UNIVERSITY of WASHINGTON

Human-Environmental Dynamics at Cape Krusenstern
Adam Freeburg and Shelby Anderson

Final Report for Task Agreement J8W07070032

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200 Generations: On the Beach of Their Time

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September 5, 2012

Front cover:

Top: (l-r) Russ Willems and Pat Reed excavating a test unit; Igichuk Hills in background (Photo: Shelby Anderson)

Left: (l-r) Josh Dinwiddie and Amy Thompson on survey; Giddings and Anderson Feature 249 (whale vertebra) in foreground (Photo: Liz Penttila)

Illustration: CAKR 15273- notched cobble (Mark Luttrell)
Illustration: CAKR 15447- concave scraper (Mark Luttrell)
Illustration: CAKR 13833a- ceramic sherd (Mark Luttrell)

Back cover:

Kelly French screening material from a test unit; Ingitkalik Mountain in background (Photo: Adam Freeburg)

This report is part of a cooperative University of Washington-National Park Service Project (J8W07070032) managed by the Pacific Northwest Cooperative Ecosystem Study Unit

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1.0 INTRODUCTION

This report is one of the final products intended to summarize and synthesize the results of archaeological research obtained through the project "Human and Environmental Dynamics at Cape Krusenstern National Monument." This project was a collaborative effort between the University of Washington (UW) and the National Park Service (NPS), specifically Western Arctic National Parklands (WEAR). Work was performed entirely within the boundary of Cape Krusenstern National Monument, a federal land holding of 267,000 hectares (660,000 acres) on the northwest Alaskan coast (Figure 1). The Collaborative and Joint Agreement H8W07060001 defining this effort was issued by the Pacific Northwest Cooperative Ecosystems Study Unit (CESU) Network. Work and funding were pursuant to Task Agreement J8W07070032 and its subsequent modifications. In addition to summarizing the work done by UW through the Task Agreement, this report includes results of archaeological analyses, including radiocarbon dating and legacy data analysis. Recommendations for future research and continued management of the archaeological resources within Cape Krusenstern National Monument are also provided.

2.0 PROJECT HISTORY

The NPS project "200 Generations: On the Beach of Their Time" began with consultation and administrative actions in the autumn of 2005 by WEAR staff in Kotzebue and Anchorage. Objectives of this project included archaeological survey and testing of the Cape Krusenstern beach ridge complex (Figure 2) as well as condition assessment of archaeological features found there. Integration of legacy data from previous research endeavors was crucial to these objectives. A successful field season in the summer of 2006 led by Chris Young and Sabra Gilbert-Young surpassed survey goals set for areal extent. The authors of this report were a part of the 2006 field crew and were graduate students at UW at the time. Due to the pending transfer of staff in Kotzebue, WEAR archaeologist Chris Young offered UW the opportunity to continue the NPS funded project. A meeting with Bob Gal, WEAR cultural resources lead, Darryll Johnson, CESU Network research coordinator, Doug Deur, a CESU-affiliated cultural anthropologist, and UW team members Ben Fitzhugh, Shelby Anderson, and Adam Freeburg was held in early 2007 to discuss the details of a collaborative agreement between NPS and UW

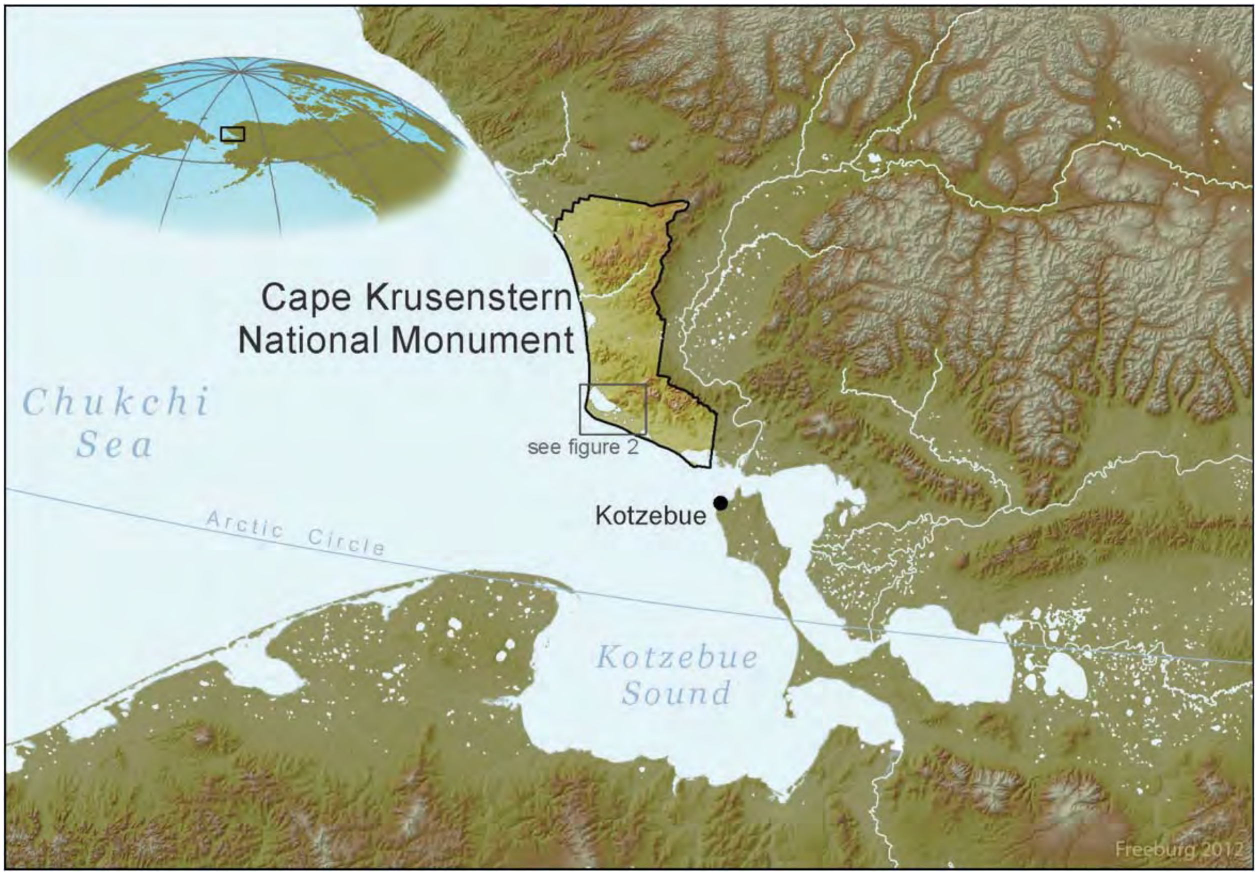

Figure 1. Location of Cape Krusenstern National Monument in Northwest Alaska

through the CESU Network. Following the meeting, a task agreement (#J8W07070032) was written by the UW team and signed by both parties. The task agreement outlined three phases of work to be completed by UW in collaboration with NPS. Phase I included the development of a work plan to guide project activities. Phase II focused on the continuation and completion of the project's field component, including the collection and dissemination of archaeological and paleoenvironmental data for research and resource management purposes. Phase II also included plans for community outreach, feedback, and involvement. Phase III tasks consisted of the finalization of the project GIS database, creation and dissemination of this final report, and creation and dissemination of education and outreach materials for the public, particularly for the local Northwest Alaska community. A separate task agreement between NPS and Antioch University New England was approved for the geomorphological component of this project, with Jim Jordan as the principal investigator.

The activities carried out by UW during all phases were reported to NPS in a series of post-field season progress reports and annual interim reports (UW 2007; Freeburg et al. 2008; Anderson and Freeburg 2008; Anderson and Freeburg 2009a; Anderson and Freeburg 2009b; Anderson and Freeburg 2010; Freeburg and Anderson 2010; Freeburg and Anderson 2011a; Freeburg and Anderson 2011b). Public presentations were given in Kotzebue at the NPS visitor center annually, and additional professional, public, and school presentations were given in communities throughout the Northwest Arctic Borough (see Section 7.3.2). Collections, field documents, and other project related materials were returned to the NPS at the conclusion of the project.

Figure 2. Study area and local landmarks

3.0 Prior Research

3.1 Archaeological research

The current project builds on the work conducted by J. Louis Giddings and Doug Anderson at Cape Krusenstern and in the surrounding region. Giddings began research in the Kotzebue Sound region in the 1940s as part of his effort to establish a tree-ring dating sequence for the Arctic (Giddings, 1938, 1940, 1941, 1942, 1948, 1951, 1952a, 1952b, 1961, 1964, 1967; Giddings and Anderson, 1986). In the 1950s and early 1960s, Giddings worked extensively in Northwest Alaska, surveying the Choris Peninsula, the Seward Peninsula, and the beach ridges at Cape Krusenstern as a part of his beach ridge dating project. In 1958, he recognized the importance of the Cape Krusenstern beach ridge complex (Giddings 1967). Giddings realized that the horizontal deposition of cultural materials on the beach ridges were the key to dating archaeological sites across the region, particularly after correlating them with the deeply stratified Onion Portage site on the Kobuk River (Giddings 1966) where earliest occupations date to over 9500 years ago (Anderson 1988)(Figure 3). Giddings returned to Cape Krusenstern every subsequent field season until his death in 1964, after which his student Doug Anderson took over the beach ridge dating project, later publishing their findings in a monograph published by NPS (Giddings and Anderson 1986). The correlation of archaeological materials through the horizontal stratigraphy found at Cape Krusenstern, Cape Espenberg, Sisualik, Cape Prince of Wales, and other beach ridge complexes in the Kotzebue Sound region provided a strong chronological and cultural historical framework upon which all subsequent archaeological research in this region is based. NPS estimated that over 600 archaeological sites and features were identified on the beach ridge complex before 2006 (NPS 2007). These sites were primarily recorded by Giddings and his students while working at Krusenstern from the late 1950s to early 60s. However, NPS also estimated that before 2006, the beach ridge complex was only about 25% surveyed (NPS 2007). As such, at the outset of this project, considerable potential existed for new archaeological discoveries at Cape Krusenstern.

George Moore's (1960, 1966) initial work on geological processes on northwest Alaskan coasts, including Cape Krusenstern, was later refined by subsequent geomorphological and archaeological research at Cape Krusenstern and other northwest Alaskan beach ridge systems (Hopkins 1977; Mason 1992; Mason and Jordan 1993; Mason, Jordan, and Plug 1995; Mason and Ludwig 1990). Following Giddings'archaeological work, several limited surveys were conducted at and near the Cape Krusenstern beach ridges. Doug Anderson returned to the beach ridge complex in 1965 to excavate House 70, and again in the 1970s for additional research (Anderson, personal communication, 2008). He also conducted a survey of the proposed Cape Krusenstern National Monument (Anderson 1977a). Zimmerman (1978) carried out a remote

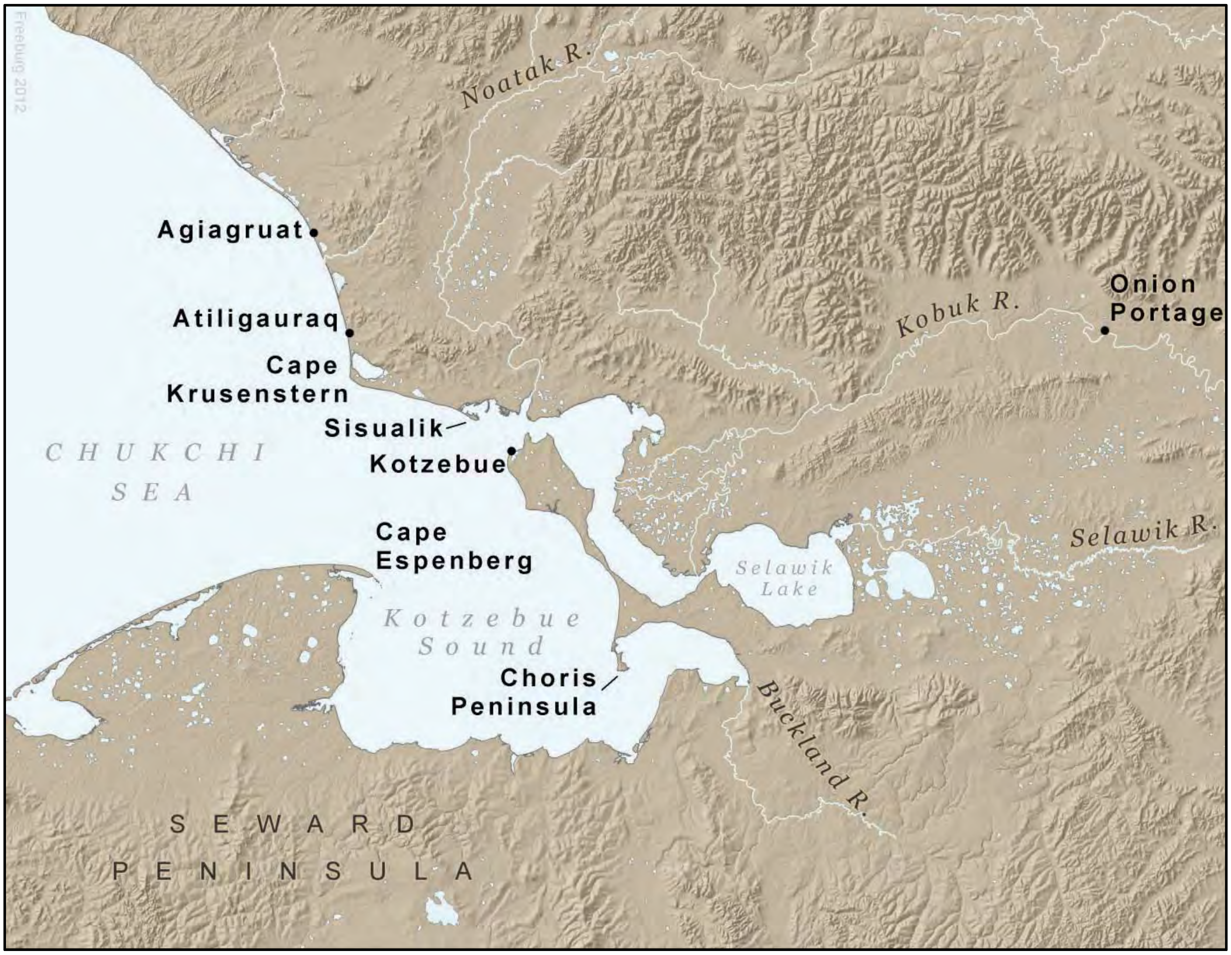

Figure 3. Map showing locations mentioned in text

sensing research project at Krusenstern that involved testing potential settlements identified through analysis of satellite imagery. A reconnaissance level survey of previously unsurveyed areas within the Monument, including the Krusenstern Lagoon area, was conducted in the late 1980s by the NPS (McClenahan 1993; McClenahan and Gibson 1990). In 1995, NPS archaeologist Steve Klinger carried out a limited survey project aimed at identifying some of the beach ridge settlements reported by Giddings (Bob Gal, personal communication, 2008). More recently, Darwent (2006) reanalyzed faunal material collected by Giddings at the Old Whaling site, located within the project area. Darwent found that the faunal data supported Giddings' hypothesis that the shallow depressions at the site were occupied in late spring/early summer, while the deeper depressions were occupied in winter. Following this reanalysis, a team from University of California Davis undertook an intensive augering project at the Old Whaling site in the summer of 2003 (Darwent 2006; Darwent and Darwent 2005). This research identified two previously unknown shallow middens as well as another cultural level, interpreted as a dwelling structure, underneath a previously excavated house. Darwents' work illustrates the potential for new information to be obtained from continued field work at Krusenstern, as well as the value of reanalyzing existing collections in light of new research.

Other regional work that informed the current project includes Giddings' dendrochronological and archaeological research along the Kobuk River and at Kotzebue in the early 1940s, which led to the identification of Arctic Woodland Culture and the discovery of the Onion Portage site (Giddings 1952a; Giddings 1961). Additional work was carried out at Onion Portage in the 1960s, first by Giddings and then by Doug Anderson (Anderson 1988:28). Giddings' work at Cape Denbigh was also important to interpretation of Denbigh period finds at the Krusenstern beach ridge complex (Giddings 1964). On the coast, VanStone (1955) undertook excavations in Kotzebue in 1951, and conducted various ethnographic and ethnohistoric research projects in other areas of Northwest Alaska (Lucier and VanStone 1992; Lucier and VanStone 1995). Several projects in Kotzebue were primarily related to development (Gannon 1987; Scott et al. 1978; Smith and Gleason 1991), and include the nomination of the Kotzebue Archaeological District (KTZ-00036) by the NPS (Gal 1986). In the late 1990s, the NPS carried out excavations at the Agiagruat (NOA-00217)(Christopher Young 2000) and Atiligauraq (NOA-00284) (NPS 1997; Clark 1997) sites, both located north of the Cape Krusenstern beach ridge complex on the coast of the Chukchi Sea. Current work at Krusenstern is further informed by Mason's synthetic works on northwest Alaskan prehistory (Mason 1998, 2000, 2004, 2009a, 2009b; Mason & Barber 2003; Mason and Bowers 2009; Mason and Gerlach 1995a; Mason and Gerlach 1995b), by research in the Bering Land Bridge Preserve (Harritt 1994; Powers et al. 1982; Schaaf 1988; Schaaf 1995), and in the Bering Strait region (e.g. Dumond 1998; Dumond & Collins 2000; Harritt 1995, 2003, 2004; Mason 2000). Surveys and excavations in Noatak National Preserve (Anderson 1972, 1978; DeAngelo 2001; Gilbert-Young 2004; Hall 1971, 1974, 1975, 1976a, 1976b; Shirar 2007, 2009), Kobuk Valley National Park (Anderson 1977b; Hickey 1968; Hickey 1977; Kunz 1984), and along the Selawik River (Anderson 1974-75, 1977b; Anderson and Anderson 1971, 1972, 1977) have furthered archaeological understanding of late Holocene occupation of the Northwest Alaska interior. Much, however, remains unknown about this time period, particularly regarding the interaction between people living across the coasts and interior of this region. The prevalence of grey literature and unpublished research for numerous northwest Alaskan projects further complicates this issue.

3.2 Ethnographic Research

Ethnographic and archaeological work has traditionally gone hand in hand in Northwest Alaska. Locally, Uhl and Uhl (1977) conducted ethnographic research within the proposed Cape Krusenstern National Monument, including the beach ridge complex, and were also part-time residents (see also Uhl and Uhl 1979). Burch published numerous regional studies drawing upon both ethnographic fieldwork and ethnohistoric documents in an effort to reconstruct the period immediately before and after direct contact with Europeans in the 19th century (Burch 1998, 2005, 2006). Ethnographic research by Ray (1975), Foote (1965; Foote and Williamson 1961; Foote and Williamson 1966), and Anderson and colleagues (Anderson and Anderson 1977; Anderson et al. 1998) provide further context for archaeological research. Along with studies on subsistence resources and their uses (Georgette and Loon 1993; Georgette and Schiedt 2005; Jones 2006; Jones 2010), this ethnographic work provides continuity between past and present use of Cape Krusenstern, which retains an important place in local subsistence, economy, and culture.

3.3 Need for Renewed Research

The previous work at Cape Krusenstern and in the surrounding region summarized above established a basic chronology and culture history for Northwest Alaska. There were, however, issues with the existing data set that hindered further interpretation and analysis. The prior existing radiocarbon dates from Cape Krusenstern were primarily from the Old Whaling site; 18 out of the total 32 Cape Krusenstern dates were from Old Whaling (Giddings and Anderson 1986: 30). In addition, many of these dates were obtained when radiocarbon dating was a new technology, and not as accurate or precise as it is today. Little is known about the context of these dates and $^{13}C/^{14}C$ values are not reported, making it difficult to adequately evaluate the dating results. The marine correction is particularly problematic for several of these dates. Giddings and Anderson dealt with this issue by subtracting 10% of the radiocarbon age from dates obtained from the Old Whaling site (Giddings and Anderson 1986:32), but there is still no reliable marine correction factor for the region (see Dumond and Griffen 2002). For the most part, dating of sites at Cape Krusenstern was done by relative position of beach ridges, with the assumption that at any given time people tended to live on the most seaward beach ridge. The fact that the beach ridges themselves were not dated further limited chronological interpretation (Mason and Ludwig 1990).

While standard at the time, the methods and strategies of past work limit the utility of legacy data in addressing questions we wish to ask today. For example, lack of information concerning methods used in the collection of archaeological materials and the absence of screening biases existing faunal and artifactual samples from Cape Krusenstern. Prior research was concerned with building a strong chronological framework and, in the infancy of radiocarbon dating, relied on comparison of artifact types. Work was therefore focused almost entirely on houses and house excavation; other site types were rarely sampled or analyzed. This is acknowledged by Giddings and Anderson (1986), who recommended that future work include investigation of additional feature types in settlements with excavated houses. Spatial data generated by previous projects limited the clarity of spatial –and presumed chronological– relationships between settlements at Cape Krusenstern. Provenience information has also been lost for some of the sites originally documented by Giddings and his crew. These and other challenges were faced when attempting to connect legacy archaeological data to spatial locations and newly recorded archaeological features (see section 8.5). Although preliminary geomorphological research has established a basic relationship between past weather patterns (i.e. storminess [Mason and Jordan 1993]), few data were available on the timing and nature of beach ridge formation and landscape evolution over the past 4000 plus years since the beach ridge complex began to form. These limitations hindered management of these sites by NPS archaeologists and limited what could be learned through analysis of existing collections from the beach ridge complex.

4.0 Project Goals

Given the needs of NPS resource managers and the desire for renewed archaeological and paleoenvironmental research within Cape Krusenstern National Monument, this project's objectives were set forth as follows:

1) To re-evaluate the chronology and culture history established by Giddings and Anderson (1986) based on new data

2) To identify patterns of dynamic human and environmental interactions at Cape Krusenstern and to determine if these are related to late Holocene environmental changes

3) To study technological change and to investigate how, if at all, this change is related to environmental dynamics

4) To refine understanding of local beach ridge formation and erosion history as it relates to past human use of the beach ridges and to archaeological site preservation and vulnerability

5) To refine understanding of past climate and vegetation history through higher resolution palynological analyses

6) To collect site location, condition, and other information needed to better inform future cultural resource management decisions and to facilitate future research

7) To involve the Kotzebue community in the project through community presentations, volunteer participation in fieldwork, and publication of educational materials and pamphlets.

The collaborative UW-NPS project was directed at objectives 1, 6, and 7, with objective 4 pursued through a related project but separate agreement led by Jim Jordan at Antioch University New England. Objective 2 cannot be addressed until Jordan's geomorphological work is complete. Because the current project focused on survey level data, with a minimum of test excavation units, the goal of studying technological change (Objective 3) relied on access to diagnostic materials held by Brown University. These collections were accessed for one week in 2008, at which time a cursory inventory of the collections was taken; a catalog of these materials was not available. Subsequent access to the collections was not possible and additional technological analyses were not carried out as part of this agreement (although see Anderson [2010, 2011, 2012] for ceramic research that includes Krusenstern collections). As outlined by the Task Agreement, the UW team applied for National Science Foundation funding to expand the paleoenvironmental component of the project to meet Objective 5, adding lake sediment and palynological work under the supervision of Co-PI Patricia Anderson. The proposal received a positive rating and the team was advised to revise and resubmit. However, after considering the feasibility of carrying out additional fieldwork within the project's time frame, the proposal resubmission was withheld. As such, the findings reported here include a description of chronological and settlement pattern data collected by the current project, detailed site management information, and a summary of archaeological outreach activities.

5.0 Background

5.1 Cultural Context

The culture history of Northwest Alaska was influenced by people living on both sides of the Bering Strait who participated in many shared cultural traditions (Burch 2005; Ray 1975). A general model of cultural development in the region exists (Anderson 1984; Giddings and Anderson 1986) and is presented here in brief (see Dumond 1977, 1984 for an alternate model). Earliest evidence of human occupation in Northwest Alaska includes recently discovered lithic materials, including fluted stone points, and faunal material attributed to the Paleoindian tradition that may be over 10,000 years old (Hedman 2010; Rasic and Gal 2000; Young and Gilbert-Young 2007). Interior northwest Alaskan Paleoarctic sites reflect a full-time terrestrial hunting orientation that remained in place until about 4000 BP, when there was a shift toward seasonal occupation of the coast (D. Anderson 2008; Esdale 2008). Earlier coastal sites in this region were likely obscured by rising sea-level (Brigham-Grette et al. 2004; Erlandson and Braje 2011; Erlandson et al. 2008).

Between 4000 and 1500 years ago, significant changes in settlement patterns, subsistence and technology took place as marine hunting and fishing became increasingly important to coastal peoples. Overall, the evidence points to increased population and competition over resources in some regions, particularly in coastal settings. There is considerable debate over the relationship between the archaeological cultures identified during this time period and the people these material remains represent. Research over the last 50 years has shown that these relationships are even more complex than originally thought with many archaeological cultures overlapping in time (Table 1) (see Mason 2009b for summary). This suggests that these archaeological cultures may represent ethnic or cultural groups that interacted and overlapped in time and space. This pattern is not surprising given that Northwest Alaska is located near the juncture of two continents and between two ocean systems.

The earliest previously known sites at Cape Krusenstern belong to the Arctic Small Tool Tradition (ASTt), also known as the Early or Proto Denbigh Flint complex in the western Arctic. At Cape Krusenstern these sites date to between about 4000 and 2750 years BP. The small seasonal campsites here, along with other sites dating to this period identified around the region, indicate that people lived in small groups and were highly mobile. While some data suggest focus on caribou resources during this time, the small number of known sites, along with the potential for sampling bias due to preservation issues and sampling strategies, suggest that this hypothesis remains to be tested with additional data (see Tremayne 2010 for more information). By about 3000 years ago, site distributions across Northwest Alaska suggest that some people began to live on the coast full time while interior groups maintained a more transitory seasonal pattern. Accompanying this change in settlement patterns were various technological changes, including the introduction of ceramic technology and the use of slate; this period of change is referred to as the Choris culture (2750 – 2250 BP) (Anderson 1984). Several Choris campsites were identified at Cape Krusenstern (Giddings and Anderson 1986), at nearby Cape Espenberg (Schaaf 1988), and semi-permanent winter dwellings from the same time period are found at the type site on the Choris Peninsula (Giddings 1957; Giddings and Anderson 1986). Overall, few sites are known from this period, particularly in the interior of the region (Anderson 1988; Mason and Gerlach 1995a), and the observed patterns are based on little data.

During the same time period at Krusenstern, a unique occupation termed Old Whaling culture appears for a short period of time between about 2800 and 2670 BP (Darwent 2006; Darwent and Darwent 2005). Old Whaling culture has no clear progenitors or successors. This coastal occupation and accompanying tool kit has only been identified at Cape Krusenstern (Giddings and Anderson 1986). The site consists of several large semi-subterranean cold season houses and also several shallower summer houses. Lance heads and other weapon-head insets found at the Old Whaling site are similar to more recent whaling harpoon heads. These tools were found along with long-bladed butchering tools, side notched points and semi-lunar knives interpreted as implements used by people who actively hunted whales (Anderson 1984; Giddings and Anderson 1986). Despite these finds, the faunal evidence from the Old Whaling site does not suggest that localized intensified whaling was undertaken during this time period at Cape

Table 1. Summary of archaeological cultures of Northwest Alaska (adapted from Mason 2009b)

Archaeological Culture	**Approximate Age Range (cal BP)**	**Geographic Distribution**	**Subsistence Focus**	**Social Space**
Denbigh	4500-2750	Kotzebue Sound, Brooks Range	Highly varied, not well known	Unknown
Choris	2750-2250	Kotzebue Sound, Brooks Range, Northern Yukon Territory	Seal and caribou, possibly beluga. Fishing?	Large oval structures, either houses and/or collective spaces
Norton (Norton-Near Ipiutak in Northwest Alaska)	2250-1350	Southern AK Peninsula to Western Canada, unknown in Siberia and Chukotka	Seal and caribou north of Seward Peninsula, fishing south of Seward Peninsula	Square houses, ca. 16 sq m, large community structures at some sites
Ipiutak	1750-1150	Norton Sound to Point Barrow, interior of Northwest Alaska and Brooks Range	Seal, walrus, and caribou hunting. Fishing	Both winter and summer houses of variable size, possible community structures
Birnirk	1350-750	Eastern and western shores of Chukchi sea	Seal, walrus, whale, caribou. Fishing?	Small houses, few larger structures.
Thule	1000/950-550	Bering Strait to Greenland	Seal, walrus, whaling, caribou, fishing	Multi-room houses, some evidence of larger structures.
Arctic Woodland	750-250	Inland areas of Northwest Alaska	Fish, caribou, seal (near coasts)	Usually single room houses with tunnels, occasional multi-room houses. Some evidence of larger community structures.
Kotzebue	550-250	Coastal areas of Northwest Alaska	Fish, caribou, seal	Usually single room houses with tunnels, occasional multi-room houses. Some evidence of larger community structures.

Krusenstern, which is about 1000 years before evidence for intensified whaling appears throughout the region around 2000 BP (Mason 1998; Mason and Barber 2003; Whitridge 1999b). Although archaeologists have sought connections between Old Whaling and contemporary or earlier occupations on the Chukchi Coast and northern islands of Siberia (Ackerman 1998), the origins of Old Whaling culture at Cape Krusenstern remain unclear. Recently discovered evidence of early whale hunting in Chukotka (Odess et al. 2008) may help clarify this issue.

Norton culture developed out of Choris culture in northern Alaska around 2500-1350 BP. While there is evidence of continuity in lithic and ceramic technology from the Choris to the Norton culture, the shift to Norton (or Norton-Near Ipiutak in northwest Alaska) culture is marked by an increased reliance on sea mammals in the north and fish, mainly salmon, south of the Bering Strait (Anderson 1984). Evidence of this is in the form of various technological developments, such as increased use of end and side blade insets used for seal and caribou hunting weapons, an increase in notched fish weight/sinkers, biface knives, scrapers, ground burin-like implements for antler and ivory working, ground adz blades, both linear and check stamped pottery, as well as use of clay and stone lamps (Anderson 1984). During the Norton period there are more coastal settlements both north and south of the Bering Strait, although population size north of Bering Strait appears not to have increased during this period as much as in the south (Anderson 1984). Residence patterns shifted from large Choris settlements to isolated winter houses during the Norton period in northern Alaska (Anderson 1984). At Krusenstern, known sites and assemblages dating to this time period consist of hearth features and pottery and lithic scatters (Giddings 1957; Giddings and Anderson 1986). There are few known Norton-Near Ipiutak sites overall at Cape Krusenstern.

After about 2000 years ago, settlement size increases and the emergence of social difference is evident across the region, in part through the presence of elaborate burial practices and goods (see Mason 1998; Mason 2004). During this period, ground slate tools, lamps and pottery were abandoned by some groups, and sea mammal hunting equipment was simpler than contemporary cultures of the Bering Strait; the focus was on seal, walrus and caribou rather than whale hunting (Anderson 1984; Dumond 1977; Giddings and Anderson 1986; Hoffecker 2005).

Termed Ipiutak culture (Larsen and Rainey 1948), this pattern persists in Northwest Alaskafrom about 1750 to 1150 BP, overlapping with early Neoeskimo sites on the mainland of eastern Beringia (Table 1). Ipiutak settlements are well represented by several large coastal sites at Point Hope (Larsen and Rainey 1948; Mason 2004), Deering (Bowers 2006; Larsen 2001), and Cape Krusenstern (Giddings and Anderson 1986) as well as inland sites (Clark 1977; Gerlach 1989; Hall 1976a).

