully does not add any additional confusion.

6.3.1. The Neptune Site (35LA3)

First recorded in 1951 by Lloyd Collins as part of an archaeological survey of the Oregon coast, The Neptune Site (35LA3) is situated along the south bank of Gwynn Creek extending southward along the ocean shoreline for 100 meters (Tasa and Bland 2003). The site has been described as located on an elevated bluff and containing multiple areas of exposed midden and house pit features (Erlandson and Moss 1993; Minor 1986; Tasa and Bland 2003). In 1976, the site was rerecorded by Debra Barnes who separated the site into two major midden concentrations (Barnes 1976; Ross 1976). Barnes described the northern concentration of exposed midden as "Area A" and included the point of land west of the picnic and parking area encompassing the majority park developments (Figures 6.1 and 6.2). Site "Area B" is located approximately 100 meters to the south of Site Area A and was described as containing an area of eroding midden exposed in a high sea cliff (Figures 6.1 and 6.3). For the remainder of this thesis, 35LA3, Area A will be referenced as 35LA3A and 35LA3, Area B will be referenced as 35LA3B.

Under the supervision of Richard E. Ross in 1973, archaeological excavations were conducted at 35LA3B as part of the Oregon State University (OSU) archaeological field school. As a result of the excavations, two radiocarbon dates were obtained but only one date of 320 ±45 RYBP (394 ±50 cal BP) (DIC-1399), which was in direct association with shell midden deposits, was fully reported (Table 6.1) (Barner 1982; Zontek 1983). The second sample

Figure 6.2. Overview photograph of site 35LA3A. View is to the south.

Figure 6.3. Overview photograph of site 35LA3B. View is to the east.

Table 6.1. Summarized radiocarbon dates from past archaeological work at sites 35LA3, Areas A and B, and 35LA5 within Neptune State Park.

^{14}C Age RYBP	Sample No.	Sample Material	Location/ Comments	Reference
35LA3, Area A				
1,200±80	Beta-61122	Shell (*M. californianus)*	Base of uppermost of three shell midden lenses, south bank of Gwynn Creek, northeast side of site, 24 m west of Hwy 101 shoulder (45-50 cm below the surface).	Erlandson and Moss 1993:40
1,090±60	Beta-61123	Shell (*M. californianus)*	Lowest of three shell midden lenses (10 cm thick), south bank of Gwynn Creek, northeast side of site, 24 m west of Hwy 101 shoulder (70-80 cm below the surface).	Erlandson and Moss 1993:40
880±70	Beta-96904	Charcoal	Northwest corner of site, within a cluster of FCR and charcoal 1.5 m below the cutbank surface.	Moss and Erlandson 1998:18
4,770±40	Beta-146108	Wood charcoal, hearth	Northwest edge of Area A, within eroding cutbank (ca. 130 cm below the surface).	Tasa and Connolly 2001:49
35LA3, Area B				
8,310±110	WSU-1644	Charcoal	"immediately below the shell midden in the top of the consolidated sand dune" "a dark organically stained stratum containing no shellfish remains but which produced a few lithic flakes"	Ross 1979:1 Lyman 1991:314
320±45	DIC-1399	Bone	"just below the heavy shell strata, at approximately 1.2-1.4 meters below the surface"	Barner 1981:68
300±60	Beta-61124	Shell (*M. californianus)*	Northern end of Area B, "upper 10 cm of dense shell midden"	Erlandson and Moss 1993:41
430±70	Beta-61125	Shell (*Tresus sp.)*	Northern end of Area B, "lower 10 cm of dense shell midden"	Erlandson and Moss 1993:41
35LA5				
630±50	Beta-62995	Shell (*M. californianus)*	Sample from base of the dense midden deposit exposed on the southwest side of the higher site area (the undercut area of the sea cliff).	Erlandson and Moss 1993:42

returned a much earlier age of 8,310 ±110 RYBP (9,343 ±110 cal BP) (WSU-1644). Ross (1979) describes the date as located “immediately below the shell midden in the top of the consolidated sand dune”. This earlier date was also described by Lee Lyman (1991:314-314) as contained within “a dark organically stained stratum containing no shellfish remains but which produced a few lithic flakes”. The date was considered “somewhat surprising” during the excavation by Ross (1979:1) because of the close stratigraphic proximity (i.e., immediately below) of late Holocene-age marine shell and the earlier dates from the charcoal obtained from the layer only containing lithic material (Ross 1979:1). This date has raised questions about an early Holocene-aged cultural occupation at the site that yet remains to be substantiated (Erlandson and Moss 1993; Minor 1995; Moss and Erlandson 1998).

Additional research conducted at the site includes two OSU masters theses that involved the analysis of shellfish remains by Debra Barner (1982) and fish remains from the site collection by Terry Zontek (1983). Site 35LA3 has been formally revisited numerous times since the OSU excavations with all recorders noting various degrees of sea cliff erosion due to natural coastal processes and recreational tourist foot-traffic as well as site impacts related to park improvements and illegal looting (Ross 1976; Minor 1986; Erlandson and Moss 1993; Tasa and Bland 2003). Shell midden exposures are noted to primarily contain mussel, barnacle, and other rocky shore taxa (Erlandson and Moss 1993). Other artifacts include elk and deer antler wedges, awls, modified antler tines, bone points, and one composite harpoon valve (Barner 1982). Additional artifacts include one each basal-notched and stemmed CCS projectile point, scrapers, knives, modified flakes, lithic debitage, fire-cracked rock, and wood charcoal. One iron wedge was found below the midden deposit that could have been obtained from trade or scavenged from driftwood of wrecked vessels. The site is currently experiencing rapid erosion along the sea cliff at both Areas A and B as a result of both coastal processes and recreational foot-traffic (Erlandson and Moss 1993).

Site 35LA3 was visited numerous times as part of a formal survey and reevaluation of coastal sites located within Oregon State Parks (Erlandson and Moss 1993). As part of this effort, five radiocarbon dates were obtained from shell and charcoal samples located within cultural deposits of both 35LA3A and 35LA3B (Moss and Erlandson 1998). Because the sites held potential for containing an early Holocene-aged cultural deposit, additional effort was given to examining the exposed sea cliff profiles within the northwest site area (35LA3A), in the area believed to be where Ross had collected the 8,310 ±110 RYBP-aged charcoal; however, the area where Ross collected the early Holocene-aged sample is in fact within 35LA3B, which will be clarified below. The investigation identified a “charcoal-rich paleosol underlying the shell midden” but did not find any artifacts associated with this deposit (Moss and Erlandson 1998:18). Moss and Erlandson submitted two shell samples from 35LA3A for radiocarbon dating, which returned ages of 1,200 ±80 RYBP (1,120 ±705 cal BP) (Beta-61112) and 1,090 ±60 RYBP (1,005 ±50 cal BP) (Beta-61123) (Erlandson and Moss 1993; Moss and Erlandson 1998). Two additional samples were taken from the midden at 35LA3B and these returned radiocarbon ages of 430 ±70 RYBP (482 ±50 cal BP) (Beta-61125) and 300 ±60 RYBP (394 ±50 cal BP) (Beta-61124). One additional charcoal sample was obtained from soil described by Moss and Erlandson (1998:18) as “nonshell midden soil” within the northwest corner of the site and was dated to 880 ±70 RYBP (767 ±40 cal BP) (Beta-96904). The latter charcoal sample was taken from within a cluster of fire-cracked rock that was exposed within the cutbank and was temporally contemporaneous with the dates from the shell midden located to the east.

One source of confusion that should be clarified is that Ross’s 1970s excavations took place within 35LA3B, not within 35LA3A. Supporting evidence for this statement includes the April 10, 1976 site record where Debra Barnes describes the site as containing two areas. Barnes states that “Richard E. Ross from Oregon State University excavated in Area “B” in 1973”. Additional evidence included faint outlines of possible backdirt piles and excavation/looting

pits that are currently visible within Area B. Debra C. Barner (1982:53), whose thesis work was conducted within the same area excavated by Ross, states the site is located “15 meters above the present beach” and “15 meters west of Highway 101”. Barner’s observations better describe Area B as opposed to Area A which sand dune is located upwards to 60 meters west of Highway 101. For comparison, the radiocarbon date reported by Barner (1981:68) of 320 ±45 RYBP (394 ±50 cal BP) (DIC-1399) was obtained within the same upper levels of midden deposits excavated by Ross during the OSU excavations at 35LA3B. The dates obtained and reported by Moss and Erlandson (1998) for samples within the 35LA3B midden have dated between 300 ±60 RYBP (394 ±50 cal BP) and 430 ±70 RYBP (482 ±50 cal BP) and are within one sigma of Barner’s reported date of 320 ±45 RYBP (394 ±50 cal BP). The congruency in dates within 35LA3B support the conclusion that the 1970s OSU excavations were located within 35LA3B and not in the northwest corner of the site (i.e., 35LA3A) as described by Minor (1986) and Moss and Erlandson (1998).

In 2000, Tasa and Connolly (2001) conducted exploratory excavations in support of proposed construction and damage mitigation within 35LA3A. One radiocarbon date of 4,770 ±40 RYBP (5,513 ±40 cal BP) was returned on charcoal collected from a suspected hearth feature observed to be eroding from the cutbank on the southern edge of Gwynn Creek. This suspected hearth was excavated from the cutbank exposure and appears to be located below the area where Moss and Erlandson (1998) report the location of the 880 ±70 RYBP (767 ±40 cal BP) charcoal date. In addition to the exposed suspected hearth feature, Tasa and Connolly (2001) placed a single one meter square test pit within the limits of 35LA3A, which recovered two pieces of CCS debitage and several pieces of fire-cracked rock from a maximum depth of 80 centimeters (cm) below surface.

6.4. Methods

Field and laboratory methods were selected for this project that would most effectively help to understand the temporal and stratigraphic relationships between deposits located within Neptune State Park. By understanding the temporal and spatial association of deposits between sites 35LA3 and other parts of the Neptune State Park landscape, we will be able to begin to reconstruct site formation at both synchronic and diachronic scales.

6.4.1. Field Testing

Fieldwork at Neptune State Park was conducted during three separate field sessions between the dates of January 28 - 29, 2010, February 1 - 4, 2010, and February 20, 2010. Field crew members included Celeste Henrickson and Steven Jenevein supervised by Principal Investigator, Dr. Loren G. Davis. Two methods of excavation were employed during this project. Archaeological test unit excavation was designed to gather detailed controlled data on the nature of subsurface deposits contained within site 35LA3A and to collect suitable material for dating and physical and geochemical analysis. Representative stratigraphic section profiling was designed to characterize geologic deposits throughout the Neptune State Park landscape in an effort to correlate the stratigraphic exposures with deposits identified within the test unit excavations.

A single, one (1) meter square test unit (TU1) was excavated on the northwestern edge of 35LA3A on a terrace overlooking the south bank of Gwynn Creek (Figures 6.1 and 6.2). This location was selected in an effort to sample undisturbed stratigraphy representing the different environmental facies that could potentially be present within the landform based on the above described model of coastal landscape evolution. In an effort to sample undisturbed site matrix and to avoid potentially damaging late period cultural deposits, TU1 was placed away from areas of known surface disturbance and visible shell midden

deposits that are exposed throughout the surface of the site and are visible within cutbank exposures.

The test unit was manually excavated by both 10 cm arbitrary levels and in accordance with natural stratigraphy. All removed sediment was screened through 3.2 mm (1/8 inch) hardware cloth. Artifacts and fragments of charcoal suitable for dating that were observed *in situ* were mapped in place by recording the items' northing, easting, and depth below datum (established by line level from the unit's southeast corner). All cultural materials observed during the excavation were collected, bagged, and labeled for future laboratory analysis. Upon completion, each level was described and the unit floor mapped and photographed. Once completed, the unit was backfilled and the surface re-contoured.

Unit stratigraphy was described and recorded following U.S. Department of Agriculture, Soil Survey Staff (1993) guidelines, the Field Book for Describing and Sampling Soils (Schoeneberger et al. 2002), and in accordance with the North American Stratigraphic Code (NACSN 1983). Bulk sediment samples (n=7, ~200 g) were removed for physical and chemical laboratory analysis at 10 cm intervals from a representative vertical column located on the east wall of TU1. Sediment and soil characteristics were examined and described in the field to help characterize deposits observed during the excavation. Upon completing the unit excavations, wall stratigraphy was described, sketched, and photographed in detail from the east and south walls. Lithostratigraphic and pedostratigraphic boundaries and elevations were recorded in the walls for all corners of the unit.

In addition to the excavation of TU1, three stratigraphic sections were prepared, studied, and sampled during the project (Figure 6.1). Two sections were located at site 35LA3A (Sections 1 and 2), and one section was located at site 35LA3B (Section 3). Sections were placed at natural cut bank exposures

that provided the maximum stratigraphic variability with the least amount of preparation and ground disturbance. Sections averaged 50 cm in width and varied in height depending on height of the cut bank. Sections were lightly scraped by hand to an approximate depth of less than two cm to clearly expose stratigraphic units. Representative bulk sediment samples (~200 g) were collected from principal stratigraphic units within each section for physical and chemical laboratory analysis. Sections were described, profiled, and photographed in the field following standard procedures as defined above. At Sections 2 and 3, slump was removed from the lower portions of the section to expose stratigraphic contacts. After this work was completed, slump and scraped sediment was replaced to minimize visual impacts and avoid attracting attention to the site area.

Intact undisturbed sediment samples intended for micromorphological analysis were taken at various locations throughout the project area (Figure 6.1). Blocks of sediment were cut out of the exposure to be sampled and encased within a 2.25 x 3.25 x 1.25 inch (5.72 x 8.26 x 3.18 cm) deep plastic electrical outlet box, tightly wrapped in duct tape noting the sample's location and orientation. Two thermoluminescence (TL) samples were removed from the lower stratigraphic units exposed in the southern wall of TU1. The sampling procedure included lightly pounding a six inch long by two inch (5 x 5 cm) diameter section of capped PVC plastic pipe into a deposit to be dated, carefully excavating around the pipe to accommodate controlled removal, and then immediately capping the inserted end of the tube to protect its sampled contents from sunlight. The end was then quickly wrapped in plastic wrap to retain the sample's original moisture, and bagged for transport. All fieldwork was conducted under a State of Oregon, Archaeological Excavation Permit (No. AP1279) and an Oregon State Parks, Scientific Research Permit (No. 025-09).

6.4.2. Laboratory Methods

All materials collected during the course of the project were numbered and cataloged in a project database. A field number (FN) was assigned to each artifact or collected sample and was used to track the item through both the field and lab phases of the project. Consecutive numbers were assigned to additional samples generated during the laboratory phase of the project. A compete artifact catalog is provided in Appendix A. Laboratory analysis was conducted on both flaked stone artifacts, and fire-cracked rock. Physical and micromorphological analysis was conducted on sediment samples at the Pacific Slope Archaeology Laboratory (PSAL), housed at the Department of Anthropology, OSU. Specialized analyses and preparation of micromorphological samples were conducted off site at various locations. Six wood charcoal samples were sent for Accelerator Mass Spectrometry (AMS) radiometric dating at Beta Analytic Inc., in Miami, Florida. Two *in situ* sediment sample tubes were sent for TL dating at Quaternary TL Surveys, in Nottingham, United Kingdom, and eight samples of intact sediments were sent for micromorphological block preparation at Spectrum Petrographics in Vancouver, WA. All artifacts and associated project documentation will be permanently curated at the OSU, Department of Anthropology.

Cultural Assemblage Analysis

Material type identification and technological analyses of lithic artifacts were conducted on all lithic artifacts recovered during project excavations. Material type was determined by visual inspection considering color, translucency, grain size, inclusions, and bedding. Due to the small number of flaked stone tools recovered (n=1), no formal system was needed to separate artifacts into descriptive classes. For the one biface recovered (FN-109), recorded attributes included the material type, maximum length, width, thickness, weight, percent of cortex, and morphological descriptions of the tool attributes.

Debitage that was diagnostic of a particular reduction technology was separated between bifacial reduction flakes, core reduction flakes, and pressure flakes (Andrefsky 2005; Odell 2003; Flenniken 1981). Lithic debitage was classified into one of four categories of breakage as defined by the Sullivan and Rozen (1985) free-standing typology. These categories include (Odell 2003): complete flake (unbroken); broken flake (point of applied force is absent but ventral surface is discernible); and debris (ventral surface is not discernible). Technological and material analysis was intended to provide basic information on the type of reduction technologies used and the raw material preference.

Fire Cracked Rock Analysis

All fire-cracked rock (FCR) observed *in situ* was mapped in place and collected for later laboratory analysis. FCR was classified into one of five material types to include: Coarse-grained Sedimentary (Sandstone), Fine-grained Sedimentary (Siltstone), Fine-grained Igneous (Basalt), and Coarse-grained Igneous (Rhyolite), which included a Rhyolite subclass of Highly Weathered. FCR was visually discriminated from other rock and or lithic artifacts found during the project based on a number traditionally recognized attributes. Latas (1992) describes common attributes of FCR to include cobble sized rocks that have carbon staining or oxidization, planar, curvilinear, irregular, jagged, or potlid fractures, the presence of cortex, and the absence of flaking attributes. To better evaluate and understand the depositional history of FCR identified during excavations, a number of attributes were recorded and analysis conducted that loosely followed the work conducted by Timothy Latas (1992) on FCR at the British Camp Shell Midden. Recorded attributes for FCR include size, weight, sphericity, roundness, fracture type, roundness of fracture edges, percent of cortex, and the presence of carbon staining or oxidization and any adhering charcoal fragments. Research questions surrounding FCR for this project include evaluating the depositional history, the vertical and horizontal

relationships among FCR and between other artifacts, and any post depositional alterations that have occurred.

Sediment Analysis

Grain size analysis was conducted on seven (7) sediment samples collected at 10 cm intervals from a vertical column along the east wall of TU1. Samples were first pretreated to remove organic matter (OM) by adding the sample to a solution of deionized water and 30% hydrogen peroxide (H_20_2). The sample was then heated to 40°C until reactive frothing occurred and then the process repeated by adding more H_20_2 to the solution until the reaction subsided and the sample color bleached to a color of strong brown (7.5YR 4/6). Pretreated sediments were dried and subjected to granulometric analysis by mechanically agitating a 100 g sample through a series of six nested graduated screens with a Ro-tap Sieve Shaker for 15 minutes. Screen sizes follow Wentworth (1922) size classification and include granule (>2 mm), very coarse sand (1 - 2 mm), coarse sand (0.5 - 1 mm), medium sand (0.25 - 0.5 mm), fine sand (0.125 - 0.25 mm, very fine sand (0.0625 - 0.25 mm), and residual silt and clay size particles (0.00006 - 0.0625 mm) collected in the basal pan. Residuals from each screen and pan were weighed and recorded as the percent of the total 100 g sample.

Grain size analysis was also conducted on the sieved samples using the hydrometer method (Gavlak et al. 2003) in order to measure the granulometry of silt and clay. With the hydrometer method, a 40 g sample of oven dried sediment that has been pulverized to pass through a 2 mm screen is soaked for 16 hours in a solution of sodium hexametaphosphate $(NaPO_3)_6$ (SHMP) and deionized water to disaggregate peds. The solution was then quantitatively transferred to a sedimentation cylinder, combined with deionized water to bring the contents to 1000 ml in volume and allowed to equilibrate to room temperature. The contents were then mixed and hydrometer readings were taken at 40 seconds (sand) and at 6:35 hrs (clay) based on a solution temperature of 27°C. Values were

recorded and calculated to classify each sample into its respective percentage of sand, silt, and clay.

The percent of organic matter contained within each sample was determined by using the loss-on-ignition (LOI) method. This involves heating a 10 g sample of oven dried sediment in a muffle furnace to 550°C for two hours then weighing the sample again (Heiri et al. 2001). The loss in weight after combustion represents the total percent of organics that was contained within the sample.

6.5. Results

Outlined below are the combined results of both the archaeological excavations conducted within TU1, and the resulting geoarchaeological field and laboratory analysis from representative stratigraphic sections and exposures located throughout the Neptune State Park landscape.

6.5.1. Site Stratigraphy

Stratigraphy at site 35LA3 has been separated into different categories that address a number of issues regarding site formation, landscape stability, the temporal context, and the past cultural occupation within the site area.

Lithostratigraphy

Lithostratigraphic Units (LU) are defined on the basis of observable physical characteristics and properties that can be identified between stratigraphic units (NACSN 1983; Waters 1992). Seven lithostratigraphic units (LU1-7) were identified within the stratigraphy exposed at 35LA3A and B. Units consist of marine, alluvial, aeolian, and culturally deposited sediment of ages ranging from the last interglacial period to the late Holocene. Variability among each of the seven units was subdivided by a letter subscript (a,b,c). Of the seven units, only

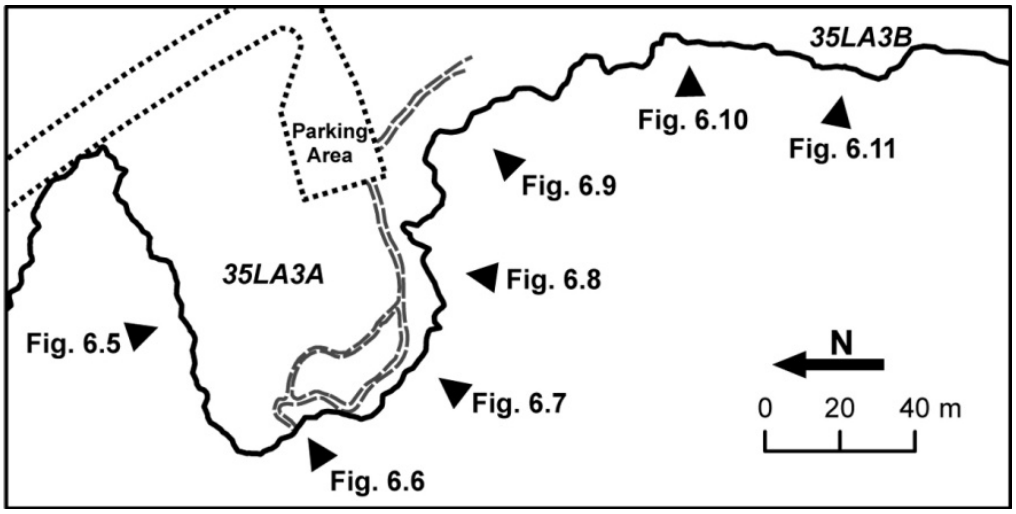

Figure 6.4. Stratigraphic section index map.