During this same time period, various cultures developed in the Bering Strait region and in some cases may have been contemporaneous. These include Old Bering Sea, Okvik, and Punuk cultures, all of which are thought to have originated sometime between about 2000 and 1450 BP, perhaps on St. Lawrence Island and/or the Diomede Islands. The relationship between Ipiutak and cultures of the Bering Strait is not well understood and the Birnik-Thule relationship is equally unclear (see Mason 2000 for further discussion; Mason 2009a; Mason and Bowers 2009). It is apparent that by 1450 BP people in the Bering Strait region and beyond were competing for the best sea mammal hunting areas along the coast (Hoffecker 2005; Mason 1998; Mason and Barber 2003; Whitridge 1999a; Whitridge 1999b). The following 1500 years of prehistory encompass considerable technological and subsistence variability, with evidence of increasing settlement size, economic complexity, interaction across the Bering Strait, and social difference (Anderson 1984; Dumond 1977; Giddings and Anderson 1986; Hoffecker 2005; Mason 1998). House and settlement patterns in Northwest Alaska shifted as larger structures, which were either multi-family dwellings or shared community structures, appear in larger settlements, with smaller structures often grouped around the community structures (Anderson 1984; Giddings and Anderson 1986; Mason 1998). This archaeological pattern is considered antecedent to modern Yup'ik and Iñupiat people in Alaska.

Approximately 500 years ago, larger coastal settlements changed in character again, with the exception of the largest whaling villages in places like Point Hope and Barrow where population levels and settlement density remained high (Anderson 1984). Overall, settlements became more dispersed and population may have decreased across the region, perhaps in response to changing climate and/or marine mammal availability. In some cases, this settlement pattern change may represent a shift from marine mammal resources to fishing on the coasts and rivers (Anderson 1984; Mason and Barber 2003). These patterns, termed the Kotzebue period on the coast and late Arctic Woodland in the interior of the region, were in place into the historic period. There are numerous Kotzebue period sites at Cape Krusenstern, although the published information on previous research at these sites is minimal. Historically, Cape Krusenstern was occupied for much or all of the year until very recently (Burch 1998). Today, many people inhabit camps and visit the cape as part of seasonal subsistence activities. Cabins on private allotments are apparent all along the coastline of the beach ridge complex and numerous current residents of Noatak, Kotzebue, and other villages grew up spending time at the cape.

5.2 Environmental Context

A more extensive paleoclimate literature review is being prepared by Jim Jordan. The following is a summary to provide context for the archaeological research described in this report. Pollen data from Northwest Alaska and the central Brooks Range suggest that the mid-to-late Holocene climate was cooler and wetter than the early Holocene (Anderson and Brubaker 1994; Mann and Hamilton 1995). Near-present day water levels in east-central Alaska, however, indicate that the climate was cooler and drier there during the mid-Holocene (Edwards et al. 2000). New zooarchaeological data from the Aleutians indicates that Neoglacial sea ice expansion in the Bering Sea was more substantial than previously thought, altering the distribution of pinnipeds and cetaceans (Crockford 2008; Crockford and Frederick 2007). A 2000-year varve reconstruction from the central Brooks range indicates that cooling and reduced precipitation prevailed after 1220 BP, culminating in a cold period between 970 and 920 BP, followed by warming between 920 and 330 BP (Bird et al. 2009). Little Ice Age cooling from 330 to 70 cal BP is also evident in the Brooks Range varve record. These patterns are supported by data on northwest Alaskan glacial advance (Calkin et al. 1998; Ellis et al. 1981) and regional tree-ring proxies of climatic fluctuations (Graumlich 1997; Jacoby, Workman, and D'Arrigo 1999). Periods of storminess marked by beach ridge degradation are known from 3300 to 1700 BP and from 1200 to 900 BP at Cape Krusenstern and other beach ridge complexes across Northwest Alaska and Chukotka (Mason and Jordan 1993; Mason and Jordan 2002; Mason et al. 1995). Storm frequency in the North Pacific may also have contributed to aridity in the Kobuk valley during the mid-to-late Holocene (Mann et al. 2002), highlighting the differences in climate change response between coastal and interior environments of Northwest Alaska. New data and conflicting paleoclimatic reconstructions indicate that Holocene climate change was highly regionalized in timing and magnitude (see Jordan 2009). As a result, archaeologists are reconsidering many long-held environmental-cultural correlations and related explanations.

6.0 Research Design

In order to address the research questions and project goals outlined in Section 4, this project relied on various methods of data collection and analysis. These can be organized into two related categories that required integration for successful results: 1) geospatial methods, including GIS and GPS technologies and 2) field methods, including archaeological sampling design for survey and sample/artifact collection and the collection and analysis of management related information (e.g. site boundary definition, site condition, etc.). The results of prior research informed both methodological decisions and expectations for archaeological chronology and settlement pattern analysis.

6.1 Geospatial Methods

6.1.1 GPS and GIS in archaeological analysis

A geographic information system (GIS) is an assemblage of software, hardware, and user input used in the curation, display, and analysis of data. The main power of GIS comes from its ability to store and recall spatial information as well as non-spatial, or attribute, information. As outlined in the Task Agreement, a GIS was created for this project to assist in the storage, management, and analysis of collected data. The project GIS enables a user to display and perform analyses on field collected data such as the location, shape, and size of cultural features, condition information of applicable features, and collections information as well as laboratory analyses such as radiocarbon dating results. The GIS was essential in integrating information resulting from previous research at Cape Krusenstern and will be shared with NPS at the completion of the project to assist in the management of cultural resources within the monument.

6.1.2 GPS at Cape Krusenstern

The treeless tundra of the Cape Krusenstern beach ridges is an ideal environment for GPS data collection with no overhead obstructions and clear views to the horizon. The need for highly accurate spatial location information of cultural resources also derives from the amount and density of cultural remains at the cape. Due to the horizontal stratigraphy generated by the history of beach ridge development, the accurate location of cultural features has considerable bearing on archaeological interpretation. Likewise, final interpretation of the geomorphology of the beach ridge complex will be based on radiocarbon dates of non-cultural materials that reflect beach ridge age. It is crucial to be able to record the location from which these dated samples came with a high degree of accuracy. Private allotments are also present within the beach ridge complex. For this reason, it is imperative that future researchers (archaeologists and others) be aware of the location of allotment boundaries that are often unmarked on the ground. The use of a mobile device capable of viewing GIS data enables field crews to know their location relative to these electronically displayed boundaries.

Global positioning system (GPS) units were used in the field at the start of the geospatial workflow. Two types of GPS units were used for different purposes. High accuracy mapping-grade Trimble units were used to collect all survey and excavation spatial data as well as accompanying attribute data, such as condition or sample collection information. These units consisted of GPS receiver and a high accuracy antenna mounted on a two meter carbon fiber range pole. These GPS units have advertised decimeter accuracy and are capable of recording detailed attribute information through a data dictionary. Handheld units with color screens allow real-time viewing of collected spatial data. Mistakes in recording that would result in polygon errors (crossing boundaries) or misrepresentation of the on-the-ground feature could be immediately deleted and the data re-recorded. Data was then evaluated again after nightly downloads to a field laptop. Small errors were often left intact, as they were often addressed during the differential correction process. Errors that existed after differential correction were addressed in the lab (see section 9.3 for an example). Recreational grade Garmin units with external antennas were used in a GPS/Photo kit configuration that allowed digital photographs to be embedded with spatial location data with an accuracy level of less than three meters. Accuracy reports are not routinely derived for recreational grade spatial data, as they are not intended for differential correction. The GPS data associated with photographs are all point features, and remain unedited.

GIS and GPS technologies greatly facilitated the ground truthing of legacy data features (see Section 8.6 for legacy data integration results). While in the field, crews used GPS to navigate to legacy feature locations as determined in the GIS, verifying or re-collecting their spatial location, and collecting other pertinent data such as condition information. Based on the high density of archaeological material expected during survey, the use of high accuracy GPS equipment was considered an efficient and ideal alternative to other survey and mapping strategies.

The project GIS allows the viewing and querying of all archaeological features recorded by the current project, as well as the integrated legacy data. Queries can be locational (e.g., How many features are within a particular beach segment?) or by attribute (e.g., Of tested cache pits, which ones had charcoal collected from them?), or both (e.g., Show all house features in "poor" condition within beach segment II). Locational queries were used to tally features by beach ridge segment. Beach segments digitized from published sources (Giddings 1966, 1967) (see section 8.1 for description of units of analysis) were individually selected. Features with locations within the selected segment could then themselves be selected, displayed, and counted. In this way, the amount of newly recorded features within a certain segment could be compared to the number of previously recorded features with accompanying spatial data in the same segment. Once new beach ridge segments are produced from the results of geomorphological analysis, this process can be repeated for definitive feature counts.

The GIS also integrates additional attribute information that was not collected in the field, such as laboratory processing or analytical data, through its use as a relational spatial database. By incorporating the collections catalog table and radiocarbon dating results table, linked to spatial locations through a common database record entry, collections information and dating results can be queried by location or attributes. For instance, collections from a tested location or group of locations can be displayed. Similarly, an artifact or group of artifacts in the collections table can be chosen to show their exact points of recovery. This feature was used extensively to ensure the desired spatial distribution of samples submitted for analysis.

6.1.3 GPS Data Post-Processing and Accuracy Reports

While the use of mapping grade GPS equipment adds a great deal of efficiency, accuracy, and depth to field data collection, it also significantly increases the amount of time needed to process and edit the resulting spatial and attribute data. Below we describe the estimated spatial accuracy of each year's data. After each field season, post-processing and accuracy reporting was completed by Joel Cusick of the NPS Alaska Regional Office (AKRO) GIS team in consultation with the UW team.

Differential correction is a process in which GPS data collected at a known, stationary location are used to correct the data received by nearby roving GPS units. In 2006, a survey-grade GPS base station was installed on the EON building on Second Avenue in Kotzebue. The data collected by this base station was used to differentially correct the field collected GPS data from 2006. In subsequent years, additional base stations were installed in Kotzebue and around the region, allowing more robust data accuracy verification.Spatial accuracy control for "truth" and comparison of accuracy results from different field seasons is estimated from data collected over geodetic monuments ("monumentation"). Before each field season, a survey monument in Kotzebue was occupied with each GPS unit. The collected data was sent to Joel Cusick for verification of acceptable real time and\or post-processed spatial accuracy. Each year, the same set of survey monuments within the Cape Krusenstern beach ridge complex was also occupied, again with resulting GPS data transferred to Joel Cusick for accuracy verification. Spatial precision is controlled through GPS software, which prevents the collection of spatial data if precision falls below a predetermined mark set by the user. Following the advice of Joel Cusick, maximum PDOP on the Trimble GPS units was set to a value of 6.0. This setting kept all positions within the advertised tolerance of the GPS receiver, which is up to 15 centimeters after post-processing.

Initial work in developing a project GIS was facilitated by the transfer of existing geospatial files from NPS. This included relevant files such as newly produced coastal orthorectified imagery (Manley et al. 2007), NPS specific layers such as park boundaries, and the 2006 field data. This transfer was carried out by Joel Cusick, who provided remote technical support and guidance on GPS/GIS issues throughout the duration of the project. UW received

GIS layers composed of 37 Trimble rover files of 2006 field collected data that had been differentially corrected using the NPS base station in Kotzebue. The accuracy report for the positions within these rover files can be seen in Table 2. As directed by Joel Cusick, all data was projected into UTM zone 3 North using the NAD83(CORS96) datum. This became the standard projection for all project geospatial data.

Table 2. Post processed accuracy assessment of 2006 GPS data

Estimated Accuracy Range	Percentage
0 - 15 cm	88.2
15 - 30 cm	6.7
30 - 50 cm	2.1
0.5 - 1 m	2.9
1 - 2 m	0.1
Total Corrected Positions = 43933	

As in 2006, all 2008-2010 field collected GPS data was transferred to Joel Cusick for accuracy estimation and post-processing. Monumentation recorded each field season was always processed with different data correction methods to assess spatial accuracy of each. Discussions between Joel Cusick and Adam Freeburg regarding field conditions, hardware settings, and issues of data accuracy and editing guided the post-processing technique used on each year's complete dataset.

Post-processing (carrier float) and real time (Wide Area Augmentation System- WAAS) correction methods were compared for the 2008 GPS data. Joel Cusick reported that WAAS correction slightly outperformed post-processed corrections using established GPS base stations in Kotzebue (CORS and OTZ1), though there was no statistically significant difference (Table 3). Further considerations included gaps in data storage of the locally available base stations, as well as incorrect antenna settings on one of the GPS receivers that would have prevented carrier post-processing to be performed. Additionally, Joel recommended the WAAS data correction because of the smoothness with which it rendered the polygon features representing archaeological features. This reduced the amount of data editing to be performed by the UW team. Ultimately, the WAAS correction was chosen for all data points.

Table 3. 2008 accuracy estimates by correction type (Cusick 2010)

Correction Type	Average Horizontal Error (meters)
Postprocessed Carrier Float	0.643854
WAAS	0.565726

Variability of differential correction using different base stations was assessed in 2009 using the GPS data collected at survey monuments. UNAVCO triple base processing using the following sites was chosen as the preferred correction method: Kotzebue (AB18), Buckland (AC07), and Talyor (AC50). Accuracy estimates for the monumentation files are given in Table 4. Final accuracy estimates for the complete data set were not reported.

Table 4. 2009 accuracy estimates for monumentation data using UNAVCO triple base (Cusick 2010)

Estimated Accuracy Range	Percentage
0 - 15 cm	55.4
15 - 30 cm	42.4
30 - 50 cm	2.1
0.5 - 1 m	0.0

UNAVCO triple base was again used for data correction in 2010, but the Taylor, AK site was unavailable. The next closest UNAVCO station in Nome was used, though it exceeded the recommended 200 kilometer limit of geographic distance. WAAS was not considered since the satellite serving the field area (PRN 135) was reported as off orbit. Following the recommendation of Joel Cusick, the UW field crew turned off WAAS enabling on their GPS receivers. Estimated accuracies for all collected GPS positions are given in Table 5. For unknown reasons, the data show decreased accuracy, though more than 76% of the data are within an accuracy of 50 centimeters. This has not hindered GIS representation or analyses in any known manner.

Table 5. 2010 accuracy estimates for monumentation data using UNAVCO triple base (Cusick 2010)

Estimated Accuracy Range	Percentage
0 - 15 cm	31.2
15 - 30 cm	9.7
30 - 50 cm	35.2
0.5 - 1 m	23.5
1 – 2 m	0.5

6.1.4. 2006 data integration

Extensive preparatory work by both WEAR cultural resources staff and AKRO GIS team staff went into the creation of the data dictionary used to record all attribute data for GPS locations recorded in 2006. The data dictionary was modified in the course of the 2006 field season to better reflect the locations and features that were encountered. Overall, we are confident that the 2006 team mapped features encountered accurately, and assigned them to a feature type based on their extensive archaeological experience in Northwest Alaska. However, inconsistencies in data collection –especially lack of clarity and consistency in definition of feature types– led to the need for some amount of editing to match the 2006 data with data from subsequent field seasons. The ability to see the data dictionary in use in 2006 and perform preliminary analyses with the 2006 spatial data was a great advantage to the UW team in creating the final version of the data dictionary that was used throughout the 2008-2010 field seasons. The 2006 data was subsequently adapted to fit the updated data dictionary and feature definitions as outlined by UW. Below we describe the effort taken to make 2006 GPS data compatible with GPS data collected in subsequent field seasons

No feature definitions from the 2006 field season were received in the transfer of NPS files to UW. However, a document titled "CAKR_2006_DDF Protocols.doc" created by Joel Cusick and last edited in April 2006 by Chris Young outlined the GPS features and attributes capable of being collected by some version of the 2006 data dictionary. Unfortunately, this version was not the same version that was deployed in the field, so the document provides little insight into survey feature determinations. Chris Young (personal communication, 2007) confirmed that feature definitions were not formally documented for the 2006 season and that the data dictionary was altered several times throughout the field season to better reflect the cultural resources encountered. The UW team created a feature definition protocol to be used for the

2008 season, using knowledge of the types of cultural features encountered as crew members in 2006 and taking into account the abilities and limitations of GPS technology. To view the feature definitions used in 2008-2010 field seasons, see Appendix I. After verifying the utility of these feature definitions during post-field analysis, the 2006 data were edited to match. The most significant inconsistencies involved the 2006 GPS feature types of “ex_feat” and “ex_point” (interpreted to mean “excavated feature” and “excavated point”, respectively). It appeared that these features were created to dichotomize between previously excavated locales and newly identified cultural features. However, the UW team felt this dichotomy would unnecessarily complicate research and management. Instead, individual features could be classified in the field, or post-hoc, according to the feature definition protocol. Attribute data collected at the time of mapping would indicate whether the feature was previously excavated or was judged to be a newly identified feature. Therefore, these GPS feature types were discontinued after the 2006 season.

Where possible, digital features contained in “ex_feat” were transferred to the appropriate GIS feature class following the 2008 protocols. For example, house features in both Old Whaling summer and winter settlement excavated by Giddings (1967; Giddings and Anderson 1986) were mapped in 2006 using the GPS feature type ‘ex_feat.” These features are now included in the “housepit” GIS feature type, so they are included in tallies and analyses that include house features. This process is recorded in the resulting GIS data; when a GIS feature is selected with the “Identify” tool in ArcMap, a feature history is visible in the top pane of the resulting window. GIS features that have been relocated from other GIS feature types will display more than one feature (Figure 4). For similar reasons, GIS features in “ex_feat” with attributes indicating the presence of substantial amounts of fire modified rock were transferred to the GIS feature “hearth.” If the amount of fire modified rock was limited to one or two specimens, or if the quantification was indeterminate, no transfer to “hearth” occurred. Because “hearth” is a GIS point feature, and “ex_feat” is a GIS polygon feature, the geometric centers of the relevant “ex_feat” GIS features were transformed into point features which were then transferred to the “hearth” feature class. While transforming polygons into their geometric centroid results in the loss of spatial data (two dimensional polygons to a single point), the recording of hearths as point features matches the 2006 survey methods. We continued this during subsequent field seasons.

Additionally, it was not clear that the GPS feature types "ex_feat" and "ex_point" were used exclusively to indicate previously excavated features. Both suspected and confirmed previously excavated cultural features were recorded in both the "area_gen" and "locality" GPS feature types. It also possible that some cultural features recorded "ex_feat" were newly discovered. Since the collected data are ambiguous, it remains impossible to tell.

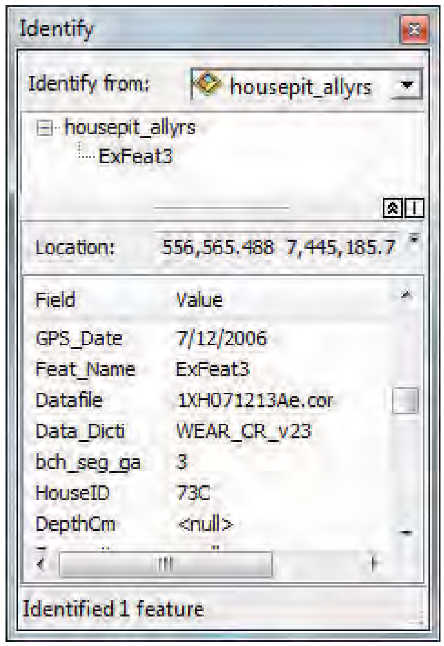

Figure 4. ArcMap "Identify" Window showing a current house feature that was originally in the 2006 "ExFeat" feature class

Similar problems were discovered with the "ex_point" data, a point feature class in GIS. While the attributes of a few GIS points clearly indicate the mapped location was excavated, or was suspected to have been excavated by previous researchers (both Giddings and C. and J. Darwent are suggested), where this information is lacking, differentiation between 2006 field efforts and previous research is impossible. Additionally, two previously excavated shovel tests, attributed to Giddings' fieldwork, are also recorded under the 2006 GPS feature "stp." As with polygonal cultural features, we wished to have all point features of the same type to be grouped together irrespective of their investigative date. All "ex_point" points were transferred to the GIS feature "test_pt." All points of artifact collection or subsurface inspection, past or present, in the 2008-2010 field seasons were recorded as a "test_pt" GPS point feature. Attribute information reflects whether the mapped point was tested during the current project or was suspected to be a result of previous research.

The “locality” GPS feature type also proved to be problematic. The feature type contained polygons of cultural remains such as lithic scatters, ceramic scatters, and faunal scatters as well as known excavated house and cache features and activity areas. Where applicable, the settlement features were transferred to their respective GIS feature datasets (house, cache, etc.), while the scatter features were moved to a feature type used in the current project, “surf_scat” (surface scatter). In fact, the format of the “locality” feature class formed the basis of “surf_scat”, with minor modification.

While every effort was made to integrate the 2006 data into the 2008-2010 project field data, some features recorded in 2006 remain excluded. The feature dataset “ex_feat_06” is an edited version of “ex_feat” that contains the features that were unable to be merged with other feature types. “Ex_feat_06” also preserves the mapped polygons of the features that were transferred to the “hearth” point feature. Additional recorded features from 2006, such as modern phenomena, that were determined unrelated to prehistoric or historic cultural features were also excluded from analyses. The unmodified 2006 data is still available in the project GIS for comparison with interpretations provided here or for re-categorization and analysis. Though the 2006 data were integrated into features as defined in subsequent field seasons, caution should be exercised when using the combined 2006-2010 dataset. For analyses with internally consistent feature definitions, we recommend using 2008-2010 data only.

6.2 Field Methods

6.2.1 NPS Methods - 2006

The field methods of the 2006 field season differed from the field methods used by UW-led crews, so are summarized here to the extent possible based on personal experience and recollection. Archaeological survey was carried out in transects that were scaled to the width of each beach ridge. Survey was predominantly carried out along the crest of the beach ridges, though some testing was also conducted on the margins of the ridges and in the swales between ridges. The testing interval was 40 meters with additional discretionary tests within this interval as deemed necessary. Subsurface testing procedures included shovel test pits and surface scrapes. Shovel test pits were minimally 30 centimeters wide, dug to the point of groundwater, substrate infilling/collapse, or permafrost. When a shovel test yielded indications of a dwelling, such as structural components or a central hearth feature, the shovel test was sometimes expanded to a 50 centimeter square test pit. No consistent collection strategy was applied, though charcoal from features with a surface expression was sought and routinely collected. Thirteen faunal samples were also collected from house and midden features for isotopic analysis by Cody Strathe (Strathe 2007). Shovel scrapes involved the removal of the vegetative and/or sod layers when present from areas of artifact surface scatters, including lithic scatters and hearths or locations of fire modified rock, in order to delineate and map their extent with GPS. All subsurface tests, cultural and suspected cultural features, as well as previously excavated archaeological features were recorded with mapping-grade GPS. Field photos were linked to recreational grade GPS positions with the use of GPS Photolink software, as in subsequent seasons.

6.2.2 UW Methods - 2008-2010

The overall strategy in selecting survey areas for the UW-led project was the need to sample across both time and space in order to address project objectives. As such, survey areas were intended to cover a section of land from Krusenstern Lagoon to the modern sea coast. Data from previous research at the Cape was also a factor in survey area selection, since project goals included relocating and testing previously identified sites. The lack of methodological information available from Giddings' work, however, limited our ability to address some questions, such as developing site density estimates. Lastly, geomorphologic information from remotely sensed imagery (Manley et al. 2007) and data from 2006 fieldwork were used to identify areas with higher and lower potential for past occupation. We assumed that areas of low elevation that are presently closer to the water table and/or seasonally under water were similarly situated in the past, and would have therefore been avoided by past inhabitants for most activities. Advice was sought from Jim Jordan in identifying such areas. Areas considered “low-potential” included:

- Low-elevation areas in the central and eastern areas of the beach ridge system, as well as ridges adjacent to Krusenstern Lagoon in the northwest area of the beach ridge complex.

- The eastern boundary of the beach ridge system along the Tukrok River – this area includes the ends of successive spits that evolved over time to form the beach ridge complex. These areas would have been less desirable for habitation in the past.
- Swales between ridges

"High potential" areas included:

- Higher elevation ridges
- Tops and sides of ridges (rather than swales)

For the purposes of this project, systematic survey is defined as archaeological survey with 10 meter transect spacing across a beach ridge (from swale to swale, including ridge sides and crest) with subsurface shovel tests no more than 40 meters apart on a single transect. Subsurface tests were also conducted in and/or around suspected cultural features as identified by surface expressions of vegetation, topography, or other indications. All encountered archaeological features and artifacts were recorded with mapping-grade GPS, as were areas of anomalous vegetation.

Figure 5. Areas of varying archaeological potential mentioned in text

Some areas were surveyed non-systematically for various reasons, including time constraints, permission of landowner, and low archaeological probability. Non-systematic methods included surface-only survey at 10 meter transect intervals as well as limited subsurface testing focused on probable cultural features. Additional areas evaluated in the field for their archaeological potential but deemed low probability were not surveyed. This includes areas of dense shrub vegetation that prevented subsurface testing.

Subsurface testing consisted of three types: shovel tests, surface scrapes, and test units. All subsurface testing was conducted in a manner that attempted to minimize long term impact on natural and cultural resources. Sod and vegetation, if present, was removed as carefully as possible and replaced after testing. This was often difficult due to a generally sparse organic soil horizon as well as the presence of plants with delicate root structure such as lichens and tundra berry species. All subsurface tests were backfilled after data and artifact collection concluded. Each subsurface test was given a unique alphanumeric ("TestID") and recorded with mapping grade GPS equipment. All crew members were required to keep daily field notes, recording items such as weather, tasks and activities, and interpretations not recorded in other field documentation. In 2009 and 2010, daily notes also included profiles of positive test pits . Standard information from test excavation units was collected on paper level forms.

Shovel tests were 30 centimeters in diameter and were excavated to the maximum depth allowed by subsurface conditions. Depth was most often limited by the collapse of unconsolidated gravels, but was also affected by the presence of the water table or permafrost. Due to the large clastic nature of the substrate, no screens were used in the shovel testing process. Instead, excavated material was shoveled onto plastic tarps (to protect adjacent vegetation) and troweled through by hand to identify cultural material. Each shovel test was immediately backfilled and the sod/vegetation layer replaced.

Surface scrapes were conducted where deep subsurface investigation was considered unnecessary. This included shallow deposits of archaeological features such as hearths or surface scatters. To adequately sample differently sized features, shovel scrapes of 0.5x1 meter, 1x1 meter, and 3x3 meters were used. If present, the sod/vegetative layer was carefully removed and examined for artifacts. Near-surface sediment was then troweled through by hand up to three centimeters below surface to locate and identify artifacts. Diagnostic artifacts, charcoal, and other artifacts considered important to the interpretation of the unit were mapped on paper level forms with three point provenience. No screens were used and no bulk samples were collected. Once finished, the sediment was restored to as close to its original position as possible, and the sod/vegetative layer replaced.

All test units were one meter square, excavated by trowel and other small hand tools in 50 by 50 centimeter quadrants. When possible, the sod/vegetative layer was removed intact. Excavation followed naturally occurring layers with ten centimeter arbitrary levels if no natural changes were observed. All excavated material was screened through one-quarter inch (1/4") mesh, and every fourth bucket of excavated material was also screened through one-eighth inch (1/8") mesh. Screened material was captured on tarps to protect nearby surface vegetation. Paper level forms were used to record excavation details. Diagnostic artifacts, charcoal, and other artifacts found in situ were mapped onto the paper forms using three-point provenience. Plan view photographs were taken prior to excavation and at the end of each level. Units were considered to be sterile after a full ten centimeter layer was excavated without yielding cultural material. A shovel test was then dug into the culturally sterile strata to confirm the absence of archaeological material. At least one wall's stratigraphic profile was mapped to record the placement and association of cultural layers with natural layers and disturbances such as faunal turbation. All test unit profiles are included in Appendix II of this report. After profile mapping, modern materials such as flagging tape or visqueen were placed at the bottom of the unit, indicating the limit of excavation, and the unit was backfilled. Sod was then replaced, and a final photograph was taken of the test unit location.

The artifact collection strategy for the 2008-2010 field seasons differed from the 2006 collection strategy described in Section 6.2.1. Isolated artifacts were only collected if they were diagnostic in nature. All cultural material from shovel tests, shovel scrapes, and test units was collected, with the exception of fire modified rock and large quantities of wood or charcoal. The presence of fire modified rock was documented through photographs, mapping, and/or description in field notes and level forms. Large pieces of wood, such as structural members of house features, as well as large quantities of charcoal were sampled to provide sufficient material for wood identification and dating. Bulk samples were collected from one quadrant per level of test unit excavation in 2008. In an effort to collect samples more representative of the entire excavation unit, bulk samples were collected as grab samples from throughout the entire level in 2009 and 2010. Bulk samples were also collected from selected vegetation anomalies for future geochemical analysis. After 2008, bulk samples were screened in the field through one-quarter inch mesh to remove large clastic material that would not be subjected to analysis to reduce weight and shipping costs.

Field data capture included the recording of all sub-surface tests or other excavation units, surface finds of archaeological and historic artifacts and features, and survey monumentation such as National Geodetic Survey datums or Bureau of Land Management allotment markers. The use of a GPS data dictionary allowed rapid entry of attribute (non-spatial) data, through predefined drop-down menus and manual entry, providing efficient and consistent data capture. The project data dictionary was largely based upon the final version of the data dictionary used in 2006. Due to the amount and types of changes, these two data dictionaries are not wholly compatible (see Section 6.1.2 for further discussion). The project data dictionary was changed again after the 2008 field season with no loss of compatibility to the previous version. The full data dictionary was previously reported in Appendix I of Anderson and Freeburg (2010) and is included in this report as Appendix III. For consistency in data collection only Shelby Anderson and Adam Freeburg operated the Trimble units.

GPS workflow was necessarily integrated with other archaeological field methods, and was also partially dependent on the firmware running on the Trimble GPS units. A unique rover file was created at the start of each day the Trimble units were needed. This rover file would hold only the spatial and attribute data for the corresponding day. Subsurface tests were recorded as point features with attribute information including whether the test was positive or negative, material encountered, and total depth. Spatial locations of shovel tests were recorded at the edge of the unit. Shovel scrape and test unit locations were recorded at their southwest corner, used as a local datum. The unique alpha numeric (TestID) assigned to each subsurface test was coded “A” or “B” to correspond to the GPS unit that mapped it. The number set for each GPS unit was kept as a running tally so as to prevent repetition in the TestID data. In some cases, TestIDs were created post-hoc using existing spatial information, and were assigned a suffix of “C” or “D”. Isolated artifacts and faunal material found on the surface were also recorded as single points. Archaeological features visible on the ground surface, such as house depressions, cache pits, or concentrated artifact scatters, were collected as polygons. Legacy excavations were mapped following these same protocols; shovel tests were recorded as point features mapped anywhere along their edge, and larger test units were recorded at their southwest corner or the closest approximation, if the unit was not aligned with cardinal directions. Fully excavated features, such as house, cache, and burial features were recorded as polygons by following the highest portions of excavation backdirt surrounding the feature. If the backdirt was negligible, we recorded the apparent limits of excavation. Excavated hearths were recorded as points, and the largest dimension of the excavation was recorded as the feature diameter. All recorded features that did not require a TestID were also coded according to GPS unit, but were numbered according to a daily tally. Therefore, feature identifications repeat between rover files, but are unique when combined with the rover file name. Each rover file name is a combination of a prefix defined by user input and a standard date format that is set by Trimble. Our chosen prefix included the last two digits of the project year as well as the GPS unit model, either ProXH or GeoXH. Therefore, there are many features named House 2B, but only one feature named House 2B of 09ProXH0723A. See Figure 6 for explanation of the GPS feature name format used for this project. Table 6 shows the prefixes used during each project year.

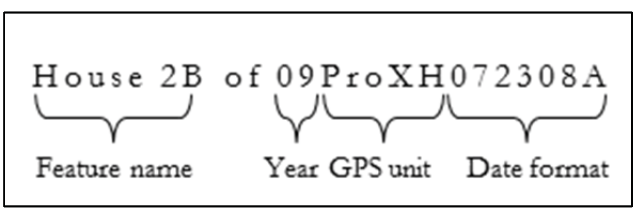

Figure 6. GPS feature name format

Table 6. Trimble rover file prefixes by year

	GPS Unit	
Year	ProXH	GeoXH
2006	ProXH1	1XH
2008	ProXH	2XH
2009	09ProXH	09GeoXH
2010	10ProXH	10GeoXH

The data dictionary file received input such as notes on predominant vegetation, relationship to legacy data, as well as NPS-required management and condition information (ASMIS). The areal extent of hearths, defined as concentrations of fire modified rock, were often too small to record reliably given the accuracy tolerance of the GPS units and were therefore collected as points. Feature definitions are described in Table 7.