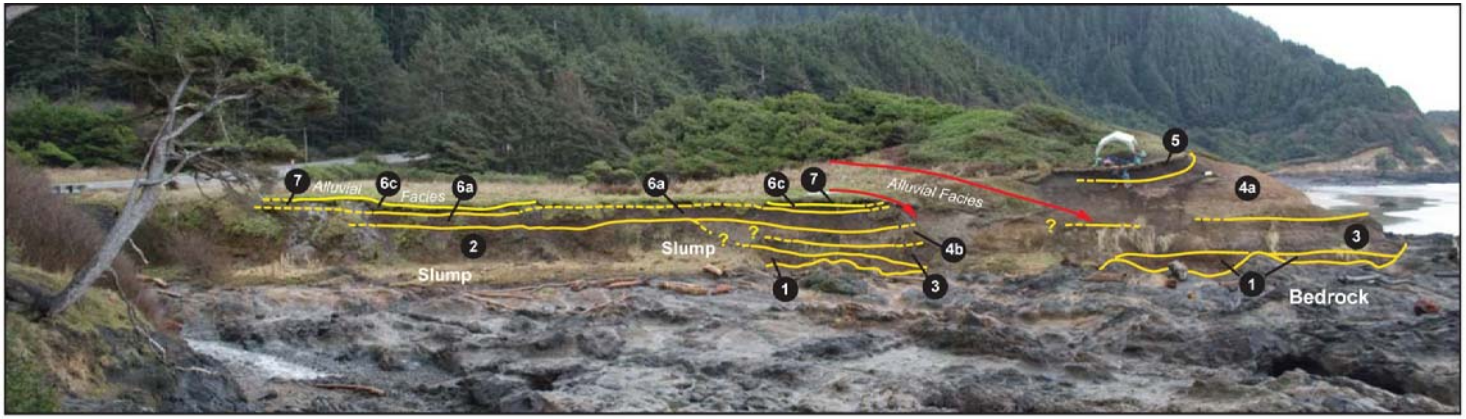

Figure 6.5. Panaroma photograph of site 35LA3A (northern site area) showing lithostratigraphic unit boundaries. Red arrows indicate the approximate path of a past alluvial channel.

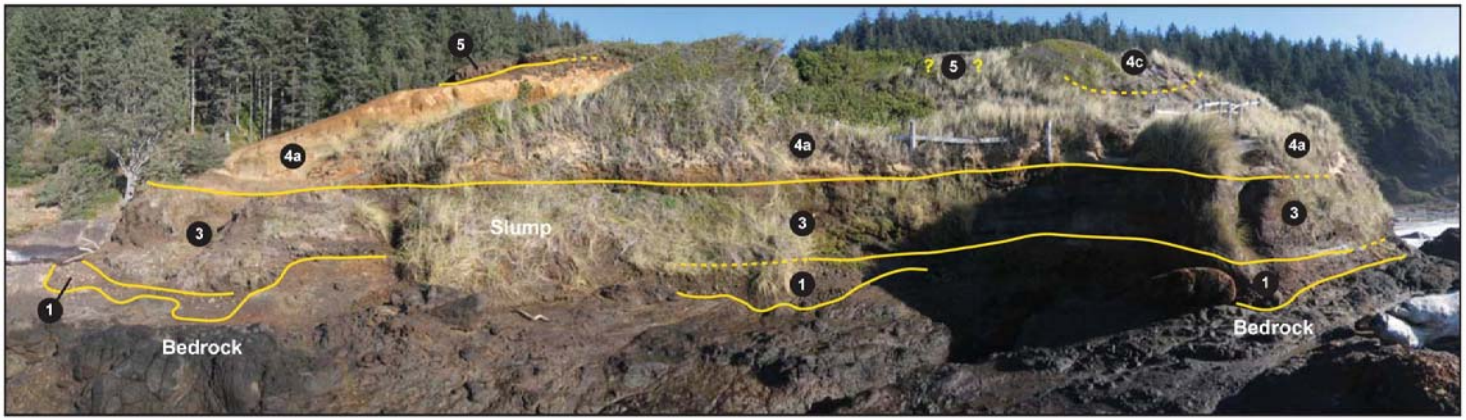

Figure 6.6. Panaroma photograph of site 35LA3A (northwestern site area) showing lithostratigraphic unit boundaries.

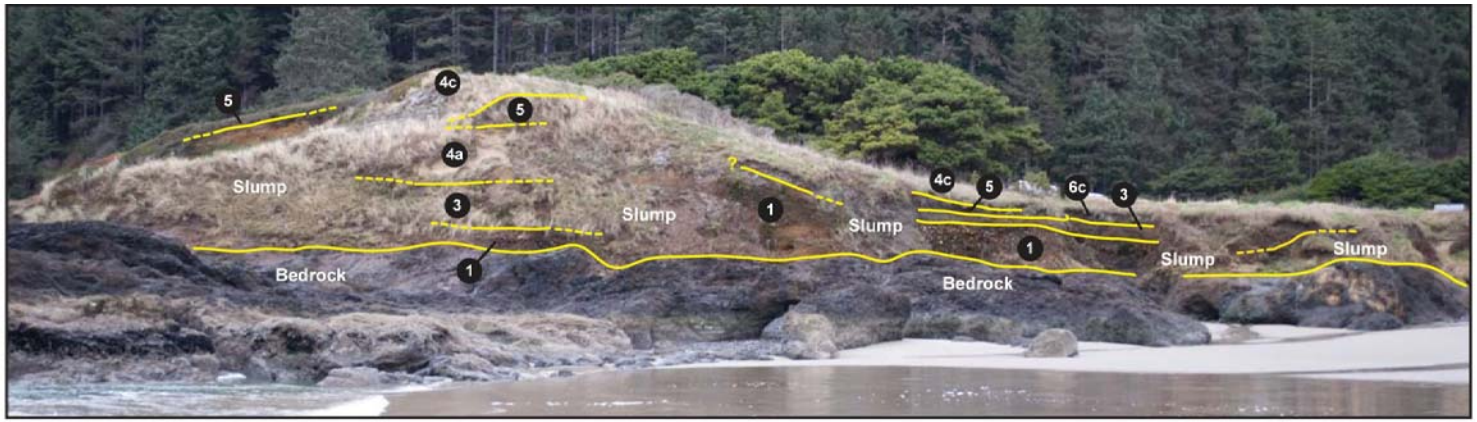

Figure 6.7. Panaroma photograph of site 35LA3A (western site area) showing lithostratigraphic unit boundaries.

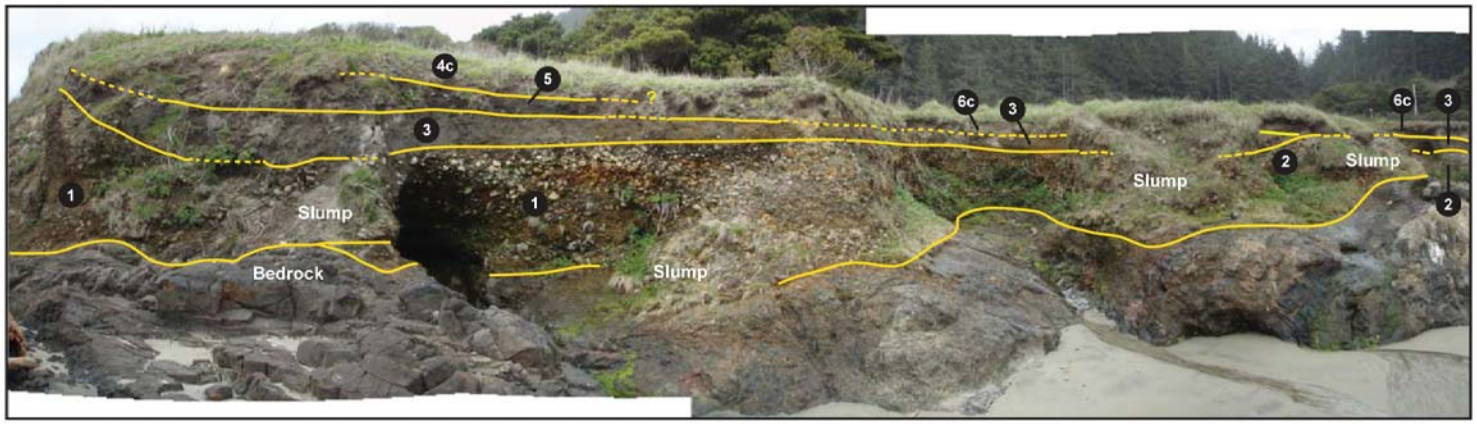

Figure 6.8. Panaroma photograph of site 35LA3A (southwestern site area) showing lithostratigraphic unit boundaries.

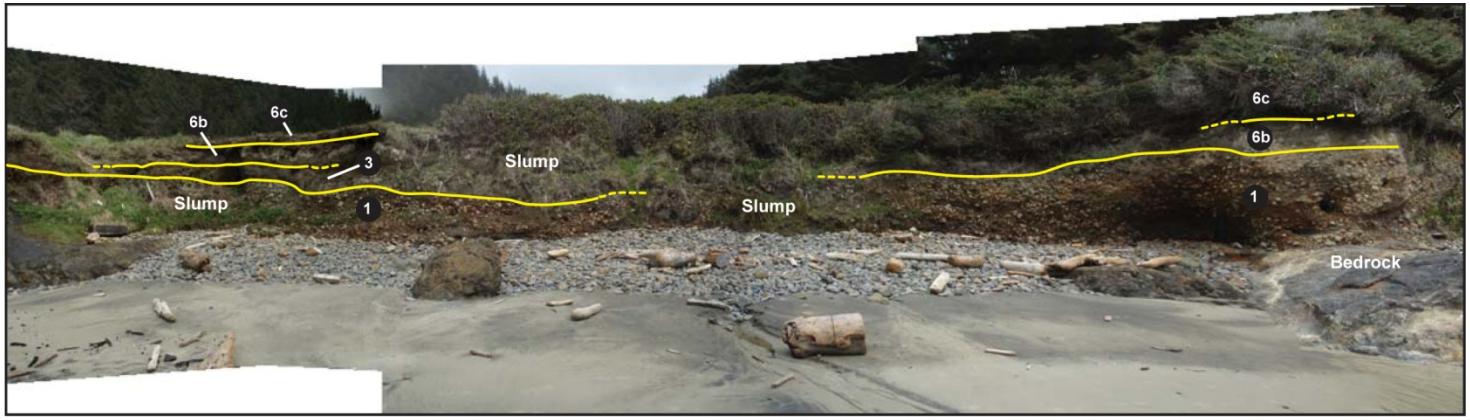

Figure 6.9. Panaroma photograph of site 35LA3 (central site area - north) showing lithostratigraphic unit boundaries.

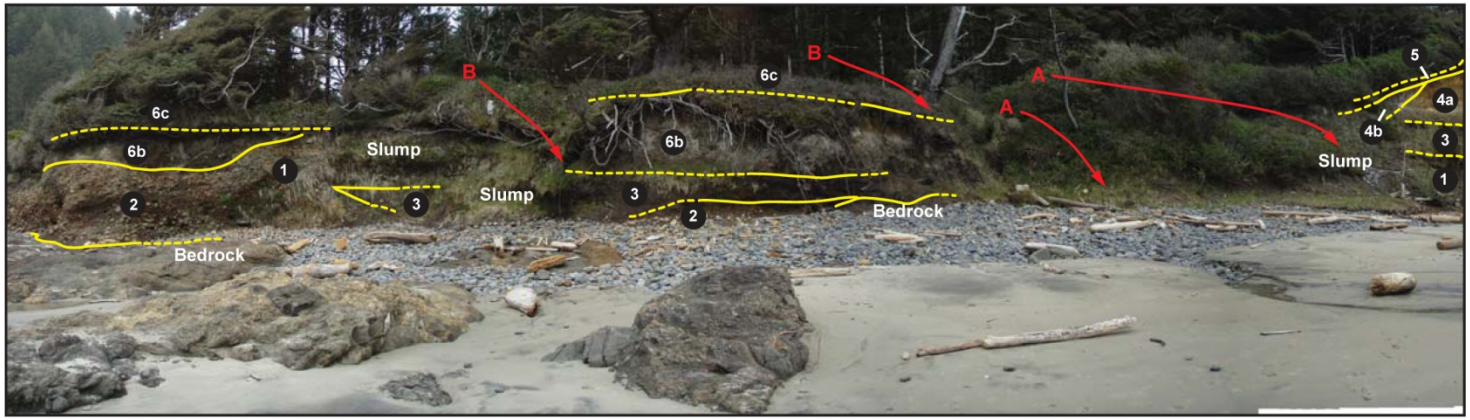

Figure 6.10. Panaroma photograph of site 35LA3 (central site area - south) showing lithostratigraphic unit boundaries. Red arrows indicate the approximate path of two past alluvial channels.

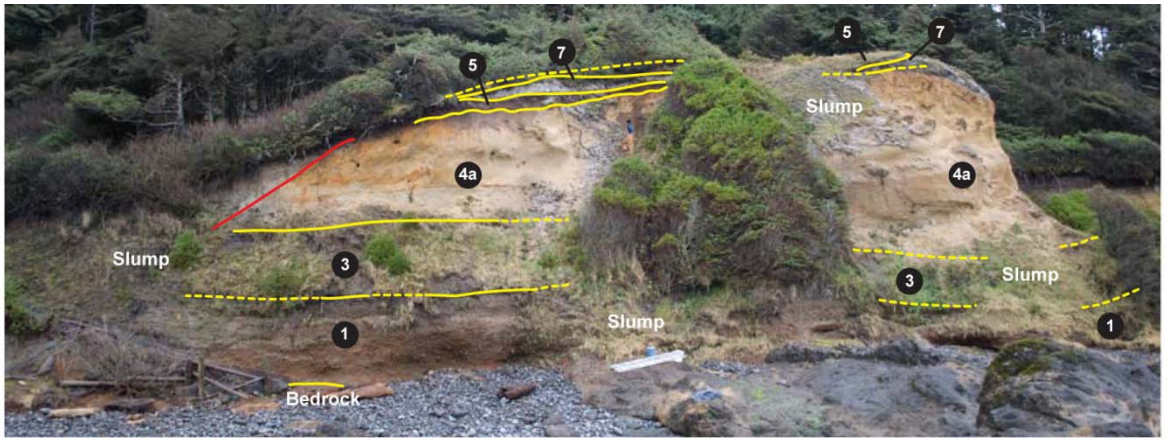

Figure 6.11. Panaroma photograph of site 35LA3B showing lithostratigraphic unit boundaries. The red line indicates the boundary between gleyed (left) and non-gleyed (right) portions of LU3a. A past remnant stream channel is located left (north) of the line.

two (LU4a and LU5) were represented within TU1 and the cutbank exposure (Section 3) located below 35LA3B. Figures 6.4 to 6.11 show the stratigraphy of site 35LA3A, B in profile outlining identified lithostratigraphic units. With the exception of LU5 and the surface of LU4a, sedimentological properties were not verified by laboratory analysis and were solely field identified.

Lithostratigraphic Unit 1: LU1 is the primary basal sediment overlying the Yachats Bench basalt wave cut platform. The unit ranges 0.5 - 2 m in thickness consisting of yellowish brown (10YR 5/4) sand, with highly compact single grain to massive structure containing strong iron staining throughout. The unit contains highly weathered moderately sorted, clast-supported subrounded to well-rounded pebbles through cobbles. Bedding within the unit varies laterally throughout the site, but primarily consists of horizontal bedding with areas of discontinuous parallel beds that exhibit a fining-upwards sequence[7]. The lower boundary of the unit is abrupt and in direct contact with bedrock. The contact between LU1 and the overlying unit (LU3) is conformable.

Lithostratigraphic Unit 2: LU2 is similar in texture and structure to LU1 but represents areas that have been possibly reworked by alluvial processes producing variances in bedding and sorting compared to LU1. The unit ranges 2 - 3 m in thickness and consists of yellowish brown (10YR 5/4) sand with highly compact single grain to massive structure exhibiting strong iron staining throughout. Clasts include highly weathered poorly sorted and clast-supported subrounded to well-rounded pebbles through cobbles. Cobbles are the mean clast size within the unit. Within the poorly sorted deposit, few lenses of discontinuous wavy and curved nonparallel bedding exist. The lower boundary of the unit is abrupt and in direct contact with bedrock or LU1. The contact between LU2 and the overlying unit (LU3, LU6a, and b) is conformable.

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[7] Fining-upwards sequence is a term used in sedimentology to describe sediment that progressively becomes finer-grained up the stratum.

Lithostratigraphic Unit 3: LU3 is generally laterally continuous throughout the study area overlying LU1 sediment. The unit ranges 0.5 - 1.5 m in thickness and consists of dark grayish brown (10YR 4/2) compact clay to clay loam, with strong angular blocky to weak subangular blocky structure. The unit contains lenses of matrix supported rounded to subrounded pebbles and gravels and cumulic deposits of relatively high organic content sediment comprised of well-sorted even parallel beds of silt, clay, and organic material to thick deposits of poorly sorted woody material/peat exhibiting a clear to gradual wavy to smooth lower boundary. LU3 conformably overlies the gravel and cobble deposits of LU1, and LU2.

Lithostratigraphic Unit 4a: LU4a ranges 1 - 4 m in thickness and consists of brown (10YR 4/3) to dark yellowish brown (10YR 4/4) sand with massive structure. Weak subangular blocky structure exists in areas of the unit that are exposed or located near the modern unit surface and influenced by soil development. The lower portion of the unit contains highly compact oxidized very well-sorted sand grading to unweathered fine sand. The southern portion of the unit located beneath 35LA3B contains visible foreset bedding that dips ~26° to the north. The unit has a clear to diffuse wavy lower boundary with a well-developed Ortstien pan that has formed on the surface of the underlying unit (LU3). LU4a unconformably overlies LU3 as indicated by soil development observed in the upper limits of LU3.

Lithostratigraphic Unit 4b: LU4b ranges 0-1.5 m in thickness and consists of greenish gray (10Y 6/1) sandy clay loam with firm medium subangular blocky structure that is mottled with oxidized strong brown (7.5YR 5/8) finely disseminated concentrations primarily within the upper 50 cm. The unit exhibits a gradual wavy lower boundary and unconformably overlies LU3 as indicated by soil development observed on the surface of the underlying unit.

Lithostratigraphic Unit 4c: LU4c ranges <1 m in thickness and consists of light yellowish brown (10YR 6/4) fine to medium sand with a loose, well-sorted single grain structure. No lower boundary could be located within the exposed stratigraphy. The unit is only observed in the area of 35LA3A.

Lithostratigraphic Unit 5: LU5 ranges 0.5 - 1.5 m in thickness and consists of black (10YR 2/1), very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) sandy loam with structure grading from weak fine granular to very fine weak subangular blocky structure. Consistence of the unit was loose to very friable exhibiting a clear wavy lower boundary. LU5 unconformably overlies LU4a in the area of 35LA3A as indicated by a truncated erosional unconformity on the LU4a surface exposed within TU1. An erosional surface was also identified at the contact between LU5 and LU4a in the area of 35LA3B. Within the central site area, soil development was observed on the surface of LU5 underlying the remobilized aeolian deposits of LU4c.

Lithostratigraphic Unit 6a: LU6a ranges 1 - 2 m in thickness and consists of dark brown (10YR 3/3) sandy loam with weak subangular blocky structure exhibiting a friable consistence. The unit contains matrix supported, generally poorly sorted, rounded to sub-rounded gravels with sorting dependent on the lateral position within the unit. Some horizontal bedding of sands and gravel is present with some areas exhibiting a fining-upwards sequence. The unit has a gradual wavy lower boundary where it overlies LU3 and a clear wavy lower boundary where it overlies LU2. The surface of LU6a contains a weakly developed paleosol. In the northern site area, LU6a overlies both LU2 and LU4b. The contact between LU6a and the LU2 surface is conformable in contrast to the contact between LU6a and LU4b, which is unconformable, signaled by a moderately developed paleosol in the upper limits of LU4b.

Lithostratigraphic Unit 6b: LU6b is located within the lowlying area separating 35LA3A and 35LA3B. LU6b ranges ~2 m in thickness and consists of a matrix

supported pebbly grayish brown (10YR 5/2) fine sandy loam with strong subangular blocky structure. Lenses exhibiting parallel and wavy bedding are also visible within the unit containing well-sorted rounded to subrounded sand and pebbles. The unit contains cumulic deposits of organic material within well-sorted even parallel bedding of silt, clay, and organic material to thick deposits of poorly sorted woody material with a clear to gradual wavy to smooth lower boundary.

Lithostratigraphic Unit 6c: LU6c is a surface layer located throughout the lower lying areas of the site. LU6c ranges 0.1 - 0.5 m in thickness and consists of very dark brown (10YR 2/2) sandy loam, with weak granular to very weak subangular blocky structure. Consistency of the unit is loose and contains clast sizes ranging from few poorly sorted pebbles through gravels, with a gradual wavy lower boundary. Although the contact between LU6c and the underlying units (LU3, LU6b) is generally conformable in the southern site area, the exposed cutbank located on the south exposure of the 35LA3A landform exhibits a truncated erosional surface at the contact between LU3 and LU6c. The unit also contains a moderately developed paleosol located at the contact between LU6a and LU6c exposed on the northern cutbank along Gwynn Creek.

Lithostratigraphic Unit 7: LU7 consists of culturally deposited shell midden that is exposed within both the north and southern cutbank exposures at 35LA3A and within the cutbank exposure of 35LA3B. LU7 ranges 0.5 - 0.75 m in thickness and exhibits an abrupt smooth lower boundary. The contact between LU7 and the underlying units (LU6a in the area of 35LA3A and LU5 in the area of 35LA3B) is conformable.

Test Unit 1 Lithostratigraphy: Particle size analysis was conducted on seven sediment samples from a representative vertical column located on the east wall of TU1 (Table 6.2). One sample (depth 70 - 75 cm below surface) was located within LU4a and six samples (depths 10 - 65 cm below surface) were located

within LU5. All sediment was fine textured consisting predominantly of medium (m = 13.5 %) and fine sand (m = 34.3 %) with a relative large percentage of silt (m = 30.2 %). All samples (10 - 75 cm below surface) exhibited a bimodal particle size distribution between medium and fine sand and silt suggesting that the sediment was deposited through aeolian processes, probably with the addition of loess (Figures 6.12 and 6.13). Particle size analysis within TU1 suggest that fine textured sediment, most likely dune sand with the addition of aeolian loess has formed LU5 and the surface of LU4a comprising all sedimentary deposits observed during excavations within TU1.