Table 7. Human-Environmental Dynamics at Cape Krusenstern feature type definitions

Feature Type	Description
House	Large (≥4 m^2) surface depressions that may have the following features: multiple rooms, tunnel(s), and/or associated features such as cache pits, surface scatters, or vertical posts. At CAKR, minimum arbitrary house dimensions derived from data on previous house excavations at CAKR (Anderson 1962; Giddings and Anderson 1986).
Cache Pit (term used for subterranean storage features in keeping with prior research in region).	Small (<4m^2 when unexcavated) surface depressions that may be circular or square in shape, and are usually associated with a house feature, other cache features, or other features. Recorded features larger than this as cache pits when associated with houses and/or a series of caches.
Unidentified	Isolated depression feature – could be a single house, could be storage features associated w/more ephemeral occupations. Cannot distinguish the two situations w/o further testing. Surface or subsurface cultural features that do not fit in any of the other feature categories were categorized as "unidentified".
Surface Scatter	Surface artifacts found together at a moderate to high density (>3/25m^2).
Activity Area	Post-field designation for sub-surface cultural materials that otherwise meet the description of surface scatters (above). Frequently, these activity areas are adjacent to house or other depression features (unidentified features, cache pits). These features are of unknown extent and were typically identified by systematic shovel testing in the vicinity of other cultural features.
Hearth	Concentration (≥5/1m^2) of any or all of the following: fire modified rock, charcoal, burnt artifacts (eg. burnt bone).
Burial/Human Remains	Includes: 1) Known burials – report in oral history or written documentation as burials, 2) Burial indicated by stacked wood, whale bone, or other ethnographically (or archaeologically) known burial marker, 3)Inadvertently discovered burial
Vegetation Anomaly	Vegetated areas (>5m^2) that are different than the surrounding vegetation, with a regular shape/appearance. May have a slight or deep depression or mound w/in the vegetated area. Have the appearance of cultural features, but no cultural materials are found upon further investigation (surface examination or subsurface testing).

Digital images were taken of almost all of the features encountered during survey. Vegetation anomalies and some cache pits and unidentified features were not photographed. A recreational grade Garmin GPS was carried by each crew's photographer, a task that rotated daily. These GPS units collected spatial position every five seconds throughout the work day. Manual photo logs were used to record the date, photographer, direction of the photo, and photo description. GPS-Photo Link software uses the time stamp of a digital photo to match each photo with a collected spatial location. This allows each photo to be geotagged with the spatial location of the photographer as well as other data defined from the photo logs (Figure 7). GPS-Photo Link also provides output spatial files of the daily GPS track and photo locations, which are included in the project GIS.

Figure 7. Example of watermarked digital photo (S. Anderson)

7.0 PROJECT ACTIVITIES

7.1 Research Activities

7.1.1 Field Work

The field component of NPS's "200 Generations" project was carried out between June 26 and July 23, 2006. The crew consisted of Western Arctic National Parklands archaeologists Chris Young and Sabra Gilbert-Young and seven seasonal crew members. These crew members included Shelby Anderson, Adam Freeburg, Stacy Hipsak, Shane Husa, Scott Shirar, Cody Strathe, and Cindy Williams. Bob Gal and Joel Cusick were also present during the first week of field activity, assisting with camp set up and GPS/GIS troubleshooting, respectively. The field camp was located on the northernmost portion of the beach ridge complex where the active ocean front and Krusenstern Lagoon are only separated by approximately 150 meters of land. Goals of the field season included archaeological survey of a portion of the beach ridge complex, as well as documentation and testing of cultural features. Feature documentation included mapping and condition assessment using both high-accuracy and recreational grade GPS equipment. In all, 494 hectares (1221 acres) were surveyed during the 2006 field season (Figure 8) (all areal measurements are derived through automated geometry calculations in GIS). The 2006 survey extent was previously reported by Chris Young as 16,768 acres (Young, no date). This error could have resulted from interpreting a GIS perimeter calculation of the 2006 survey boundary in meters as an areal measurement. The 2006 field data, as well as accompanying files such as orthoimagery, NPS GIS data, budgets, reports, copies of field notes, and artifacts were transferred to UW upon the approval of the task agreement and work plan in 2007.

Beginning in 2008, the UW carried out three field seasons at Cape Krusenstern. Camp location varied from year to year (Figure 9) based on the area chosen for survey and various logistical concerns (e.g. access to fresh water, aircraft/boat access, etc.). Crew size also varied between years. Each season began with training and field prep in Kotzebue, and also ended in Kotzebue with equipment clean-up and storage. An exception to this was in summer 2010 when the crew completed bear and firearms training, as well as newly required ATV training, while in the field.

In 2008, a crew of six archeologists spent six weeks at Cape Krusenstern, between June 26th and August 9th, 2008. In addition to Shelby Anderson and Adam Freeburg of UW, the crew included Patrick Reed, Jennifer Gebhardt, Russell Willems, and Nick Radko. Jim Jordan conducted geomorphological fieldwork between July 4th and July 11th. Bob Gal, NPS archaeologist, assisted with field deployment and with Jim Jordan's geomorphological fieldwork. Other short term visitors/crew members included Eileen Devinney, NPS cultural resources manager, Sarah Campbell, Western Washington University professor/NPS VIP, and her son, Kevin Mitchell, NPS VIP. The crew was based at the Anigaaq Ranger Station for the duration of the field season. ATVs and a small boat were used to access different areas of the beach ridge complex for survey and testing. Because of mechanical issues with both the boat and the ATVs, more survey and testing than originally planned was carried out in the vicinity of Anigaaq, particularly on private allotment tract CAKR-04-129 (see section 9.2.1).

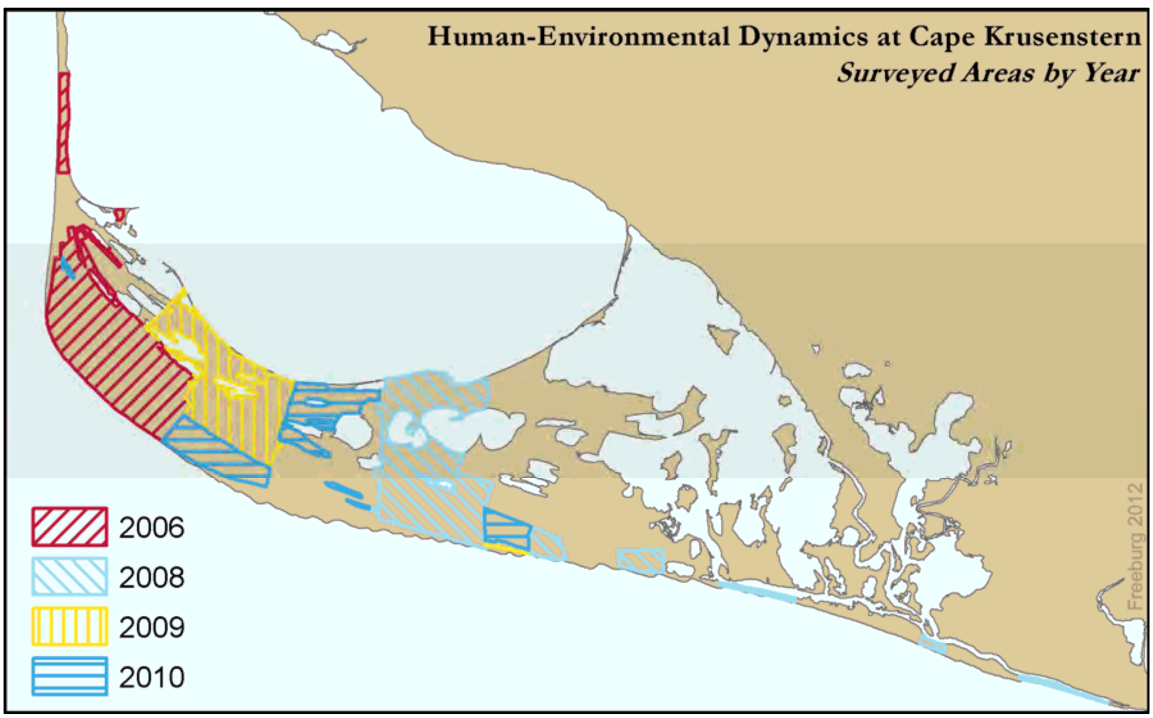

Figure 8. Surveyed areas by year

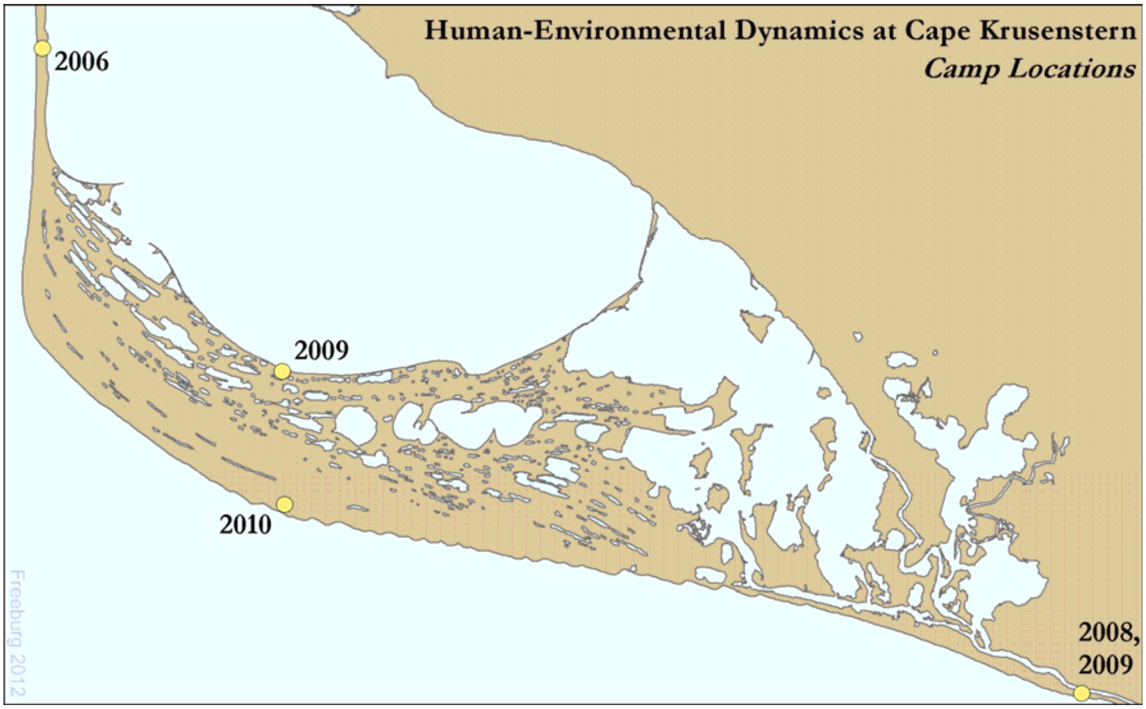

Figure 9. Field camp locations for current project

In 2009, the UW-led crew returned to Krusenstern for a longer field season, between June 19 and August 16. The crew of six included Shelby Anderson, Adam Freeburg, Patrick Reed, Fawn Carter, Katherine Ou, and Lindsey Tibke. Scott Shirar, from the University of Alaska Museum Archaeology Department, assisted with fieldwork from August 4 to 13. Ben Fitzhugh, project principal investigator, was in the field from July 31 to August 7. Michael Holt, NPS Archaeologist, also joined the crew for two days, from August 12 to 13. Jim Jordan was in the field for several weeks in June and July conducting geomorphological fieldwork. The Sisualik Culture Camp visited the crew in the field for a short lecture and day of outdoor archaeological activities on June 23rd. Logistics were complicated in 2009, as the crew moved from the Anigaaq Ranger Station to a camp on the southern shore of Krusenstern Lagoon for a portion of the field season. The second camp was established to facilitate access to the older beach ridges along the shoreline of Krusensteren Lagoon and reduce reliance on boats and ATVs. Moving camp proved difficult due to rapidly changing water levels; the crew had trouble boating through the lagoon mouth and also experienced mechanical issues with the NPS boats. By keeping one boat on each side of the lagoon mouth as much as possible and portaging gear between the lagoon and the river system, camp was successfully established in its new location within three days.

The objective of the archaeological fieldwork completed in 2009 was to survey, map, and test both previously recorded and new archaeological sites in an area between the 2006 and 2008 survey areas. Areas selected for survey included segments of the beach ridge complex for which little previous information was available. Survey was also carried out on the southern portion of a single private allotment, CAKR-04-117, the permission for fieldwork having been obtained from the landowner by NPS. The 2009 survey block in the central area of the beach ridge complex was not completed as planned and the crew returned to finish this survey block in 2010. Several locations identified in 2006 and 2008 were revisited in 2009 to carry out test excavations and/or to collect additional information.

The 2010 field crew was the largest since 2006, comprised of a total of 10 archaeologists who worked between June 20 and August 1. Crew members included Shelby Anderson, Adam Freeburg, Amy Thompson, Josh Dinwidde, Anthony Hofkamp, Kelly French, Josh Diles, Sarah Chappell and Elizabeth Penttila. Because of an NPS-wide moratorium on ATV use issued prior to the start of the field season, the UW crew established a field camp on the coast in the central part of the beach ridge complex. While lacking direct access to fresh water by boat, this camp location made it relatively easy to access planned survey and testing areas without reliance on ATVs. Following mid-season ATV training the crew used ATVs to access more distant testing locations.

Completion of the systematic survey involved surveying the rest of the 2009 survey area, increasing the areal extent of survey in some beach ridge segments/time period, and relocating and mapping previously recorded sites that had not yet been located by systematic survey. Additional areas were chosen for survey based on previous reconnaissance that identified features or areas of interest. Due to their unique geologic histories, beach ridge segments differ in the total area they contribute to the complex. Because of this, and due to the placement of survey blocks, some segments received more survey coverage than their total relative areal contribution. This has the potential to further bias the results of archaeological survey data analysis already impacted by differential erosion of beach ridge segments over time. To offset this, a new portion of beach segments V and VI was surveyed in an effort to increase the proportional coverage of those two segments. As a result of joint requests by UW and NPS personnel, private allotment owners graciously permitted the project to include investigation of their land. Survey was carried out on areas of four private allotments CAKR-04-110, CAKR-04-116, and CAKR-04-117. In addition to survey activities, locations identified in 2006-2009 seasons were revisited in 2010 to carry out test excavations and/or to collect additional information. As planned, the 2010 season saw intensified testing relative to previous project years. A full recounting of field methods including survey, testing, artifact collection, and data acquisition was previously reported in Appendix II of Anderson and Freeburg (2010).

Each field season, the UW crew made every effort to restore camp locations to their original state. A visit to the 2006 field camp in summer 2009 indicated that the site had been completely revegetated and could only be relocated with GPS location information; its footprint was not visible on the ground. While camped at the Anigaaq Ranger Station, the crew often did minor repairs to the complex and also notified NPS staff annually of any larger maintenance issues. NPS staff in Kotzebue provided critical logistical support over the course of the project.

7.1.2 Laboratory Work

Lab activities were directed at artifact cleaning, cataloging, and sample preparation for radiocarbon dating and other analyses. Cataloging followed NPS procedures and resulted in an Excel spreadsheet that is in an ANCS+ ready format. Lab activities were supervised by Shelby Anderson and Adam Freeburg, with numerous UW undergraduates working in the lab for credit. The lab was run for a total of 7 quarters: Fall 2008, Spring 2009, Fall 2009, Winter 2010, Fall 2010, Winter 2011, Summer 2011 and Winter 2012. Approximately 44 students worked in the lab over the course of this project. Several independent and on-going projects involving analysis of project materials include macrobotanical, ceramic, lithic, and geochemical analyses conducted by Shelby Anderson. This work is beyond the scope of the current project and the results of these efforts will be reported elsewhere. Ceramic results have already been reported (Anderson 2011, 2012; Anderson, et al. 2011). Two hourly workers, Sarah Ashmore and Will Brown, assisted with tasks such as site form creation and ASMIS entry. Sarah Ashmore and Dave Hunt digitized the test unit profiles found in Appendix II. The amount of data collected required considerable effort in GIS editing, maintenance, and spatial analysis, as well as artifact catalog maintenance. These tasks were primarily done by Adam Freeburg and Shelby Anderson. The majority of lab work with the excavated faunal material has been in preparation for curation. All faunal material was air dried completely after shipment from the field and cleaned by dry brushing. Cleaned fauna were labeled with assigned catalog numbers on acid free paper applied with Rhoplex. Fauna material was sorted by species and skeletal element and separated by classes (marine mammal, terrestrial mammal, avian, fish) as requested by NPS. Artifacts and samples were placed in zip-top plastic bags with foil backed labels indicating provenience information as well as accession and catalog numbers as assigned by NPS.

UW is collaborating with Christyann Darwent of UC Davis on a project titled "Prehistoric Use of Large Whales in Kotzebue Sound." Whale samples collected from Cape Krusenstern test units and surface fauna are currently under analysis for DNA, isotopes, and radiocarbon dating. Destructive analysis permissions were granted by WEAR for these studies. Reporting of results to NPS and the research community will occur elsewhere, and will be headed by Darwent.

In 2008 and 2010 human remains were inadvertently discovered during fieldwork. The procedures outlined by project NAGPRA consultation were followed, including documentation and reporting of the discoveries. Additional details can be found in the burial reports submitted to NPS (S. Anderson 2008; Freeburg and Anderson 2010a).

7.2 Management Activities

While there is considerable overlap between research and management goals of the project, several aspects of the project were specifically directed at meeting NPS management needs. These activities included: completing Alaska Heritage Resource Survey (AHRS) records, documenting condition information, updating Archaeological Site Management Information System (ASMIS) data, and meeting ongoing NPS requests for summaries, photos, and field details for NPS permitting and internal reporting needs.

Because of the unique nature of the archaeological record at Cape Krusenstern, special procedures for collecting and reporting ASMIS and AHRS data were developed in consultation with NPS and Alaska State Historic Preservation Office (SHPO) staff. In addition, the multi-year aspect of project data collection meant that new data and/or survey of adjacent areas in subsequent years altered the team's perception of archaeological feature density over the course of the project. As mentioned in the 2010 interim report (Anderson and Freeburg 2010), the site boundaries drawn between areas of archaeological deposits do not create archaeologically meaningful or useful units of analysis, given the overall density of sites within the Cape Krusenstern beach complex. However, sites are a useful resource management unit, particularly for such a large area; sites are a way to divide and track information about the number and condition of archaeological features. Site areas were therefore not defined in the field, but rather identified after fieldwork was completed by applying a series of criteria to the spatial data. A "siteless" strategy (Dunnell and Dancey 1983) of data collection is most appropriate here. While the linearity of the beach ridges and swales make survey transects most efficient when run parallel to ridge orientation, "sites", as determined by artifact and/or feature density (Dunnell 1992; Plog et al. 1978), can be spread across one or more ridges and adjacent swales. By following a siteless strategy, sites can be determined, if necessary, post-hoc by evaluation of artifact and feature density. For research purposes, we consider the entirety of the beach ridge complex (the Cape Krusenstern Locality, NOA-00002) to be a "site." For AHRS reporting purposes, we have delineated localities with sufficient densities of cultural features as bounded entities. We do not consider these to be discrete sites in the sense that other AHRS locales may be considered sites. However, we do understand the purpose of delineating these clusters for administration and reference purposes.

Site boundaries were based primarily on the distance between positive test pits and/or positively identified cultural features and the position of archaeological features on a landform. Alaska SHPO site definition guidelines were used with modifications made with permission of NPS and SHPO staff. In general a 50 meter buffer between positively identified archaeological features was used. This resulted in many multi-component sites, which reflects the use of the beach ridges by prehistoric inhabitants. In some cases, geomorphological boundaries and dating results were used to delineate between groups of archaeological features that were within the 50 meter buffer but were thought to be more properly managed if assigned to separate sites. SHPO mapping requirements were met, with digital maps as well as shapefiles of site boundaries and centroids submitted. Additional site maps that included site and feature boundaries, artifact location, and other pertinent spatial information were also included to facilitate NPS management activities, along with ASMIS condition and other feature specific information available for each site. AHRS site forms will be submitted to the Alaska SHPO as well as NPS. As per SHPO and NPS site recording requirements, all of the newly defined sites are within previously established NOA-0002, which encompasses the entire beach ridge complex, as well as the Cape Krusenstern Archaeological District, NOA-00042, a National Historic Landmark (NHL) that encompasses all of Cape Krusenstern National Monument and beyond. Other site areas that are adjacent to, overlap with, or include parts of the project area include: NOA-00003, NOA-00138 and 00139 (the Palisades and Lower Bench sites respectively), NOA-00140, NOA-00274, NOA-00278, 00279, 00280, 00281, and NOA-00282 (Figure 10). Because the Cape Krusenstern NHL encompasses an area larger than Cape Krusenstern National Monument, it is not depicted on the figure. Note that site eligibility determinations for the national register were not made by UW, in accordance with the site recording activities outlined in the Task Agreement.

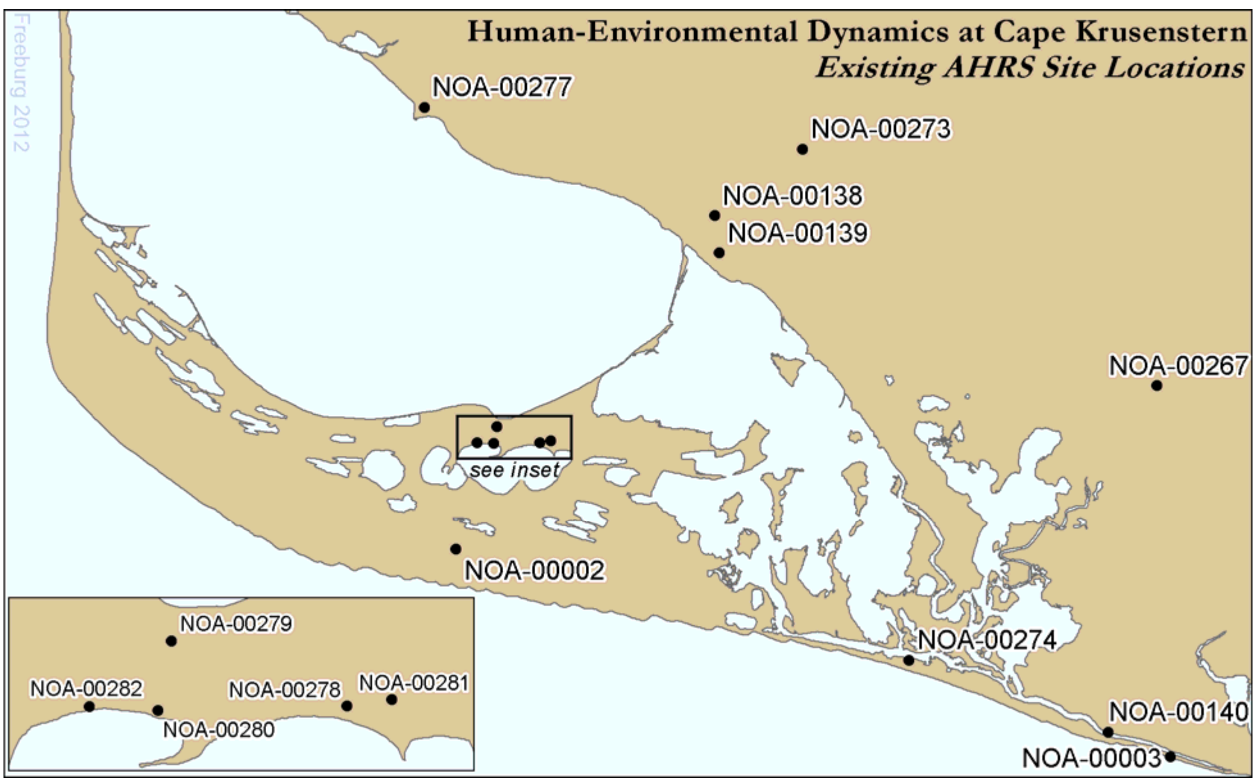

Figure 10. Previously recorded sites in or immediately adjacent to the project area

ASMIS data fields were included in the project data dictionary and notes on condition were recorded directly in the GPS during field work. These data were gathered according to guidelines provided by the NPS in spring 2008; interim ASMIS-ready data were submitted to the NPS annually in an Excel spreadsheet for approval of data format. Initially, the plan was for the NPS to enter these data into ASMIS, but in 2011 the UW agreed to take on this responsibility. Site condition information was grouped and entered into the NPS ASMIS database according to the site areas defined and assigned AHRS numbers by the project. Condition information was collected for each archaeological feature during fieldwork; upon the advice of the NPS these features, and associated condition information, were subsequently entered into the ASMIS database as sub-sites of the AHRS numbered sites. Condition information for the site was derived from feature condition information. For example, if the majority of the features had moderate depositional integrity, then the same condition information was applied to the site as a whole. If the condition of features within a site was highly variable, no condition information was entered for the site as a whole. If the site management (threat/disturbance) information varied among features within the site, the following data was entered in the main site form: Disturbance severity level - unknown/no data entered; class - undetermined; type - unassessed; date - site discovery date; Effect on resource – no data entered. Previously established NPS drop down menus were used for site information, in order to better align project ASMIS data with other NPS condition information in the ASMIS database. In addition, UW did not have permission to add fields to drop down menus, so deviation from previously established data entry procedures was not possible. Treatments, documented inspection schedules, and maintenance requirement fields were not completed because entries in these fields are not required and will trigger additional NPS ASMIS requirements; as such, these decisions need to be made by NPS staff in a manner consistent with other WEAR projects and priorities.

In addition to ASMIS and AHRS data, the UW provided information for, or completed, the internal NPS research permit application form prior to field work in 2008, 2009, and 2010. Annual field summary reports were shared with the NPS in August or September in 2008, 2009, and 2010 to fulfill NPS internal reporting needs; the UW completed the NPS reporting template to the extent possible and then returned a draft report to the NPS for completion.

7.3 Community Activities

Ongoing consultation, outreach, and collaboration with the local community were included in goals of the UW-NPS project at Cape Krusenstern. Additional details on outreach activities can be found in project interim reports (Anderson and Freeburg 2009a; Anderson and Freeburg 2010; Freeburg et al. 2008; Freeburg and Anderson 2011a). A summary is provided here.

7.3.1 Consultation

Initial stages of consultation and outreach were carried out by the NPS prior to UW involvement in the project. As the federal agency responsible for government-to-government consultation with various Alaska Native organizations, the NPS led all NHPA Section 106 and NAGPRA consultations, as well as requests for permission to carry out research on private allotments. Beginning in 2007, the UW was involved in consultation activities and provided technical assistance to the NPS over the next five years. This assistance took many forms and included: community visits and presentations, meeting participation, phone calls, written summaries, and draft consultation letters for the park to use in formal consultation. In 2008, the NPS carried out NAGPRA consultation for the collaborative project with the Native Villages of Noatak, Kivalina, and Kotzebue. Based on the results of initial consultation, in-depth NAGPRA consultation continued with the Native Village of Kotzebue. A plan for avoiding known or reported burials and for dealing with the inadvertent discovery of human remains during fieldwork was developed in consultation with the Native Village of Kotzebue. These procedures were further formalized in 2009 through a plan of action between the NPS and the Native Village of Kotzebue.

The NPS also reviewed the project for Section 106 compliance. In 2008, an assessment of "no adverse effect" was given by the Section 106 coordinator, and the project was deemed to be in compliance through programmatic exclusion under a 1995 servicewide programmatic agreement for Section 106. A notice to proceed with work was given by WEAR Superintendent George Helfrich on June 14, 2008. Permission to work on Native allotments was sought by the NPS from allotment owners through the Bureau of Indian Affairs (BIA) on an annual basis beginning in 2008. Varying levels of permission (survey only, survey and testing, destructive analysis) were given for a majority of the allotments, although permission was denied in a few cases. Reports were prepared for all allotment owners on an annual basis, with allotment-specific information included where applicable (Anderson 2009a, 2009b; Freeburg and Anderson 2010b). The BIA Anchorage office later determined a need to issue an ARPA permit to NPS to allow research to be conducted on private allotments. This permit was issued in 2010. The NPS shared 2008 reports with the BIA and UW sent copies of subsequent allotment reports to Ricky Hoff, BIA archaeologist in 2009 and 2010.

7.3.2 Community Involvement and Outreach

Community involvement took various forms. For example, the UW hired local residents to assist with project logistics. Cyrus Harris and John Goodwin provided boat support for the project. Northwest Aviation and Hageland Aviation Services provided air support. Herbert Foster and family also provided logistical support and supplied invaluable advice on local conditions, small engine repair, and living “in the country.”

Community outreach activities included: annual public presentations in Kotzebue, presentations to NPS staff, presentations in Kotzebue Middle and High School Iñupiaq, social studies, and science classes (2008, 2009, 2010, 2012), Kobuk Middle and High School (2009), and Noatak Middle and High School (2012), a presentation in Nome in 2012, assisting WEAR with their July 4th festival booth in 2012, as well as a KOTZ radio interview in 2008. The Sisualik Culture Camp spent a day in the field with the archaeology crew in 2009; K-12 age students and adult chaperones learned to survey and test archaeological features through participation in hands on activities organized by the UW team. In addition, the UW provided information and photos for the NPS project web page on an annual basis. This information can be found at (web addresses are active at time of this reporting):

- www.nps.gov/cakr/historyculture/places.htm?eid=203485&root_aId=403#e_203485
- www.nps.gov/cakr/historyculture/Archeology.htm
- www.nps.gov/archeology/sites/npsites/capekrusenstern.htm

The UW met ongoing NPS requests for additional written material and photos for NPS outreach purposes, such as project summaries for Subsistence Resource Commission meetings or for internal NPS reporting and outreach. The UW research group met with a delegation of Russian park and community members from the Chukotka region in May 2011; the visit was organized by the U.S. State Department's International Visitor Leadership Program.

Project products include this final technical report, as well as project related posters (see Appendix IV) and a fact sheet for public distribution. The most extensive and comprehensive outreach product is an education kit that includes middle and high school science, math and social studies curricula developed by the UW in collaboration with UW Burke Museum Education Department staff. The Burke Museum frequently collaborates with researchers and local teachers to develop education kits that meet Washington State curriculum standards. Archaeology kits often include background information, books, maps, photos, curriculum, worksheets, artifact replicas, samples, and other materials needed for lessons. Museum educators and local teachers use the kits both at the museum and in local schools to teach a variety of topics. This type of outreach product seemed ideal for sharing details of our project and giving something back to northwest Alaskan communities. Student and student-learning was one of the priorities identified by community members at the outset of the project, as communicated to UW by NPS.

In spring of 2010, UW met with Kotzebue middle and high school teachers who were interested in project related education curricula, as well as other potential education collaborations. The purpose of this meeting was to identify teacher needs (e.g. content, lesson plans, materials) to ensure that the final project product was of use to both NPS staff and local teachers. The teachers and NPS education staff both identified a need for middle and high school science curriculum, with math and social studies curriculum also identified as priorities. The UW research team subcontracted with the Burke Museum's Education Department to create the education kits. The research team and Burke Museum staff worked together to design the structure and content of the education kit. The research team created content which education staff then edited to be age-appropriate and fit within the context of specific lessons. The research team edited lessons, provided additional content, ideas, and background information through the course of kit development. Artifact replicas for use in lessons were made by Tim Rast of *Elfshot*, a business specializing in artifact replication, and by Roswell Schaeffer of Kotzebue. The NPS reviewed a draft version of the education kit, and in February 2012 the UW research team took a draft education kit to Kotzebue and to the village of Noatak for testing with students, teachers, agency personnel and interested community members. Feedback from this visit as well as NPS-provided reviews were incorporated into the final kit. Two copies of the completed education kit will be given to the NPS interpretive staff in Kotzebue for use. NPS staff agreed to maintain the kits and make them available for check-out to the local community.

7.3.3 Research Outreach

In addition to community outreach activities, the UW research team has presented papers and posters on project activities in a variety of professional venues. A paper was given at the Park Science/Beringia Program conference in Fairbanks in fall of 2008 (Anderson, et al. 2008), and at the Arctic Conference in Boulder Colorado in Fall of 2009 (Anderson and Freeburg 2009c). A poster was given at the 2008 Society for American Archaeology (SAA) meetings (Anderson and Freeburg 2008b) and two papers were presented at the 2011 SAA meetings (Anderson et al. 2011; Freeburg and Anderson 2011). A paper presented at the WAURISA 2009 conference (Freeburg et al. 2009) received an honorable mention in the student paper competition; the UW team also gave a presentation to the Pacific Northwest Cooperative Ecosystem Study Unit group in Fall of 2009 (Freeburg and Anderson 2009). A poster was presented at the NPS Resource Information Management Conference in 2010 (Freeburg and Anderson 2010). Papers were given at the Alaska Anthropological Association Meetings in 2009 and 2011 (Anderson and Freeburg 2009d; Freeburg, et al. 2009b; Freeburg and Anderson 2011a). Posters were presented at the UW graduate student research symposium in 2008 (Anderson and Freeburg 2008c) and the UW GIS Day in 2011 (Freeburg and Anderson 2011b); the latter received second place in the poster competition. Two posters were presented at the 2012 International Polar Year Conference in Montreal (Anderson and Freeburg 2012; Freeburg and Anderson 2012). An article describing preliminary work on the project was published in Park Science in 2009 (Anderson et al. 2009) and an encyclopedia entry on the Cape Krusenstern site is in review. Several peer-reviewed publications are currently in preparation

8.0 ANALYSIS AND RESULTS

8.1 Units of Analysis

Giddings (1966, 1967; Giddings and Anderson 1986) defined what he called beach ridge "segments" based on geomorphological, micro-topographic, and archaeological evidence. As others have suggested, there are various problems with these existing units of analysis; the segments were refined by Mason and Ludwig (1990) and correlated with other beach ridge systems in the region by Mason and Jordan (1993; Mason et al. 1995). The beach ridge segments are thought to represent periods of beach ridge development, erosion, and human occupation, but are based primarily on the dating of archaeological features rather than geomorphological characteristics. Furthermore, the dating of these features rests on a relatively small number of dates, making additions to this sequence carry significant weight. The dates obtained through recent work at Old Whaling confirm the more conservative age range for the Old Whaling settlement as ranging between about 2700 and 2900 radiocarbon years BP (Darwent and Darwent 2005). These three new dates have altered the ideas about both the age of this unique site complex, and also the age of its associated beach ridge segment and the other sites dated by relative position. In a similar fashion, new dates from the current project further refine the existing archaeological chronology. Additional dates are needed from both archaeological and geological contexts in order to create new, higher resolution chronostratigraphic units of analysis in which the age of a beach ridge is not conflated with that of archaeological deposits within it. This is particularly important because past residents of the complex left archaeological deposits across the range of ridges in existence at the time of their occupations. They were not confined to the ocean front ridges of their time, even if much of their activity may have been concentrated in those areas. Furthermore, more thorough and precise dating of individual features within settlements is important for better understanding the duration of occupation and the relationship between settlements at Cape Krusenstern, which will result in an improved understanding of population and settlement density. These needs have, in part, directed the current research effort.

Legacy data incorporated into the project GIS included the configuration of beach ridge segment boundaries as reported by Giddings (1966, 1967). Figures indicating beach ridge segments from these publications were scanned, imported into GIS, rubbersheeted to orthographic imagery (Manley et al. 2007) and georeferenced (Figure 11). The boundaries were then digitized as polygons and coded as to beach segment number as reported by Giddings. The resulting units were used as areal subdivisions for reporting feature totals (Anderson and Freeburg 2009a, 2010; Freeburg and Anderson 2011a). It is important to note that the original figures are of an inappropriate scale upon which to base future analyses, and were not intended for this purpose. Giddings' beach segments were used by the current project because the visual/spatial data associated with more recent modifications to the beach ridge segmentation (Mason and Ludwig 1990; Mason and Jordan 1993; Mason et al. 1995) were not printed at a scale adequate for digitization and incorporation into GIS. Once digitized, the beach segment boundaries were compared to recent orthophotographic imagery (Manley et al. 2007) and adjusted slightly in some places to better fit our interpretation of Giddings' intended placement. The resulting beach ridge segments create the units of areal analysis used to analyze and discuss research results. These units will be revised when the geomorphological study is complete and the results of that research are available.

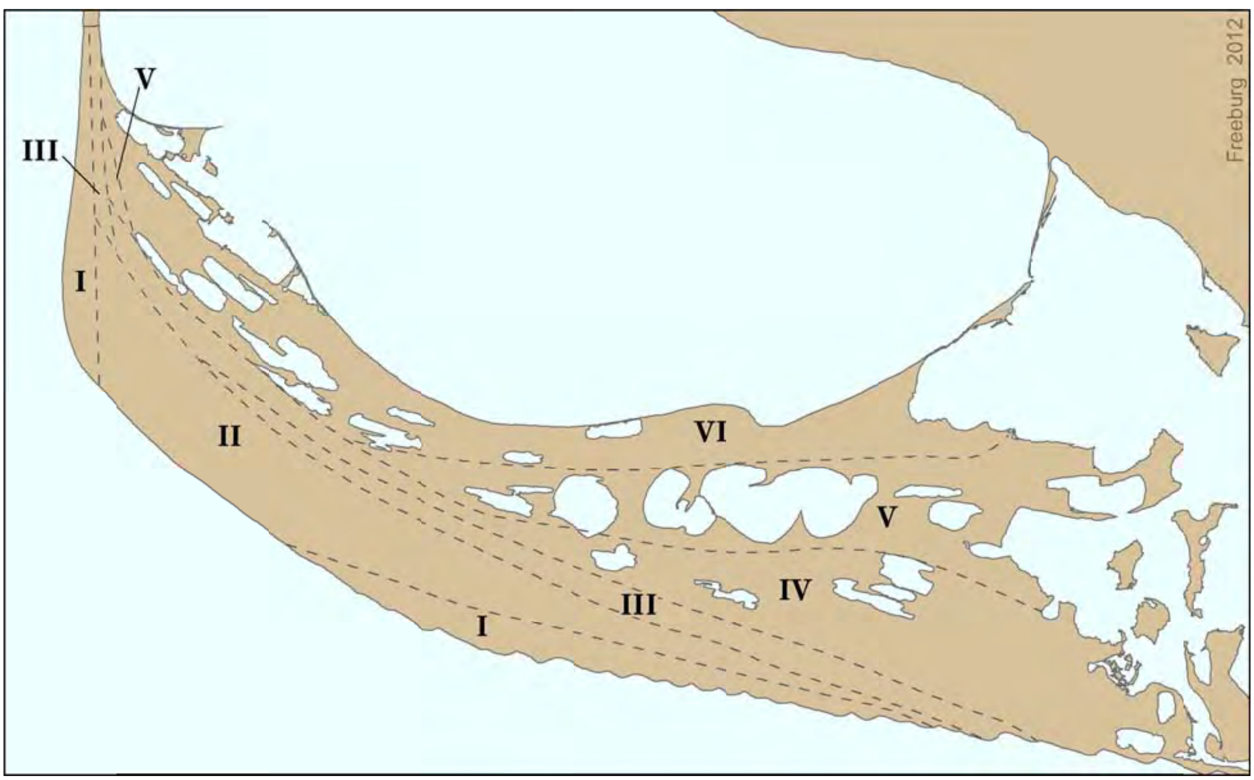

Figure 11. Units of analysis (beach segments) as they were understood at the outset of the current project; after Giddings (1966, 1967)

8.2 Survey Results

The Cape Krusenstern beach complex encompasses approximately 3300 hectares (8200 acres) south and west of Krusenstern Lagoon, including low lying areas west and south of the Tukrok River. A total of 1205 hectares (2978 acres) were systematically surveyed by the current project (Figure 12; Table 8). An additional 171 hectares (424 acres) were surveyed systematically, but with limited or no subsurface testing, and 169 hectares (418 acres) were surveyed using non-systematic methods (pedestrian survey without regular transects, and arbitrary test locations, if any) as they were deemed areas of low archaeological potential due to their low-lying topography, high water table, or heavy shrub vegetation (Figure 12). The systematically surveyed area makes up about 36% of the entire beach complex. Total coverage of all surveyed areas, including non-systematically surveyed areas, is approximately 47% of the beach ridge complex. Relative to their overall area, beach ridge segments were sampled somewhat unevenly (Table 9) because of their varied widths and configuration throughout the study area, though a total of 53% of the beach ridge complex assigned to a segment was surveyed (Table 9). The area defined by Giddings' beach segments (Figure 11) does not include island areas in the Tukrok River system or the composite ridge that creates the western bank of the lagoon to which Giddings assigned no beach segment number. We consider these areas to be outside of the main beach ridge complex. An additional 44 hectares (110 acres) outside of the main beach ridge complex were surveyed with limited shovel testing or surface mapping only, since they were not of primary interest to the project. Surface feature mapping and limited subsurface testing occurred particularly in the vicinity of the Anigaaq ranger station and areas between the ranger station and the mouth of the Tukrok River. Additional survey and testing occurred on private allotments east of the beach ridge complex. In all, 2529 confirmed archaeological features and isolated artifacts were recorded. Vegetation anomalies of suspected, but not proven, cultural origin totaled 262 (Table 10). It is important to recognize that these totals include features recorded in 2006 that were standardized to 2008-2010 feature definitions. See Section 6.1.4 for a discussion of the integration of 2006 data with 2008-2010 data.

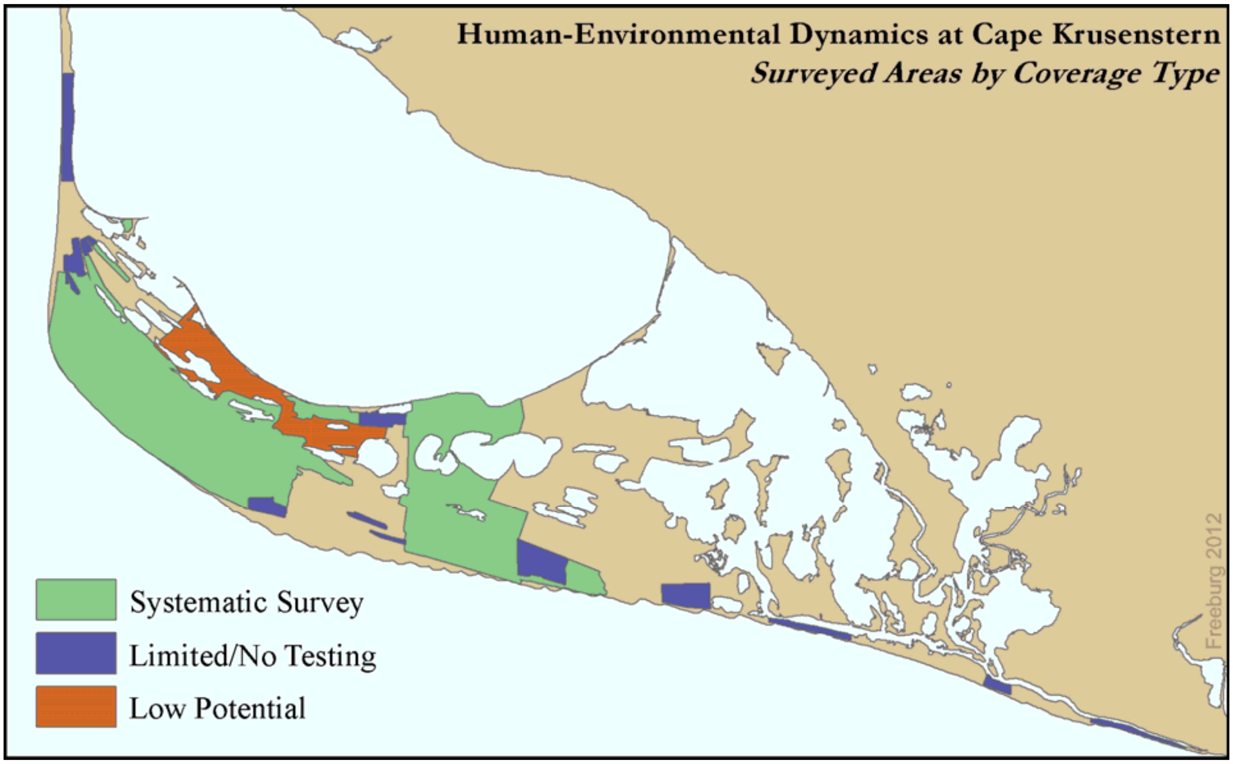

Figure 12. Areas surveyed by project

Table 8. Surveyed area by coverage type (in hectares)

Year	Systematic Survey	Limited Survey	Low Potential	Totals
2006	450	44	-	494
2008	434	53	-	487
2009	196	-	121	317
2010	125	74	48	247
Total	1205	171	169	1545

Table 9. Surveyed area by beach segment

Beach Segment	Area (hectares) Total	Surveyed	Percent Coverage
None	498	44	9%
I	256	91	36%
II	581	485	83%
III	238	154	65%
IV	735	293	40%
V	385	121	31%
VI	640	351	55%
Total*	2835	1495	53%

* Areas not in a beach segment not included in total

Table 10. Summary of features and artifacts recorded

	Beach Segment							
Feature Type	**I**	**II**	**III**	**IV**	**V**	**VI**	**n/a**	**Total**
Hearth	1	15	13	33	31	8	0	101
Cache Pit	95	176	7	3	1	1	88	371
House	35	92	9	12	0	0	35	183
Surface Scatter	12	18	19	34	15	5	2	105
Burial	4	5	2	0	0	0	2	13
Surface Artifact	93	132	47	121	53	26	15	487
Isolated Fauna	47	72	11	23	4	4	9	170
Unidentified	168	401	112	16	19	17	111	844
Vegetation Anomaly	65	156	16	2	1	0	17	257
Total	520	1067	236	244	124	61	279	2531
*Previously Recorded**	*76*	*127*	*34*	*63*	*39*	*20*	*0*	*359*

*Legacy features as derived from annotated photomosaic

A total of 57 one meter by one meter test units were excavated by the UW team, the vast majority of which were within the main beach ridge complex (Figure 13, Figure 14). To complement pre-existing excavation data from house features, we chose to excavate test units primarily in features that were not interpreted to be houses from their surface expression. It was thought that this would provide additional information on non-house features within a settlement:

evaluation of feature type with sub-surface data, activities represented, duration of feature use, etc.

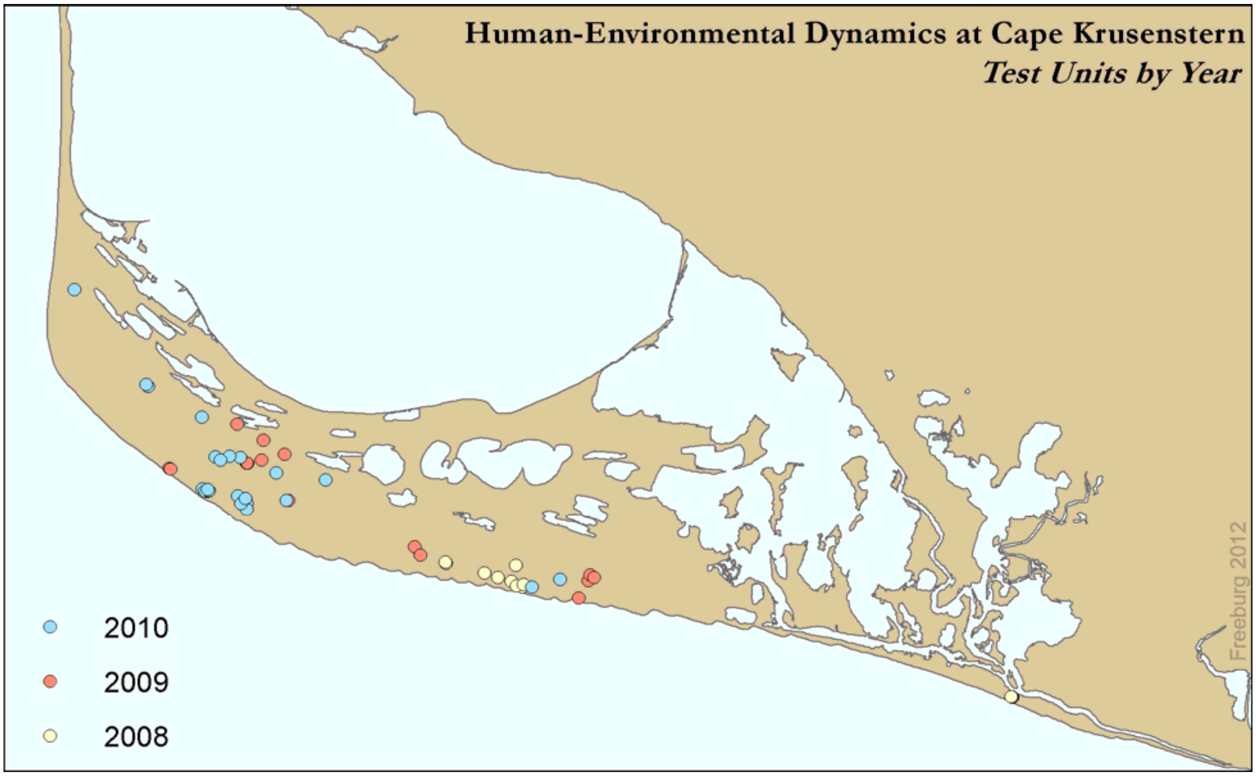

Figure 13. Locations of test units excavated by the current project

Nearly half the test units were place in “Unidentified” features that could not be classified based solely on surface information. Test units were placed within presumed house features when no prior excavation was reported in the vicinity and the excavation of a house was judged to be the best opportunity to retrieve dateable organics or diagnostic artifacts. In some cases, test units were excavated where shovel testing indicated the presence cultural remains despite the lack of a surface expression of any type of feature. See Table 11 for a breakdown of test unit by feature type.

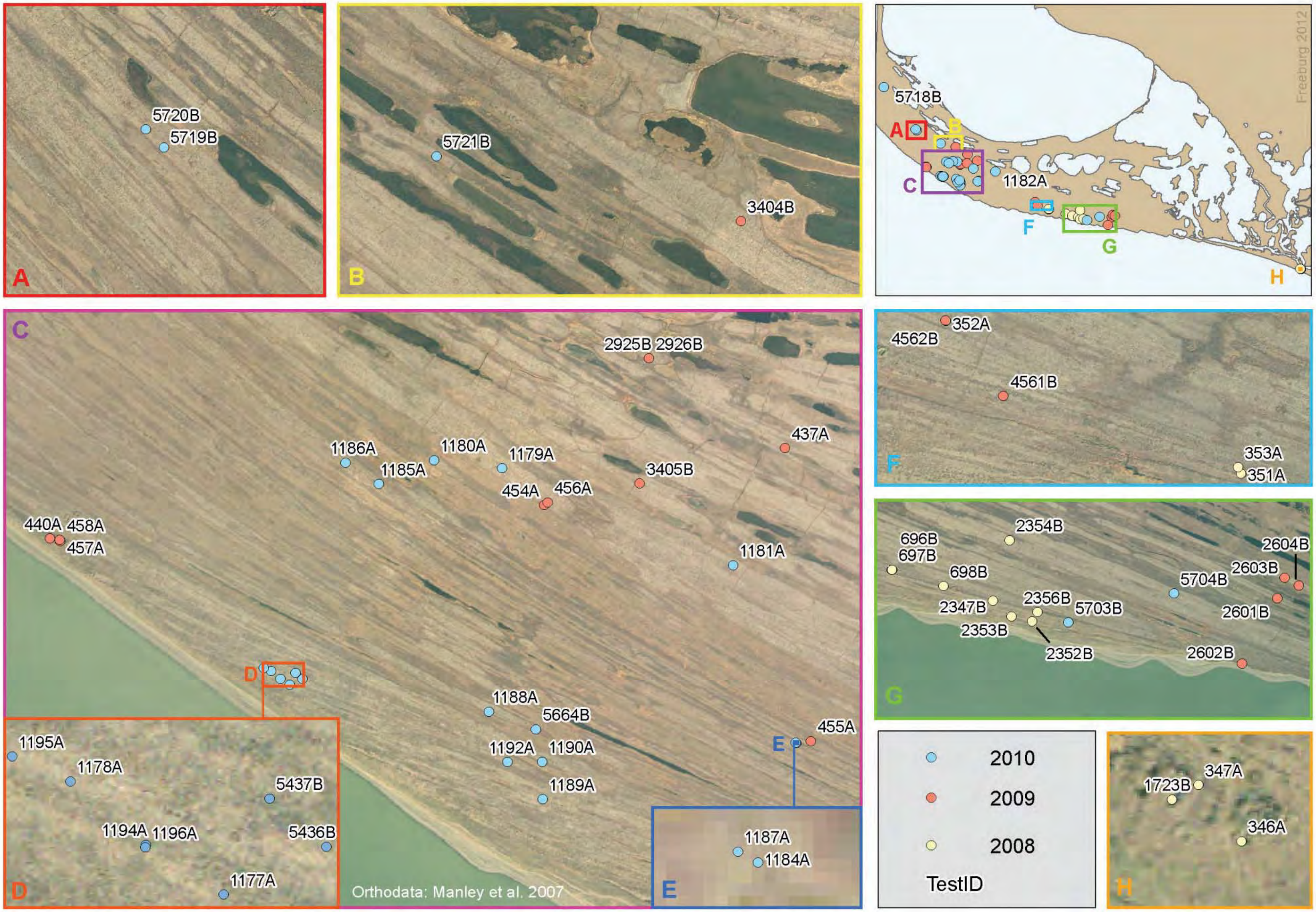

Figure 14. Test unit locations (detail)

Table 11. Test Units by Feature Type

Feature Type	# Test Units
House	11
Cache	5
Hearth	6
Surface Scatter	2
Unidentified	28
No Surface Feature	5
Total	**57**

8.3 Artifacts and samples

A total of 2216 artifacts and samples were collected over the course of this project, including samples and artifacts obtained in 2006. This includes level bags of bulk-collected lithics, ceramics, and faunal material. As such, the actual artifact count is much higher. The majority of collected materials include charcoal and charred wood material for dating, along with faunal, lithic, and bulk sediment samples (Table 12). Relatively few formal tools were found over the course of the project, less than 10% of collected material. Based on prior research at the site (Giddings and Anderson 1986) much higher tool and tool production related artifacts were expected, but perhaps the differences are because the current project focused on testing non-occupation features.

Ceramic material consisted almost entirely of cooking vessel fragments, although one clay cup was collected from the Early Western Thule settlement identified by Giddings and Anderson (1986). Results of ceramic analysis are reported elsewhere (Anderson 2011, 2012). Results of ceramic residue analysis are reported in Appendix V.

Table 12. Artifact and sample counts

	Total Cataloged Items (including level bags)	Percentage of collected material
Lithics		
Lithics	568	25.63
Ceramics		
Ceramics	94	4.24
Organic Tools and modified materials		
Antler	4	0.18
Bone	7	0.32
Ivory	5	0.23
Subtotal	16	*0.72*
Samples		
Faunal	483	21.8
Charcoal and charred wood	481	21.71
Wood (structural/modified/unmodified)	263	11.87
Sediment	236	10.65
Paired charcoal and faunal	14	0.63
Paired charcoal and ceramic	7	0.32
Other	6	0.27
Subtotal	1490	*67.24*
Other		
Coal labret	1	0.05
Historics (glass, metal, etc.)	12	0.54
Cemented sediment	30	1.35
Other/unknown	5	0.23
Subtotal	*48*	*2.17*
TOTAL	**2216**	***100***

A lithic analysis project by Shelby Anderson is on-going. Initial results indicate that the assemblage of lithic materials is dominated by chipped stone materials (Table 13). The chipped stone assemblage is made up primarily of tool-making debris, including flakes (n=4829), cores (n=61), possible flakes and cores (n=20). The chipped tool assemblage is small, but includes 50 whole and fragmentary bifaces, 13 projectile points, one microblade, two possible microblades (one fragmentary), one possible burin, one burin spall, two cobble tools, 5 end blades, two side blades, and seven unifaces. Other tool making debris includes several hammerstones and possible hammerstones (n=4). The ground stone assemblage is much smaller, and includes a single jade groundstone adze fragment, four ground slate tools (knives/ulus), four ground and chipped stone scrapers (tci-tho), and 100 fragments of slate, shale, and schist, presumably from slate and groundstone tool production. The jade is most likely from the central Kobuk river valley, in the Jade Mountain region. Chert is by far the most commonly represented lithic material. A large number of broken flakes and tools were observed, suggesting that post-depositional effects (e.g. animal trampling, freeze/thaw) have impacted lithic preservation across the beach ridge complex. Shelby Anderson is also working on analysis of the bulk sediment samples, which includes processing, sorting, and carrying out geochemical analysis of the fine sediment fraction. Further sediment analysis depends in part on future funding.

Organic tools were infrequently encountered in excavation. This is likely due to the sampling design, which focused on non-house features. Formal tools include three harpoons (one of which was complete), one ivory implement (possibly a harpoon blank), two ivory knife handles, one ivory point, one bone flaking implement, one antler fishing weight, and a possible sled runner fragment. A single jet or coal labret was collected in 2006. Pictures of selected artifacts are provided in Appendix VI.

Table 13. Results of preliminary lithic analysis

	Count	Percentage of subgroup	Percentage of total lithic assemblage
Groundstone			
Groundstone adze fragment	1	0.92	0.02
Ground slate tools (knives/ulu)	4	3.67	0.08
Ground and chipped stone scraper (tci-tho)	4	3.67	0.08
Slate/shale/schist fragments (modified and unmodified)	100	91.74	1.92
Subtotal	109	100	*2.09*
Chipped Stone			
Biface/Biface fragments	50	0.99	0.96
Burin spall	1	0.02	0.02
Chipped stone scraper	2	0.04	0.04
Cobble tool	2	0.04	0.04
Core	61	1.21	1.17
End blade	5	0.1	0.1
Flakes	4829	95.62	92.79
Microblade	1	0.02	0.02
Possible Burin	1	0.02	0.02
Possible cores/flakes	20	0.4	0.38
Possible microblade	2	0.04	0.04
Possible tools/pre-forms	5	0.1	0.1
Projectile Point (whole and fragments)	13	0.26	0.25
Retouched Flakes/Flakes used as cores	35	0.69	0.67
Shatter	14	0.28	0.27
Side blade	2	0.04	0.04
Uniface	7	0.14	0.13
Subtotal	5050	100	*97.04*
Other Lithic Materials			
Possible hammerstone	1	2.22	0.02
Possible lamp	1	2.22	0.02
Hammerstone	3	6.67	0.06
Netsinker/possible netsinker	4	8.89	0.08
Misc	36	80	0.69
Subtotal	*45*	100	*0.86*
TOTAL	**5204**		***100***

Faunal analysis is being completed by Adam Freeburg as part of his dissertation research. Initial number of identifiable specimens (NISP) tallies from selected test units within previously reported settlements were given by Freeburg and Anderson (Freeburg and Anderson 2011a; Freeburg and Anderson 2011c), and showed strong similarity in relative species abundance to counts given by Giddings and Anderson (1986) and Anderson (1962). Small phocids (cf. ringed seal- *Phoca hispida*) dominate the faunal assemblage in all periods. The second most abundant species varies by culture period: bearded seal (*Erignathus barbatus*) in Ipiutak, caribou (*Rangifer tarandus*) in Early Western Thule, and fish (*Oncorhynchus* spp.) in a newly discovered settlement that dates to the Late Western Thule or early Kotzebue period (see Section 9.2.1). For the purposes of comparison, the same skeletal elements reported by Anderson (1962) were tallied, which included most major limb and axial elements. Continued tallying that incorporates additional identifiable elements, such as vertebrae, ribs, carpals, tarsals, metapodials, and phalanges, has resulted in an appreciable increase in the representation of small phocids within the collections. Future work will include tests of density mediated attrition to explore possible bias in the faunal record as well as testing of hypotheses related to season of occupation. This analysis is ongoing, and will be reported fully in Freeburg's dissertation work.

Temporally diagnostic artifacts include portions of ceramic material and lithic tools. The overall small number of diagnostic artifacts does little to clarify issues of site age, occupation duration, and/or the contemporaneity of occupation in some of the larger settlements or feature clusters. As a result, the radiocarbon dating effort is of increased importance in understanding the occupation chronology and changing settlement patterns at Cape Krusenstern.

8.4 Results of Radiocarbon Dating

The NPS obtained 19 dates on 2006 samples and a total of 228 samples were submitted by the UW team (Appendix VII). To minimize errors due to "old wood" and marine reservoir effects, preference was given to terrestrial mammal bone in sample selection for dating. However, terrestrial mammal bones are not abundant in the collections from Cape Krusenstern. Charcoal samples from willow or birch were submitted for dating when available, because these species are less likely to be obtained from driftwood; full cross sections of branches were chosen over fragments when available. At Cape Krusenstern, charcoal fragments of spruce (*Picea* spp.)

and larch (*Larix* spp.) are presumed to be remnants of burnt driftwood. These species were submitted for dating when no other wood or charcoal materials were available; this was often the case and the majority of the radiocarbon dates come from *Picea* charcoal fragments. Segments of whole logs from structural wood were not dated to avoid the issue of structural wood re-use in this treeless environment. New radiocarbon dates were calibrated using Oxcal version 4.1 software (Bronk Ramsey 2009) and the IntCal 09 and Marine09 calibration curves given by Reimer et al. (2009). Of the 228 samples submitted by UW, eight dates were acquired from samples from non-archaeological contexts as part of the paleoenvironmental effort. These samples are not included in subsequent analysis or discussion in this report. Thirteen dates were obtained on seal bone, ten on caribou bone or antler, and the rest were on charcoal or wood identified to the lowest taxonomic level possible prior to submission for radiocarbon dating. Dates from seal bone were obtained in cases where they were found closely associated with macrobotanical or terrestrial mammal remains which were also submitted for dating. These paired marine-terrestrial samples will contribute to a larger effort to develop a marine reservoir correction for the Kotzebue Sound region headed by Josh Ruether of the University of Arizona/Northern Land Use Research, Inc. To this end, all dated marine samples underwent isotopic measurement by Dr. Joan Coltrain of the University of Utah. Results of isotope analysis are provided in Appendix VII. The 19 dates obtained by the NPS in 2006 were submitted for wood species identification, but identification did not occur prior to radiocarbon sample submission. Wood identification for the NPS collected samples was completed by Claire Alix of the University of Alaska Fairbanks/Université Paris-Sorbonne. Wood identification for the UW submitted samples was completed by PaleoResearch Inc. All wood sample reports are attached in Appendix IX. Radiocarbon samples were dated by either Beta Analytic or by the National Ocean Sciences Accelerator Mass Spectrometry Facility at the Woods Hole Oceanographic Institute. In order to improve the chronological integration of legacy research with data collected by this project, we hoped to date samples from the collections held at Brown University's Haffenreffer Museum. Unfortunately, it was not possible to do so within the time frame of this project.