Pedostratigraphy

Pedostratigraphc units are defined within stratigraphy based on the degree of soil development observed between different units. Pedostratigraphc units can develop on any stable surfaces and can be contained within a single or crosscut multiple lithostratigraphic units (Waters 1992). Four soil horizons (PU1-4) that exhibited pedogenic development were identified within the stratigraphy exposed at 35LA3A and B. Pedostratigraphic units identified within the site were generally constrained within individual lithostratigraphic units with the exception of PU4 that developed within both LU4a and LU5. With the exception of PU4, observed pedostratigraphic unit soil properties were not verified by laboratory analysis and were based on soil qualities recorded in the field.

Pedostratigraphc Unit 1: PU1 consists of poorly drained soils that have formed in mixed alluvium. PU1 has developed primarily within LU3 and consists of cumulic deposits of organic material and wetland sediment. Averaging 0.5 - 1.5 m in thickness, PU1 may more accurately represent the combination of multiple soil horizons developed during periods of landscape stability. PU1 consists of dark grayish brown (10YR 4/2) compact clay to clay loam, with strong angular blocky to weak subangular blocky structure, and includes lenses of matrix supported rounded to subrounded pebbles and gravels. The unit contains well-

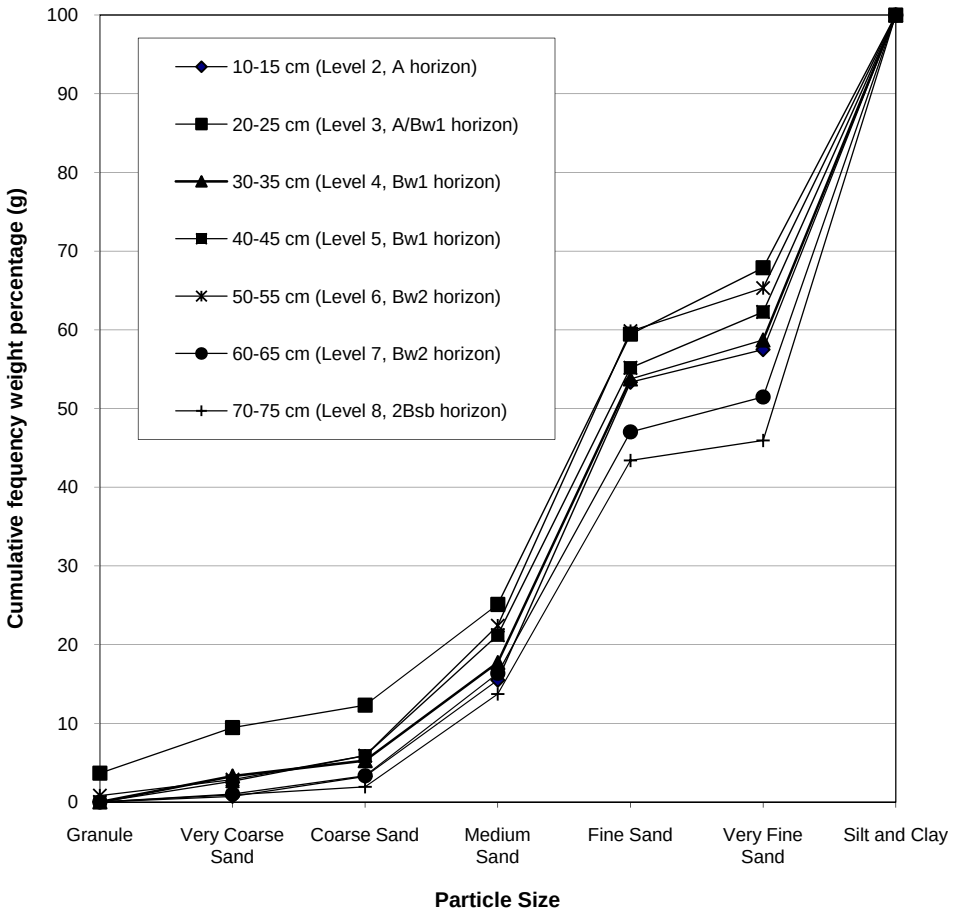


Figure 6.12. Cumulative frequency distribution of sediment samples within Test Unit 1.

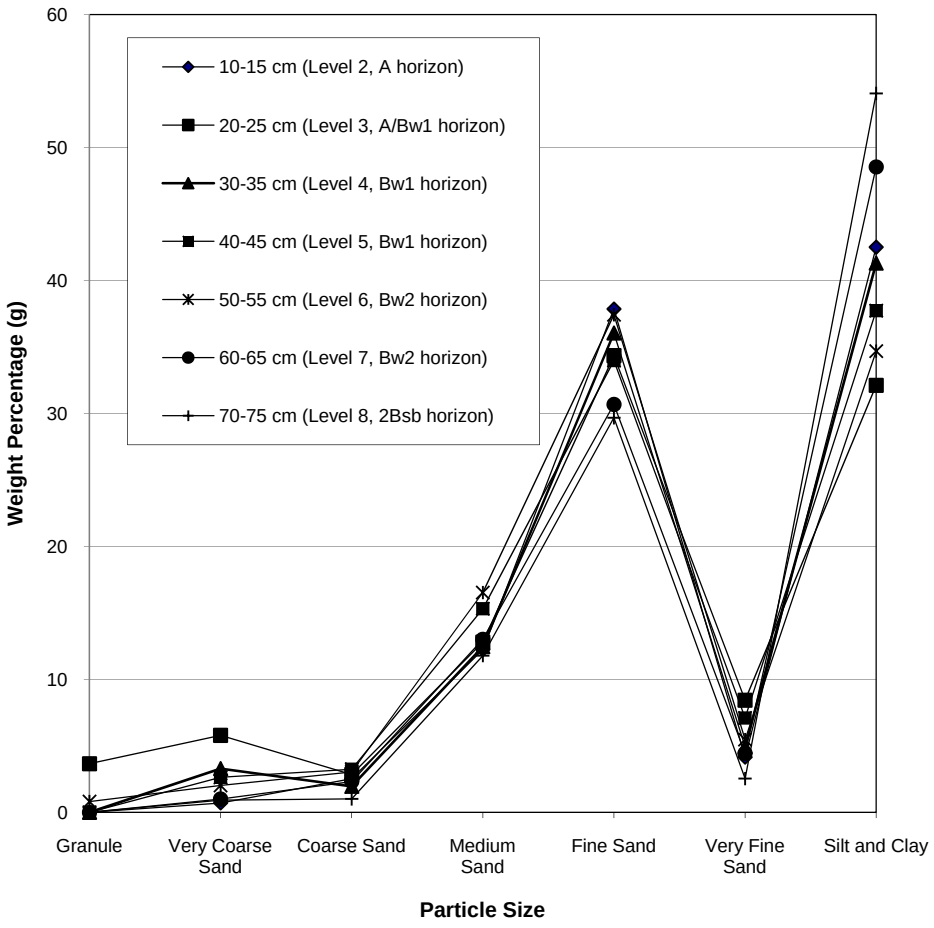


Figure 6.13. Grain size distribution of sediment samples within Test Unit 1.

Table 6.2. Results of laboratory analysis on sediment samples from 35LA3A, Test Unit 1.

Depth (cm)	Soil Horizon	Sand Fractions (Dry sieve analysis)					(Hydrometer analysis)				Texture	% OM
		% G	% VCS	% CS	% MS	% FS	% VFS	% Sand	% Silt	% Clay		
10 - 15	A	0	0.71	2.53	12.25	37.85	4.15	62.5	31.25	6.25	Sandy Loam	22
20 - 25	A/Bw1	3.66	5.79	2.85	12.8	34.35	8.43	65	25	10	Sandy Loam	21
30 - 35	Bw1	0	3.3	1.96	12.46	36.05	4.94	57.5	27.5	15	Sandy Loam	18
40 - 45	Bw1	0	2.64	3.25	15.31	33.98	7.1	57.5	30	12.5	Sandy Loam	20
50 - 55	Bw2	0.81	2.03	3.04	16.53	37.42	5.48	65	20	15	Sandy Loam	16
60 - 65	Bw2	0	1.01	2.32	13.02	30.68	4.44	52.5	37.5	10	Sandy Loam	17
70 - 75	2Bsb	0	0.91	1.02	11.79	29.67	2.54	52.5	40	7.5	Sandy Loam	17

Note: G = Granual, VCS = very coarse sand, CS = coarse sand, MS = medium sand, FS = fine sand, VFS = very fine sand, OM = Organic Matter.

sorted, even, parallel beds of silt, clay, and organic material and thick deposits of poorly sorted woody material or peat.

Pedostratigraphc Unit 2: PU2 consists of poorly drained soils that have formed within aeolian deposited sediment in LU4b. PU2 ranges from 0.1 - 1.5 m in thickness, consisting of greenish gray (10Y 6/1) sandy clay loam with firm medium subangular blocky structure. Mottling was observed within the unit showing oxidized strong brown (7.5YR 5/8) finely disseminated concretions primarily within the upper 50 cm of the profile. The upper limit of the unit exhibits a moderately developed paleosol averaging 10 cm in thickness.

Pedostratigraphc Unit 3: PU3 consists of moderately drained soils that have developed within mixed alluvium of LU6a. Weak soil development within the profile suggests that the unit was continually receiving new sediment. The surface of PU3 can be visually differentiated by a weakly developed paleosol, and slightly better developed structure with both a higher color value and croma compared to the overlying deposit. PU3 ranges 1 - 2 m in thickness consisting of dark brown (10YR 3/3) sandy loam with weak subangular blocky structure and exhibiting a friable consistence. The unit contains generally poorly sorted, rounded to subrounded gravels with sorting seen to vary laterally. Some horizontal bedding of sands and gravels are present and some areas exhibit a fining-upwards sedimentary sequence.

Pedostratigraphc Unit 4: PU4 is uppermost and consists of moderately drained soils that have formed within both mixed alluvium and aeolian sediment. PU4 profiles that have formed within alluvial parent material are located primarily within the lower lying areas of the landscape. PU4 profiles containing aeolian deposited parent material primarily occupy elevated landscape positions. PU1 was described primarily from the stratigraphic profile exposed within TU1 with the complete results presented within Table 6.3. PU1 consists of a moderately

developed sandy loam containing of a high accumulation of organic matter that ranged from 17% to 22%. Some illuvial clay accumulation was observed in the form of clay films on the surfaces of peds within the Bw1 layer. The PU1 profile extends through LU5 and into the eroded surface of LU4a (2Bsb).

The PU4 exposures formed within aeolian sediment that ranges 0.5 - 1.5 m in thickness, containing black (10YR 2/1), very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) sandy loam with weak fine granular structure to very fine weak subangular blocky structure. Soil consistence is generally loose to very friable. The thickness of the PU4 that formed within alluvium ranges 0.1 - 0.5 m in thickness, with very dark brown (10YR 2/2) sandy loam with weak granular to very weak subangular blocky structure. Soil consistence is loose, containing poorly sorted gravels. PU4 also includes similar very weak soil development (A/C) that was also observed in LU4c to be occurring within the active dune material located within the northern site area.

Test Unit 1 Pedostratigraphy: Five soil horizons were exposed within the stratigraphy of TU1 (Table 6.3). Both the east wall (Figures 6.14 and 6.15) and south wall (Figures 6.16 and 6.17) were profiled and photographed. The surface horizon (Oe) consisted of mat of moderately decomposed leaf and root material. Soil horizon A consisted of black (10YR 2/1) sandy loam exhibiting weak fine granular structure. Common very fine through fine roots and few medium through coarse sized roots were identified throughout the horizon. The weak fine granular structure of the A horizon was consistently observed within all surface soils throughout the site area. The subsoil within TU1 was separated by two slightly different weakly developed B horizons (Bw1 and Bw2). Soil horizon Bw1 consisted of very dark brown (10YR 2/2) sandy loam, exhibiting fine weak subangular blocky structure. The horizon contained fewer roots throughout compared to the overlying A horizon. Faint clay films were observed on faces of the peds and few oxidized dark reddish brown (5YR 3/4) and dark yellowish

Table 6.3. Stratigraphic description of soils within Test Unit 1, 35LA3A.

Oe--0-2 cm; mat of moderately decomposed leafs and roots, smooth lower boundary.

A--2 to 22 cm; black (10YR 2/1) moist, sandy loam, weak fine granular structure; loose, slightly-sticky, slightly-plastic; common very fine through fine roots and few medium through coarse roots throughout; few very fine through fine dendritic tubular pores; gradual wavy boundary. (20 to 24 cm thick)

Bw1--22 to 52 cm; very dark brown (10YR 2/2) moist, sandy loam, fine weak subangular blocky structure; friable, slightly-sticky, slightly-plastic; few fine roots throughout; faint clay films on faces of peds; few very fine dendritic tubular pores; few oxidized dark reddish brown (5YR 3/4) and dark yellowish brown (10YR 3/4) < 5 mm fragments of sandstone, gradual wavy boundary. (25 to 34 cm thick)

Bw2--52 to 79 cm; very dark grayish brown (10YR 3/2) moist, sandy loam, very fine, weak subangular blocky structure; very friable, slightly sticky, slightly plastic; few fine roots; few very fine dendritic tubular pores; clear wavy boundary. (20 to 28 cm thick)

2Bsb—79+ cm; dark yellowish brown (10YR 4/4) moist, sandy loam, moderately firm fine subangular blocky structure; moderately sticky, moderately plastic; unknown lower boundary.

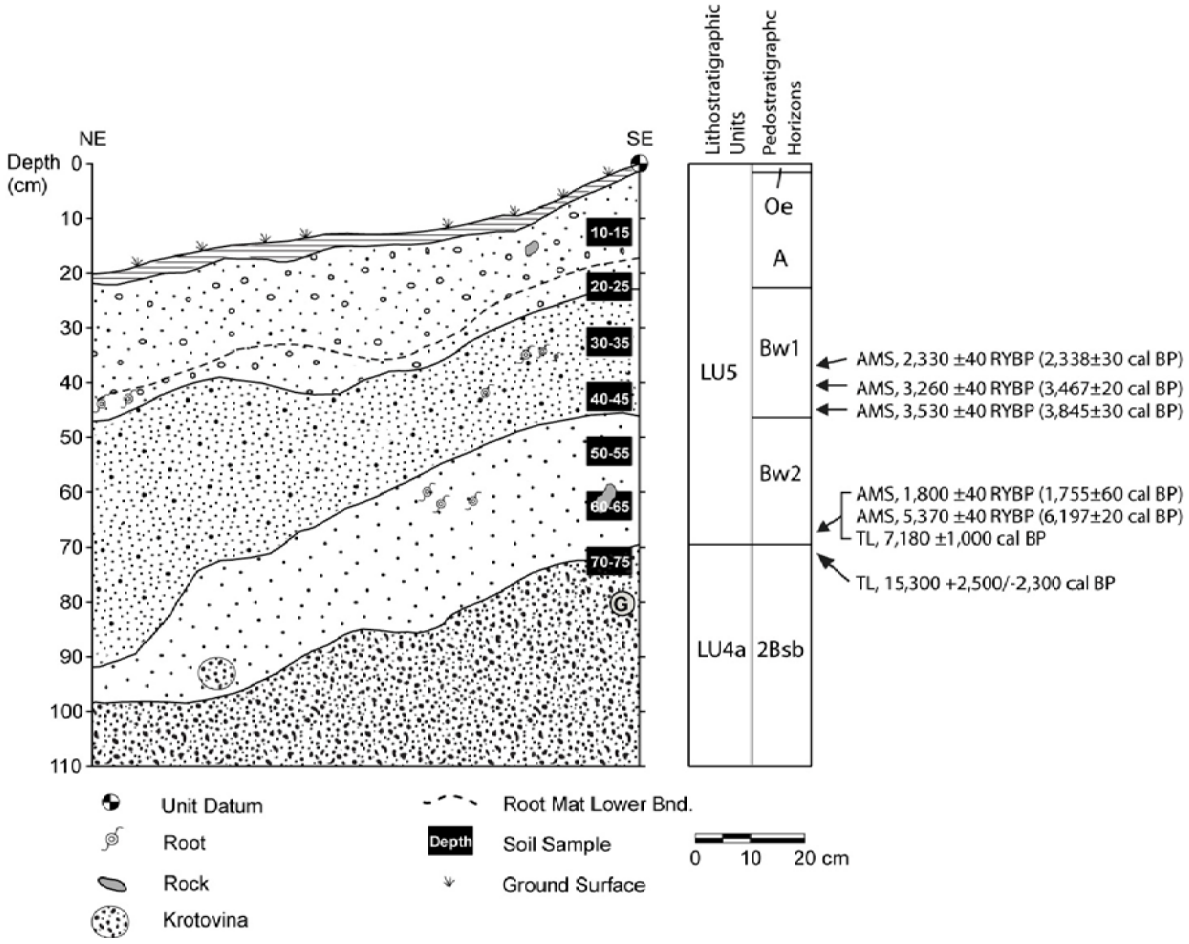


Figure 6.14. Profile drawing of 35LA3A, Test Unit 1, east wall.

Figure 6.15. Photograph of 35LA3A, Test Unit 1, east wall.

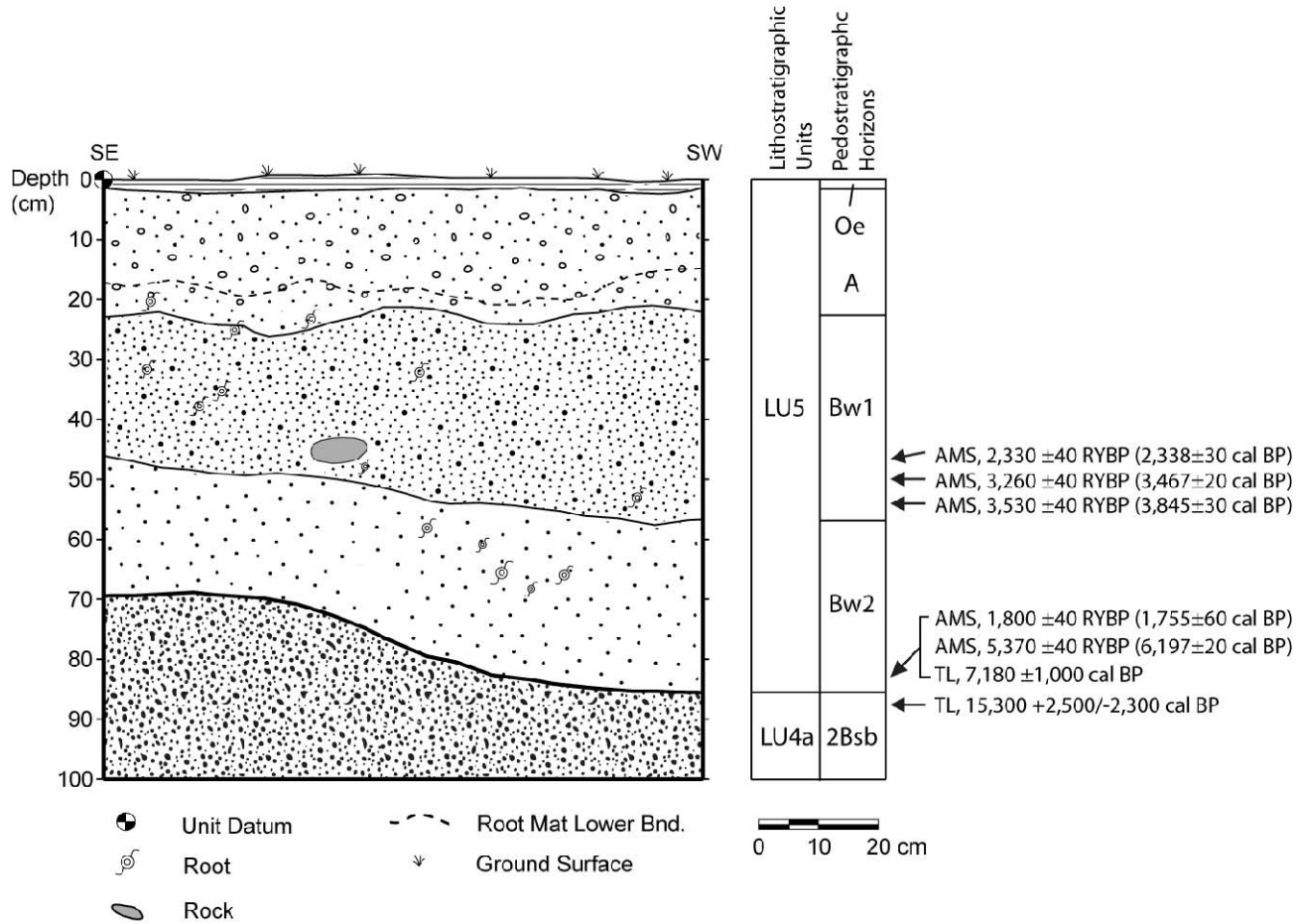


Figure 6.16. Profile drawing of 35LA3A, Test Unit 1, south wall.

Figure 6.17. Photograph of 35LA3A, Test Unit 1, south wall.

brown (10YR 3/4) < 5 mm fragments of sandstone were also observed within the horizon. The Bw2 horizon differed slightly from the Bw1 by a slight change in color to very dark grayish brown (10YR 3/2), and a change in structure to very fine, weak subangular blocky with a very friable consistency. Soil horizon 2Bsb showed evidence of the accumulation of illuvial sesquioxides and organic matter producing a color of dark yellowish brown (10YR 4/4). The high organic matter content (17 - 22%) of the upper levels and subsequent pedogenic overprinting on the underlying surface has significantly altered the 2Bsb (LU4a) surface.

On site soils have been defined by the National Resources Conservation Service (NRCS) as Lint silt loam that is described as deep, well drained soil formed within mixed alluvium. Lint silt loam is expected to be present in areas of the site influenced by the addition of alluvial sediment from Gwynn Creek, but is not present within TU1 as the units is located above the creek's influence with the primary sediment source being aeolian deposited sand and loess.

Chronostratigraphy

Temporal control for 35LA3A stratigraphy was established from six (6) radiocarbon ages obtained from charcoal and two (2) TL ages measured on sediment samples obtained within TU1 (Tables 6.4 and 6.5, Appendices B and C). Four additional radiocarbon ages from both charcoal and shell taken during past site investigations between 1993 and 2001 were used to refine the site chronostratigraphic sequence (Table 6.1) (Erlandson and Moss 1993:40; Moss and Erlandson 1998:18; Tasa and Connolly 2001:49). Four (4) additional ages from radiocarbon samples taken between 1979 and 1993 will also be evaluated for deposits located within 35LA3B to help correlate stratigraphy and deposits between the two areas (Ross 1979:1; Barner 1981:68; Erlandson and Moss 1993:41).

Table 6.4. Radiocarbon dates from the Neptune Site, 35LA3A excavations.

Sample No.	Location	Depth below datum (cm)	Soil Horizon	Sample Material	Uncalibrated radiocarbon age (^{14}C yr BP)	Calibrated radiocarbon age† (^{14}C yr BP)
Beta-276052	Section 2	52*	A	Charcoal	640±40	579±20
Beta-276053	TU1	57	Bw1	Charcoal	3260±40	3467±20
Beta-276054	TU1	56	Bw1	Charcoal	2330±40	2340±30
Beta-276055	TU1	62	Bw1	Charcoal	3530±40	3845±30
Beta-276056	TU1	87.5	Bw2	Charcoal	5370±40	6197±20
Beta-276057	TU1	87	Bw2	Charcoal	1800±40	1755±60

* Depth is measured in cm below ground surface.
† CALIB 6.1 radiocarbon age calibration (Stuiver and Reimer 1993)

Table 6.5. Thermoluminescence ages from the Neptune Site, 35LA3A excavations.

Sample No.	Location	Depth below datum (cm)	Soil Horizon	Sample Material	Thermoluminescence age range (ka cal BP)
TL-1	TU1	80	2Bsb	Soil	15.3 +2.5 / -2.3
TL-2	TU1	65	Bw2	Soil	7.18 ± 1.0

All charcoal selected for radiometric dating within TU1 were recovered from samples discovered *in situ* during excavations. Samples selected for dating were found in close association with FCR and/or lithic artifacts and were located away from obvious areas of disturbance noted during excavation. To help select samples for dating, all charcoal samples were graded and assigned an arbitrary score based the fragment shape (blocky or tubular), size, proximity to preserved disturbance (root intrusions or krotovina), and relative association to cultural materials. Of the 26 point plotted charcoal samples recovered within TU1 and one (1) sample recovered within Section 2, a total of six (6) samples were selected for dating. An attempt was made to select sample pairs from the different stratigraphic units observed within TU1.

The resultant radiocarbon ages are generally comfortable and internally consistent with the stratigraphy within TU1, with the exception one sample (Beta-276057) recovered from the 2Bsb surface (Figure 6.18). An age of 640 ±40 RYBP (579 ±20 cal BP) (Beta-276052) was obtained from a large ~30 mm blocky charcoal fragment located 52 cm below the surface within the A horizon of Section 2 (located 4.4 m west-southwest from TU1). Within TU1, three samples obtained within the Bw1 layer returned ages of 2,330 ±40 RYBP (2,338 ±30 cal BP) (Beta-276054) located at 56 cm below datum, 3,260 ±40 RYBP (3,467 ±20 cal BP) (Beta-276053) located at 57 cm below datum, and 3,530 ±40 RYBP (3,845 ±30 cal BP) (Beta-276055) located at 62 cm below datum. One sample obtained from within the Bw2 layer at 87.5 cm below the unit datum returned an age of 5,370 ±40 RYBP (6,197 ±20 cal BP) (Beta-276056). This latter date was obtained from charcoal found in direct contact with an FCR fragment (FN-60), and near a piece of lithic debitage (FN-58). The concentration of charcoal, FCR, and flake was overlying (~2 cm) the contact of the 2Bsb surface. One sample from charcoal obtained just above the 2Bs2 surface at a depth of 87 cm below the unit datum returned an age of 1,800 ±40 RYBP (1,755 ±608 cal BP) (Beta-276057) and is not consistent with the positions of other radiometric dates within TU1 and is interpreted as representing intrusive material. All radiocarbon dates,

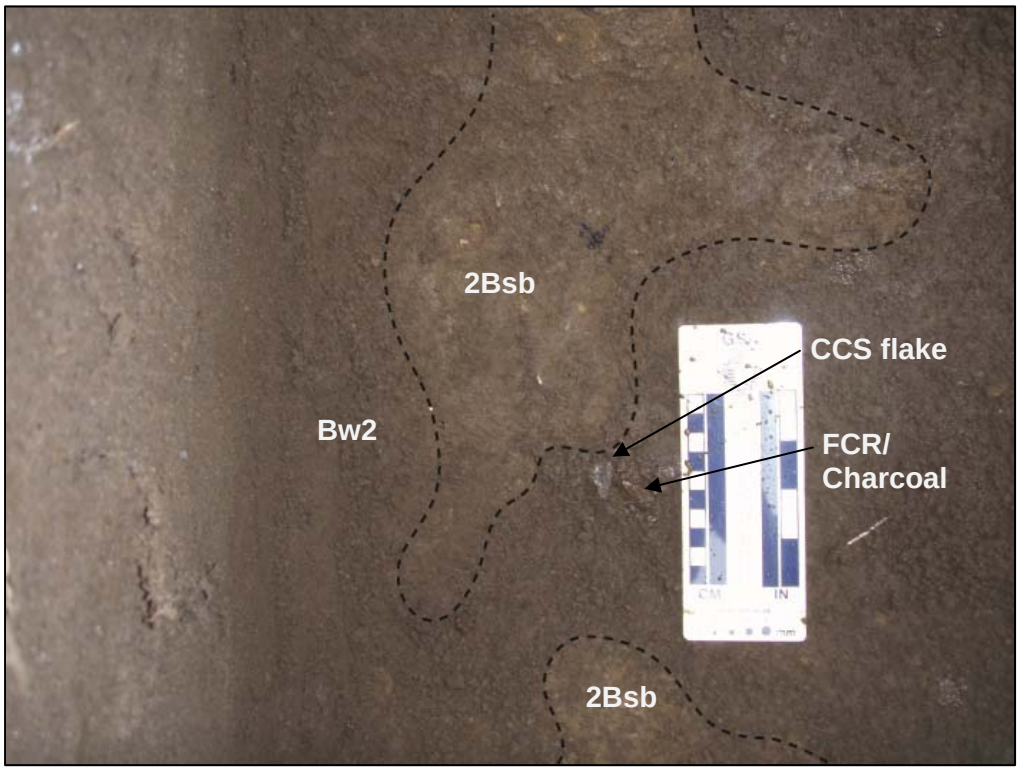


Figure 6.18. Detail photograph of FCR, charcoal, and lithic flake cluster exposed within Test Unit 1, Level 9. The charcoal returned an age of 5,370±40 RYBP (6,197±20 cal BP (Beta-276056), and was recovered near the surface of stratum 2Bsb (LU4a).

with the exception of the 1,800 ±40 RYBP (1,755 ±60 cal BP) (Beta-276057 age, are interpreted to accurately reflect the age of their surrounding sedimentary deposits.

Past dated cultural deposits at 35LA3A include one radiocarbon age of 1,200 ±80 RYBP (1,120 ±70 cal BP) (Beta-61122) that was obtained from marine shell located at the base of the uppermost of three shell midden lenses along the north bank of Gwynn Creek (Erlandson and Moss 1993:40). The sample was located 45 - 50 cm below the surface, 24 m west of the Highway 101 road shoulder. An additional sample shell was collected by Erlandson and Moss (1993:40) within the lowest of three shell midden lenses at the same location of the previous sample but at a depth of 70 - 80 cm below the surface, and returned an age of 1,090 ±60 RYBP (1,005 ±50 cal BP) (Beta-61123). One charcoal sample exposed in the cutbank of the northwest edge of 35LA3A returned an age of 880 ±70 (767 ±40 cal BP) (Beta-96904) (Moss and Erlandson 1998:18). The sample was located 130 cm below the surface within a cluster of FCR. Based on the stratigraphic description provided by Moss and Erlandson (1998:18), this sample is believed to be within the A horizon of LU5.

Two sediment samples were collected for TL dating from the south wall of TU1 (Figure 6.16). The first (TL-1) was obtained from sediment within the 2Bsb layer at a depth of 80 cm below unit datum. The second (TL-2) was obtained from sediment within the Bw2 layer at a depth of 65 cm below the unit datum. TL-1 (2Bsb horizon) returned an age of 15,300 +2,500/-2,300 cal BP. TL-2 (Bw2 horizon) returned an age range of 7,180 ±1,000 cal BP.

Test Unit 1 Chronostratigraphy: Radiocarbon ages obtained from charcoal samples within TU1 are generally comfortable and are consistent with stratigraphy with the exception one late Holocene-aged sample (Beta-276057) recovered from the 2Bsb surface. Radiocarbon ages spanned approximately

2,000 years dating from the mid- to late Holocene. Within the Bw1 layer, radiocarbon ages ranged from 2,330 ±40 RYBP (2,338 ±30 cal BP) to 3,530 ±40 RYBP (3,845 ±30 cal BP). One charcoal sample within the Bw2 layer returned an age of 5,370 ±40 RYBP (6,197 ±20 cal BP). This older date is interpreted as accurately representing the age of the sedimentary deposit (located just above the 2Bsb surface). One sample from charcoal obtained just above the 2Bsb surface returned an age of 1,800 ±40 RYBP (1,755 ±60 cal BP) and is not consistent with other dates within TU1 and is interpreted as representing intrusive material.

Limited floralturbation was mapped in levels 4 and 5, and was primarily observed to be occurring within the Bw1 layer. Evidence of rodent tunneling was noted in the northwest quad within the floor of level 8. Evidence of additional disturbance was not found except for evidence of rodent borrowing on the 2Bsb surface and one krotovina trace was noted in the sidewall of the northeast quad just above the 2Bsb surface. The irregular surface of the 2Bsb layer (LU4a) is suspected to be partially the result of bioturbation that could have occurred before the surface was truncated prior to the deposition of the LU5 sediment (Figure 6.19). If the irregular surface of the 2Bsb layer was solely the result of rodent activity that occurred within LU5 during the late Holocene, then one would expect to see additional coarser grained sediment (e.g., FCR) to be vertically transported within the subsoil, and left resting on the hardened contact between the two units. This is not currently the case within TU1, where few artifacts (n=4) representing 9% of all rock recovered within the unit were found resting on the 2Bsb surface. Results of the TL dating are confortable[8] and support ages obtained from charcoal samples within TU1. TL dating suggests that the lower limits of the LU5 sediments (Bw2 horizon) were fully buried (i.e., no longer subjected to inputs of TL-zeroed sediments) by 7,180 ±1,000 cal BP but were deposited sometime after 15,300 +2,500/-2,300 cal BP. The difference between

[8] Confortable is a geologic term used to describe a geologic sequence where no significant breaks in deposition or erosion have occurred.

Figure 6.19. Photograph of the floor of Test Unit 1, Level 11 showing the irregular surface of stratum 2Bsb (LU3a). Top of frame is the unit's south wall.

the statistical extremes of the two TL ages positioned above and below the erosional contact between the LU5 (Bw2) and LU4a (2Bsb) deposits indicates that up to 11,400 calendar years (i.e., the period between 6,180-17,600 cal BP) of stratigraphic time, and any associated archaeological evidence, was probably eroded away at 35LA3A during the middle Holocene.

Fire Hearth Feature Evaluation

In 2001, Tasa and Connolly (2001:49) recovered and dated wood charcoal believed to be contained within a hearth feature eroding from the northern cutbank of 35LA3A (Figure 6.20). The feature was located 130 cm below the surface and its charcoal returned an age of 4,770 ±40 RYBP (5,513 ±40 cal BP) (Beta-146108). Macrobotanical analysis conducted on sediment from the feature identified one fragment of “processed edible tissue” (Tasa and Connolly 2001:81-82), charcoal, and one obsidian flake. In an effort to fully understand the stratigraphic association of the feature in relation to the TU1 excavations, slumped sediments were removed from the LU4a surface below TU1, exposing the outline of the purported 2001 fire hearth profile (Figure 6.21). Tracing the upper boundary of the LU4a (2Bsb) surface placed the upper extent of the excavated hearth beneath the surface of the late Pleistocene-aged unit. The upper boundary of the LU4a (2Bsb) surface was visible within the cutbank adjacent to the suspected feature. Tracing the upper boundary of the LU4a (2Bsb) surface placed the upper extent of the excavated hearth beneath the surface of the late Pleistocene-aged unit that dates to 15,300 +2,500/-2,300 cal BP. Further examination surrounding the suspected feature identified radiating burnt earth features similar to highly combusted tree root features. No FCR, or charcoal was observed within any of the surrounding features. Moreover, micromorphological analysis was conducted on samples obtained from sediment within the feature and on a similarly-appearing burnt earth and charcoal feature exposed in deeper late Pleistocene-aged deposits (LU4a) adjacent to the feature. This analysis identified no noticeable difference within the sedimentary fabric of

Figure 6.20. Overview of possible fire hearth outline excavated by Tasa and Connolly (2001). Unit corners were relocated based on soil discoloration and are marked with pink pin flags located in center of frame. Pin flags are roughly 50 cm apart. View is to the east.

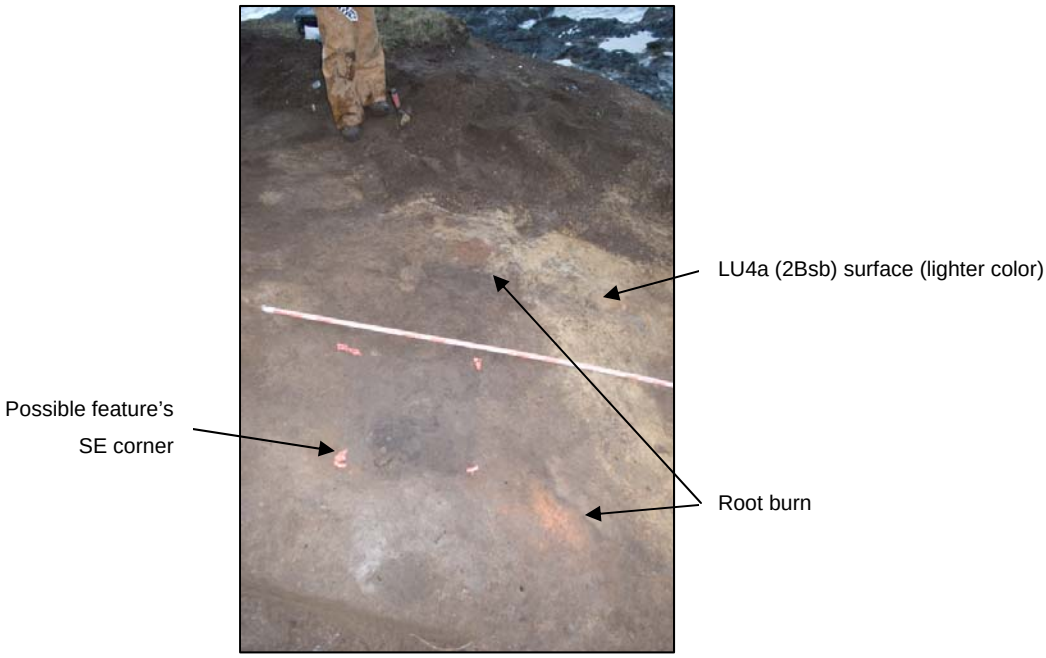


Figure 6.21. Detail of possible hearth outline showing the underlying lighter color of the 2Bsb (LU4a) sediment and surrounding root burns. View is to the west.

the sample located within the supposed hearth feature compared to the sample associated within the deeper burnt earth and charcoal feature (Loren G. Davis, personal communication 2010). As a result of the recent dating and the stratigraphic and micromorphological analyses conducted in the in the area of the suspected hearth feature, it is the opinion of the author that the feature is likely noncultural and simply a subsurface feature produced by a tree that burned during the middle Holocene, and is only circumstantially associated with LU4a. The single identified obsidian flake and processed edible tissue fragment was probably derived from sediments that slumped from the adjacent cutbank of 35LA3A, which now blanket the exposed surface of LU4a.

6.5.2. Facies Interpretation and Site Formation History

Two primary aims of geoarchaeology are to understand processes of site formation and to interpret the landscape that existed around a site during its occupation (Waters 1992). This process of interpretation is aided by describing the lithofacies that are present in a site's stratigraphic sequence. Lithofacies are the descriptive lithological aspects of sediment texture, bedding, fabric, and unit boundaries, and are related to the geomorphic environment in which they were created. Interpreting lithofacies helps to reveal a site's past depositional history and subsequent formation, and because they can reflect simultaneous geomorphic processes across a landscape, the analysis of lithofacies reveals lateral variability among the characteristics of sedimentary deposits of the same age (Waters 1992; Gladfelter 2001). Lithofacies evaluation at site 35LA3A and B identified three major depositional processes to include marine, alluvial floodplain, and aeolian and are described in relation to their associated lithostratigraphic unit.

LU1 represents a conglomerate of consolidated marine-emplaced gravels and cobbles that overlie the wave cut Yachats Bench that date to the late Pleistocene post ~125 ka cal BP. This marine sediment is comprised of swash

zone and beach deposits that were left after sea level receded during the end of the last interglacial period (Lund 1971; Ticknor 1993). Poorly sorted gravel and cobble deposits exposed along the cutbank of Gwynn Creek suggest that the stratified marine deposits have been reworked sometime after original emplacement by fluvial processes. These high-energy deposits associated with the reworking of marine deposits by alluvial processes include LU2 and are observed along the current channel of Gwynn Creek and in the cutbank south of 35LA3A.

Alluvial sediments can be found in lower lying areas of the landscape within Neptune State Park (Figures 6.5 and 6.10). Deposited sometime after the last sea level highstand at ~125 ka cal BP, LU3 represents low energy alluvial sediment representative of wetland infilling and deposits that are high in organic material. LU3 deposits range from highly reduced soil containing well-sorted even parallel bedding of silt, clay, and organic material to thick deposits of poorly sorted woody material and peat.

After a period where low energy wetland sediments blanketed much of the lower lying areas of the site after ~125 ka cal BP and before ~15 ka cal BP, the low energy wetland deposits of LU3 were replaced by medium energy alluvial floodplain lithofacies (Figures 6.5 and 6.10). These alluvial floodplain deposits are represented within LU6a and LU6b and appear as horizontally bedded sands and gravels with some areas exhibiting a fining-upwards sequence. These sediments are interpreted to represent meandering stream channel infilling. As with the LU3 deposits, LU6a and LU6b deposits are thickest in the lowlying areas of the site that have historically served as an accommodation space for sediment. LU6c represents sediment that has been deposited since the mid to late Holocene and is a mixture of both alluvial and aeolian material. LU6c is the primary surficial sediment in those areas of the site most affected by ancient and modern flood events.

During the late Pleistocene sometime between ~125 ka cal BP but before ~7,000 cal BP, aeolian sands were deposited over the elevated surfaces of 35LA3A and 35LA3B (Figures 6.5 and 6.10). These dune deposits vary in thickness depending on their position in the landscape. Although it is not known if dune deposits previously covered other portions of the landscape, evidence of channel infilling with mobilized aeolian sands is represented by LU4b and possibly LU6c. It is also possible that the sediment source for some of the other overthickened fluvially-deposited lithofacies may have originated as aeolian dune material. Capping the late Pleistocene-aged dune material is an organic-rich sandy loam (LU5) that was deposited during the mid-Holocene over the partially eroded LU4a surface. Composed of aeolian deposited sand and finer loess, LU5 also contains a small percentage of gravels, which are probably due to cultural activities (e.g., shellfish collecting, cooking activities). LU4c represents the most recently formed lithofacies at the site and is comprised of eroded and remobilized dune deposits from LU4a, which are located only in the northwestern site area surrounding 35LA3A.

6.5.3. Cultural Stratigraphy

Based on past and current archaeological excavations, three general periods of human occupation have been identified at site 35LA3. The earliest date of 8,310 ±110 RYBP (9,343 ±110 cal BP) reported by Ross (1979:1) as potentially associated with cultural deposits in the area of 35LA3B could not be adequately assessed as part of this project. Although a biface preform fragment was found exposed at 35LA3B in the cutbank below the main midden deposit, within an organically stained layer containing no shell, the artifact was clearly in association with a rodent burrow. It is most likely that answers to the questions related to the chronostratigraphy of 35LA3B will be obtained only by conducting controlled archaeological excavations. However, based on the chronostratigraphy of 35LA3A, which includes early Holocene-aged terrestrial

deposits, we should not yet discard the hypothesis that an early Holocene-aged cultural component is actually present at 35LA3B.

Excavations within TU1 suggest a potential 1,200 year span of human occupation occurred at site 35LA3A spanning the middle-late Holocene (Figures 6.14 and 6.16). Beginning as early as ~5,370 ±40 RYBP (6,197 ±20 cal BP), evidence of human use of the area is preserved within the aeolian dune deposits of LU5, unaffected by fluvial processes that were occurring within the low lying areas of the landscape. These deposits are located within non-shell bearing sediments located at the northwest corner of the site. More recent ages of charcoal (880 ±70 RYBP (767 ±40 cal BP) (Moss and Erlandson 1998:18) and 640 ±40 RYBP (579 ±20 cal BP) (the current study) sampled from within the A horizon that is also developed in LU5 may possibly reflects burned roots, the effects of floralturbation, or even an isolated cultural event not observed within TU1.

The age of the shell midden exposed along the southern bank of Gwynn Creek within 35LA3A suggests that human occupation occurred in this area during the late Holocene between ~1,030 RYBP (~955 cal BP) and ~1,280 RYBP (~1,185 cal BP). Cultural materials are contained primarily within alluvial sediment (LU6c) with the likely addition of aeolian sediment. In the area of 35LA3B, radiocarbon ages of shell obtained from three samples date cultural deposits to the late Holocene between 260 to 500 RYBP (Barner 1982; Zontek 1983; Erlandson and Moss 1993; Moss and Erlandson 1998). Cultural deposits within 35LA3B are contained within LU5, which in turn unconformably overlies LU4a, exhibiting a similar stratigraphic sequence to cultural deposits identified within TU1 located at 35LA3A. In sum, research thusfar indicates that human occupation at site 35LA3 clearly begins during the middle Holocene at ~6,200 cal BP and continued sporadically until the late Holocene ending sometime around ~400 cal BP.