Two samples (CAKR 13450 and CAKR 13626) yielded modern ages and are therefore excluded from subsequent analysis. Two dates (CAKR 15219 and 14286) are clearly outliers, dating to more than 10,000 years ago when the beach ridge system had not yet formed. These samples may have been contaminated by modern carbon; it is unlikely that driftwood would circulate for that long in the ocean prior to deposition and use at the Cape after 4200 years ago (the earliest occupation of the site complex). In addition, three dates (CAKR 13242, CAKR 14285, and CAKR 15012) are likely also outliers, dating to the very earliest times or before the ridge complex began to form about 5000 years ago. It seems probable that these samples were either contaminated with marine mammal oil, which in this region can yield dates up to 750 years older than terrestrial samples of the same age (Dumond and Griffen 2002), or were pieces of driftwood that predate human use and deposition by several hundred years. The $\delta^{13}C$ values for these outlier samples are similar to those for other specimens from the site, indicating that marine contamination is an unlikely explanation for the outlying dates.

8.5 Legacy data Integration

8.5.1 Pre-field Activities

An initial goal of this project was to integrate previously recorded information, particularly that recorded by Giddings and Anderson, with current findings and data. Once integrated, this "legacy data" could be used in research analyses and for management needs. Sources of legacy data included published sources (Giddings 1966, 1967; Giddings and Anderson 1986), two USGS airphoto mosaics annotated in ink by Giddings[1], and a feature catalog that matched numbered locations on the photomosaic as well as locations not marked on the photo. This effort also included digitization of Giddings' beach ridge segments from published maps, as discussed previously in Section 8.1. NPS staff began the integration of legacy data by compiling spatial and attribute information of legacy data points from a copy of the annotated photomosaic, the published report, and a set of feature notebooks provided to Bob Gal by Doug Anderson. The resulting information was shared with the UW team soon after the signing of the Task Agreement pertaining to this project. The feature notebooks were not included in this data transfer, though the information they contained was summarized in the data files received by UW. Descriptions of over 600 features reported by Giddings and Anderson (1986) were included in tabular form, and a GIS file of over 300 feature locations was also

[1] It is our understanding that the photomosaics were marked primarily by J.L. Giddings. While we refer to this as his work, it is entirely possible that others, including crew and students, were also responsible for placement of some annotations.

provided by NPS. These initial efforts at legacy data integration by NPS provided a valuable sense of the scope of the project.

Unfortunately, the NPS efforts at interpreting spatial locations of the legacy features encountered challenges such as registration and georeferencing errors beyond their control (Bob Gal, personal communication 2012). For example, NPS staff did not work with the original photomosaic, but with a scanned copy. Additional problems arose from errors in base imagery available at the time. For these reasons, the GIS locations derived for legacy features did not match features visible in newly released orthographic imagery (Manley et al. 2007) or locations recorded during the 2006 field season. Additionally, the NPS-provided files of legacy feature locations lacked metadata, specifically the geodetic datum used to record and report feature locations. The UW team determined that because the errors inherent in the feature location data were not systematic (as would be caused by a datum and/or projection shift), the data should be re-collected from primary sources. During a visit to the Circumpolar Studies Lab at Brown University's Haffenreffer Museum in February 2008, two original annotated photomosaics were located; one with beach numbers and one with numbered feature locations. Digital photos were taken of overlapping portions of the original photomosaics, creating secondary mosaics. These images were imported into GIS software where they were rubbersheeted and georeferenced. Stable lagoon and lakeshore features within the beach ridge complex were used as reference points to match the 1950s airphoto data to orthographic imagery (Manley et al. 2007). Once an entire photomosaic was rubbersheeted to the orthophotographic imagery, the handwritten annotations were digitized as points in the GIS. This occurred for the photomosaic of beach numbers as well as for the one of numbered feature locations. For the features, spatial placement of each annotated point was checked against ground features visible on the recent orthoimagery. If placement of a legacy data point could be improved from the rubbersheeted position upon visual comparison to the orthographic data, the point's location was adjusted accordingly. In most cases, on-screen comparison was not helpful, so the feature placement was left unchanged to be verified during fieldwork. Some features were indicated only by their number, so a corresponding point was created in GIS directly above the number as marked on the photomosaic. Other locations were marked by a small dot of ink with an adjacent feature number. GIS points for these features were placed in the exact location of the ink dot.

At a few locations it was possible to confirm feature locations using published maps and new orthographic imagery. This mostly occurred with large previously excavated features such as houses. In these cases, the legacy data points were moved from their original locations as marked on the photomosaic. The discrepancies between the original and updated locations were assessed by comparing the feature numbers on the rubbersheeted photomosaic and the GIS point file features. A second edited feature file was created and feature locations were moved to locations visible in the orthoimagery. For example, the Early Western Thule house features are numbered four through eight on Giddings' photomosaic. The relationship between Giddings' placement of these features and their actual locations can be seen in Figure 15. While Giddings' location for Houses 4, 6, 7, and 8 are quite accurate, relative to each other, House 5 is shown to be further away from House 4 than it actually is. This serves as an important overall lesson for working with legacy data in GIS; while digitally acquired and manually placed data can be compared, it does not follow that they are comparable in terms of accuracy and spatial error. Because of the capabilities of GIS, we are able to view the annotations of Giddings' photomosaic at scales for which they were not intended. For example, the placement of Early Western Thule house 5 on the photo mosaic was not intended to be accurate for smaller scales. Rather, additional location information was collected at the site level, producing reasonably accurate maps such as that for the Early Western Thule settlement (Giddings and Anderson 1986: figure 47). Without geodetic control points common to both Giddings' photomosaic and the new orthographic imagery, it is impossible to quantify the error inherent in the rubbersheeting of Giddings' photomosaic to the new imagery. Through visual inspection and qualitative assessment, we feel that the two data sets match remarkably well. However, the accuracy of Giddings' feature locations still varies from feature to feature, which is understandable given the largely featureless tundra on which he was working. Ultimately, this integration work resulted in a set of several GIS files: raster files of each original annotated photomosaic, a file of point feature locations with numbered attributes copied directly from the georeferenced rasters, an edited point file with feature locations adjusted to newly acquired orthographic data, and an annotation file of georeferenced beach ridge numbers.

Figure 15. Early Western Thule settlement orthophoto with annotated airphoto overlay

Information from the feature card catalog was transcribed into a digital spreadsheet and used to update and edit the feature attribute information provided by NPS. We were told that the card catalog was the most reliable source of feature information (Doug Anderson, personal communication 2008), though discrepancies with entries from the feature notebooks were observed and documented. Problems encountered have been those expected when using legacy data: missing and duplicate feature numbers, unfamiliarity with the numbering system, features in the publication or notes that are not marked on the map. The legacy feature spreadsheet was cross-checked with the published data that included feature numbers (Giddings and Anderson 1986). Features reported in the text but not in other legacy data sources (i.e., aerial photo, card catalog, NPS legacy data) were added to the legacy feature spreadsheet. Feature types were coded (see Table 14) to allow some simple analysis of the patterns in the legacy data. This process resulted in the identification of features that were known and/or reported on previously, but for which there may or may not be accompanying spatial data. These activities were previously reported (Anderson and Freeburg 2009a, 2010) and presented to the archaeological community (Anderson and Freeburg 2009c; Freeburg et al. 2009b).

True tallies of legacy features are difficult to report, as Giddings' feature numbers frequently refer to more than one feature, and sequential numbers can refer to series of adjacent features. Descriptions and/or locations of approximately 280 features were provided in spreadsheet form by NPS. The unedited GIS file contains 359 points as copied directly from the annotated feature photomosaic. In some cases, annotated points represented more than one feature. Also, some legacy locations not marked on the original photomosaic could be determined from other sources, including new orthoimagery. For instance, features 500-510 were represented as five points on the annotated photomosaic. Six points were added in GIS within the spatial limits of the original five points to account for the missing points. Additions and edits such as these resulted in 370 points of legacy data with spatial locations and attribute information that includes any or all of the following: annotation feature number, published feature number, or feature description (published and/or unpublished). Because attribute field length is limited in GIS and information exists for features without precise spatial data, the spatial files cannot stand alone in evaluation of the legacy data. Full feature attribute information derived from all legacy sources exists only in non-spatial database form. The legacy feature database includes this information for 688 features. This is considered a conservative estimate for the total number of features that Giddings noted and/or included in his investigation at the beach ridge complex in the 1950s and 60s. Of these features, nine were found to have non-unique feature numbers or other means of differentiation, and so may be duplicate entries. One feature had two annotated locations on the photomosaic. Only 659 features could be attributed to a particular beach ridge or segment. A total of 519 of these legacy features are associated with the 370 annotated points from the photomosaic. There is no spatial data at all for 29 features. Note that just as with the current project, hearths and surface scatters are overlapping categories in the legacy data. For all of the reasons outlined here, these legacy data should be treated with caution. Nevertheless, some general trends in these data are apparent (Table 14). For example, the majority of the features are cache pits, followed by hearth and surface scatters. The highest number of legacy features is in beach segment II, although feature numbers in segments IV and V are also high.

Table 14. All known legacy features

	Feature Type											
Beach Segment	**Unknown**	**House**	**Cache Pit**	**Burial**	**Midden**	**Campsite**	**Hearth**	**Isolated Artifact**	**Surface Scatter**	**Unspecified Surface Depressions**	**Environ-mental Station**	**Surface Fauna**	**Total**
I	1	15	49	3	0	2	0	0	0	0	0	0	70
II	2	71	135	12	10	3	2	0	3	21	0	5	264
III	0	1	3	2	0	1	4	3	15	3	0	0	32
IV	4	11	6	4	4	1	40	4	41	0	1	15	131
V	4	0	0	0	0	0	75	2	62	0	0	1	144
VI	5	0	0	0	0	0	12	0	1	0	0	0	18
Unknown	6	7	3	1	0	0	0	0	3	9	0	0	29
Total	**22**	**105**	**196**	**22**	**14**	**7**	**133**	**9**	**125**	**33**	**1**	**21**	**688**

*only if specifically designated a “campsite” in legacy data

8.5.2 Post-field Results

Acknowledging the limitations mentioned above, we can report that of the 370 annotated features now in GIS, 137 are in locations that fall within 2008-2010 survey areas. The 2006 survey area contains 127 legacy features. By loading these locations onto GPS units, field crews were able to anticipate and investigate the approximate locations of features recorded by Giddings. A large number of features were relocated and determined to be Giddings' features with a relatively high degree of confidence. Remarks pertaining to the possibility of a feature on the ground matching an expected legacy feature were noted while GPS mapping, and remain in the "comments" field of the attribute table of each GIS feature dataset. In some cases, several features were located near the reported location of the legacy feature, and we were not able to determine which feature was the likely legacy feature. At other legacy feature locations, there was simply nothing found. Regardless of the number of legacy features relocated, the benefit of a systematic survey in locating and documenting archaeological features is evident when comparing legacy features with those now recorded (Figure 16).

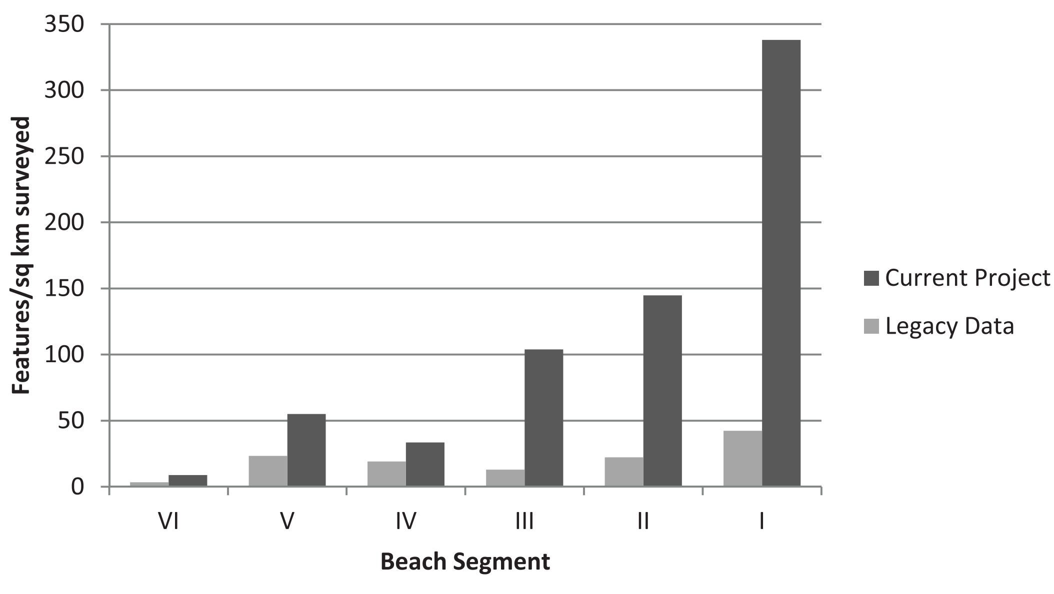

Figure 16. Density of current feature totals and legacy features in 2006-2010 survey areas

Spatial locations and published and unpublished descriptions of individual features remain important to our evaluation and interpretation of sites within the Cape Krusenstern beach ridge complex. Though we review features within the surveyed area below, continued analysis of legacy data can be readily accomplished using the project GIS and other legacy data files. Such a comparison may be useful in estimating the numbers and types of features within areas not surveyed by the current project. Legacy data should also be consulted when evaluating the impact of future research or development plans within park boundaries. It is recommended that future survey work, if carried out, utilize the legacy feature location data and continue the ground truthing of feature locations as carried out by this project.

Incorporation of published and unpublished data from previous research at Cape Krusenstern has afforded insight and perspective on the amount and variety of archaeological resources found therein. Review of collections held by Brown University revealed a significant portion of artifacts that were unpublished in plate form by Giddings and Anderson (1986). The results of a cursory inventory will be submitted to NPS along with the rest of the legacy data analysis results. Unfortunately, no catalog of collections was provided to UW, which made even the planning of technological and other analyses difficult or impossible. We are still unaware of the full extent of collections recovered from previous work. This also impaired our plans for attaining new radiocarbon dates from existing collections.

compares tallies of archaeological features found during 2006-2010 survey with previously recorded features with known spatial location within the survey areas. While this is only one way to compare what was known from prior research to the information presently available, it provides an excellent example of the increase in documented archaeological features throughout the beach ridges.

8.6 Legacy site assessment

Comparing published maps and descriptions of previously reported settlements is a useful exercise that demonstrates the utility of how legacy data and recently collected data may be used together. The following comparisons are useful to compare between feature type and number reported by Giddings and Anderson (1986) and those found and recorded during the current project. It is useful for comparative purposes to overlay the published maps on the GPS recorded data. This is not intended to highlight or adjudicate the spatial accuracy of the published maps, which is varied. The fact that these maps, some of which were originally drawn over 60 years ago, match so well is a testament to the quality of the previous work. Rather, by comparing published descriptions with the results of the current project, we aim to highlight features that may have been previously recorded but are no longer visible on the surface. Likewise, features that were recorded with GPS but not previously reported may indicate more archaeological resources than were previously anticipated. The knowledge of both of these scenarios is important in making management and research decisions regarding these locations. Giddings' placement of legacy feature locations on the photomosaic is often within ten or twenty meters of the GPS location. Having used manual instruments, or even no instruments, to plot these points, we find this accuracy to be remarkable.

Publicly available aerial imagery hosted by alaskamapped.org lists grayscale aerial photos from the Cape Krusenstern beach ridge complex as part of a larger set acquired by the U.S. Air Force between 1948 and 1956; we assume these photos are the same as those used by Giddings to create his photomosaic. Since raw aerial photos exhibit distortion everywhere expect directly under the nadir of the photo, they cannot be considered true geographic representations of the portion of the earth they are depicting without orthorectification. This can make accurate feature marking a quite complicated and difficult task before this error correction. Marking features accurately on even an orthorectified map would likely prove challenging. Our advantage in this effort is largely due to the use of available GPS technology and access to orthorectified imagery.

The following is a review of known settlements and other prominent archaeological features that were relocated and mapped, as confirmed through information from published work as well as field and laboratory documentation collected at the Brown University Laboratory for Circumpolar Studies such as the annotated photomosaic and archaeological feature card catalog. Digital reproductions of the photomosaic shown here, especially at small scales, make some annotations seem more ambiguous or difficult to read than they are on the original. Annotated points were placed in GIS while conferring with the original photomosaic at Brown's Circumpolar Archaeology Lab. Likewise, the legacy feature numbers were copied directly from the original with the aid of magnification when needed. Often, an annotation that lacks clarity can be inferred from other numbers around it, as features were often numbered in sequence along a beach ridge or series of ridges. This advantage is removed when viewing portions of the photomosaic, as shown here. Acknowledging the multiple sources of error possible in the placement of legacy features in GIS, the term “derived legacy feature location” is used to distinguish our interpretation of the feature location. Additional legacy features, such as cache pits and hearths that are not in published settlement descriptions, were relocated and mapped but are not included in detail below. Evaluation of legacy burials, including relocated features and our interpretations of the burial numbering scheme, is included in the discussion of newly recorded burials and inadvertently discovered human remains in an appendix to this report available from the National Park Service, Alaska Regional Office.

8.6.1 Denbigh

Feature 500-510 series

Due to the smaller size of archaeological features within beach segments V and VI, legacy features there tended to be more difficult to relocate. The most frequently relocated features were hearths. Previously excavated hearths often had fire modified rock (FMR) redistributed into an area of higher density as a result of the excavation process. Also, due to the generally sparser vegetation and soil formation of the ridges near the lagoon, excavated hearths were often large areas of exposed gravel substrate several meters across, and had little or no soil or vegetation regeneration since initial disturbance (Figure 17). Hearths were often reported as occurring in linear series along a beach ridge. It is unknown whether the close proximity of the hearths within a specific series implies contemporaneity, but it is generally assumed that the number of features resulted from a small number of people returning to the beach ridge complex over the course of multiple years.

One such hearth series noted on the annotated photomosaic is feature series 500-510 (Figure 18). Feature 500 is reported by Giddings and Anderson (1986:271) to be on beach ridge 78, which “has its western extension truncated by a large lake.” Though all eleven hearths exhibited lithic debitage and seal bones, only Feature 500 was reported to have “contained artifacts.” This presumably refers to diagnostic or formal tools. The characteristics of these artifacts, Denbigh-type burins and bifacial burins as well as an end blade inset, caused the hearths to be considered as transitional between the Denbigh and Choris periods.


Figure 17. A previously excavated hearth, presumably from the 500-510 series (Photo: F. Carter)

The derived locations of the 500-510 series were included within our survey area during the 2009 season, so a relocation of these features was attempted. The ridge marked as having the features in the photomosaic was thoroughly walked over and several shovel tests were excavated. Only one feature, excavated or unexcavated, was located. A 10 centimeter high vegetated mound less than one meter in diameter was tested and revealed a whale vertebra with 13 pieces of FMR directly underneath it. This feature did not appear to have been previously disturbed. The ridge adjacent to the south, however, held 12 hearths within a 500-meter long area. A microblade was collected from one of these hearths, near the derived location of legacy feature 251 (visible near the center of Figure 18). Unfortunately, no charcoal was recovered from any of these features, only three of which were possibly undisturbed. We left these three hearths untested, although we did search for charcoal on the ground surface. We believe some of these features represent the 500-510 legacy series and were mis-mapped on the photomosaic (Figure 18). It is possible that more hearths were initially present, as the tendency of prior excavators to pile FMR to the sides of the feature caused difficulty in reassessing the original feature count.

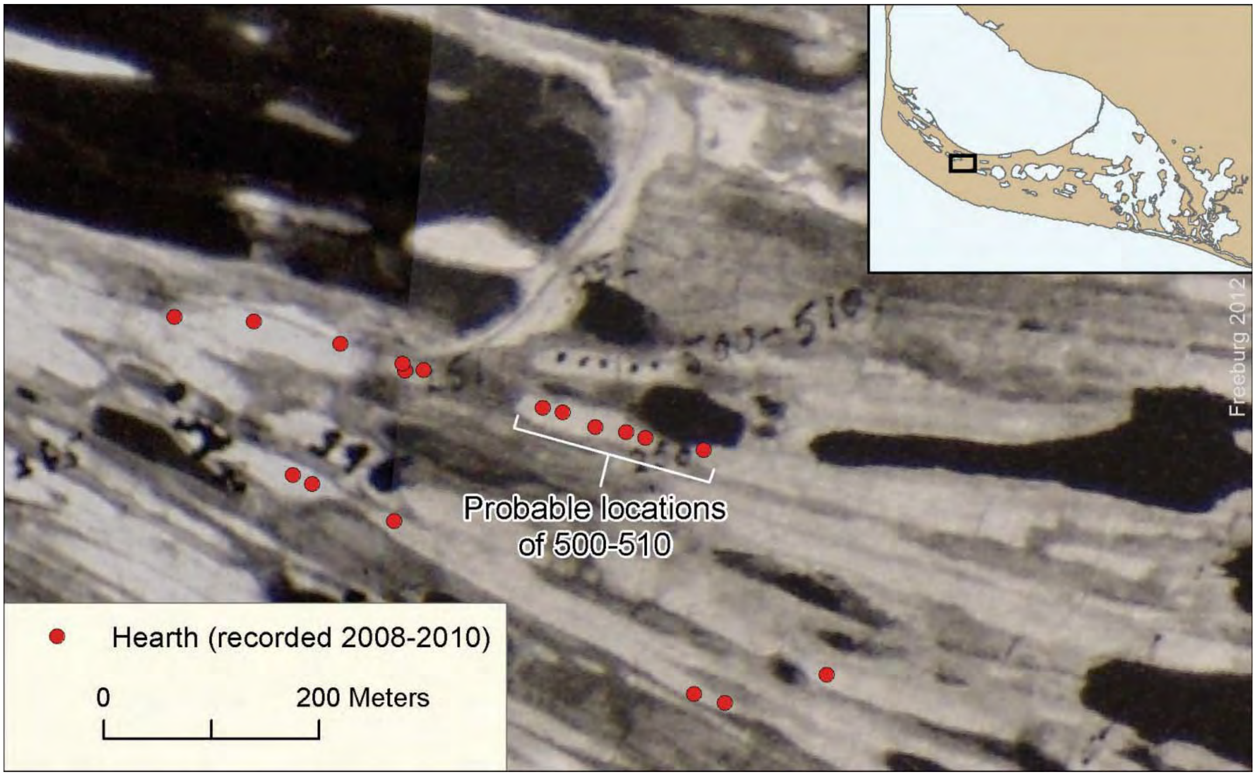

Figure 18. Annotated photomosaic showing 500-510 series and newly recorded hearths

A second set of features possibly from the Denbigh period was marked in Giddings' photomosaic just north of the round lakes in the central part of the beach ridge complex (Figure 19). This location is on or near the boundary between beach segments V and VI. Information about these features is not found in published sources, and the legacy feature catalog provides little additional information. Each feature has an identical entry from Doug Anderson in 1978, noting that there are no notes on these locations. Since the eastern boundary of our survey area fell approximately 150 meters west of Feature 418, a relocation of only Feature 419 was attempted. This is an excellent example of the accuracy with which the legacy features were able to be placed on the photomosaic- within two meters of the derived feature location we found a deflated surface lacking vegetation but containing a concentration of FMR (Figure 20). This is the same location as site NOA-00280. The AHRS form lists the site as

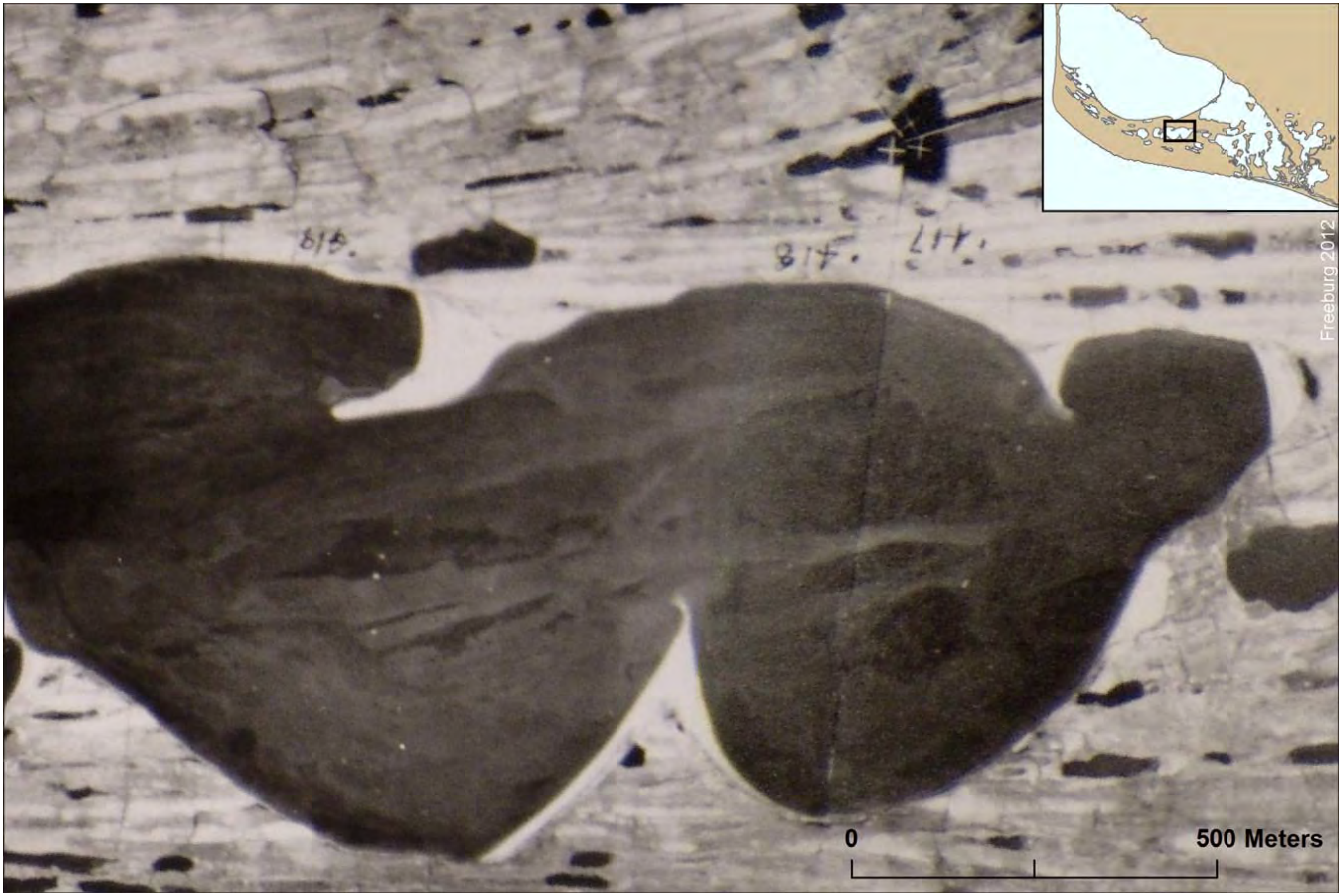

Figure 19. Legacy features 419, 418, and 417 (l-r) on legacy photomosaic; note annotations are upside down

a “concentration of fire altered rock, located on the edge of a 5m x 4m deflation.” In our experience throughout the beach ridge complex, a deflated surface with FMR to one side indicates prior excavation. Therefore, we determined legacy feature 419/site NOA-00280 to be an excavated hearth. Though excavated, a thorough surface search was conducted in and around the blowout to determine if any artifacts were present, but nothing was found except FMR.

Three additional hearths were recorded in the central beach ridge complex near the segment V/segment VI boundary (Figure 21), including site NOA-00282. Other than legacy feature 419, no hearth appeared to have been previously excavated. Charcoal was found and collected in each feature except Hearth 2B of 08ProXH071209A, which is located 280 meters east of legacy feature 419. Jim Jordan discovered an additional charcoal sample and biface fragment eroding out of a lakeshore cutbank. Both were collected, and the charcoal was submitted for dating. The locations of these collections are shown in Figure 21 and are labeled with their TestID. Radiocarbon results are given in Table 15. The dates of each charcoal sample falls well within the Denbigh culture period. These are the first absolute dates on Denbigh period materials from Cape Krusenstern.


Figure 20. Legacy feature 419/NOA-00280- an excavated hearth (Photo: A. Freeburg)

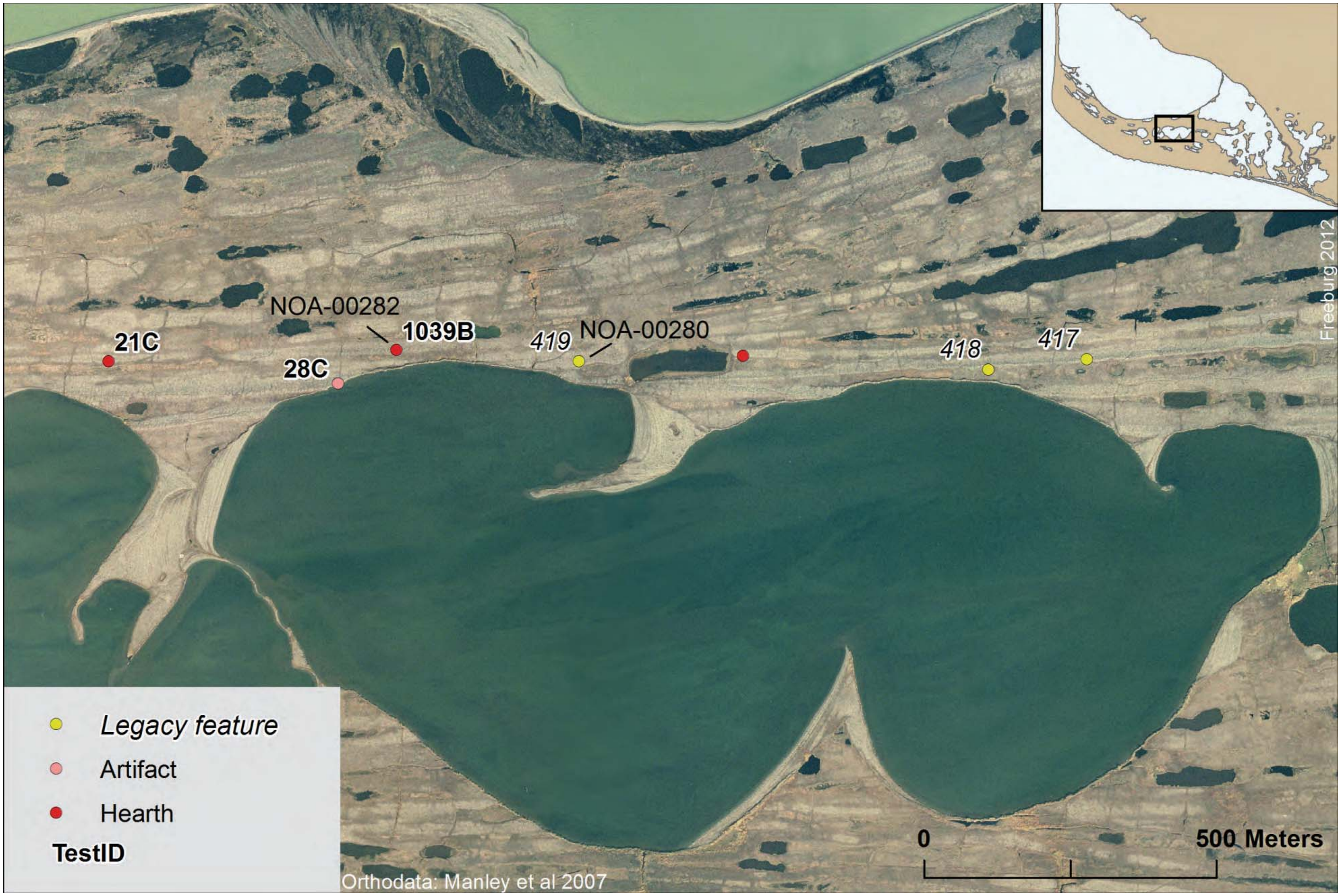

Figure 21. Locations of newly recorded Denbigh features and legacy features; TestID labels can be matched to radiocarbon results reported in Table 15

Table 15. Denbigh feature radiocarbon dating results

TestID	Feature	Catalog Number	Lab Accession	Material Type	Material Description	RC Age†	$\delta^{13}C$ (‰)	Calibrated Date§
21C	Hearth 1B of ProXH072712A	CAKR 13580	OS-78551	Charcoal	*Picea*	3760 ± 35	-24.39	2289 B.C. - 2041 B.C.
28C	n/a	CAKR 14011	OS-81685	Charcoal	*Salicaceae,* cf. *Salix*	3620 ± 30	-26.56	2119 B.C. - 1893 B.C.
1039B	Hearth 1B of ProXH071109A	CAKR 13389	OS-78586	Charcoal	*Picea*	3450 ± 30	-22.87	1880 B.C. - 1688 B.C.