6.5.4. Archaeological Record

A total of 49 artifacts were recovered during the excavation of TU1, including 10 pieces of lithic debitage, 36 pieces of FCR, two historic/modern bullet casings, and one potential gizzard stone classified as miscellaneous. Other artifacts recovered during the sampling of stratigraphic sections located outside of TU1 include one lithic tool, and one piece of lithic debitage. Outlined below are the laboratory analysis results for each artifact class identified within TU1 followed by a summary of the additional artifacts identified during stratigraphic section profiling. A complete artifact catalog is provided within Appendix A.

Lithic Analysis Results

A total of 10 pieces of lithic debitage was recovered during excavations within TU1 (Table 6.6). Four flakes (40%) of the debitage are attributed to bifacial reduction activities and one flake (10%) is the result of pressure flaking. The debitage assemblage recovered from TU1 represents late-stage bifacial reduction and pressure flaking associated with tool manufacture and re-sharpening activities. Cryptocrystalline silicate (CCS) was the only source of lithic raw material. Lithic material was located within levels 3, 5, 6, 7, and contained within layer A/Bw1 to Bw2 (Figures 6.22 and 6.23). The majority (60%) of lithics were recovered within levels 5 and 6 contained primarily within layer Bw1. Two lithic artifacts (20%) were recovered within level 9 that is situated just above the surface of the 2Bsb layer.

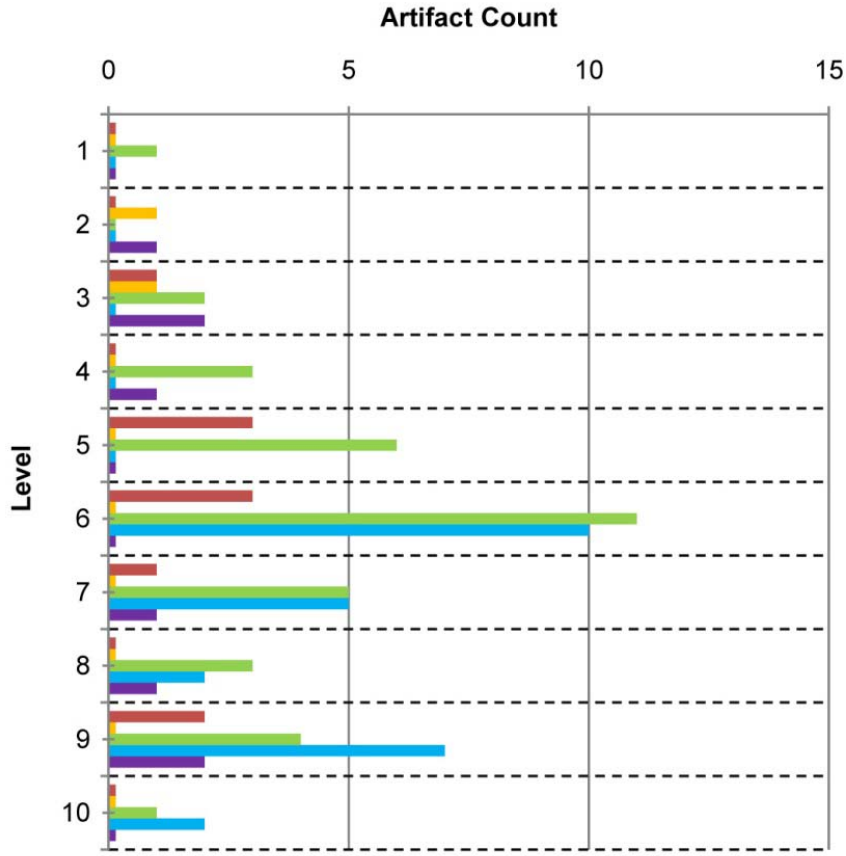
Fire-Cracked Rock

A total of 36 pieces of fire-cracked rock (FCR) were collected during excavations at TU1 (Table 6.7). The FCR represented 82% of the total rocks recovered within the unit (n=44) of which 32 (73%) were mapped in place during excavations. Five different material types were represented among the FCR to include: Coarse-grained Sedimentary (Sandstone), Fine-grained Sedimentary (Siltstone), Fine-grained Igneous (Basalt), and Coarse-grained Igneous

Table 6.6. Lithic debitage recovered from 35LA3A, Test Unit 1 excavations.

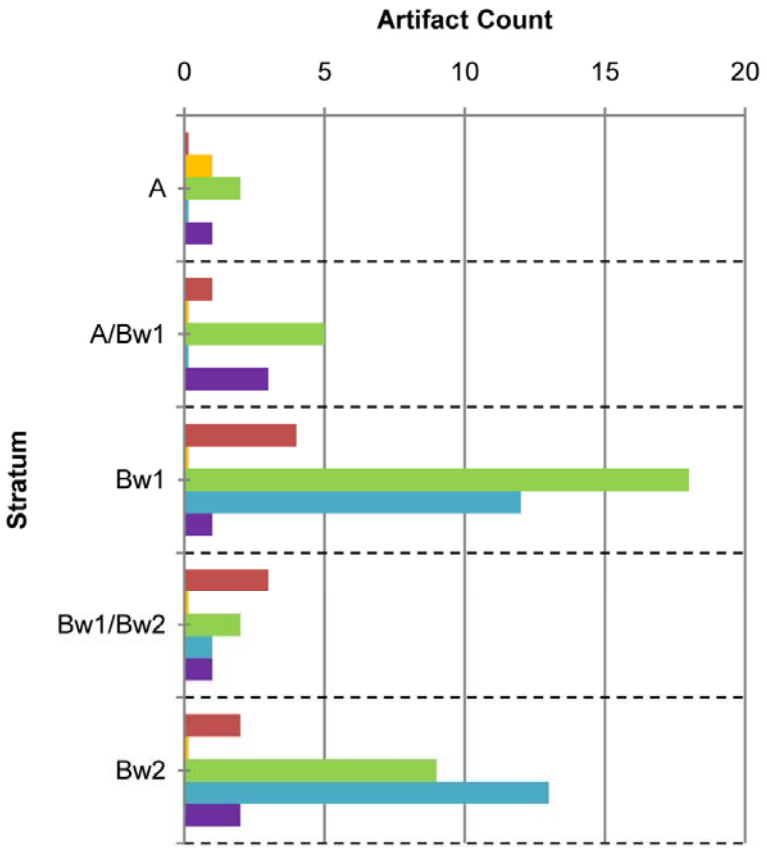
Location	Level	Material	Color	Size (mm) length/width/ thickness	Reduction typology*	Free standing typology analysis†
TU1	3	CCS	v. dk. gray	7.5 x 1.1 x 1.1	UNK	broken flake
TU1	5	CCS	brownish yellow	7 x 5.5 x 0.5	bifacial reduction	complete flake
TU1	5	CCS	lt. greenish gray	9 x 5.5 x 2	bifacial reduction	complete flake
TU1	5	CCS	white	4 x 2.5 x 0.4	bifacial reduction	flake fragment
TU1	6	CCS	lt. gray	7.5 x 6 x 1.5	bifacial reduction	broken flake
TU1	6	CCS	brownish yellow	10 x 7 x 4.5	UNK	debris
TU1	6	CCS	dk. brown	10 x 8.5 x 3.5	UNK	debris
TU1	7	CCS	white	5 x 4.5 x 0.05	bifacial reduction	complete flake
TU1	9	CCS	dk. greenish gray	23.5 x14.5 x 6	UNK	debris
TU1	9	CCS	dk. brown	5 x 5 x 1	pressure flake	complete flake

References: *Andrefsky 2005; Odell 2003; Flenniken 1981; †Sullivan and Rozen 1985.



Level	10	9	8	7	6	5	4	3	2	1
Debitage	0	2	0	1	3	3	0	1	0	0
Hist	0	0	0	0	0	0	0	1	1	0
FCR	1	4	3	5	11	6	3	2	0	1
Charcoal	2	7	2	5	10	0	0	0	0	0
Rock	0	2	1	1	0	0	1	2	1	0

Figure 6.22. Bar plot of artifact quantities per level in TU1.



Stratum	Bw2	Bw1/Bw2	Bw1	A/Bw1	A
Debitage	2	3	4	1	0
Historic	0	0	0	0	1
FCR	9	2	18	5	2
Charcoal	13	1	12	0	0
Rock	2	1	1	3	1

Figure 6.23. Bar plot of artifact quantities per stratum in TU1.

Table 6.7. Fire-cracked rock artifact summary from 35LA3A, Test Unit 1.

Field No.	Level	Material Type	Size (mm)	Wt. (g)	(Shape) Sphericity/Roundness		Fracture Type	Roundness of edges	Cortex (%)	Staining
1	1	FG-IG	6	0.2	SP	A	P	A	0	N
4.1	3	FG-IG	17	0.9	SP	A	I	A	0	N
4.2	3	CG-SED	NA	1.3	SP	SA	P	SR	0	N
8	4	CG-IGW	50	39.5	SP	SR	IR	SR	75	C
8.1	4	CG-IGW	20	1.1	P	A	P	A	0	N
8.2	4	CG-IG	19	2.4	SP	A	I	AA	20	O
9	5	CG-IG	45	44.1	S	SA	I	VA	40	CS-O
10	5	CG-IG	17	1.2	S	SA	I	A	50	CS-O
11	5	CG-IG	20	5.2	S	A	I	A	25	O
12	5	CG-IG	35	12.9	S	A	I	A	40	CS-O
13	5	CG-IG	21	39.6	S	SA	I	AA	40	O
88	5	CG-IG	39	39	S	VA	I	VA	25	CS-O
15	6	CG-IGW	35	6.9	P	A	IR	A	75	N
16	6	CG-SED	22	8.1	SD	SR	I	SR	25	O
17	6	CG-SED	34	7.6	SP	SA	I	SR	35	N
18	6	CG-IG	15	1.3	S	SA	P	A	45	O
19	6	FG-IG	23	2.3	P	SA	P	A	50	CS-O
20	6	CG-SED	35	9.5	SP	SR	I	SR	0	CS
21	6	CG-IG	29	18.2	S	A	I	A	30	CS-O
22	6	FG-SED	78	112	S	R	P	A	50	N
23	6	CG-IG	28	9.3	SP	SA	I	A	40	CS-O
33	6	FG-IG	29	1.9	SP	A	I	A	0	N
36	6	FG-SED	88	421	SD	R	NA	NA	100	C
40	7	FG-IG	44	24.6	SP	SA	IR	A	75	O
43	7	CG-IG	33	7.7	SP	SA	I	A	20	CS-O
46	7	CG-IG	44	41.3	S	SR	I	A	50	O
48	7	CG-IG	47	27	S	A	I	A	0	CS-O
89	7	CG-IG	45	63	S	A	I	VA	65	CS-O
52	8	CG-IG	28	8.4	S	A	I	A	40	O
53	8	CG-IG	NA	NA	SD	R	NA	NA	100	O
56	8	CG-IG	29	6.2	S	A	I	A	5	O
60	9	FG-IG	29	7.3	S	SA	IR	A	60	O
61	9	CG-IGW	36	7.4	P	A	IR	VA	30	N
64	9	FG-IG	46	9.7	SP	SR	C	A	50	O
67	9	CG-IG	21	6.5	SD	SA	I	A	35	O
72	10	CG-IG	20	3.8	SD	SR	I	SA	0	O

Material Type: (CG-SED) Coarse Grained Sedimentary "Sandstone", (FG-SED) Fine Grained Sedimentary "Siltstone", (FG-IG) Fine Grained Igneous "Basalt", (CG-IG) Coarse Grained Igneous "Rhyolite", (CG-IW) Coarse Grained Igneous "highly weathered Rhyolite".

Shape (Sphericity): (P) Prismoidal, (SP) Sub-Prismoidal, (S) Spherical, (SD) Sub-Discoidal, (D) Discoidal.

Shape (Roundness): (VA) Very Angular, (A) Angular, (SA) Sub-Angular, (SR) Sub-Rounded, (R) Rounded, (WR) Well Rounded.

Fracture Type: (P) Planar (flat), (C) Curvilinear, (I) Irregular, (J) Jagged, (PL) Potlid.

Roundness of edges: (VA) Very Angular, (A) Angular, (SA) Sub-Angular, (SR) Sub-Rounded, (R) Rounded, (WR) Well Rounded.

Staining: (CS) Carbon Staining- blackening, (O) Oxidization- reddening.

(Rhyolite), that included a Rhyolite subclass of highly weathered. FCR was visually discriminated from other rock and or lithic artifacts found during the Project based on a number traditionally recognized attributes as summarized by Latas (1992). Common attributes of FCR within TU1 include cobble-sized rocks that have carbon staining and or oxidization, planar, curvilinear, irregular, jagged, or potlid fractures, the presence of cortex, and the absence of flaking attributes. Most rock specimens classified as FCR within TU1 exhibited multiple FCR like attributes the most common being carbon staining and or oxidization.

Grain size analysis within TU1 classifies all excavated matrix as medium to fine-grain sand, silt and clay that was deposited through aeolian processes. TU1 is removed from sources often attributed with supplying new sediment within a coastal setting, most notably from colluvial and alluvial processes. TU1 is located on the relatively flat surface of the Yachats Bench and unaffected by the downslope movement of residuum or landslide debris. TU1 is also elevated and removed from the influence of Gwynn Creek and does not exhibit evidence of alluvial deposited sedimentation. Due to the relatively close proximity to the modern coastline, there is a possibility that larger grained sediment could have been deposited in TU1 by storm events or tsunami. Both of these scenarios would leave evidence within TU1 that could include such things as bedding, graded sediment, or numerous pebbles, gravels, and cobbled mixed within the deposits. No well-defined bedding commonly associated with coastal storm surge events or tsunami runup was observed within TU1, and the total small amount of rock present within TU1 (n=44) suggests that these two scenarios would be unlikely sources of the FCR and rock found within TU1. Some gravel may have been deposited on site by animal agents such as birds carrying shellfish with attached pebbles or granules in their anchoring fibers. Based on this rationalization, most sediment larger in size than a pebble (>4 mm) is interpreted as being deposited by and associated with human use with the exception of some additions by animal agents.

Of the 36 pieces of FCR identified within TU1, 53% were classified as coarse-grain igneous (rhyolite), 19% fine-grain igneous (basalt), 11% coarse-grain sedimentary (sandstone), 11% coarse-grain igneous, highly weathered (rhyolite), and 6% fine-grain sedimentary (siltstone) (Figure 6.24). Of the 8 pieces of rock classified not as FCR, 50% was coarse-grain sedimentary (sandstone), 25% coarse-grain igneous, highly weathered (rhyolite), and 13% each fine-grain sedimentary (siltstone) and unknown. All FCR and rock material types represented within the collection are available from local sources. The predominant material type comprising 43% of the total rock recovered within TU1 is coarse-grain igneous (rhyolite) that is available as cobbles found along Gwynn Creek and the beach within the immediate vicinity of the site. The FCR was not associated with concentrations of charcoal or burned earth that would indicate the presence of a hearth feature. All FCR was concentrated within levels 5, 6, and 7 and 9 and contained within layer Bw1 and Bw2 (Figures 6.22 and 6.23).

Miscellaneous Other Artifacts

Other miscellaneous artifacts recovered during the investigation include two bullet casings and one rock that is interpreted as a bird's gizzard stone. Recovered shell casings included one Winchester .22 long rimfire shell that was recovered from within level 2 (layer A) and one .22 Winchester magnum rimfire (WMR) shell (24 mm length) that dates to post 1960 was recovered from within level three (layer A). One rounded and highly polished quartz pebble (4 mm diameter) was recovered from within level 9 (layer Bw2).

Test Unit 1 Artifact Summary

Excavations at 35LA3A, TU1 produced a limited number of artifacts. A total of 49 artifacts were recovered, which include 10 pieces of lithic debitage, 36 pieces of FCR, two historic/modern bullet casings, and one possible gizzard stone classified as miscellaneous. With the exception of the two historic/modern bullet casings, all artifacts were primarily recovered from within the Bw1 and Bw2 layer. Only one piece of FCR was located at the boundary between the A and

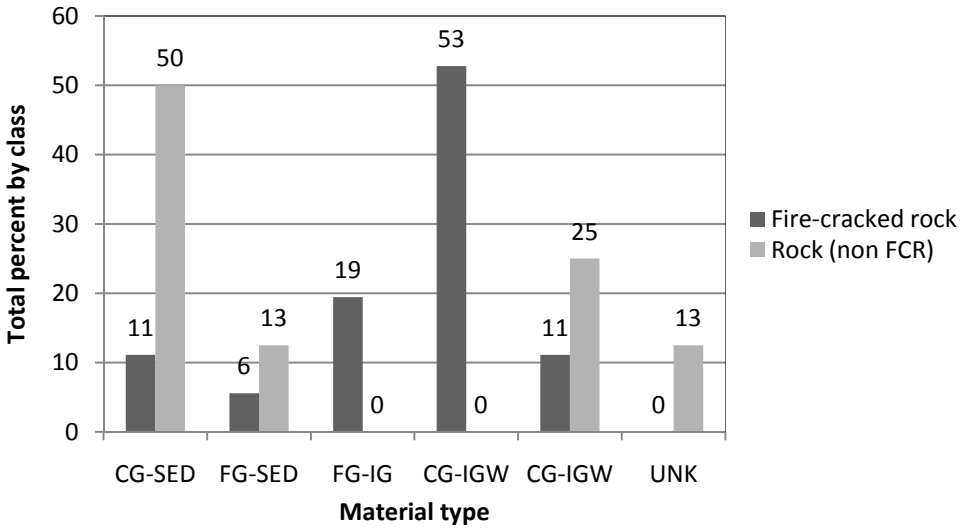


Figure 6.24. Percent of fire-cracked rock and rock recovered from within TU1. Class values include coarse grained sedimentary, sandstone (CG-SED), fine grained sedimentary, siltstone (FG-SED), fine grained igneous, basalt (FG-I), and coarse grained igneous, rhyolite (CG-I), coarse grained igneous, rhyolite, highly weathered (CG-IW), and unknown (UNK).

Bw1 horizon. Most recovered artifacts were located primarily within excavation levels 5 - 7.

Stratigraphic Section Artifacts

Two lithic artifacts were collected during the sampling of the stratigraphic sections located on the edges of 35LA3A and B. One CCS platform-bearing flake was located 98 cm below the ground surface of Section 2 within an upwardly trending 30 mm diameter rodent hole (Table 6.8). The flake was positioned on the lower boundary of the layer within Bw2 and in association with one piece of FCR (not collected). At 35LA3B, Section 3, a fragment of a minimally shaped biface was located exposed within the profile at 97 cm below the ground surface (Table 6.9). The biface fragment was located along the lower irregular boundary of a 2Bsb layer associated with 45 mm rodent hole that was infilled with darker soil from the upper limits of the profile. Marine shell fragments were also observed within the rodent hole located approximately 50 cm below the main 35LA3B shell midden deposits. Both of these lithic artifacts were probably vertically displaced from upper cultural deposits through a process of bioturbation.

6.5.5. Cultural Occupation Summary

Archaeological excavations conducted at site 35LA3A reveal evidence of human occupation beginning at the site around ~6,200 cal BP and continuing, at least sporadically, until ~2,340 cal BP. Analysis of the limited lithic artifacts found at the site point to late stage tool manufacture and resharpening activities. No cultural features were identified or associated with the FCR observed within TU1. The limited number (n=36) and the relative small mean size (33 mm) of recovered FCR fragments may represent the partial remains of an FCR feature cleaning event or the presence of a nearby feature undiscovered by the current excavation. All evidence of human use at the site was contained within the

Table 6.8. Lithic debitage recovered from Stratigraphic Section 2, 35LA3A.

Location	Depth below surface	Material	Color	Size (mm) length/width/ thickness	Reduction typology*	Free standing typology analysis†
Section 2	98	CCS	brn. and brownish yellow	40 x 27 x 13	core reduction	broken flake

References: *Andrefsky 2005; Odell 2003; Flenniken 1981; †Sullivan and Rozen 1985.

Table 6.9. Lithic biface recovered from Stratigraphic Section 3, 35LA3B.

Location	Depth below surface	Material	Color	Size (mm) length/width/ thickness/ weight (g)	Notes
Section 3	97	CCS	yellowish brn.	76 x 47 x 23, 71.8	Minimally shaped biface (stage 2*), exhibiting two areas of edge wear on proximal end.

References: *Andrefsky 2005.

aeolian sediments of LU5 and in a mixture of both aeolian and alluvial deposited sediment within LU6a.

CHAPTER 7. DISCUSSION AND CONCLUSIONS

7.1. Discussion

This project set out to address three primary goals in an effort to better understand the timing and movement of early coastal peoples within the central Oregon coastal environment. Goals set for the project included addressing questions of how has the central Oregon coastal landscape changed since the LGM, and how those changes may have affected the preservation and visibility of archaeological sites. Only by addressing the first two questions will we be able to consider the third and final question of how we might locate sites of certain ages on the central Oregon coast. This thesis attempted to address these questions through the combined use of a GIS-based predictive model and archaeological test excavations at one high probability locale found within Neptune State Park along the modern central Oregon coast.

7.1.1. Evaluating Cultural and Environmental Expectations at Neptune State Park

Based on a model wherein shifting environmental zones are tied to postglacial marine transgression history, LPEH terrestrial deposits were expected to occur in the area of Neptune State Park in the form of alluvial and/or aeolian sediments overlying late Pleistocene-aged marine terrace deposits. A geoarchaeological investigation within Neptune State Park confirmed the presence of seven major lithostratigraphic units (LU1-7). These units included marine, alluvial, aeolian, and culturally-deposited sediments that dated from the late Pleistocene to the late Holocene. It was proposed that the surface of the LPEH deposits could show evidence of soil development or erosional unconformities depending on the type and amount of post depositional processes. Four major soil horizons (PU1-4) were identified at Neptune State

Park, representing periods of landscape stability that have occurred since the late Pleistocene. A number of erosional contacts were also recorded within the stratigraphy and represent periods of landscape degradation. A significant erosional unconformity was located at the contact between LU4a and LU5, positioned at the point where LPEH-aged sediments or a paleosol might have been. This unconformity separated aeolian sediments (LU5) that contained cultural material dating to the middle-late Holocene, and culturally sterile late Pleistocene-aged aeolian dune sediments (LU4a).

It was hypothesized that if sediment dating to the LPEH containing archaeological materials were found, then those cultural deposits should represent inland terrestrial uses. Unfortunately, no sediment dating to the LPEH was identified during the study; apparently lost due to terrestrial erosion. It was also suggested that sediment from later Holocene-aged alluvial and or aeolian deposits would probably overlie the LPEH deposits. This was indeed the case where both alluvial and or aeolian deposits were identified throughout the site area. Cultural materials were not uniformly contained within all late Holocene-aged deposits. Cultural bearing deposits appeared to correlate primarily to their landscape position, situated away from places that were more susceptible to significant surface flooding.

Although the non-shell cultural component identified as part of this investigation would be considered the earliest deposit of cultural material identified within the site, the associated radiocarbon age of ~5,400 RYBP (6,200 cal BP) suggests that the site was occupied since sea level approximated its modern position. The reason for the lack of shell within the TU1 deposit is unknown and could possibly represent a specific use area that was disassociated with shellfish processing activities.

7.1.2. Applying the Coastal Headland Site Formation Model at Neptune State Park

Stratigraphy exposed at site 35LA3A and B can be classified into a Type II scenario of coastal headland site formation, following the Davis et al. (2008) model. A Type II scenario involves the accumulation of stratified late Pleistocene to Holocene sediments followed by periods of erosion that removes all or some of the overlying sediment leaving heavier archaeological materials as lagged sediment on the surface of the eroded surface.

At 35LA3A, this site formation scenario is visible within the stratigraphy of LU4a and LU5. LU4a represents a remnant late Pleistocene-aged dune where the surface has been truncated by erosion prior to the deposition of LU5 sediment. The upper surface of the LU4a deposit was last exposed sometime between 6,180-8,180 cal BP (TL-2). The lower levels of the LU5 deposit, closest to the contact with LU4a, have been assigned an age of 5,370 ±40 RYBP (6,200 cal BP). Sedimentological analysis of LU4a (2Bsb) suggests that the surface has been pedogencialy altered during the late Holocene, and possibly when the sediment was exposed before burial by LU5 sediment. The erosional contact between LU4a and LU5 represents an approximate 11,400 year loss of stratigraphic time. Unlike at other archaeological sites where a Type II model has been identified (Davis et al. 2008:134), very few artifacts or other large clast material were found on the truncated surface of LU4a. This analysis supports a conclusion that human occupation in the area of 35LA3A began at least after 5,400 RYBP (6,200 cal BP) when LU5 sediments were deposited over the LU4a surface. Based on this model, even if the single CCS flake (FN-58) and FCR fragment (FN-60) found on the 2Bsb surface and contained within Bw2 (LU5) was considered to be in the original stratigraphic position, the deposit still could be no older than the basal age of 5,370 ±40 RYBP (6,197 ±20 cal BP) assigned for that unit, since the primary context of archaeological evidence can be no older than its associated intact matrix. This analysis leads to the conclusion that the

cultural deposit contained within TU1 can be no older than ~5,370 ±40 RYBP (6,197 ±20 cal BP) and no intact late Pleistocene early Holocene cultural components exist in 35LA3A, at the location of TU1.

In 2002, Davis and Fillmore conducted stratigraphic investigations at a headland exposure located at site 35LA5, also located within Neptune State Park, and situated approximately 500 m south of the current study area (Davis et al. 2008). Based on a similar geologic sequence observed at both 35LA3 and 35LA5, Davis and Fillmore suggested that the chronostratigraphic sequence identified by Ross at site 35LA3B (i.e., an early Holocene-aged lithic site might actually closely underlie a late Holocene-aged shell midden) could be caused if a late Holocene-aged shell midden was created on the eroded surface of an early Holocene-aged paleosol. In this way, Ross's date of 320 ±45 RYBP (394 ±50 cal BP), which directly overlies a date of 8,310 ±110 RYBP (9,343 ±110 cal BP), would be entirely possible. Results of this current study confirms the Davis and Fillmore hypothesis that unconformable contacts within stratigraphy exposed at Neptune State Park are producing significant breaks in site chronostratigraphy, bringing archaeological components of significantly different ages in close stratigraphic proximity to one another.

Stratigraphy observed at 35LA3 is similar to what has been observed at other archaeological sites within similar landscape positions along the Oregon coast. On the southern Oregon coast at the Indian Sands site (35CU67C), geoarchaeological investigations have also identified late Pleistocene aged aeolian dune sands interbedded with paleosol horizons (Davis et al. 2004, 2008). Stratigraphy includes one fine sandy loam layer that has been identified as the 4Bsb stratum. TL dating of sediment within the upper margin of this layer has dated the deposit to 15,600 ±1,800 cal BP (Davis et al. 2004). Located on the surface of the 4Bsb stratum is a developed paleosol that directly underlies a loamy 3Ab stratum. Charcoal found in association with lithic artifacts at the base of the 3Ab paleosol have returned an age of 10,430 ±150 cal BP indicating a

erosional unconformity is present between the 4Bsb and the 3Ab stratum representing an approximate 5,000 year loss of stratigraphic time.

Similarities exist between the stratigraphy at 35CU67C and 35LA3 in that 35LA3 also has Pleistocene aged aeolian dune sands (15,300 +2,500/-2,300 cal BP) (2Bsb) underlying more recent Holocene aged sediment (Bw2), separated by an erosional unconformity. In the case of 35LA3 however, erosion that is represented by the loss of a maximum of 11,400 years of stratigraphic time has removed all of the LPEH sediment within the area of the study. It is important to consider the potential importance of this boundary in locating intact sediment dating to the LHEH. It is believed that both the 4Bsb stratum at 35CU67C and the 2Bsb stratum found at the Neptune Site likely represent truncated spodic horizons that had formed previously within inland stabilized dunes when the landscape was forested. The identification of these types of deposits and their associated erosional features can serve as key target horizons for future coastal researchers looking for landforms and archaeological deposits and date to the LPEH.

7.1.3. A Model of Coastal Erosion: Accounting for Lost Time

Geoarchaeological investigations at Neptune State Park identified an erosional unconformity that signals the loss of lithostratigraphic and/or pedostratigraphic units dating between 11,600 and 6,200 cal BP. Identifying this loss of LPEH-aged sediments is a critical geoarchaeological clue that helps to explain the character and patterning of Oregon's early coastal archaeology. In order to answer one of the main research questions of this project which is, "how might we locate sites of certain ages on the central Oregon coast?" we must evaluate the factors responsible for the apparent loss of time between the late LPEH deposits observed at Neptune State Park in order to make suggestions as to how best locate places within the larger modern coastal landscape where this

erosional process has not occurred. Fully evaluating the cause of this erosional unconformity is beyond the scope of this paper and would be a good topic for future research. Below, I offer a hypothetical model that explains the probable causes of this loss of stratigraphic time, which might be used as a starting point for future related research. This diachronic model of coastal erosion is a good explanation for how geomorphic change has conditioned the character of Neptune State Park's stratigraphic record. The following discussion is offered in relation to the stratigraphic sequence observed in TU1 and its immediate downslope deposits.

Time 1: (>6,000 cal BP)

Starting sometime prior 6,000 cal BP, the model begins when a late Pleistocene to early Holocene-aged paleosol develops on a late Pleistocene-aged sand dune (LU4a) at a time when sea level was slightly lower (~10 m) than today. Slope erosion is active on the surface of the late Pleistocene-aged dune where upslope propagation of erosion seeks to establish a steady state of slope angle. The angle of repose along the shoreface proceeds to decrease in order to remove the nickpoint that exists between the bank and slope. The rate of slope lowering depends on the relative resistance of the eroded deposits (Figure 7.1a).

Time 2: (6,000 cal BP)

At around 6,000 cal BP, sea level continues to rise and the surface of the late Pleistocene aged sand dune (LU4a) is further truncated by erosion. It is possible that erosion on portions of the Pleistocene aged surface could have been complete enough to remove any associated late Pleistocene aged cultural materials. Slope erosion continues to be active on the surface of the late Pleistocene-aged paleosol and aeolian parent material (Figure 7.1b).

Time 3: (5,000 cal BP)

At around 5,000 cal BP, sea levels continue to rise and dark brown Holocene-aged aeolian sediment (LU5) begins to be deposited on the surface of the

truncated late Pleistocene-aged paleosol and dune (LU4a). Slope erosion continues to be active on the shore face and the exposed surface of the late Pleistocene-aged dune (Figure 7.1c).

Time 4: (≤3,000 cal BP)

At 3,000 cal BP and thereafter, sea levels stabilize and the dark brown Holocene-aged aeolian sediment (LU5) continues to accumulate, creating weakly developed soil horizons. Slope erosion continues to be active on the exposed downslope surface of the late Pleistocene-aged dune. Major shoreface erosion affects the western extent of both late Pleistocene and Holocene-aged deposits (Figure 7.2a).

Time 5: (Today)

Today, sea levels are rising (Church and White 2006) and the dark brown late Holocene-aged aeolian sediment (LU5) continues to accumulate. Slope erosion continues to be active on the shore face and the exposed surface of the late Pleistocene-aged dune. Major shore face erosion continues to negatively affect the western extent of both late Pleistocene and Holocene-aged deposits (Figure 7.2b). Global sea levels during the 20th century are estimated to be rising at an accelerated rate of 1.7 ± 0.3 mm per year (Church and White 2006). These projections are consistent with larger projections made by the Intergovernmental Panel on Climate Change within the Third Assessment Report that estimate that over the next century sea levels will rise between 0.1 - 0.9 m (Church and Gregory 2001). Recent work by Ruggiero (2008) have showed that the wave height and wave runup associated with recent climate changes has increased coastal erosion and flooding in the Pacific Northwest. These climate controlled processes have the ability to profoundly affect and increase erosion that is occurring along the shoreface.

Given the implications of the coastal erosion model presented here, where would intact LPEH sites be located within the modern coastal landscape of

Figure 7.1a.

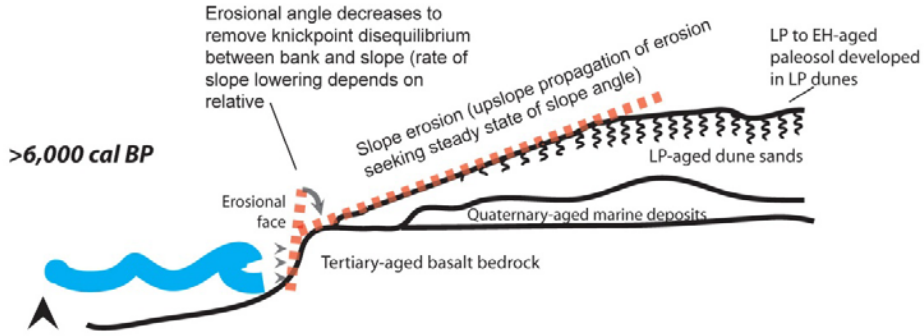


Figure 7.1b.

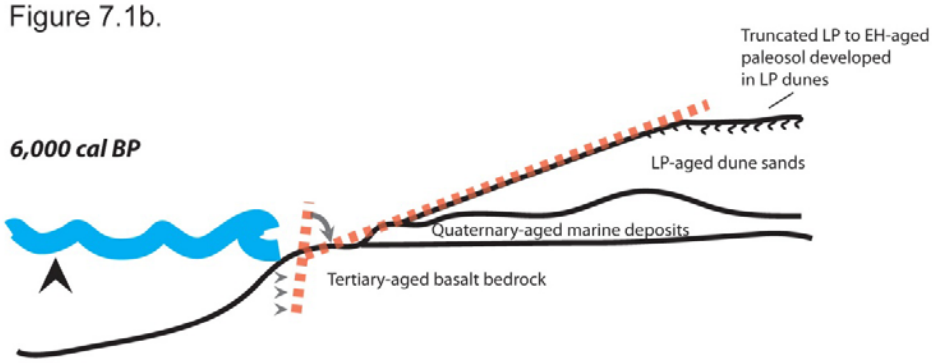


Figure 7.1c.

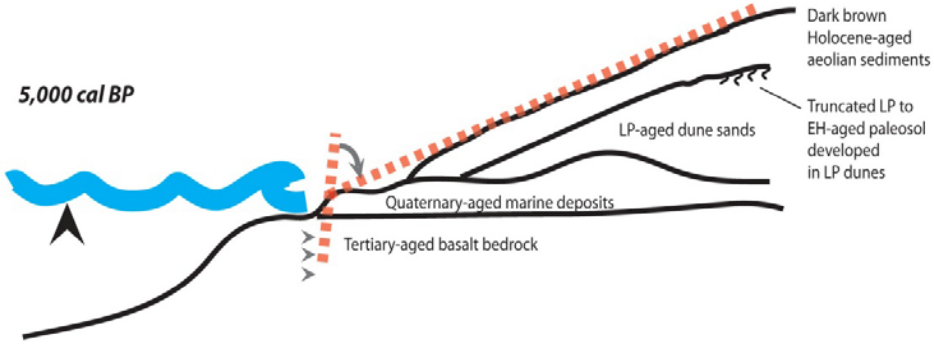


Figure 7.1a,b,c. Coastal erosion model showing potential stages of erosion occurring at Neptune State Park since the late Quaternary.

Figure 7.2a.

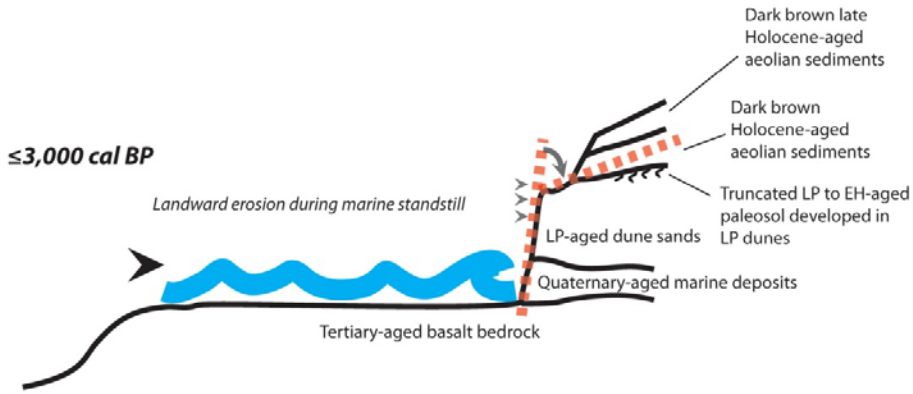


Figure 7.2b.

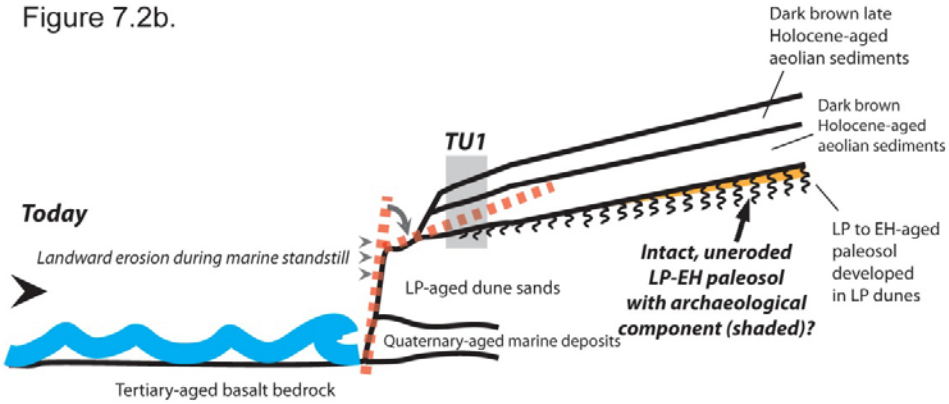


Figure 7.2a,b. Coastal erosion model showing potential stages of erosion occurring at Neptune State Park since the late Quaternary.

Neptune State Park? Assuming the area was indeed used by early coastal peoples, intact sites are expected to be located away (east) of the modern shoreface, beyond the influence of the eroded angle of repose imposed on the paleosol developed on late Pleistocene-aged dune sands (LU4a), as shown in Figure 7.2b. This concept may also apply to alluvial valleys where the stream banks have been eroded more extensively near the channel and earlier deposits are more intact farther away.

Other areas in the landscape that could hold potential for preserving early sites could include parts of the landscape that have been deeply buried by mobilized sediment since the early Holocene. During the late Pleistocene to mid-Holocene the central Oregon climate was warmer and drier and exhibited summer drought and an increased frequency of forest fires (Worona and Whitlock 1995; Grigg and Whitlock 1998). These types of conditions could be associated with greater rates of erosion possibly resulting in what is seen within the stratigraphy at 35LA3, and the loss of cultural deposits. These conditions could also contribute to the preservation of cultural materials by capping cultural deposits, preserving and protecting them from the damaging effects of erosion. These areas would be located away (east) of the modern shoreface, elevated and protected from the influence fluvial processes, and possibly protected from the erosional effects of wind being located on the leeward side of obstructions or adjacent to hill slopes where sediment could accumulate.

7.1.4. The Next Step: Strategies for Finding Early Coastal Sites Along the Central Oregon Coast

Paleolandscape reconstruction is an important tool for conceptualizing a coastal environment that no longer exists. Evaluating cultural behavior and natural processes are an essential first step for finding early archaeological sites within a fragmentary coastal environment. Tools such as GIS can be helpful to

visualize these past landscapes but their accuracy is dependent on the quality of available data. As with the current model, the usefulness is based on big picture concepts and identifying places in the modern terrestrial landscape that are located near potentially higher value offshore targets. Additional higher resolution bathymetric and tectonic data will be necessary before moving forward and investigating offshore targets of interest.

Erosional unconformities like the one identified during this project are commonly observed within the exposed stratigraphy of the central Oregon coast. Having the ability to identify these types of features is perhaps one of the most important tools for identifying parts of the coastal landscape where sites dating the LPEH may be situated. As previously mentioned, parts of the landscape located east the active shore face may be the most promising for preserving sites with LPEH sediment but are not easily identifiable in areas away from natural stratigraphic exposures. In these cases, east to west Geoprobe™ or hand auger transects may be helpful to identify these types of deposits located away from natural exposures. Although this research highlights significant geoarchaeological problems facing any efforts to find Oregon's early coastal sites, archaeological site survey along the active shore face may still be a productive way for locating early deposits and cultural materials, since uneroded examples of LPEH-aged terrestrial stratigraphy may yet be found.

7.2. Conclusion

This study of site 35LA3, located within Neptune State Park, represents a rare application of geoarchaeological methods in order to study the effects of landscape change and archaeological site formation along the Oregon coast. Stratigraphic profiles exposed within the park contain sediments that represent depositional environments that are typical of the modern coastal landscape, and

can serve as important examples for identifying and evaluating the effects of landscape change within a coastal environment.

This study has shown that GIS analysis can provide the conceptual framework necessary for evaluating the potential for archaeological sites in both marine and terrestrial settings. And although GIS analysis can be especially useful at visualizing paleolandscapes that no longer exist, it must be coupled with traditional geoarchaeological field investigations that include stratigraphic analysis and the systematic dating of depositional units to achieve its greatest effectiveness.

Archaeological excavations conducted at site 35LA3A identified a late Holocene-aged human occupation beginning at ~6,200 cal BP and continuing at least sporadically until ~2,340 cal BP. Cultural activities conducted at the site include late stage tool manufacture and resharpening, and although FCR was located within the excavation unit, no intact cultural features were identified. The earliest use identified at the site that can be characterized as a non-shell component that is primarily contained within aeolian dune deposits. Later occupation of the site exhibiting a shell component is contained within both aeolian and alluvial deposited sediment.

Examination of the stratigraphy exposed within TU1 revealed the eroded remnant of a pedogenically altered late Pleistocene-aged dune, which was buried beneath Holocene-aged sand and loess that contain cultural materials. The erosional contact between the late Pleistocene and Holocene-aged deposits marks the loss of up to 11,400 years stratigraphic time and provides another example of such patterns of site formation within Oregon's coastal headlands. To help explain the apparent loss of time between the two deposits, a diagenetic model of coastal erosion is presented. This model considers coastal erosion observed to be occurring at site 35LA3A and connects it to the stratigraphic record at Neptune State Park. The model is based on the assumption that the

erosional shoreface and adjacent slope are always eroding towards a state of slope angle balance. This slope balance is obtained through the mechanical means of surface erosion. This ongoing process has the ability to produce erosional features similar to what is observed within the excavations at Neptune State Park.

An erosional boundary that has been identified within the stratigraphy at the Neptune site is similar to other stratigraphic sequences found at other sites within similar landscape settings along the Oregon coast. This erosional boundary and distinct strata that is often represented by a Bsb soil horizon can serve as a key target horizon for identifying the important boundary between late Pleistocene and early to mid Holocene deposits. This boundary is a useful aid for future coastal researchers looking for landforms and archaeological deposits and date to the late to the LPEH.

It is a challenging endeavor and important for identifying likely locations for prehistoric coastal settlements. Considering coastal landscape change and how early people may have positioned themselves within their changing environment has great implications not just for furthering the general body of knowledge regarding Oregon's prehistory, but also for furthering the protection and management of the relatively few remaining archaeological sites left within this area. Only by applying a holistic approach that includes geoarchaeological methods to coastal studies will researchers be able to fully explore the archaeological potential of the central Oregon coastal landscape.