†Conventional radiocarbon age and standard error from NOSAMS results

§ Calibrated two sigma range using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al. 2009)

8.6.2 Old Whaling

Among the most well-known sites at Cape Krusenstern is the type site for the Old Whaling culture (Figure 22). The site consists of a winter settlement of deep semi-subterranean houses and a summer settlement of features originally shallowly dug into or constructed directly on the beach ridge surface (Giddings and Anderson 1986) which are likely the remains of tents or similar semi-permanent structures (Giddings 1967)(Figure 23). The site was recently investigated by Christyann and John Darwent (Darwent and Darwent 2005, Darwent 2005). Results show that there are likely additional occupation levels and features within the site, and that occupation was probably recurring over several centuries. Fieldwork in 2006 included the recording of this site with mapping grade GPS equipment. Shovel testing in the vicinity yielded no cultural material, though some surface artifacts were found and mapped. As with other previously excavated features, the shape provided by GPS recording reflects excavation extent more than any original shape or orientation of the archaeological feature. These coincide generally with the mapped features as published by Darwent and Darwent (2005), which was accomplished with an Ushikata pocket transit and was tied to NPS topographic data using datums placed in 1995 (John and Christyann Darwent, personal communication 2012). Since the local datums were collected with a mapping grade GPS receiver in 2006, all datasets are able to and should be combined within GIS. Recent geophysical investigation of the site by Christopher Wolff and colleagues (Wolff et al. 2012) focused on non-intrusive methods for determining subsurface cultural deposits. While no unexcavated features were discovered, results yielded information on subsurface geomorphology of the beach ridges and the cryogenic and hydrologic processes acting upon them.

Figure 22. Location of Old Whaling settlements on legacy photomosaic (right) and recent orthoimagery (left)

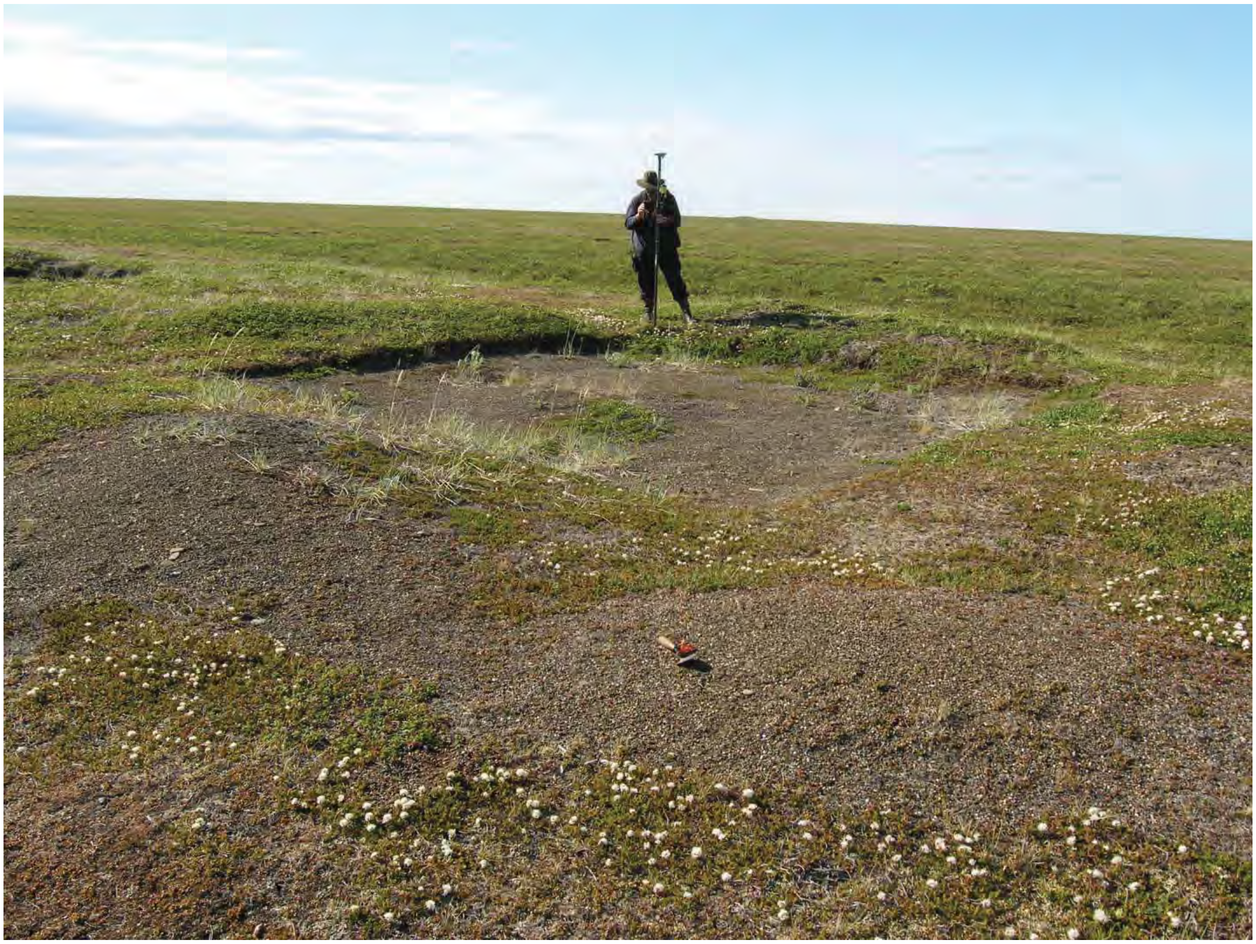

Figure 23. Chris Young mapping excavated House 205 in the Old Whaling summer settlement (Photo: A. Freeburg)

8.6.3 Ipiutak

Giddings and Anderson report nineteen excavated Ipiutak houses at Cape Krusenstern, along with one rack structure/processing area (Structure 44), in a total of six settlements. An additional lone house feature was excavated in 1965. Four of these settlements, as well as the lone house, were relocated and mapped with GPS.

House 9 and 11 and House 10 settlements

The only legacy features in this location, approximately 500 meters west of the Old Whaling summer settlement, are the excavated house features of Houses 9, 10, and 11 which were relocated and mapped in 2006. The two settlements are separated by approximately 75 meters. Of the twelve reported unexcavated houses in the House 9 and 11 settlement, most were relocated (Figure 24), though they were predominately attributed to the unidentified feature category. Seven of these features were tested though only three yielded cultural material, which was not abundant in any of the shovel tests. The midden areas indicated by Giddings and Anderson (1986:figure 70e, f) were not evident, and the cache pits reported in the northwest portion of the settlement were not relocated. Unreported features in the southeastern portion of the settlement were mapped and tested. While it cannot be confirmed that all of the mapped features are unexcavated houses as suggested by the published map, charcoal from at least one feature produced a radiocarbon age that is similar to the dates reported from House 11 by Giddings and Anderson (1986), suggesting the possibility of contemporaneous use (Table 16).

House 10 was easily re-located during survey, but only a few additional reported features, including a deep house depression adjacent to House 10 and other shallow house and cache depressions, were identified. This makes legacy map overlay in this settlement difficult at best. Newly recorded features included an approximately two and a half by two meter rectangular feature with abundant seal bones. Charcoal found in the feature yielded an age several centuries younger than the dates from the House 9 and 11 settlement (Table 16), which corroborates the general interpretation that settlements closer to the sea are younger than those farther away. Two newly recorded locations approximately 30 meters southeast of House 10 contained several pieces of fire modified rock as well as a single lithic flake.

Figure 24 shows GPS recorded features of the House 9-11 and House 10 settlements with published map overlays from Giddings and Anderson (1986). The published maps were rubbersheeted and georeferenced to match their features as close as possible with GPS recorded features with a minimal amount of distortion. This comparison provides a visual assessment of the differences in types and number of features recorded by the two projects, as well as minor feature location and scale issues with the previously published maps.

Figure 24. Houses 9, 10, and 11 GPS features with published map overlays (Giddings and Anderson 1986:figure 70e, f)

House 15 and 16

No published information is available for House 15, except that it was a disturbed area near House 16, and "may have been a summer camping area" (Giddings and Anderson 1986:125). House 16 was excavated in 1959, the results of which are briefly reported (Giddings and Anderson 1986). This brevity in reporting is likely due to the fact that most artifacts were lost in shipment. Little information was collected, or is given, on additional features in the vicinity, and the location of the house is given only as "several hundred meters southeast" of Houses 17 and 18, on beach ridge 35 (Giddings and Anderson 1986: 125). A lone rectangular feature, 5x4.5 meters, was found in 2010 approximately 300 meters from House 18. It is unlikely that this is House 16, as it did not appear to have been excavated. We find it more likely that the distance between the House 18 settlement and House 16 was previously misreported.

Using laboratory documentation, the locations of these features become less uncertain. The legacy feature catalog showed that Houses 15 and 16 were assigned feature numbers 136 and 137, respectively, and were reported to be on the "east end of the Ipiutak beach series." These numbered features are present on the annotated photomosaic at a location matching this description. Two excavated features were located and mapped in this area. We conclude that these excavations mark the locations of these two houses (Figure 25).

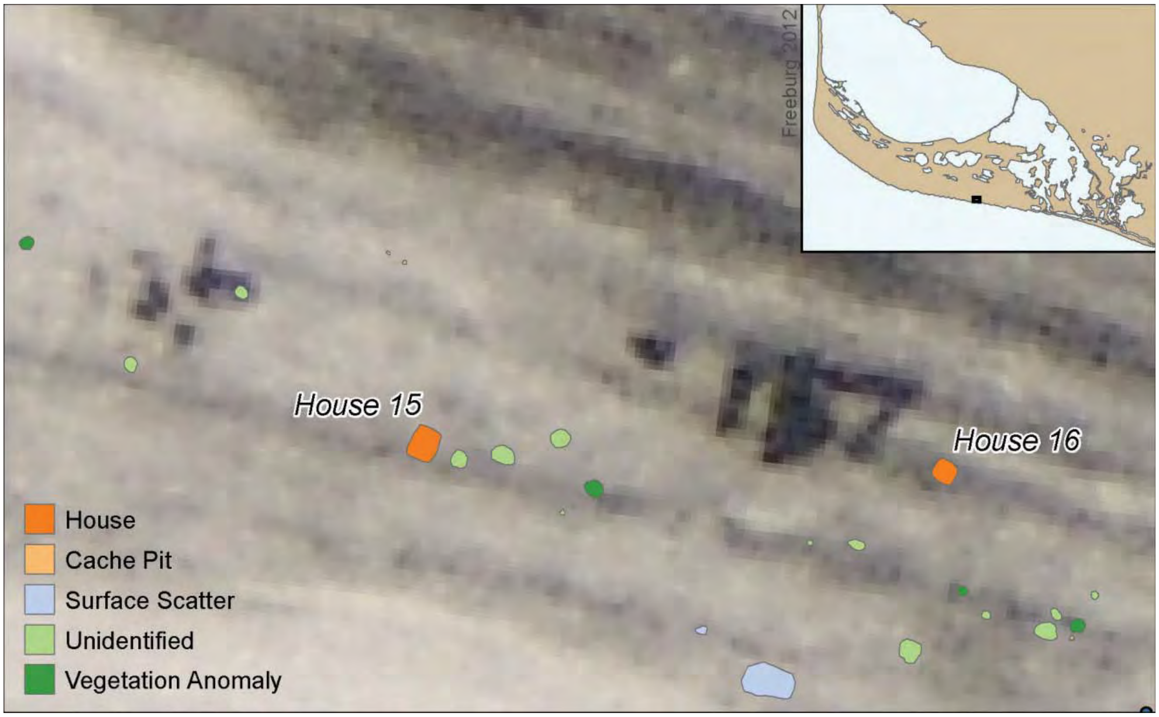

Figure 25. Legacy feature 136/House 15 and feature 137/House 16 as recorded by GPS and on annotated photomosaic

<u>House 17 and 18 settlements</u>

It is difficult to reconcile the published and unpublished notes with recently collected GPS feature data in the settlements of Houses 17 and 18. Giddings and Anderson (1986:figure 70d) show few features in addition to the excavated houses 17 and 18. They note that the exact number of features within the House 17 settlement is unknown (Giddings and Anderson 1986:122; Anderson 1962:13). Houses 17 and 18, both excavated by Hans Georg Bandi in 1959, are shown in the published map to be about 60 meters apart though elsewhere they are reported to be "ninety meters apart" (Giddings and Anderson 1986: 118). Anderson (1962:12) states that "[t]he settlements were located 90 meters apart," though this measure may refer to the least distance between features of the settlements, not the excavated houses specifically. A large unexcavated house is shown between them, presumably on the same ridge as House 18. Giddings' photomosaic was somewhat helpful in confirming the legacy feature numbers. The numbers 17, 18, and 19 are visible in the photomosaic in the southeastern portion of the beach ridge complex. The locations of, and relationships between, these numbered features match well with previously excavated features relocated and mapped in 2008 (Figure 26, top panel) but are difficult to reconcile with the published map. Additionally, the photomosaic annotations for both 18 and 19 seem to have been possibly altered. It is unclear if the annotations, from west to east, are 17, 19, and 18, or 17, 18, and 19. If the unexcavated house between House 17 and House 18 on the published map, in fact, House 19, it seems the former scenario is likely. However, it was clear from field observations in 2010 that both House 17 and the feature 65 meters east-northeast from it were previously excavated. From the published accounts, this would make the feature House 18, as portrayed in Figure 26. Additional information fails to resolve the discrepancy. House 17 is located on the beach immediately seaward of House 18, as reported by Anderson (1962). However, the beach number listed for each by Giddings and Anderson (1986:118) indicates the opposite: "House 17 on beach 30, and House 18, on beach 29…" With the current mapped information verified by the photomosaic, we confirm that House 17 is seaward of both House 18 and House 19, which are on the same ridge according to both the photomosaic and the published map. A large, round unidentified feature in the eastern portion of Figure 26 (bottom panel) aligns extremely well with the legacy annotation of "18" (possibly altered to/from 19) in the photomosaic (Figure 26, top panel). The current surface expression of this feature is such that it does not appear to be the same as all other excavated houses, which were not backfilled and are now deep depressions. However, the area is visibly disturbed. An unidentified feature less than 20 meters west of House 17 may be legacy feature 101, a possible house that tested positive for lithic material and charcoal. *Picea* charcoal found in a 2008 shovel test (1205A) within this feature and submitted for radiocarbon dating returned an age of 1190 ± 25 BP (OS-93950, $\delta^{13}C$ = -24.89‰). Additional features located adjacent to each excavated house were mapped, and are likely the remains of additional houses, cache pits, or other archaeological features that can now be included with the settlements. The area around these features was the specific focus of relocation efforts of the House 17 settlement. Systematic survey in this vicinity may add significantly to the resolution of legacy feature locations.

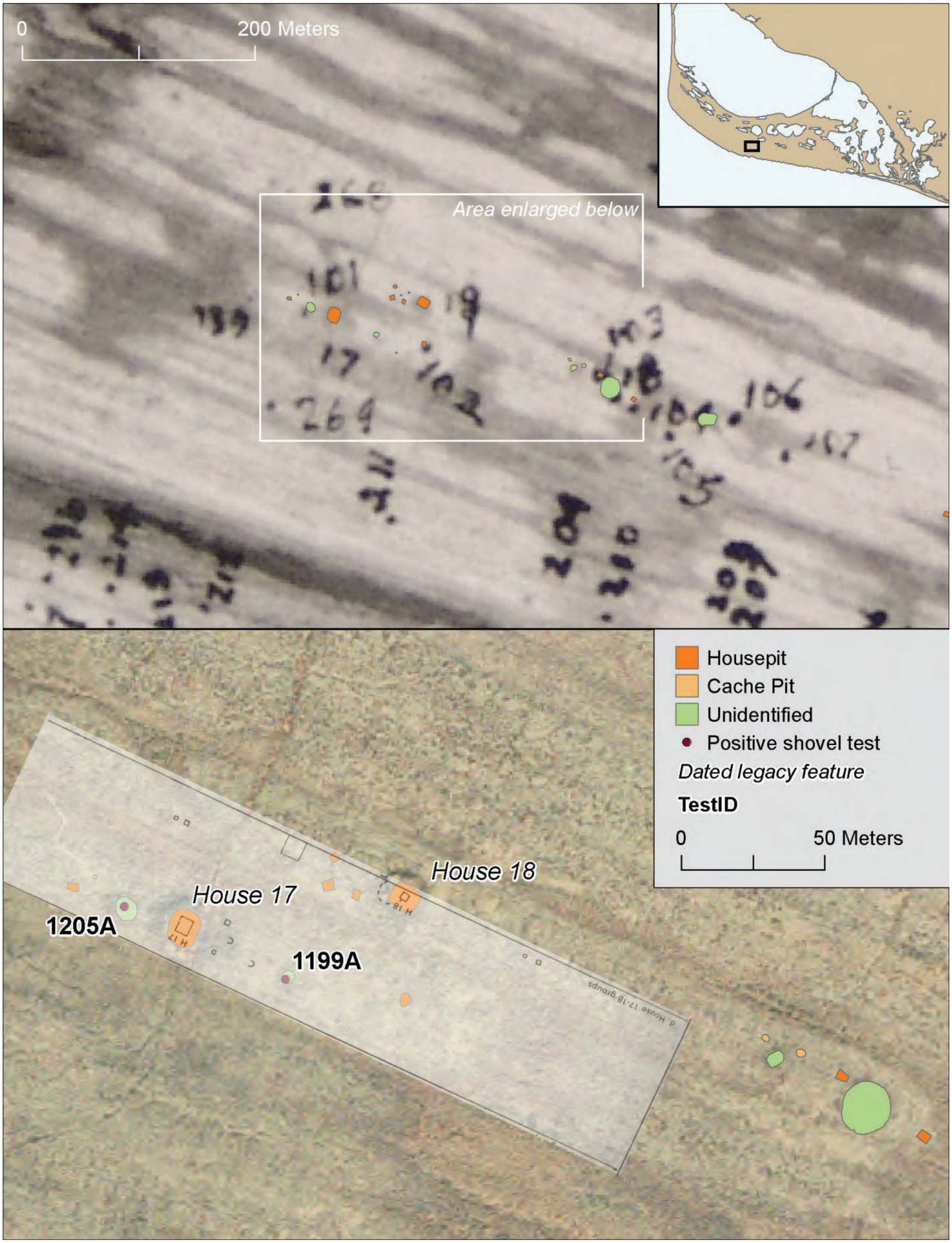

Figure 26. GPS recordings of Houses 17, 18 and 19 aligned with the annotated photomosaic (top); with published settlement map overlay (Giddings and Anderson 1986:figure 70d) (bottom)

House 30 group

The House 30 group was the most extensively excavated Ipiutak settlement at Cape Krusenstern. This settlement is located in the northwest portion of the beach ridge complex near several ridge unconformities (Figure 27). Giddings reported the excavation of seven houses (30, 36, 36a, 37, 37a, 38, and 39), as well as other features, including the anomalous seal skull mound. The settlement was mapped in 2006, and revisited for testing and ground truthing of the 2006 data and legacy points in 2010. House 30 was a large type 1 house (Anderson 1962), the remains of which were obvious in the field since the excavation was not backfilled. The remaining houses were of type 2 and less than half the size of House 30. The excavation limits of Houses 38, 37, and 37a merged into each other, so they were mapped as a single polygon. This was the same for Houses 36 and 36a, while House 39 was distant enough that its excavation limits did not overlap with either of the other two groups. The configuration and orientation of the houses, as well as their spatial relationship to House 30, is slightly different than was previously reported (Anderson 1962, Giddings and Anderson 1986). Only half of the House 30 "seal skull mound" (Giddings and Anderson 1986) was excavated. Ground truthing showed this to be the northern half, with seal skeletal elements -especially auditory bulla- visible on the entire surface of the feature. A shovel test was dug in the southern half of the skull mound in 2006, with two seal skeletal elements collected for isotope analysis. A drying and storage rack area was reported to exist northwest of and immediately adjacent to House 30 (Giddings and Anderson 1986). We found the remains of four adjoining excavation units here, presumably the "limited excavation" reported by Giddings and Anderson (1986:126). Additional small features found north of House 30 are presumed to be excavated cache pits. An important result of relocating the House 30 group is the ability to locate the settlement in relation to other archaeological remains. A ridge 75-100 meters away, in the direction of the lagoon, holds extensive surface scatters of lithics and fire modified rock (FMR). The settlement is also approximately 200 meters southeast of the Birnirk houses 32 and 33, though the distance to the House 30 settlement reported by Giddings and Anderson (1986:93) is "less than thirty meters to the south." Three radiocarbon dates acquired from near the House 30 settlement fall within the range of dates from House 30 given by Giddings and Anderson (1986:30).

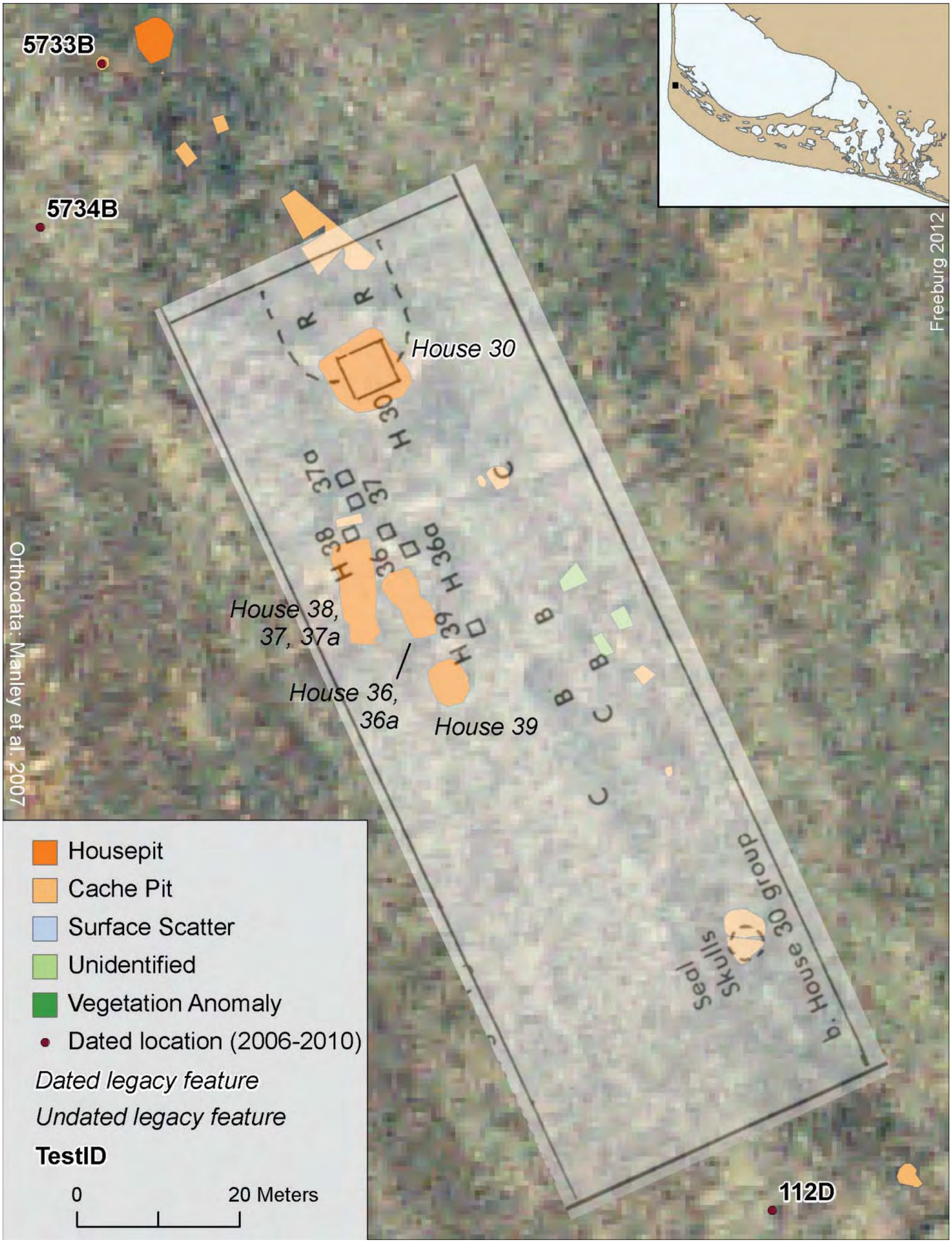

Figure 27. House 30 settlement GPS data with published map overlay (Giddings and Anderson 1986:figure 70b)

House 40 group

Giddings discovered House 40 in 1958, then relocated it again in 1960 and excavated the settlement. He posited that it was the youngest Ipiutak settlement given its location on the beach ridge sequence. While Giddings and Anderson (1986) report the settlement to be on beach 30, Giddings (1967) explicitly states that the beach number is uncertain due to ridges merging together in some locations. We found that ridges indeed converge, diverge, and at times blend completely into a swale or low area without any trace of ridge. Legacy feature numbers on the photomosaic show the features of the House 40 settlement as numbers 164 and 165. Giddings 1967:147) expressed uncertainty as to the exact number of the beach these features were on, noting "it was not always possible to be specific about [beach] numbers because in some localities several ridges merged together." This merging is due to localized geomorphic conditions; at one locale, beach sediment may have eroded and redeposited differently from another location, even though it was initially deposited along the same ridge. In that sense, beach numbering is a useful device for determining a relative location reference in a localized context. However, they do not transfer well across the entirety of the beach ridge complex. With improvements in spatial technology, the use of beach ridge numbers to refer to a location is obviated by the results of GPS mapping. They remain useful in general terms as a localized locational reference, especially while in the field.

Since all of the features within the House 40 settlement were excavated, they were easily recognized during the 2006 survey (Figure 28). Two previously reported cache pits, one on either side of House 40, were not relocated, though a squarish depression recorded as a house and two vegetation anomalies of berries and lichen were recorded southeast of House 40 (Figure 29). A shovel test (1443D) may be in a reported midden area seaward of House 41. Charcoal from ten centimeters below surface identified as *Picea* was submitted for radiocarbon dating, returning an age of 1470 ± 25 BP (OS-81283, $\delta^{13}C = -25.48‰$). Charcoal from a shovel test (1446D) in the newly recorded house feature was identified as *Salicacea* and dated to an age of 1510 ± 30 BP (OS-78460, $\delta^{13}C = -26.30‰$). These are the first radiometric dates from the House 40 Settlement (see Table 16). Additional previously unreported features within 50 to 100 meters of the settlement were mapped and some have also been dated.

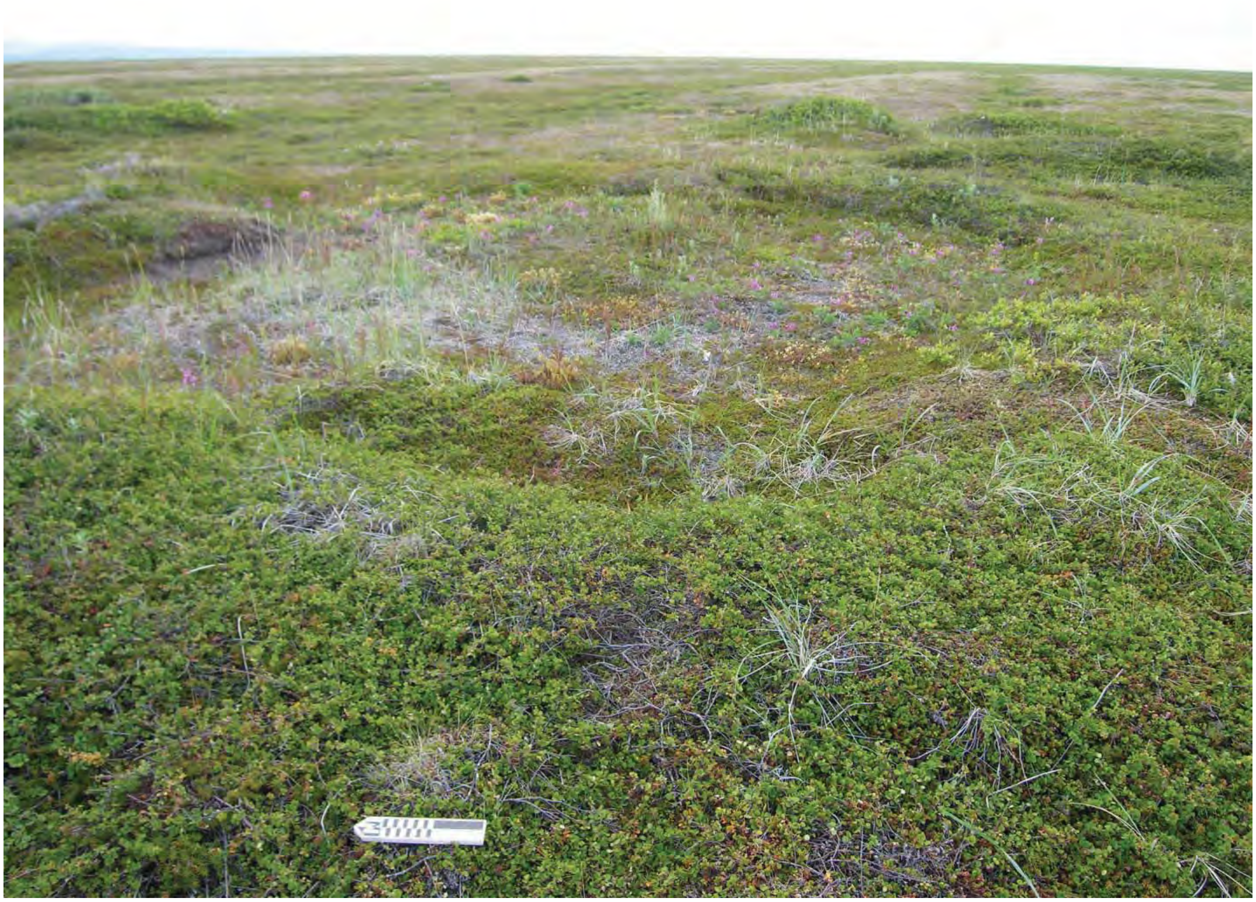

Figure 28. Structure 44 in the House 40 settlement; Houses 40, 43, and 42 (l-r) in background (Photo. S. Chappell)

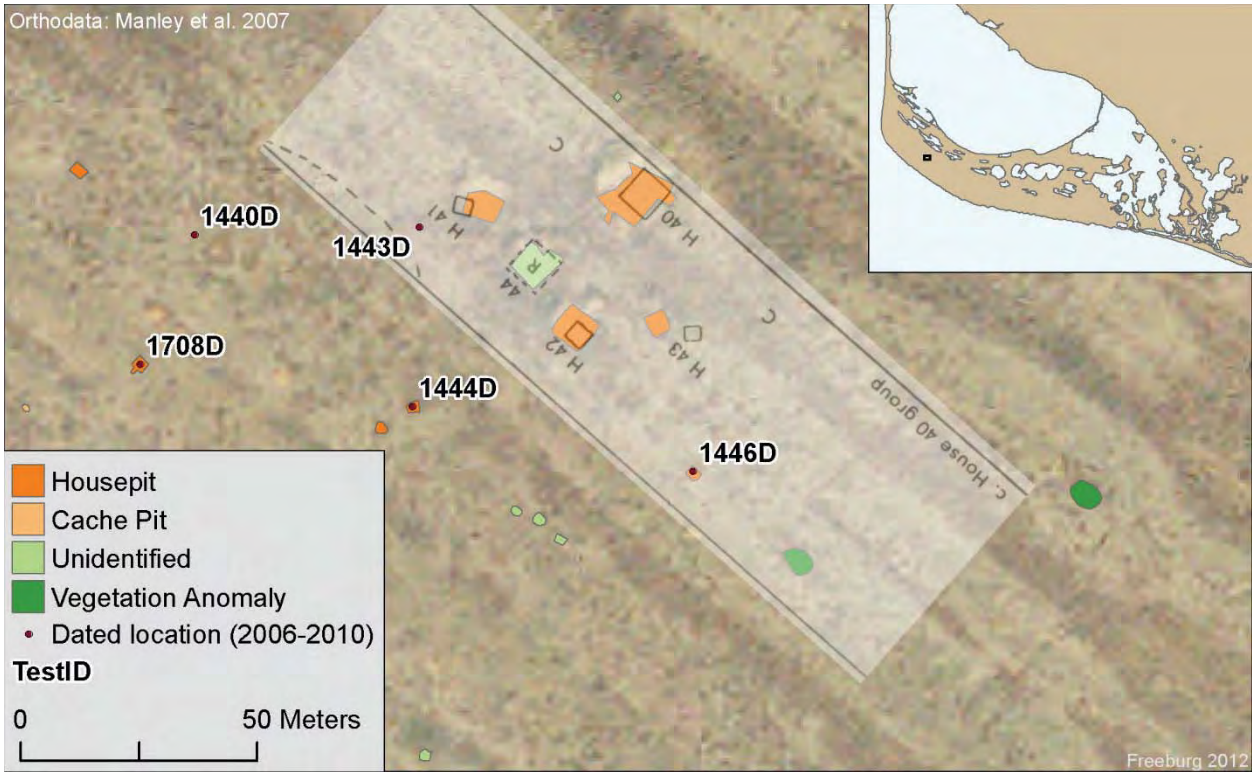

Figure 29. House 40 settlement GPS data with published map overlay (Giddings and Anderson 1986:figure 70c)

A large, shallow excavation feature was found approximately 140 meters south of the House 40 settlement (Figure 30). The excavation was approximately nine meters by nine meters with very distinct corners and boundaries (Figure 31) and was in a swale directly seaward of a narrow beach ridge. This ridge held three round depressions all approximately 20 centimeters in depth that appeared to have been previously excavated. The entire shallow excavation was full of concentrations of FMR (Figure 32). No legacy feature location was found for this area on the photomosaic. However, the size and characteristics of this feature make it a likely contender for matching legacy Feature 737. Giddings and Anderson often describe areas of concentrated FMR as "campsites" rather than hearths. They explain that they "tested several of these campsites, but excavated only one large area in its entirety, Feature 737 on beach ridge 29 (fig. 71)" (Giddings and Anderson 1986:120). The GPS mapped feature is not on the beach numbered 29 by Giddings (Figure 30). And while this is the only shallow excavation feature found of this size, we did not cover the entire beach ridge complex. However, assuming that only one "campsite" was excavated to this extent, per Giddings and Anderson (1986), it is likely that this feature is legacy Feature 737.