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APPENDICES

Appendix A: Artifact Catalog

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	1	1	1	A	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	2	1	2	A	-	-	-	Rock	R	1	28-Jan-10	Screen, rock
35LA3A	3	1	2	A	-	-	-	Metal	HIST	1	28-Jan-10	.22 shell casing in screen
35LA3A	4	1	3	A/Bw1	-	-	-	Rock	R	1	28-Jan-10	Screen, rock
35LA3A	4.1	1	3	A/Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	4.2	1	3	A/Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen, angular sandstone fragment
35LA3A	5	1	3	A/Bw1	-	-	-	Debitage	DEB	1	28-Jan-10	Screen
35LA3A	6	1	3	A/Bw1	-	-	-	Metal	HIST	1	28-Jan-10	Historic shell casing in screen
35LA3A	7	1	3	A/Bw1	-	-	-	Rock	R	1	28-Jan-10	Rock in screen
35LA3A	8	1	4	A/Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	8.1	1	4	A/Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	8.2	1	4	A/Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	8.3	1	4	A/Bw1	-	-	-	Rock	R	1	28-Jan-10	Screen, (25mm) siltstone gravel, rock
35LA3A	9	1	5	A	72	92	-38	FCR	FCR	1	28-Jan-10	
35LA3A	10	1	5	Bw1	12	64	-43	FCR	FCR	1	28-Jan-10	
35LA3A	11	1	5	Bw1	28	47	-47	FCR	FCR	1	28-Jan-10	
35LA3A	12	1	5	Bw1	2	68	-48	FCR	FCR	1	28-Jan-10	
35LA3A	13	1	5	Bw1	11	59	-43	FCR	FCR	1	28-Jan-10	
35LA3A	14	1	5	Bw1	-	-	-	Debitage	DEB	2	28-Jan-10	Screen
35LA3A	15	1	6	Bw1	76	14	-51	FCR	FCR	1	28-Jan-10	
35LA3A	16	1	6	Bw1	70	88	-55	FCR	FCR	1	28-Jan-10	
35LA3A	17	1	6	Bw1	90	15	-56	FCR	FCR	1	28-Jan-10	
35LA3A	18	1	6	Bw1	68	38	-54	FCR	FCR	1	28-Jan-10	
35LA3A	19	1	6	Bw1	62	53	-55	FCR	FCR	1	28-Jan-10	
35LA3A	20	1	6	Bw1	10	48	-52	FCR	FCR	1	28-Jan-10	
35LA3A	21	1	6	Bw1	28	98	-58	FCR	FCR	1	28-Jan-10	
35LA3A	22	1	6	Bw1	73	6	-57	FCR	FCR	1	28-Jan-10	
35LA3A	23	1	6	Bw1	78	17	-54	FCR	FCR	1	28-Jan-10	FCR associated with FN24
35LA3A	24	1	6	Bw1	80	17	-54.5	Charcoal	C	NA	28-Jan-10	Charcoal Sample (determined too small of a sample to be dated)
35LA3A	25	1	6	Bw1	10	48	-53	Charcoal	C	NA	28-Jan-10	
35LA3A	26	1	6	Bw1	18	62	-56	Charcoal	C	NA	28-Jan-10	
35LA3A	27	1	6	Bw2	4	90	-57	Charcoal	C	NA	28-Jan-10	Sample sent for AMS Dating, 3,260 ±40 RYBP (3,467 ±20 cal BP) (Beta-276053)
35LA3A	28	1	6	Bw2	12	98	-59	Charcoal	C	NA	28-Jan-10	
35LA3A	29	1	6	Bw1	62	6	-56.5	Charcoal	C	NA	28-Jan-10	
35LA3A	30	1	6	Bw1	55	18	-56	Charcoal	C	NA	28-Jan-10	

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	31	1	6	Bw1	12	22	-53	Charcoal	C	NA	28-Jan-10	
35LA3A	32	1	6	Bw1	86	46	-56	Charcoal	C	NA	28-Jan-10	Sample sent for AMS Dating, 2,330 ±40 RYBP (2,338 ±30 cal BP) (Beta-276054)
35LA3A	33	1	6	Bw1	-	-	-	FCR	FCR	1	28-Jan-10	Screen
35LA3A	34	1	6	Bw1	-	-	-	Charcoal	C	25 g dry	28-Jan-10	Screen
35LA3A	35	1	6	Bw1/Bw2	-	-	-	Debitage	DEB	3	29-Jan-10	Screen
35LA3A	36	1	6	Bw1/Bw2	25	10	-55	FCR	FCR	1	28-Jan-10	Cobble
35LA3A	37	1	6	Bw1/Bw2	-	-	-	Seed	S	1	29-Jan-10	Screen, charred seed
35LA3A	38	1	7	Bw1	60	36	-59.5	Rock	R	1	29-Jan-10	Rock
35LA3A	39	1	7	Bw1	50	2	-60	Charcoal	C	NA	29-Jan-10	
35LA3A	40	1	7	Bw1	56	78	-63.5	FCR	FCR	1	29-Jan-10	
35LA3A	41	1	7	Bw1	58	78	-62.5	Charcoal	C	NA	29-Jan-10	
35LA3A	42	1	7	Bw2	4	80	-62	Charcoal	C	NA	29-Jan-10	
35LA3A	43	1	7	Bw1	98	84	-67	FCR	FCR	1	29-Jan-10	
35LA3A	44	1	7	Bw2	44	65	-67	UNK	UNK	1	29-Jan-10	Possible plinthite fragment
35LA3A	45	1	7	Bw2	20	20	-65	Example	EX	NA	29-Jan-10	Sediment example (non-cultural)
35LA3A	46	1	7	Bw1	70	24	-62	FCR	FCR	1	29-Jan-10	
35LA3A	47	1	7	Bw1	73	23	-62	Charcoal	C	NA	29-Jan-10	Sample sent for AMS Dating , 3,530 ±40 RYBP (3,845 ±30 cal BP) (Beta-276055)
35LA3A	48	1	7	Bw2	4	70	-70	FCR	FCR	1	29-Jan-10	
35LA3A	49	1	7	Bw1	-	-	-	Charcoal	C	35.2 g dry	1-Feb-10	screen
35LA3A	50	1	7	Bw1	-	-	-	Debitage	Deb	1	1-Feb-10	screen
35LA3A	51	1	8	Bw2	37	13	-76	Charcoal	C	NA	1-Feb-10	
35LA3A	52	1	8	Bw2	69	39	-75	FCR	FCR	1	1-Feb-10	
35LA3A	53	1	8	Bw2	80	4	-79	FCR	FCR	1	1-Feb-10	FCR Cobble Not Collected
35LA3A	54	1	8	Bw1/Bw2	83	16	-77	Rock	R	1	1-Feb-10	Rock
35LA3A	55	1	8	Bw1/Bw2	-	-	-	Charcoal	C	15.9 g dry	1-Feb-10	Screen
35LA3A	56	1	8	Bw1/Bw2	-	-	-	FCR	FCR	1	1-Feb-10	Possible FCR found in screen
35LA3A	57	1	9	Bw2	48	90	-83	Charcoal	C	NA	2-Feb-10	
35LA3A	58	1	9	Bw2	54	84	-87	Debitage	DEB	1	2-Feb-10	Associated Debitage with FN59 and 60
35LA3A	59	1	9	Bw2	54	83	-87.5	Charcoal	C	NA	2-Feb-10	Sample sent for AMS Dating, 5,370 ±40 RYBP (6,197 ±20 cal BP) (Beta-276056)
35LA3A	60	1	9	Bw2	54	83	-87	FCR	FCR	1	2-Feb-10	Associated FN58 and 59
35LA3A	61	1	9	Bw2	84	4	-82	FCR	FCR	1	2-Feb-10	
35LA3A	62	1	9	Bw2	72	9	-85	Charcoal	C	NA	2-Feb-10	
35LA3A	63	1	9	Bw2	87	20	-82	Charcoal	C	NA	2-Feb-10	

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	64	1	9	Bw2	78	6	-86	FCR	FCR	1	2-Feb-10	
35LA3A	65	1	9	Bw2	32	35	-87	Charcoal	C	1	2-Feb-10	Sample sent for AMS Dating (charcoal is underlying FCR #4, ie. FN-71), 1,800 ±40 RYBP (1,755 ±608 cal BP) (Beta-276057)
35LA3A	66	1	9	Bw2	70	98	-89	Charcoal	C	NA	2-Feb-10	
35LA3A	67	1	9	Bw2	32	4	-89	FCR	FCR	1	2-Feb-10	
35LA3A	68	1	9	Bw2	-	-	-	Charcoal	C	31 g dry	2-Feb-10	Screen
35LA3A	69	1	9	Bw2	-	-	-	Debitage	DEB	1	2-Feb-10	Screen
35LA3A	70	1	9	Bw2	-	-	-	Rock	R	1	2-Feb-10	Unknown rock/lithic found in screen
35LA3A	71	1	9	Bw2	32	35	-86	Rock	R	1	2-Feb-10	Rock
35LA3A	72	1	10	Bw2	60	83	-93	FCR	FCR	1	2-Feb-10	
35LA3A	73	1	10	Bw2	57	53	-95.5	Charcoal	C	NA	2-Feb-10	
35LA3A	74	1	10	Bw2	-	-	-	Charcoal	C	12 g dry	2-Feb-10	Screen
35LA3A	75	1	2	A	7	100	-12.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 10-15 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	76	1	3	A/Bw1	7	100	-22.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 20-25 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	77	1	4	Bw1	7	100	-32.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 30-35 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	78	1	5	Bw1	7	100	-42.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 40-45 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	79	1	6	Bw2	7	100	-52.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 50-55 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	80	1	7	Bw2	7	100	-62.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 60-65 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	81	1	8	2Bsb	7	100	-72.5	Sediment Sample	CVS	~200 g	3-Feb-10	Depth is 70-75 cm below datum/surface. Sample taken at unit datum corner.
35LA3A	82	1		2Bsb	0	76	-80	TL Sample #1	TL1	1	4-Feb-10	PVC TL sample, 15,300 +2,500/-2,300 cal BP
35LA3A	83	1		Bw2	0	55	-65	TL Sample #2	TL2	1	4-Feb-10	PVC TL sample, 7,180 ±1,000 cal BP
35LA3A	84	1		2Bsb	0	76	-78	Sediment Sample	TL1	1	4-Feb-10	2 cm above TL#1, 75 g approx, (moisture test)
35LA3A	85	1		2Bsb	0	76	-82	Sediment Sample	TL1	1	4-Feb-10	2 cm below TL#1, 75 g approx, (moisture test)
35LA3A	86	1		Bw2	0	76	-63	Sediment Sample	TL1	1	4-Feb-10	2 cm above TL#2, 75 g approx, (moisture test)

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	87	1		Bw2	0	76	-67	Sediment Sample	TL1	1	4-Feb-10	2 cm below TL#2, 75 g approx (moisture test)
35LA3A	88	1	5	Bw1	6	100	-42.5	FCR	FCR	1	3-Feb-10	FCR located within 40-45 sediment sample.
35LA3A	89	1	7	Bw2	6	100	-62	FCR	FCR	1	3-Feb-10	FCR located within 60-65 sediment sample.
35LA3A	90	Profile 1	-	A	-	-	-20	Sediment Sample	CVS	~450 g	20-Feb-10	Profile 1, sediment sample #1
35LA3A	91	Profile 1	-	Bw1	-	-	-48	Sediment Sample	CVS	~450 g	20-Feb-10	Profile 1, sediment sample #2
35LA3A	92	Profile 1	-	Bw2	-	-	-80	Sediment Sample	CVS	~450 g	20-Feb-10	Profile 1, sediment sample #3
35LA3A	93	Profile 1	-	Bw1/2Bsb	-	-	-100	Sediment Sample	CVS	~450 g	20-Feb-10	Profile 1, sediment sample #4
35LA3A	94	Profile 1	-	2Bsb	-	-	-105	Sediment Sample	CVS	~450 g	20-Feb-10	Profile 1, sediment sample #5
35LA3A	95	Section 2	-	A	-	-	-20	Sediment Sample	CVS	~450 g	20-Feb-10	Section 2, sediment sample #1
35LA3A	96	Section 2	-	Bw1	-	-	-55	Sediment Sample	CVS	~450 g	20-Feb-10	Section 2, sediment sample #2
35LA3A	97	Section 2	-	Bw2	-	-	-80	Sediment Sample	CVS	~450 g	20-Feb-10	Section 2, sediment sample #3, (Bw2 Upper)
35LA3A	98	Section 2	-	Bw2	-	-	-100	Sediment Sample	CVS	~450 g	20-Feb-10	Section 2, sediment sample #4, (Bw2 Lower)
35LA3A	99	Section 2	-	Bw2/2Bsb	-	-	-125	Sediment Sample	CVS	~450 g	20-Feb-10	Section 2, sediment sample #5,
35LA3B	100	Section 3	-	-	-	-	-65	Sediment Sample	CVS	~450 g	20-Feb-10	Section 3, sediment sample #1, 5 cm below midden
35LA3B	101	Section 3	-	-	-	-	-90	Sediment Sample	CVS	~450 g	20-Feb-10	Section 3, sediment sample #2, 33 cm below midden
35LA3B	102	Section 3	-	-	-	-	-97	Sediment Sample	CVS	~450 g	20-Feb-10	Section 3, sediment sample #3, 44 cm below midden, sample is sediment that surrounds CCS next to rodent disturbance.
35LA3B	103	Section 3	-	-	-	-	-113	Sediment Sample	CVS	~450 g	20-Feb-10	Section 3, sediment sample #4, possible pleist. dune deposits C horizon.

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA5	104	Section 4	-	-	-	-	-10	Sediment Sample	CVS	~450 g	20-Feb-10	Section 4, sediment sample #1, A Horizom
35LA5	105	Section 4	-	-	-	-	-38	Sediment Sample	CVS	~450 g	20-Feb-10	Section 4, sediment sample #2, 2Bs1 Horizom
35LA5	106	Section 4	-	-	-	-	-60	Sediment Sample	CVS	~450 g	20-Feb-10	Section 4, sediment sample #3, 2Bs2 Horizom
35LA3A	107	Section 2	-	-	-	-	-98	Debitage	Deb	1	20-Feb-10	Section 2, lithic flake found in rodent hole and next to FCR. In Botton of Bw2 strata.
35LA3A	108	Section 2	-	B1w	-	-	-57	Charcoal	C	2	20-Feb-10	Section 2, Large charcoal sample located at the boundary of A and Bw1. Sample sent for AMS Dating. 640 ±40 RYBP (579 ±20 cal BP) (Beta-276052)
35LA3B	109	Section 3	-	-	-	-	-97	Debitage	Deb	1	28-Jan-10	Section 3, Flake/tool located in stratum below 35LA3B
35LA3A	110	1	2	A	7	100	-12.5	Charcoal	C	<0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 10-15 cm sediment sample.
35LA3A	111	1	2	A	7	100	-12.5	Charcoal	C	< 0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of 1CVS 0-15 cm sediment sample.
35LA3A	112	1	2	A	7	100	-12.5	Seed	B	1	3-Feb-10	Seed recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 10-15 cm sediment sample.
35LA3A	113	1	3	A/Bw1	7	100	-22.5	Charcoal	C	<0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 20-25 cm sediment sample.
35LA3A	114	1	3	A/Bw1	7	100	-22.5	Charcoal	C	< 0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 20-25 cm sediment sample.
35LA3A	115	1	4	Bw1	7	100	-32.5	Charcoal	C	<0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 30-35 cm sediment sample.
35LA3A	116	1	4	Bw1	7	100	-32.5	Charcoal	C	< 0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 30-35 cm sediment sample.

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	117	1	5	Bw1	7	100	-42.5	Charcoal	C	0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 30-35 cm sediment sample.
35LA3A	118	1	5	Bw1	7	100	-42.5	Charcoal	C	< 0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 30-35 cm sediment sample.
35LA3A	119	1	5	Bw1	7	100	-42.5	Debitage	DEB	1	3-Feb-10	white CCS flake fragment (4 mm L x 2.5mm W x .4mm t)recovered in lab sieving (No. 18 sieve/ 100 g. sample) of CVS 30-35 cm sediment sample.
35LA3A	120	1	6	Bw2	7	100	-52.5	Charcoal	C	<0.1 g.	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g. sample) of CVS 50-55 cm sediment sample.
35LA3A	121	1	6	Bw2	7	100	-52.5	Charcoal	C	0.1 g	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 50-55 cm sediment sample.
35LA3A	122	1	7	Bw2	7	100	-62.5	Charcoal	C	.3 g	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 60-65 cm sediment sample.
35LA3A	123	1	7	Bw2	7	100	-62.5	Charcoal	C	0.1 g	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 60-65 cm sediment sample.
35LA3A	124	1	8	2wB	7	100	-72.5	Charcoal	C	0.2 g	3-Feb-10	Charcoal recovered in lab sieving (No. 10 sieve/ 100 g sample) of CVS 70-75 cm sediment sample.
35LA3A	125	1	8	2wB	7	100	-72.5	Charcoal	C	<0.1 g	3-Feb-10	Charcoal recovered in lab sieving (No. 18 sieve/ 100 g sample) of CVS 70-75 cm sediment sample.
35LA3A	126	-	-	-	-	-	-	Sediment Sample	CVS	~40 g	3-Feb-10	Sediment sample "gray sediment" recovered withinin Tasa and Connolly (2001) Feature.
35LA3A	127	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Hearth" Plan View.
35LA3A	128	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Ashy patch west of hearth".
35LA3A	129	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Hearth Profile".

SITE	FIELD NO	UNIT	LEVEL	STRATUM	NORTHING	EASTING	ELEV	MAT	MAT CODE	CT	DATE	COMMENTS
35LA3A	130	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Hearth" Plan View.
35LA3A	131	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Hearth" Plan View.
35LA3A	132	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "Gray patch north of Hearth" Plan View.
35LA3A	133	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "LP root burn, all gray" (left/N).
35LA3A	134	-	-	-	-	-	-	Thin Slide Section	TSS	1.25 in box	3-Feb-10	Thin slide sample, "LP root burn, gray/brn" (right/S).

Appendix B: Radiocarbon Dating

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Darden Hood
President

Ronald Hatfield
Christopher Patrick
Deputy Directors

March 28, 2010

Dr. Loren Davis
Oregon State University
Department of Anthropology
238 Waldo Hall
Corvalis, OR 97331
USA

RE: Radiocarbon Dating Results For Samples 35LA3A-SEC2-52CMBS-FN108, 35LA3A-TU1-L6-FN27, 35LA3A-TU1-L6-FN32, 35LA3A-TU1-L7-FN47, 35LA3A-TU1-L9-FN59, 35LA3A-TU1-L9-FN65

Dear Dr. Davis:

Enclosed are the radiocarbon dating results for six samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice has been sent separately. Thank you for your prior efforts in arranging payment. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
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MIAMI, FLORIDA, USA 33155
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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Loren Davis

Report Date: 3/28/2010

Oregon State University

Material Received: 2/26/2010

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 276052 SAMPLE : 35LA3A-SEC2-52CMBS-FN108 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1280 to 1400 (Cal BP 670 to 550)	610 +/- 40 BP	-23.4 o/oo	640 +/- 40 BP
Beta - 276053 SAMPLE : 35LA3A-TU1-L6-FN27 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 1620 to 1440 (Cal BP 3570 to 3390)	3270 +/- 40 BP	-25.4 o/oo	3260 +/- 40 BP
Beta - 276054 SAMPLE : 35LA3A-TU1-L6-FN32 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 410 to 370 (Cal BP 2360 to 2320)	2350 +/- 40 BP	-26.4 o/oo	2330 +/- 40 BP
Beta - 276055 SAMPLE : 35LA3A-TU1-L7-FN47 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 1960 to 1750 (Cal BP 3910 to 3700)	3520 +/- 40 BP	-24.5 o/oo	3530 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Loren Davis

Report Date: 3/28/2010

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 276056 SAMPLE : 35LA3A-TU1-L9-FN59 ANALYSIS : AMS-Standard AMS MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 4330 to 4140 (Cal BP 6280 to 6100) AND Cal BC 4140 to 4060 (Cal BP 6090 to 6010)	5390 +/- 40 BP	-26.3 o/oo	5370 +/- 40 BP
Beta - 276057 SAMPLE : 35LA3A-TU1-L9-FN65 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 120 to 330 (Cal BP 1830 to 1620)	1800 +/- 40 BP	-24.7 o/oo	1800 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

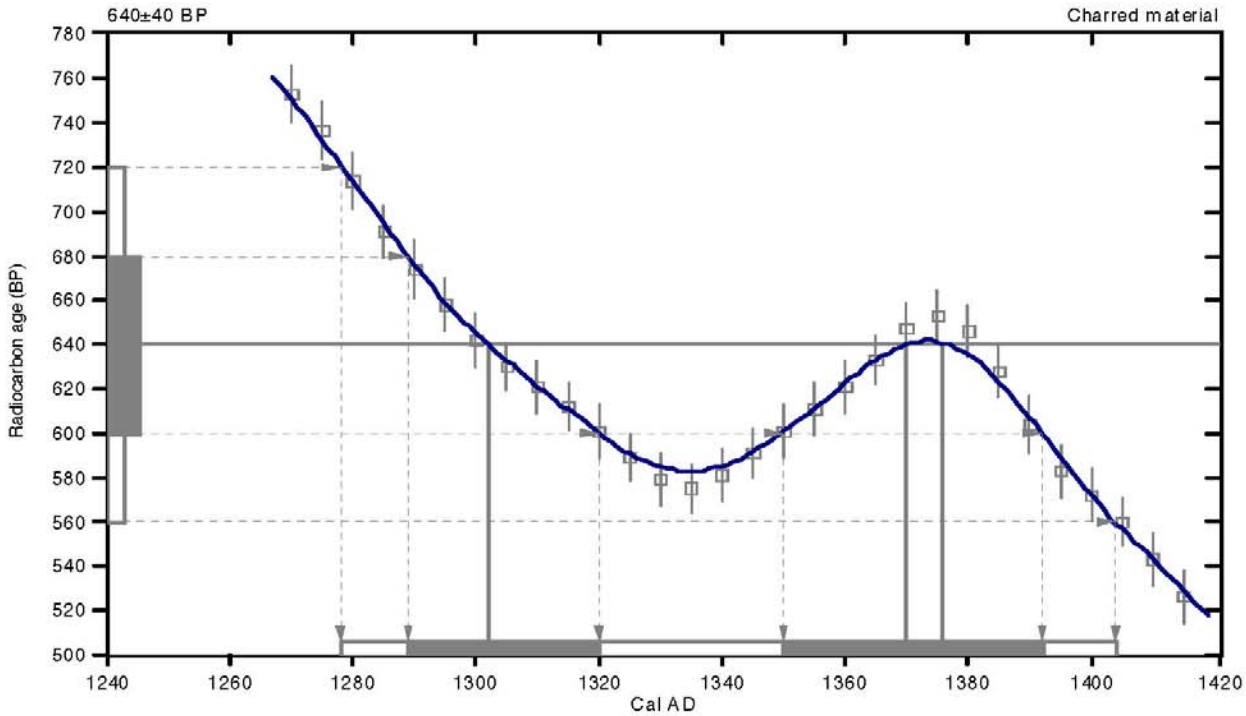
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.4:lab. mult=1)

Laboratory number:	**Beta-276052**
Conventional radiocarbon age:	**640±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 1280 to 1400 (Cal BP 670 to 550)**

Intercept data

Intercepts of radiocarbon age with calibration curve:	Cal AD 1300 (Cal BP 650) and Cal AD 1370 (Cal BP 580) and Cal AD 1380 (Cal BP 570)
1 Sigma calibrated results: (68% probability)	Cal AD 1290 to 1320 (Cal BP 660 to 630) and Cal AD 1350 to 1390 (Cal BP 600 to 560)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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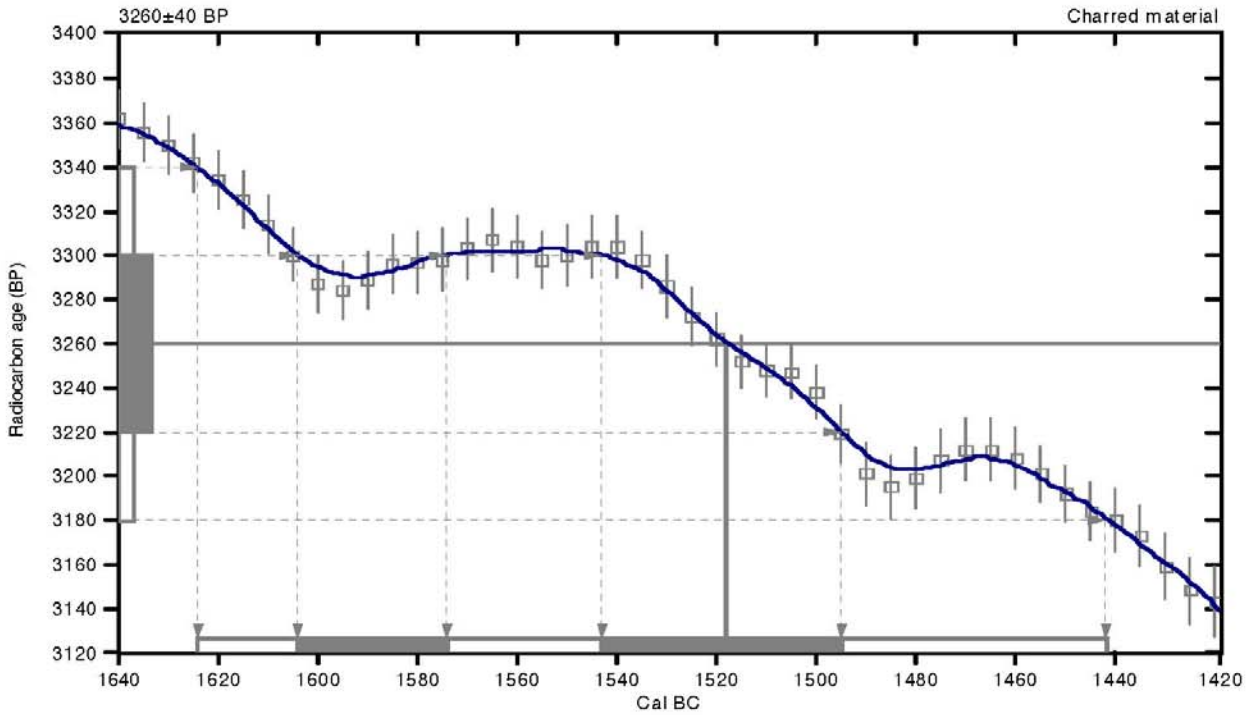
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.4:lab. mult=1)

Laboratory number:	**Beta-276053**
Conventional radiocarbon age:	**3260±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal BC 1620 to 1440 (Cal BP 3570 to 3390)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 1520 (Cal BP 3470)
1 Sigma calibrated results: (68% probability)	Cal BC 1600 to 1570 (Cal BP 3550 to 3520) and Cal BC 1540 to 1500 (Cal BP 3490 to 3440)



References:

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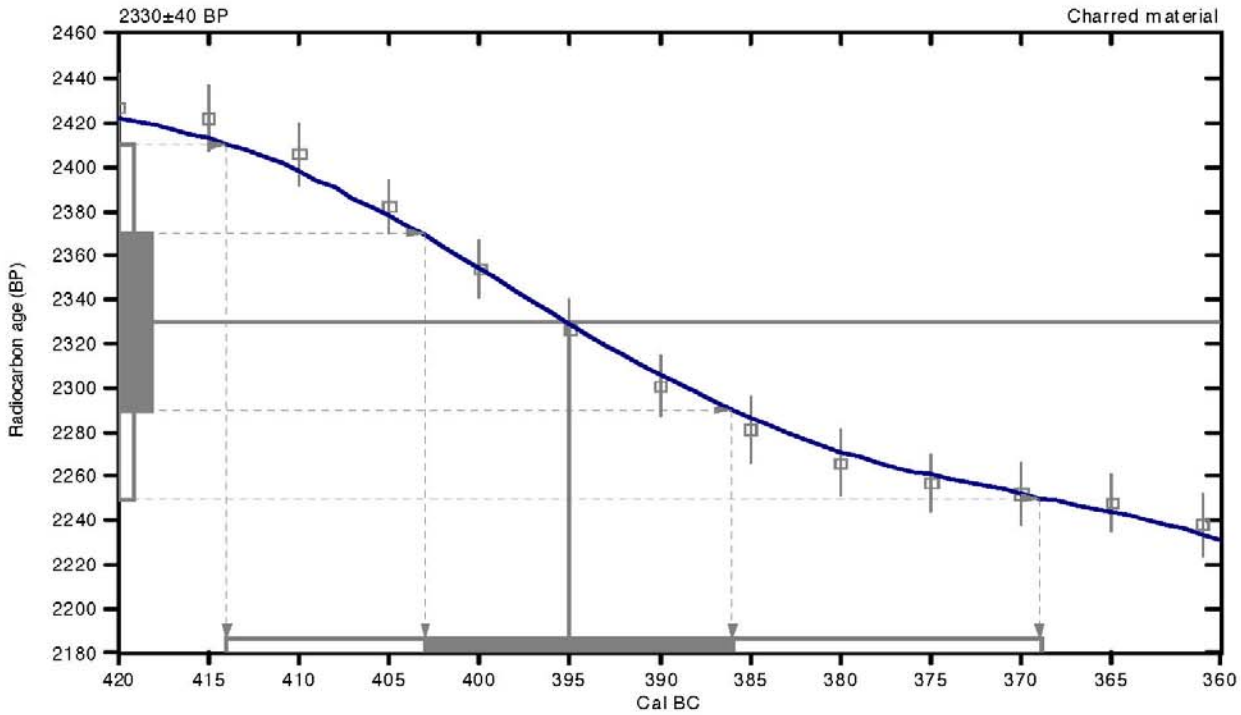
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.4:lab. mult=1)

Laboratory number:	**Beta-276054**
Conventional radiocarbon age:	**2330±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal BC 410 to 370 (Cal BP 2360 to 2320)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 400 (Cal BP 2340)
1 Sigma calibrated result: (68% probability)	Cal BC 400 to 390 (Cal BP 2350 to 2340)



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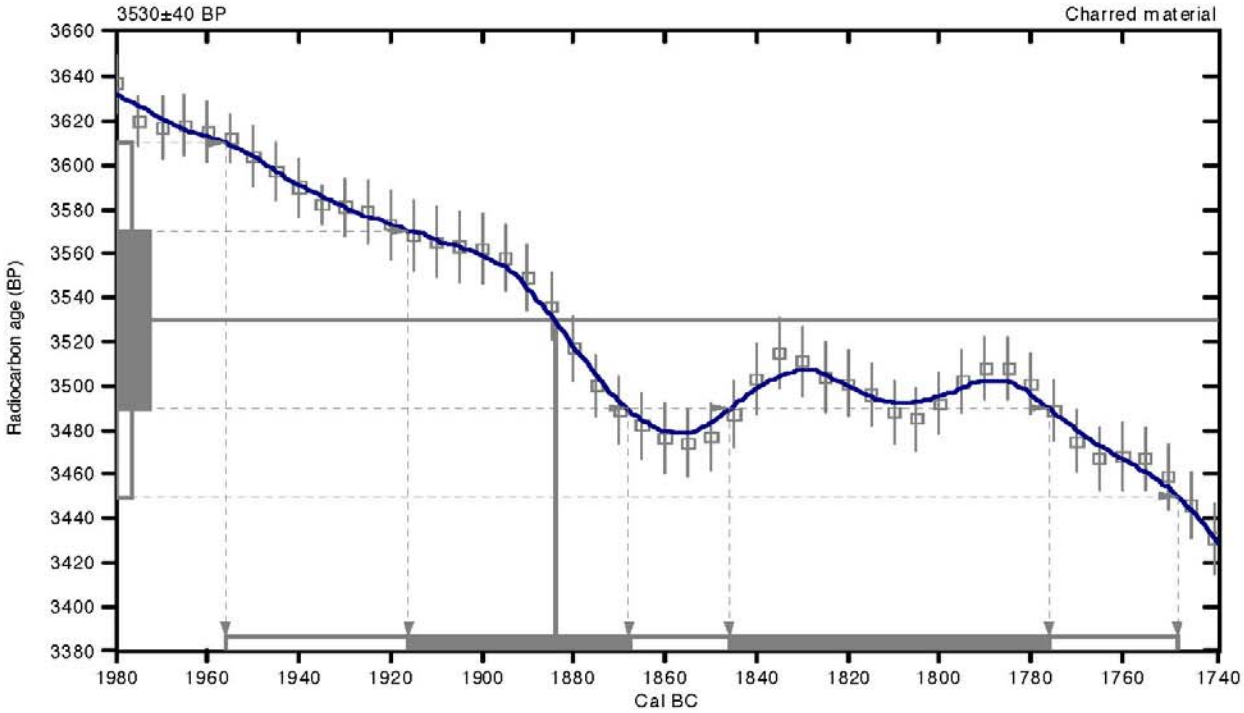
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number:	**Beta-276055**
Conventional radiocarbon age:	**3530±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal BC 1960 to 1750 (Cal BP 3910 to 3700)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 1880 (Cal BP 3830)
1 Sigma calibrated results: (68% probability)	Cal BC 1920 to 1870 (Cal BP 3870 to 3820) and Cal BC 1850 to 1780 (Cal BP 3800 to 3730)



References:

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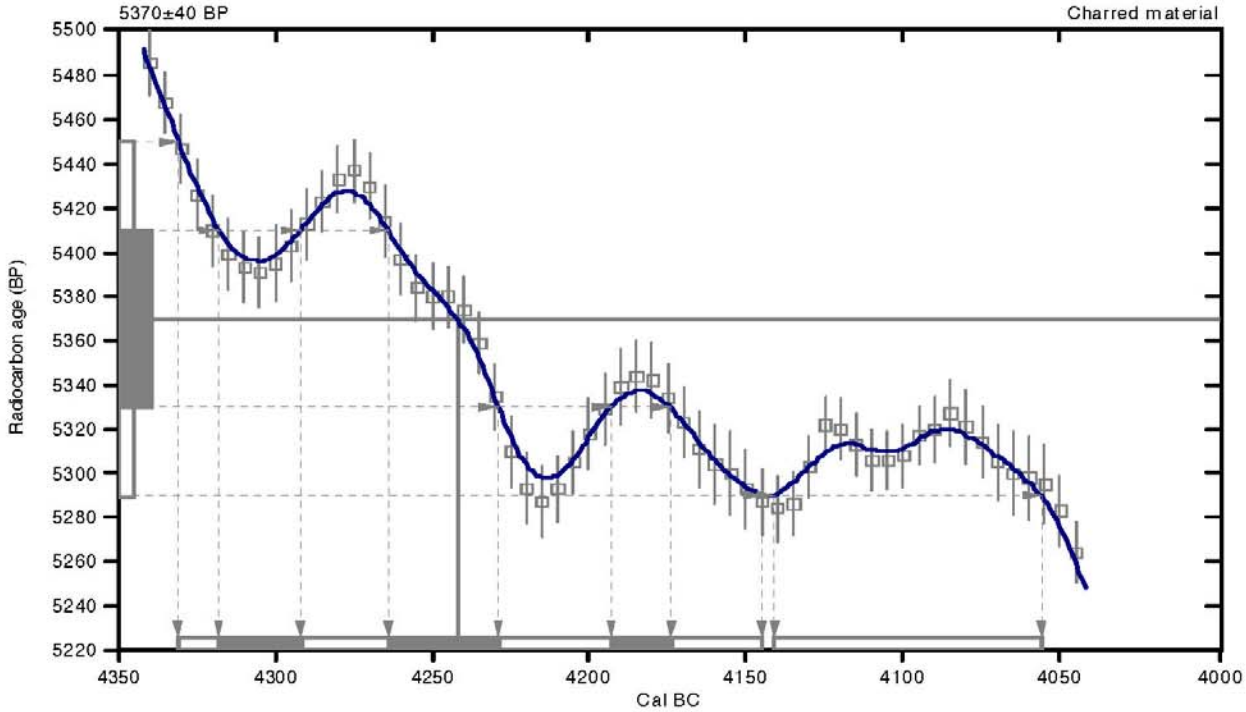
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.3:lab. mult=1)

Laboratory number:	**Beta-276056**
Conventional radiocarbon age:	**5370±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal BC 4330 to 4140 (Cal BP 6280 to 6100) and Cal BC 4140 to 4060 (Cal BP 6090 to 6010)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 4240 (Cal BP 6190)
1 Sigma calibrated results: (68% probability)	Cal BC 4320 to 4290 (Cal BP 6270 to 6240) and Cal BC 4260 to 4230 (Cal BP 6210 to 6180) and Cal BC 4190 to 4170 (Cal BP 6140 to 6120)



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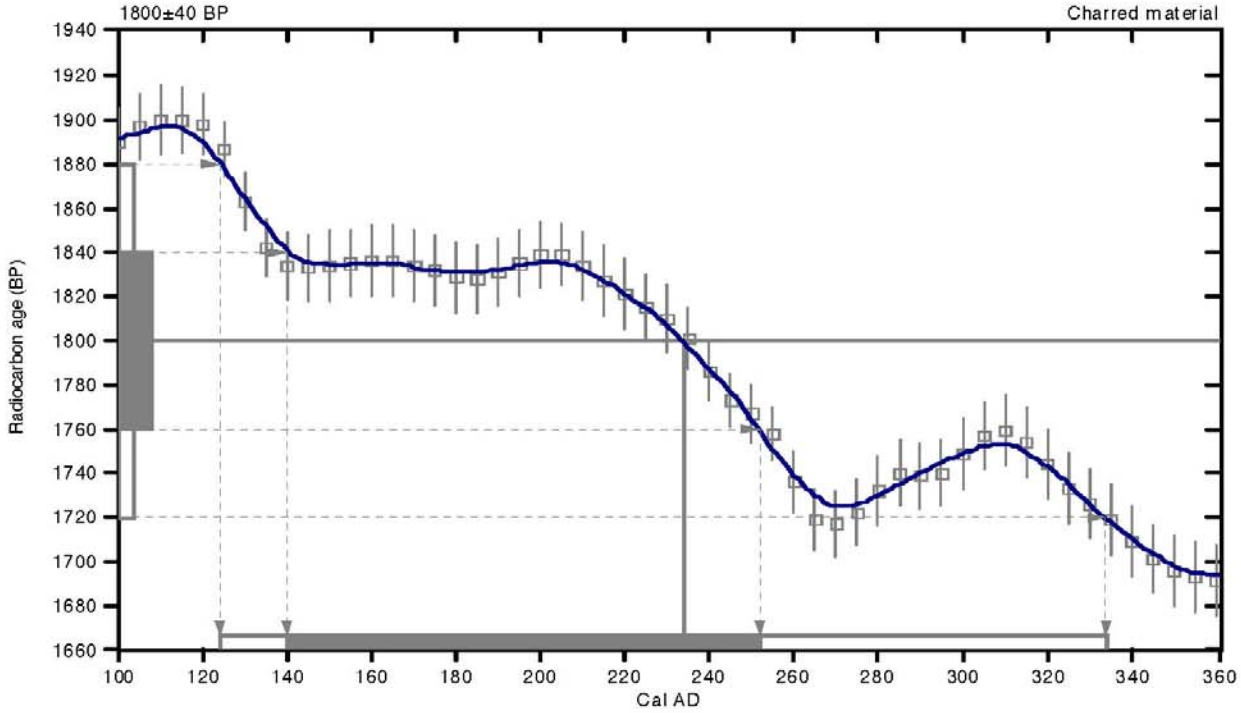
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number:	**Beta-276057**
Conventional radiocarbon age:	**1800±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 120 to 330 (Cal BP 1830 to 1620)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 230 (Cal BP 1720)
1 Sigma calibrated result: (68% probability)	Cal AD 140 to 250 (Cal BP 1810 to 1700)



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Appendix C: Thermoluminescence Dating

QUATERNARY TL SURVEYS

Thermoluminescence Dating of Sediments from the Neptune site (Oregon)

Date measurements were performed on two sediment samples from the Neptune site (35LA3A) on the coast of Oregon. The sediments were taken from the southern wall of Excavation Unit 1 and sampled two distinct paleosols which were separated by an erosional unconformity. The TL samples are identified and described as follows:

QTLS Ref.	**Description**
NEP1	=TL#1; horizon 2Bwb; 80 cm below ground surface; dark yellowish brown sandy loam.
NEP2	=TL#2; horizon B2w; 65 cm below ground surface; very dark grayish brown fine loam.

In addition, four environmental samples were also collected to support the gamma dose-rate assessments. These samples were representative of the sediment 5 cm above and below the TL sample locations.

The TL dating procedure involves two distinct measurements. The first measurement is an evaluation of the total radiation dose received by the sediment since it was last exposed to light. This quantity of radiation, which is referred to as the *palaeodose*, is determined by observing the TL emitted by the material. The second part of the date measurement is an assessment of the rate at which the palaeodose was received by the TL sample from naturally occurring radioactive sources within the deposit. By combining these two measurements, the length of time over which the palaeodose accumulated can be calculated.

The date obtained in this way refers to the sediment's most recent exposure to light. This exposure causes a large reduction in the intensity of one of the sediment's TL signals, a process referred to as *bleaching*. Most commonly, the light exposure occurs during transport of the sediment grains in a dispersed state, prior to their deposition. However, bleaching can also occur, in a limited depth of sediment, through bioturbation during a long period of soil formation.

Palaeodose Evaluations

The fine-grain fraction of each sediment was selected for TL measurement. The samples were dispersed in dilute hydrochloric acid to remove any carbonates. However, it was apparent that no carbonates were present in the samples. Sediment grains of between 2 µm and 10 µm size were separated from the bulk sample according to their settling times in water, and were washed in methanol and acetone. Finally, the fine grains were deposited from suspension in acetone onto aluminium discs.

The purpose of the TL observations is to measure the intensity of the natural TL intensity and to evaluate the doses of alpha and beta radiation required to regenerate an equal intensity in sample discs which have been bleached. The most readily bleached TL signal was maximised with respect to other emissions by selecting TL within a narrow temperature range and at ultra-violet wavelengths. The temperature ranges were centred at 290°C, in the case of NEP1, and at 280°C for NEP2, which were the lowest temperatures consistent with thermal stability. Ultra-violet wavelengths were selected with a Schott UG11 filter. The discs were normalised to second glow readouts following a standard beta radiation dose.

Around half of the sample discs were exposed to daylight for several days to remove the bleachable TL signal. This reduced the TL intensity at the selected temperature to 7.5% and 9% of the original natural TL, for NEP1 and NEP2, respectively. The bleached discs were then irradiated with different doses of beta or alpha radiation in order to regenerate corresponding intensities of TL emissions. By measuring these discs, the growth curves of regenerated TL intensity *versus* radiation dose could be determined. Natural regeneration doses (NRDs) were evaluated where the growth curves intersected the natural TL intensity. The values of the alpha and beta NRDs determined by this method are shown in table 1. The figures represent the palaeodoses received by the sediments in terms of their equivalent alpha and beta doses.

Dose-Rate Assessments

Following the original bleaching and burial of a sediment, its TL is naturally regenerated by the combined actions of alpha, beta, gamma and cosmic radiations. The first three types of radiation derive from naturally occurring radionuclides within the sediments, while cosmic radiation reaches the earth's surface from beyond the atmosphere. The alpha and beta rays are short-ranged, and the rates of delivery of the alpha and beta doses can be deduced from the radioactive contents of the TL samples. Alpha dose-rates were measured by alpha counting the sediment grains, while beta dose-rates were assessed by alpha counting and potassium analyses of the finely crushed sediment.

Gamma radiation has a maximum range in sediments of 30 cm, so that the gamma dose-rate to the TL sample depends on a weighted average concentration of gamma-emitting

nuclides within a radius of this length. In addition to each TL sample, two further sediment samples were collected at locations above and below the TL sample. Finely crushed portions of these samples were examined by alpha counting and potassium analysis. The results showed that radioactivity concentrations were homogeneous in the immediate vicinity of each TL sample. Gamma dose-rates were computed from weighted averages of all the available data. Cosmic radiation dose-rates were estimated from the burial depths of the TL samples.

Beta, gamma and cosmic dose-rate assessments are given in table 2. The sums of these dose-rates are shown in table 1, together with the measured alpha track-rates. The water content of the sediment influences the amount of radiation reaching the TL sample. The dose-rates given in the tables have been corrected to allow for the estimated past moisture levels in the sediments, and the error limits include uncertainties in these estimates.

TL Age Calculations

From the TL measurements, giving the forms of the alpha and beta regeneration growth curves, and from the dose-rate assessments, it is possible to calculate how the latent TL intensity accumulated in the sediments during their burial. The growth of TL intensity is counteracted to some degree by decay of the signal which occurs by a non-thermal mechanism with a mean life of approximately 100 ka. The TL age represents the period of time required for the increasing latent TL to match the observed present-day TL intensity.

The TL ages of the sediments are presented in table 1. These dates, which include corrections for the decay of the TL signal, are in units of calendar millennia (ka) Before Present. They refer to the most recent exposure to daylight of the fine-grain component of the sediment. The error limits of the TL dates include random and systematic uncertainties in laboratory measurements and environmental factors, and refer to the 68% confidence level.

Table 1. Palaeodose evaluations, dose-rates and TL ages.

Sample Ref.	Beta NRD (Gy)	Beta + External Dose-Rate (Gy/ka)	Alpha NRD (µm-2)	Alpha Track Rate (µm-2/ka)	TL Age (ka BP)
NEP1	31.4±1.4	1.363±0.123	18.3±0.7	0.491±0.086	15.3 +2.5/-2.3
NEP2	13.7±0.4	1.312±0.119	7.1±0.3	0.407±0.070	7.18 ± 1.00

Table 2. Beta, gamma and cosmic dose-rate assessments.

Sample Ref.	Beta Dose-Rate (Gy/ka)	Gamma Dose-Rate (Gy/ka)	Cosmic Dose-Rate (Gy/ka)
NEP1	0.708±0.102	0.465±0.062	0.190±0.030
NEP2	0.697±0.101	0.415±0.055	0.200±0.030