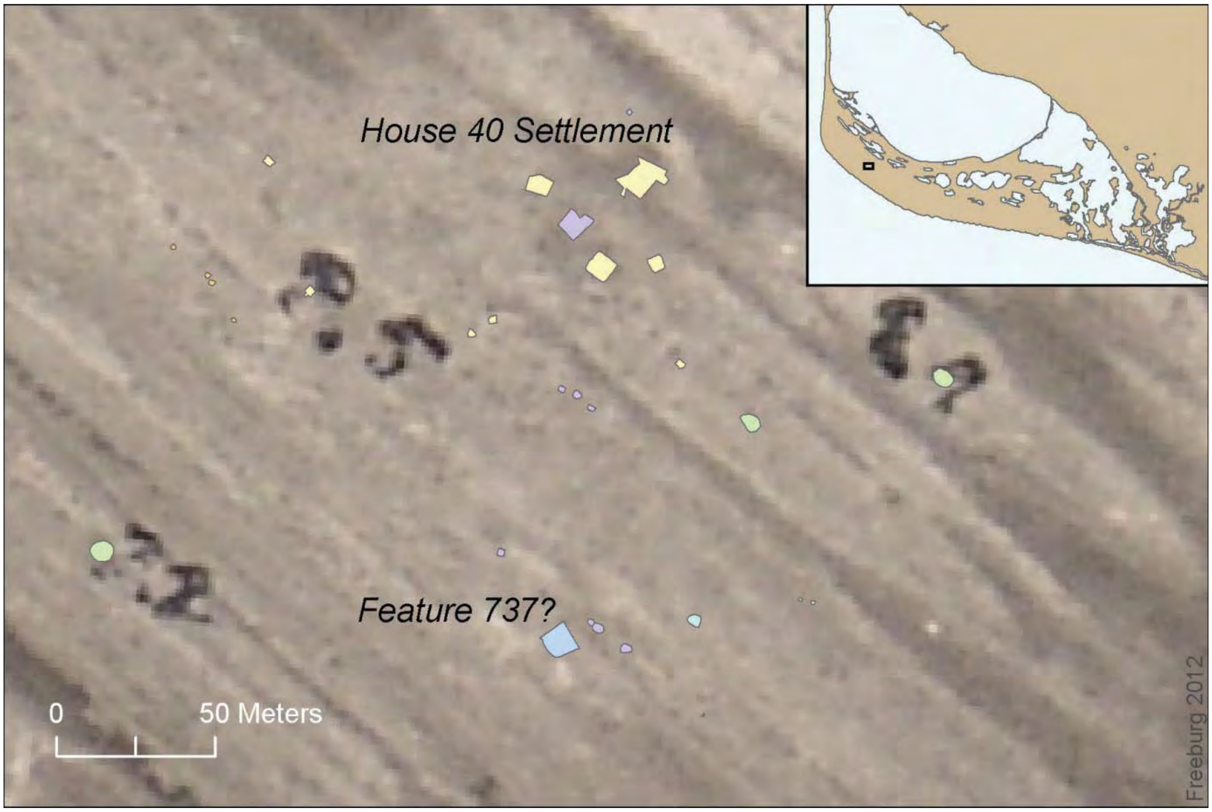

Figure 30. Feature 737 location with Giddings' annotated beach ridge numbers (L-R) 22, 25, and 29


Figure 31. Possible Feature 737 (Photo: S. Chappell)

Figure 32. FMR on ground surface of possible feature 737 (Photo: S. Chappell)

House 60 Settlement

The House 60 Settlement is a linear group of houses reported to be on ridge 35. House 60 was excavated and Houses 61 and 62 were reported as "tested" in the 1961 field season , though a plan view map of House 61 shows most of the floor uncovered (Giddings and Anderson 1986: figure 86). No legacy feature numbers on the photomosaic were found to correspond to this settlement, making the described features difficult to match with the results of GPS mapping. Additionally, the location is described as "about 2.5 kilometers from the House 30 group" (Giddings and Anderson 1986:134). The only feature that approximately matches this description is House 70 (see below). One possibility for the House 60 settlement is a set of features along the same wide composite ridge as the House 9 settlement (Giddings' beach ridge 35), approximately 3.7 kilometers from House 30. The number and arrangement of features match well with the published House 60 settlement map (Giddings and Anderson 1986:figure 70a)(Figure 33).

Figure 33. Possible location of House 60 settlement showing GPS data and published map overlay (Giddings and Anderson 1986:figure 70a)

These features also match the locations of five photomosaic annotations: three houses (Features 156-158), one possible house (Feature 155) and a "round pit" (Feature 159). The House 60 settlement is known to have an unexcavated circular depression, though this feature's location within the settlement is unreported. The derived location of legacy feature 157 is less than ten meters south of the largest excavated feature in this settlement (Figure 34) However, the excavation date of these features, according to the legacy data, is 1958; House 60 was reported to have been excavated in 1961 (Giddings and Anderson 1986). However, a description of Ipiutak features by Giddings and Anderson (1986:146) puts the House 60 settlement southeast of the House 40 group, which is true for Features 155-159. It is possible that these features do not represent the House 60 settlement, in which case they may be unreported excavated features. However, due to the number and arrangement of the features, as well as the excavations within this feature group, we think it more than likely that this is, in fact, the House 60 settlement. Radiocarbon dating results from shovel tests (3715B, 3739B, 3983B, 4003B, 4010B, and 4029B) within and near the presumed House 60 settlement as well as from a nearby test unit (1180A) supplement the one radiocarbon date for House 60 provided by Giddings and Anderson (1986) (Figure 33,Table 17).

Figure 34. Excavated legacy feature 157, possibly House 60 (Photo: F. Carter)

House 70

Discovered in 1961 and excavated in 1965 under the direction of Doug Anderson, House 70 is reported to be a lone structure "located on the landward side of the main Ipiutak beach ridge" (Giddings and Anderson 1986:13). The previously excavated feature was recorded in 2006, however, like the House 60 settlement, no annotation corresponds to House 70 on Giddings' photomosaic. We realized the location of a feature mapped in 2006 matched the location description for House 70 and revisited this feature in 2010. A small unidentified feature approximately 10 meters north of the excavated house was also mapped in 2006, as was a previously excavated shovel test within the feature. No other features were located in the immediate vicinity, and shovel testing produced no cultural material. House 70 is less than 150 meters northeast of House 40 (Figure 35).

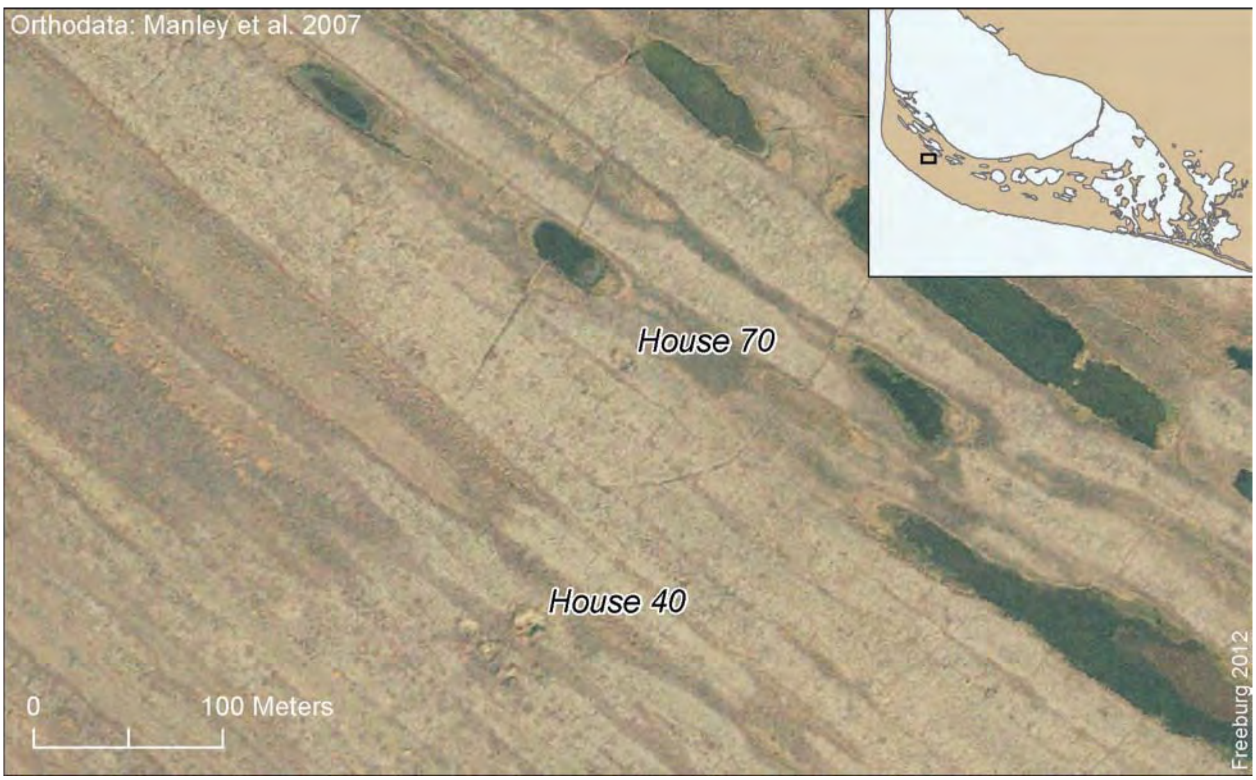

Figure 35. Excavated House 70 and House 40 settlement, as visible in orthoimagery

8.6.4 Birnirk

House 32 and 33

Giddings and Anderson (1986) attributed excavated Houses 32 and 33 to the Birnirk culture due to their artifact contents. Charcoal and/or bone from each house were also submitted for radiocarbon dating. The surface expression of the houses prior to excavation was a crescent shaped depression, resulting from the aggradation of the beach ridge immediately seaward (Giddings and Anderson 1986). A third feature –a deep, circular depression– was reported to be House 29, which remains unexcavated.(This feature number is repeated by, and should not be confused with, the House 29 located in the Late Western Thule settlement.) Birnik house features 29, 32, and 33 were mapped in 2006 along with two smaller features that were possibly previously excavated (Figure 36). Given what we now know of the frequent re-occupation of beach ridges, it is possible that the remaining house feature is not of Birnirk origin. This could mean that it was constructed at a later time than Houses 32 and 33. The published map of these features indicates House 33 and 29 to be closer to each other than to House 32. The features mapped by GPS show that the excavated houses are, in fact, closer to each other than to House 29. In any case, the question of House 29's cultural affiliation can only be resolved by disturbing the remaining intact feature. We assumed that the feature is the last remaining Birnirk house at Cape Krusenstern, and chose not to test within or adjacent to it, preserving it intact for the time being.

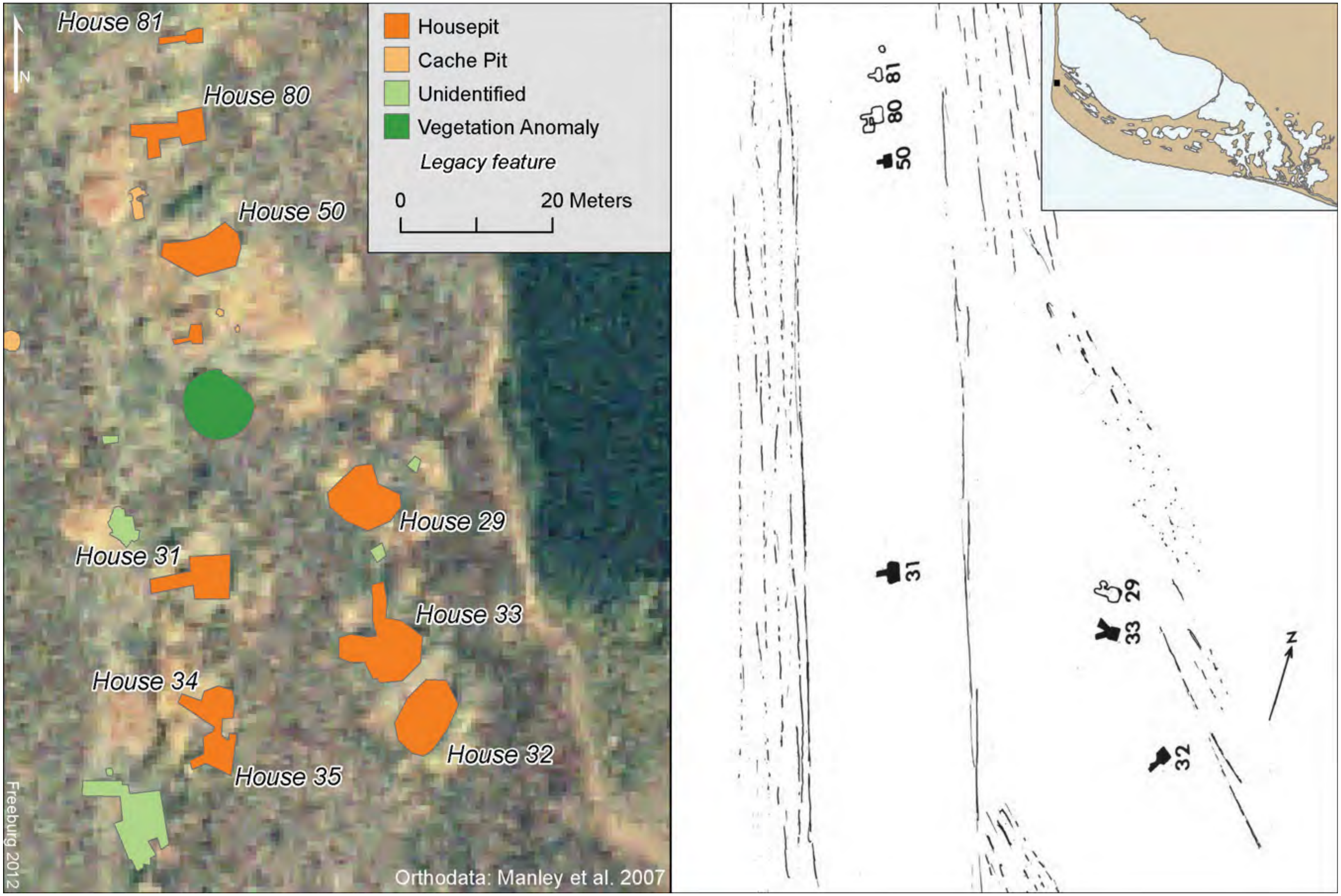

Figure 36. GPS collected data of Birnirk houses and vicinity (left); georeferenced Giddings and Anderson map of the same area (1986:figure 26)(right)

8.6.5 Early Western Thule
<u>Houses 4-8</u>

Five houses dating to the Early Western Thule period are located in close proximity to one another across two beach ridges 50 to 150 meters from the active shoreline (). These houses were excavated between 1958 and 1961 and, based on artifact styles and radiocarbon dates, are interpreted as being the remains of two distinct settlements; Houses 7 and 8 as an earlier component and Houses 4, 5, and 6 as a later occupation. House 7 is reported to have yielded a radiocarbon date of "about A.D. 1000" (Giddings and Anderson 1986: 71), but the date is not listed in the table of radiocarbon dates reported by Giddings and Anderson (1986: 30). Dates from Houses 4 and 6 are reported in that table, and are 1000±110 BP (K-850) and 1070±110 BP (K-817), respectively. However, it was later interpreted that "Houses 4, 5, and probably 6 likely date to the latter part of the thirteenth century" (Giddings and Anderson 1986:71).

Relocation and mapping of the Early Western Thule settlements began with the NPS field crew in 2006. An additional mapping effort occurred in 2009, and included testing of newly located features. Continued feature mapping in the vicinity of these settlements occurred in 2010. The main discrepancy to note between reported and relocated features is the number of features throughout the settlements. Giddings and Anderson (1986, figure 47) show a total of thirteen small circular features (presumably cache pits) within this area. An additional four are shown within the presumed excavation extent of House 7. In all, 50 features interpreted to be cache pits were mapped with GPS, including eleven features that seemingly match some of the thirteen features depicted by Giddings and Anderson. An additional six unidentified features were mapped within the now expanded settlement extent. One of the features, a small feature between houses 4 and 5, was judged to have been previously excavated. House 53C of ProXH1071120A was mapped and tested in 2006 (TestID 1678D), yielding a broken ground slate ulu, charcoal, and lithic debitage. The charcoal was identified to be *Picea* and yielded a radiocarbon age of 1230 ± 25 BP (OS-81430, $\delta^{13}C = -25.94‰$). Ceramic sherds were collected from the surface and backdirt of Houses 5, 7, and 8 in 2009. Testing of the cache features in 2009 yielded charcoal for dating as well as fauna and additional artifacts included in the present analyses. An

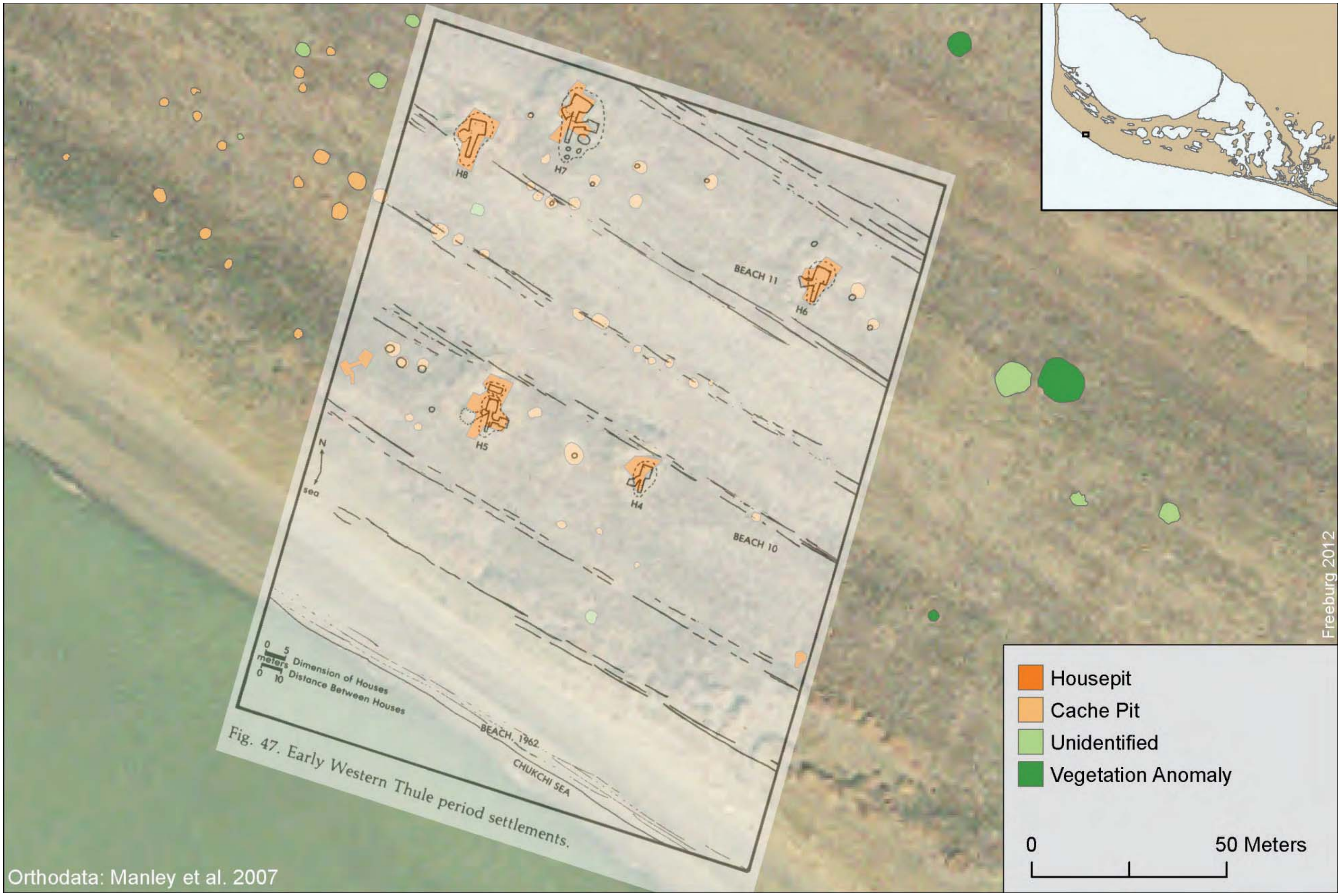

Figure 37. Early Western Thule settlement with published map overlay (Giddings and Anderson 1986:figure 47)

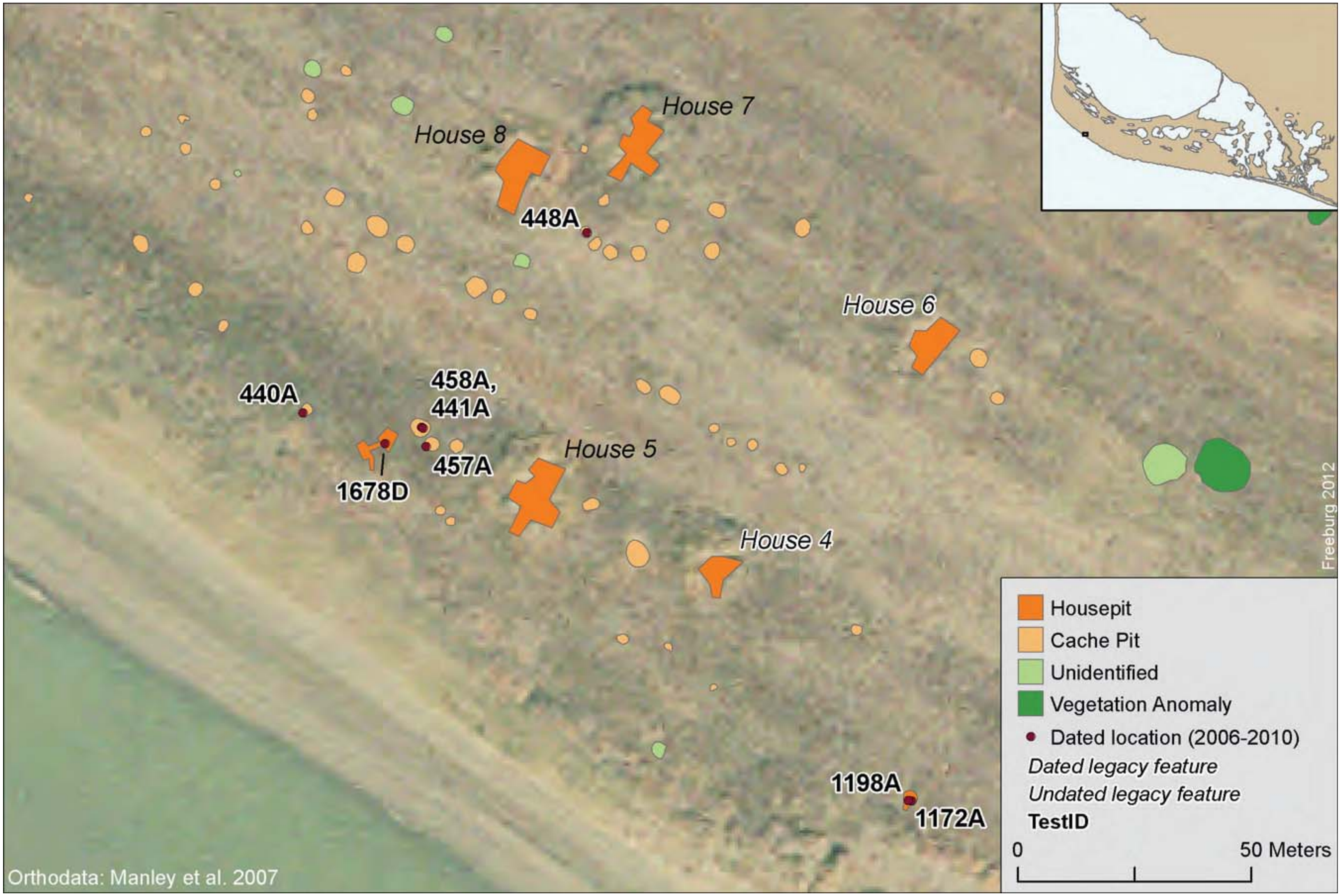

Figure 38. Newly dated features in the Early Western Thule settlement

additional house feature, House 1A of 10GeoXH070608A, was located in 2010 approximately 60 meters southeast of House 5. Two wood specimens recovered were during subsurface testing (TestID 1172A, 1198A). Dating of these samples returned ages more recent than the adjacent Early Western Thule occupation (220 ± 25 BP, *Salicaceae* wood, OS-93752, $\delta^{13}C$ = -25.93‰; 240 ± 25 BP, *Picea* wood, OS-94049, $\delta^{13}C$ = -26.33‰). Based on these results, it is unlikely that this house is contemporaneous with any of the Early Western Thule features.

Feature 700/Paul's Cache

This feature serves as a good example of the problems and inconsistencies faced when working with legacy data. Legacy feature 700 is clearly marked on the annotated photomosaic and is reported as a "hearth with beach pebbles" and numerous artifacts by Giddings and Anderson (1986:214; plate 122). An excavated feature was discovered within 15 meters of the derived legacy location. However, Feature 700 is reported as being on beach 45, and is attributed to the Choris culture (Giddings and Anderson 1986). Laboratory documentation at Brown indicates that the feature marked in the photomosaic, also known as "Paul's Cache," is "one beach back of Western Thule," and approximately 300 yards southeast of House 8. The beach description is accurate, but the actual distance between the two features is more than 800 meters (870 yards) (Figure 39). Since the Early Western Thule settlements are reported to be on beaches 10 and 11, Feature 700 would lie on or around beach 12. Thus, these two sources of information, published and laboratory reports, are contradictory. We believe this could be due to a duplication of Feature 700 in the field records. Laboratory sources refer to field notebooks for further information. As these notebooks were not available to UW, no conclusion can be reached on Feature 700 at this time.

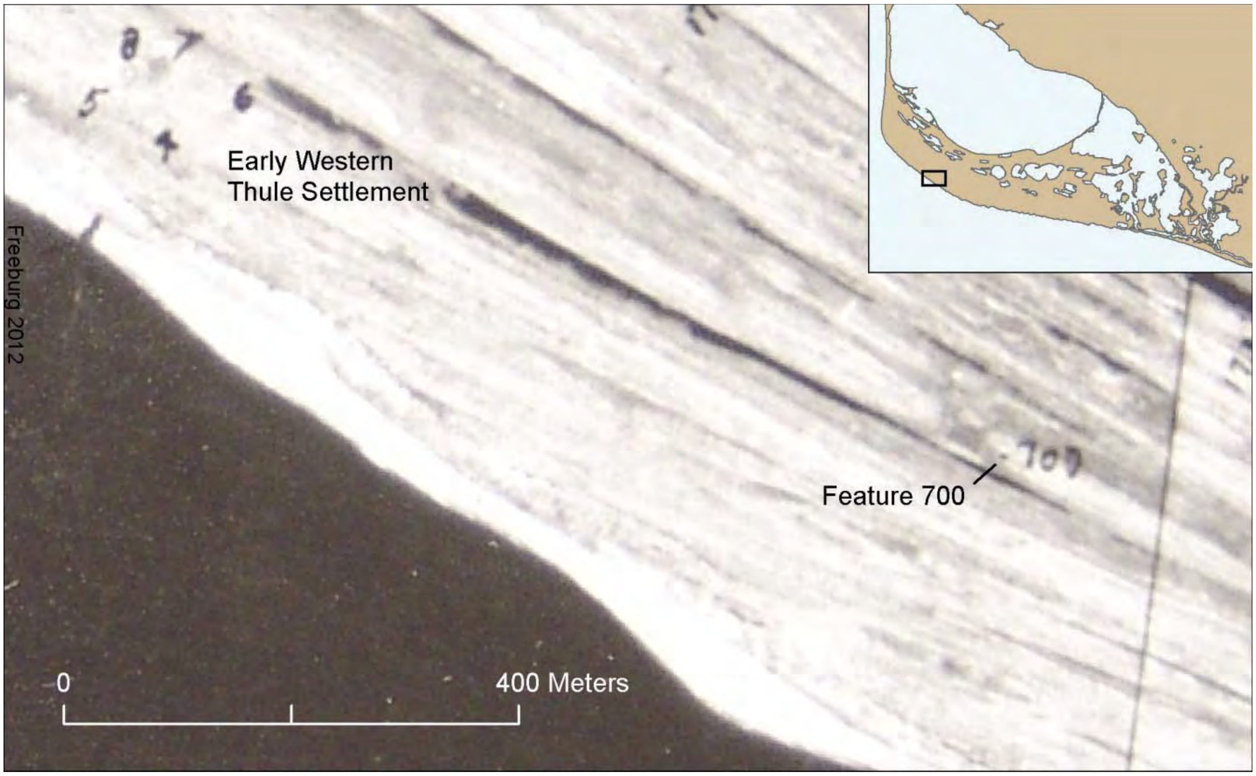

Figure 39. Annotated photomosaic showing Feature 700 in relation to Early Western Thule settlements (Features 4-8)

8.6.6 Late Western Thule

Houses 25-29

The Late Western Thule settlement investigated by Giddings during the 1959 and 1961 field seasons was a cluster of six houses, five of which were excavated (Giddings and Anderson 1986). The site was reported to be "about 1.3 kilometers southeast of the Cape Krusenstern Point" (Giddings and Anderson 1986:59). Its location is, in fact, 6.2 kilometers from the current sealing tower located on the point of the cape (Figure 40). While the features of the settlement were primarily mapped in 2006, we returned here several times throughout the project. We were able to collect ceramics and faunal material from the surface to add to our analyses. A wooden barrel containing pottery collected from the house excavations was left in the field (Doug Anderson, personal communication 2008). Our search for the barrel yielded the remains of barrel hoops, but no staves or pottery.

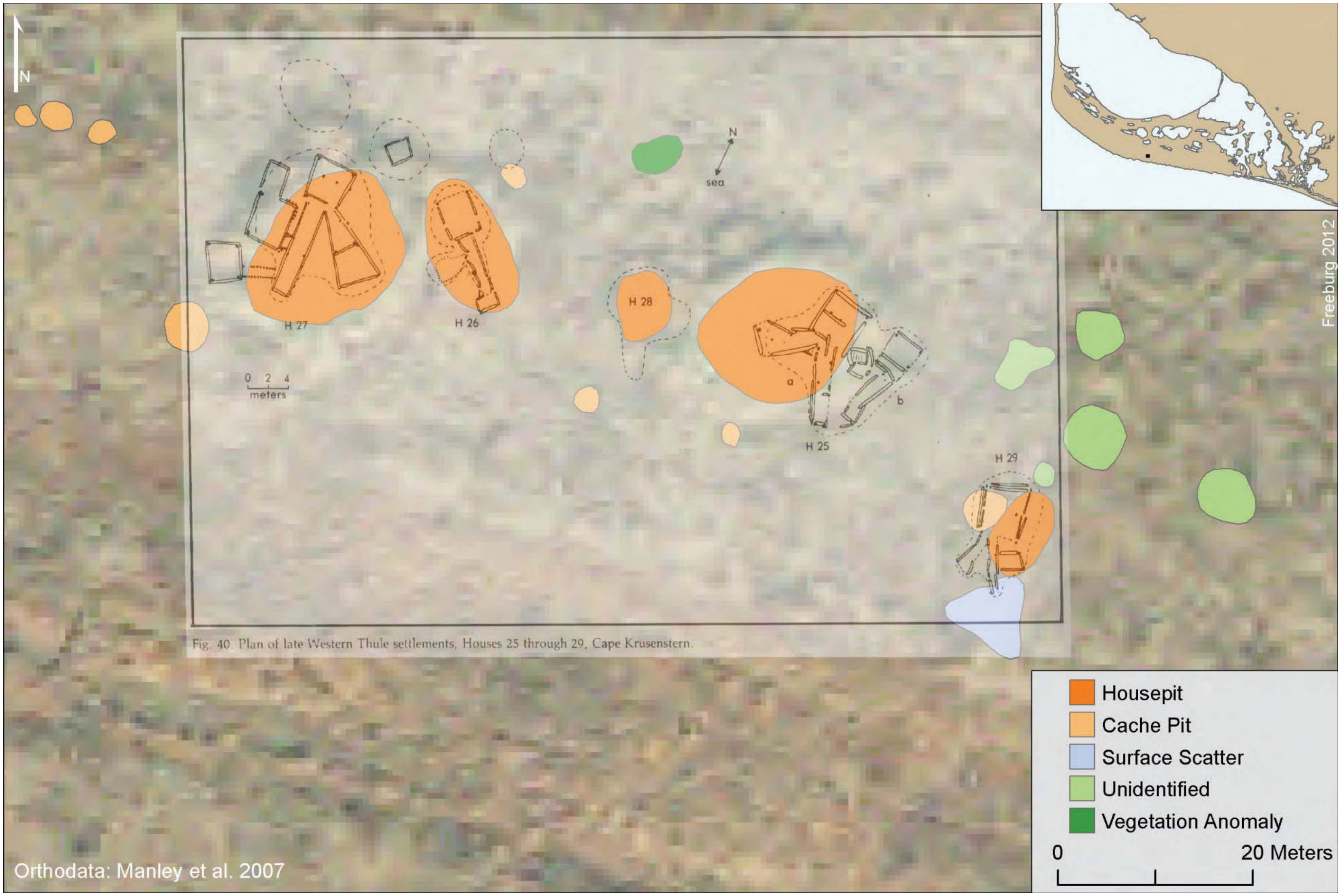

Figure 40. GPS data of Late Western Thule settlement with published map (Giddings and Anderson 1986:figure 40)

The five excavated houses of the Late Western Thule settlement appear greater in extent than the unexcavated one. This is because the mapped extent of the excavated houses is determined largely by the extent of the excavation backdirt, as the features were not backfilled. Thus, the surface expressions of the excavated features are quite large. The mapped extent of House 28, which remains unexcavated, is that of its current surface expression which is small in comparison. All houses were relocated, though there are discrepancies in auxiliary features between the GPS data and the published map. Of the three cache pits reported to be north of Houses 26 and 27, only one was located. Additional unreported cache pits were found within the settlement, including four west of and one southwest of House 27, one each in front of Houses 28 and 25, as well as one immediately adjacent to House 29. All were judged to have been previously excavated with the exception of the cache furthest west, which may not be excavated. A scatter of whale skeletal elements located in front of House 29 may be the result of prior excavation. Giddings and Anderson (1986:60) report “extensive use of whalebones in the construction of the side room.” Additional faunal elements were scattered around the settlement. Three other likely cultural features are located in the same vicinity north of House 29, though these are mounds, not depressions. An area of beach grass north of House 28 was tested but yielded no cultural evidence, so was mapped as a vegetation anomaly. Legacy Feature 200 is located approximately 50 meters southeast of House 29, and is listed as being a cache or house on beach 19. Giddings determined the Late Western Thule settlement to lie on beach 10, so this point is either misplaced or is meant to say “beach 9.” No feature was found in this location.

8.6.7 Kotzebue Period

The Kotzebue period settlements are an excellent example of the difficulties in ground truthing legacy data. Giddings and Anderson (1986:figure 26) provide a map of Birnirk and Kotzebue period houses in the northern portion of the beach ridge complex. However, no scale is given and a single beach ridge is split and stacked on top of itself in the figure, possibly due to publication layout restrictions. This figure is reproduced here in its entirety (Figure 41) for improved understanding of its georeferenced form in later figures. It is clear that the top portion of the figure, displaying houses 84-96, is situated to the north of the bottom portion. However, since no features are duplicated between the two map sections, it is impossible to know the distance intended between houses 83 and 84. Therefore, the map sections were kept separate when georeferenced into GIS.

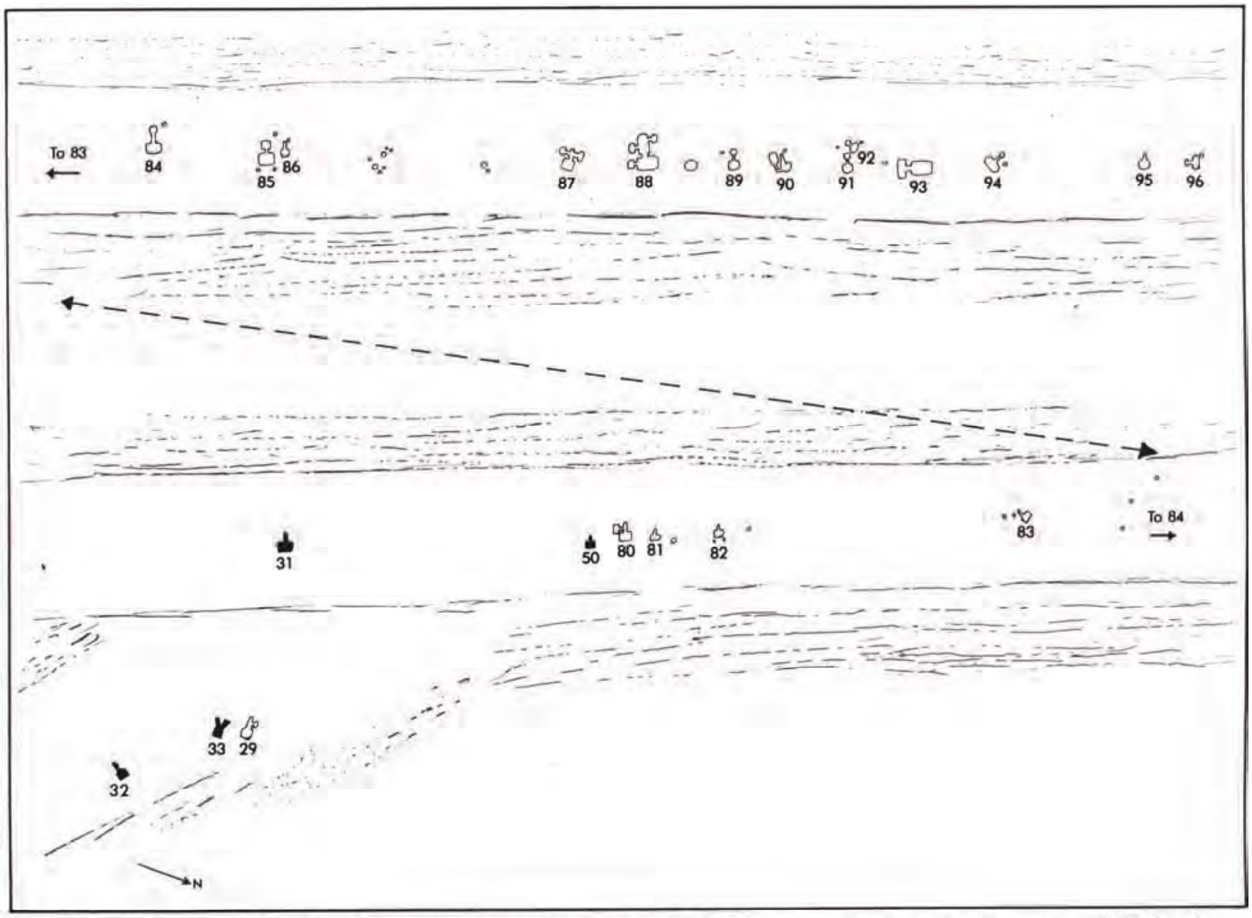

Fig. 26. Forms and groupings of Birnirk and Kotzebue-period house depressions on the northern section of beaches at Cape Krusenstern. The blackened house outlines have been excavated and are discussed in the text.

Figure 41. Giddings and Anderson (1986) figure 26

House 50 and vicinity

The bottom portion of Giddings and Anderson's figure 26 (1986:41) depicts houses 29, 31-33, 50, and 80-83. Giddings (1967, Giddings and Anderson 1986) attributed houses 29, 31, and 32 to the Birnirk culture (see section 8.6.4). The remaining houses are attributed to the late Kotzebue period or the early Recent period. Giddings and Anderson (1986:41) report that these houses occupy a portion of the cape "where beaches 1 through 9 have merged into one high composite ridge." Though 21 houses are reported in this location, only 19 are shown in the figure (plus the three Birnirk houses). Only houses 31 and 50 are marked as having been excavated, and houses 31 and 83 are reported to be "isolated ruins." This area was surveyed, mapped with GPS, and photographed in 2006. In 2010, the area was revisited but areas north of the House 50 group were not included. The locations of House 50 and House 31 were confirmed, as they were not backfilled after excavation. After the published map is aligned to features mapped in the field, it becomes clear that the scale between features and of the features themselves are not consistent (Figure 42). Therefore, the map overlay can only provide a rough guide in assessing the location of legacy features.

At the southernmost portion of the Figure 42's extent, three GPS mapped features are visible that are not indicated on the published map. The two adjoining features immediately south of House 31 were determined to be excavated Houses 34 and 35 due to the description of their location reported in relation to the Birnirk settlement (Giddings and Anderson 1986:93). This description conflicts with another provided by Giddings and Anderson (1986:42), claiming House 31 to be "the southernmost in the line of post-Western Thule house depressions," but we believe this description to be inaccurate. Although a published map of the houses (Giddings and Anderson 1986:figure 33) shows two cache pits to the east of the excavated houses, they were not re-located. If these features are indeed houses 34 and 35, and are added to the 19 houses mapped in Giddings and Anderson's figure 26 (1986:41), the total number of houses of Kotzebue/Recent periods would be 21, as reported in the text by Giddings and Anderson (1986). The artifacts from both House 34 and 35 were lost during shipment to Brown University, which may account for the lack of reporting on these features.

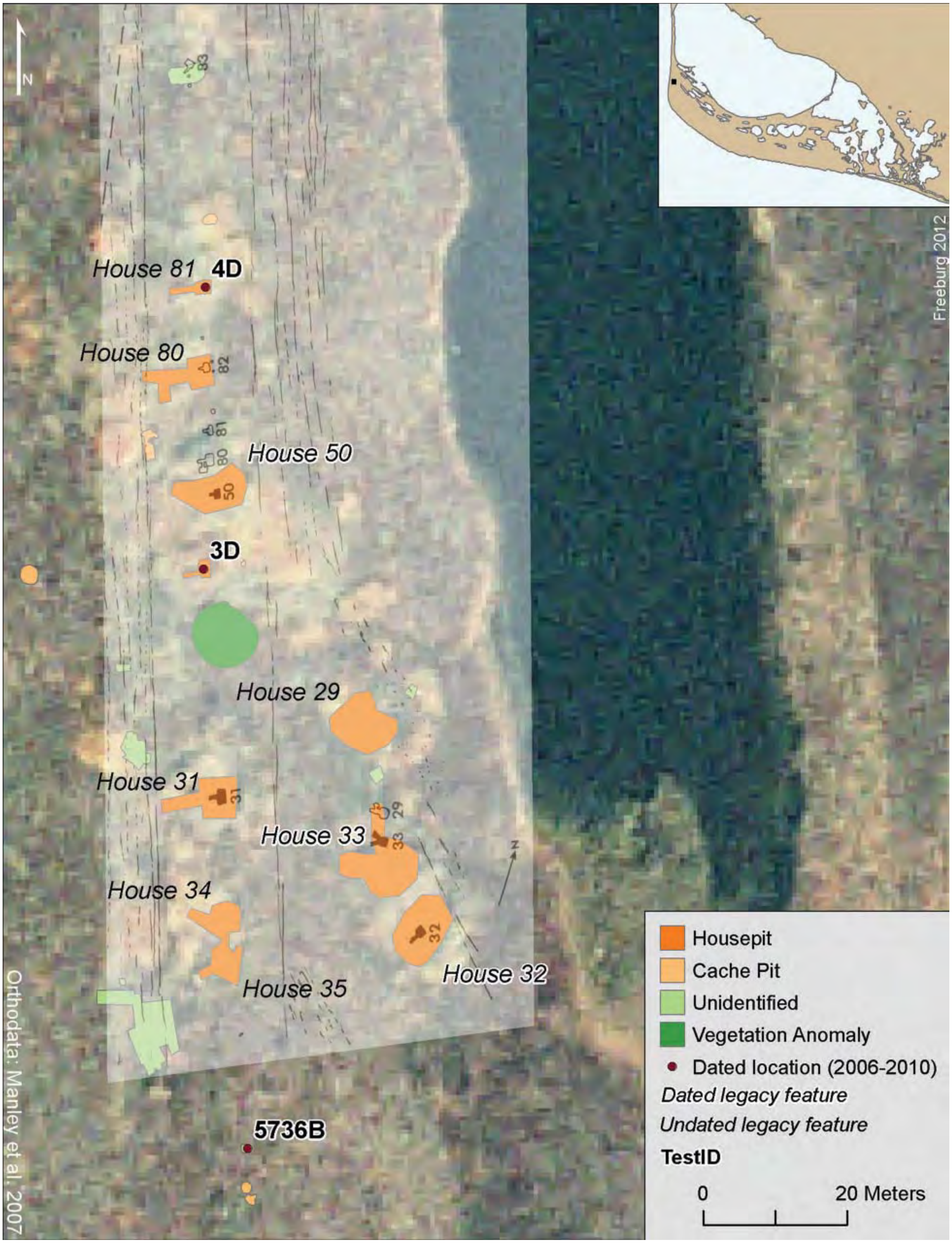

Figure 42. House 50 group and vicinity; GIS data with published map overlay (Giddings and Anderson 1986:figure 26)

An odd-shaped, excavated area with straight, linear walls was located approximately 10 meters southwest of House 35, but it is unclear what this area may have been. A shovel test and photograph from 2006 indicates the presence of FMR (Figure 43). The photo log from 2006 suggests this may be a result of Zimmerman's (1978) work, though we are unable to prove or disprove this interpretation.


Figure 43. Adam Freeburg and Cody Strathe in excavated area south of House 35 (Photo: C. Young)

Two previously excavated areas were mapped in the swale immediately seaward of House 31. The area nearest House 31 is irregularly shaped and approximately five meters by three meters. The other area is approximately 8.5 meters to the north and is rectangular in shape, measuring approximately two meters by one meter. As with the excavated area south of Houses 34 and 35, we cannot attribute this to any previous researcher with certainty.

In 2010, a vegetation anomaly of shrub willow about nine meters in diameter was discovered approximately 20 meters north of House 31. This feature was not present in 2006 data, and so was mapped with GPS. It was not tested and no previous shovel tests were found within the feature. Five meters to the north, a possible house feature was mapped in 2006. The surface expression of this feature is approximately 2.5 by 1.5 meters, with a 2 meter linear depression on the west side. This feature is not reported by Giddings and Anderson. Photo logs from 2006 suggest it may be House 80, implying that the published map is incorrect. We disagree with this interpretation. On the published map, House 80 is the next feature north of House 50, and is depicted as having a small room adjoining the south side of its tunnel. This matches the GPS feature data collected in 2006, so we maintain that House 80 is immediately north of House 50, and the newly mapped feature is likely a previously unreported house. Immediately north of excavated House 50, Giddings and Anderson report three houses (Houses 80-82) with associated cache pits, and a fourth (House 83) farther to the north. Only two features from the 2006 mapping effort were classified as houses. Though the actual distance between houses of the House 50 group differs from the published map, it is likely that the house features immediately north of House 50 are Houses 80 and 81. If the relative layout of the House 50 group depicted by Giddings and Anderson is correct, it is possible that a feature mapped in 2006 as a cache pit could be House 82. Photo logs from 2006 list a particular photo to be a "Reproduction of Figure 29 (G&A 1984)." Giddings and Anderson's figure 29 (1986:43) shows the excavation of House 31. GPS data puts the photo at the feature now determined to be House 50.

Giddings and Anderson (1986:figure 26) show a total of 18 unexcavated numbered houses with associated features north of House 50. The legacy photomosaic shows a series of 21 feature locations north of House 50/Feature 318. According to the legacy feature catalog, each feature is a house, cache pit, surface fauna, or some combination of these features. Survey in 2006 on the beach ridge in question stopped 290 meters north of House 50, while the derived legacy feature locations continue for 850 meters. Within the surveyed area, however, 23 features were recorded. The same area only includes five derived legacy feature locations. Because of these discrepancies, we did not have sufficient data to georeference the top portion of the published Kotzebue settlement map. When the top and bottom portions were joined digitally and georeferenced as one map, no GPS features matched the location of numbered houses. This is possibly due to cartographic license taken in Giddings and Anderson’s figure. No scale is given, so the figure may be intended to be a schematic of house locations, and not a scale map. However, at least one feature in the survey area was possibly relocated. We find it likely that a GPS recorded house feature with a southwestern facing tunnel is Giddings and Anderson’s House 83/Feature 322, which is also depicted as the only house feature with a tunnel that faces a southwesterly direction (Figure 44).

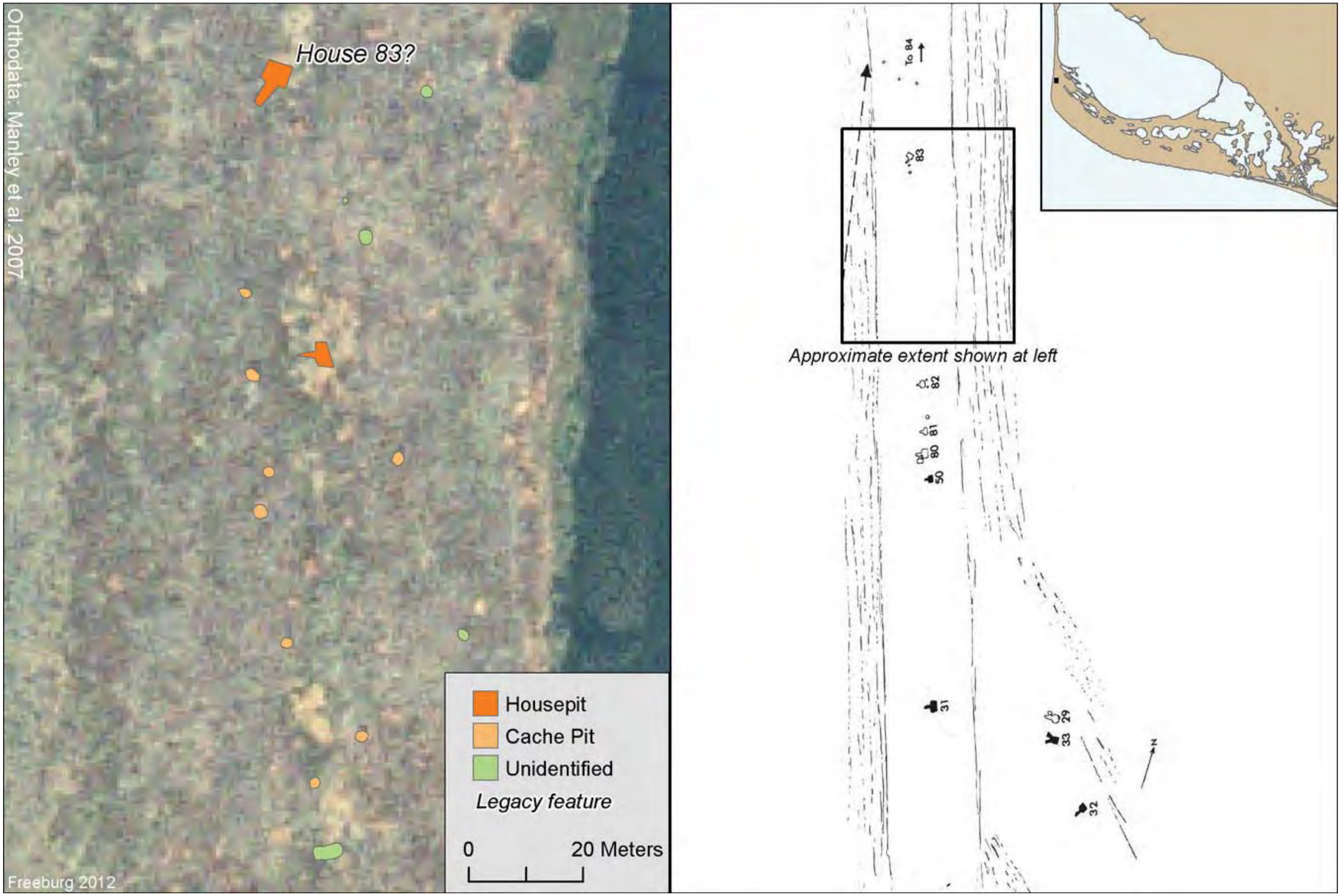

Figure 44. Possible House 83 location (left); Georeferenced published map (Giddings and Anderson 1986:figure 26) (right)

House 14

Giddings and Anderson (1986:figure 27) report a plan view of excavated House 14, which they attribute to the 18th or 19th century. Like Houses 34 and 35, the artifacts from this house were also lost during shipment and little information is given for this feature. The brief description of location and plan view generally matches the inset plan view and location of an excavated "Recent" house depicted by Giddings and Anderson (1986:figure 6). House 14 is listed in the legacy feature catalog as "at the far east of [the] beach-ridge series…Located at the junction between beach 2 and 40."An previously excavated house was mapped at the extreme southeastern portion of the beach ridges near this location. We believe this is House 14 (Figure 45), and it is very near an annotation marking Feature 138. Feature 138 is listed by Giddings and Anderson (1986:171) as shallow Ipiutak feature on Beach 38, but this description does not include any mention of House 14. Perhaps due to the feature's position on the beach ridges, near a segment boundary, it was initially attributed to the Ipiutak period, but excavations proved otherwise and the feature catalog was not completely updated. Being the only excavated feature in this vicinity, we think it likely that Feature 138 and House 14 are the same.

Figure 45. House 14, with annotated photomosaic overlay showing Feature 13

Table 16. Legacy settlement radiocarbon dates

Legacy Settlement	Legacy Feature	TestID	Lab Accession	Material	Description	RC Age	Calibrated Date§
Early Western Thule	House 4	-	K-850	Charcoal	Unreported sp.	$1000 \pm 110^{*}$	A.D. 780-1253
	House 6	-	K-817	Charcoal	Unreported sp.	$1070 \pm 100^{*}$	A.D. 694-1171
	-	440A	OS-81656	Charcoal	*Picea*	$890 \pm 35^{\dagger}$	A.D. 1040-1218
	-	440A	OS-81681	Plant/Wood	*Picea*	$110 \pm 25^{\dagger}$	A.D. 1682-1935
	-	441A	OS-81576	Bone	*R. tarandus*	$875 \pm 25^{\dagger}$	A.D. 1046-1222
	-	448A	OS-81575	Bone	*R. tarandus*	$830 \pm 30^{\dagger}$	A.D. 1160-1265
	-	457A	OS-81581	Charcoal	*Picea*	$1010 \pm 25^{\dagger}$	A.D. 981-1148
	-	458A	OS-81578	Bone	*R. tarandus*	$840 \pm 25^{\dagger}$	A.D. 1160-1259
	-	1678D	OS-81430	Charcoal	*Picea*	$1230 \pm 25^{\dagger}$	A.D. 690-880
House 9 and 11	House 11	-	P-225	Charcoal	Unreported sp.	$1651 \pm 130^{*}$	A.D. 90-643
	-	506D	OS-78455	Charcoal	*Salicacea; Salix/Populus*	$1410 \pm 25^{\dagger}$	A.D. 601-662
	-	513D	OS-81280	Charcoal	*Picea*	$1600 \pm 25^{\dagger}$	A.D. 412-537
House 10	-	1050D	Beta-226154	Charcoal	*Picea* sp./*Larix* sp.	$1200 \pm 40^{\dagger}$	A.D. 690-946
House 15	-	2590B	OS-81650	Charcoal	*Picea*	$1490 \pm 35^{\dagger}$	A.D. 441-646
House 17-19	House 17	-	B-266	Charcoal	Unreported sp.	$1450 \pm 80^{*}$	A.D. 419-765
	House 17	-	P-612	Charcoal	Unreported sp.	$1441 \pm 58^{*}$	A.D. 436-680
	House 18	-	B-280	Charcoal	Unreported sp.	$1250 \pm 100^{*}$	A.D. 621-988
	-	1199A	OS-94051	Charcoal	*Picea*	$1480 \pm 30^{\dagger}$	A.D. 540-644
	-	1205A	OS-93950	Charcoal	*Picea*	$1190 \pm 25^{\dagger}$	A.D. 771-937
House 30	House 30	-	P-597A	Charcoal	Unreported sp.	$1499 \pm 57^{*}$	A.D. 432-646
	House 30	-	P-595A	Charcoal	Unreported sp.	$1944 \pm 52^{*}$	51 B.C.-A.D. 215
	-	112D	Beta-223220	Charcoal	*Salix* sp.	$1590 \pm 40^{\dagger}$	A.D. 392-562
	-	5733B	OS-93955	Charcoal	*Picea*	$1620 \pm 35^{\dagger}$	A.D. 348-540
	-	5734B	OS-93957	Charcoal	*Betula*	$1330 \pm 30^{\dagger}$	A.D. 647-770
House 40	-	1443D	OS-81283	Charcoal	*Picea*	$1470 \pm 25^{\dagger}$	A.D. 552-642
	-	1446D	OS-78460	Charcoal	*Salicacea*	$1510 \pm 30^{\dagger}$	A.D. 435-623

*Radiocarbon age and standard error from Giddings and Anderson (1986:30)

†Conventional radiocarbon age and standard error from NOSAMS and Beta Analytic results

§ Calibrated two sigma range using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al. 2009)

Table 17. Legacy settlement radiocarbon dates (continued)

Legacy Settlement	Legacy Feature	TestID	Lab Accession	Material	Description	RC Age	Calibrated Date§
House 40	-	1440D	OS-81427	Charcoal	*Picea*	1390 ± 30†	A.D. 602-674
	-	1444D	Beta-226155	Charcoal	*Pinaceae* cf. *Picea*/*Larix* sp.	1510 ± 40†	A.D. 433-637
	-	1708D	OS-78457	Charcoal	*Picea*	1300 ± 35†	A.D. 656-776
House 60	House 60	-	P-596A	Charcoal and wood	Unreported sp.	1730 ± 61*	A.D. 134-425
	-	1180A	OS-93942	Plant/Wood	cf. Conifer	1440 ± 30†	A.D. 566-655
	-	3715B	OS-81676	Charcoal	*Salicaceae*, cf. *Salix*	1610 ± 25†	A.D. 403-536
	-	3739B	OS-81649	Charcoal	*Picea*	1600 ± 35†	A.D. 390-545
	-	3983B	OS-81611	Charcoal	*Picea* sp..	1460 ± 25†	A.D. 560-646
	-	4010B	OS-81640	Charcoal	*Picea*	1570 ± 35†	A.D. 415-565
	-	4029B	OS-81612	Charcoal	*Picea*	14750 ± 25†	A.D. 231-382
Birnirk	House 32	-	K-851	Charcoal and bone	Unreported sp.	1180 ± 110*	A.D. 644-1039
	House 33	-	K-816	Charcoal	Unreported sp.	1100 ± 100*	A.D. 686-1155
Kotzebue	House 50	-	K-837	Charcoal	Unreported sp.	1180 ± 110*‡	A.D. 644-1039
	-	3D	Beta-226692	Charcoal	*Populus* sp./*Salix* sp. cf. *Populus* sp.	390 ± 40†	A.D. 1436-1634
	-	4D	Beta-326109	Charcoal	*Phoca*, left fibula	1170 ± 30†	A.D. 1171-1296
	-	5736D	OS-93953	Charcoal	*Salicaceae*	505 ± 25†	A.D. 1400-1445

*Radiocarbon age and standard error from Giddings and Anderson (1986:30)

†Conventional radiocarbon age and standard error from NOSAMS and Beta Analytic results

§ Calibrated two sigma range using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 or Marine09 (Reimer et al. 2009)

‡ Reported as possibly contaminated (Giddings and Anderson 1986:figure 19)

9.0 Discussion

9.1 Chronology

Because ongoing current geomorphological research by Jim Jordan is unreported at this time, we cannot yet address issues of timing between landscape evolution and cultural occupation, except in a very general sense. We can, however, compare the results of survey level data and limited testing to the established chronology of the cape.

Mason and Jordan (1993) used legacy radiocarbon dates to establish a limiting age for beach segments as defined by erosional truncations. Using our now expanded series of available radiocarbon dates of cultural occupation on the beach ridges of Cape Krusenstern we are able to update these limiting ages (Table 18, Figure 46). The updated limiting ages are derived from the oldest calibrated date from each segment. Exclusions were made for outliers (e.g. a 6000 BP date on beach segment II). Additionally, care was taken to ensure the collection location of each sample was within the correct beach segment. As explained above, the beach segment boundaries digitized from published maps are inexact at best. While we are waiting for the results of geomorphological analyses to re-define these boundaries, we used the digital orthophoto (Manley et al. 2007) to estimate where Giddings intended the segment boundaries to fall. Ostensibly, these limiting ages could vary with newly defined segment boundaries, though we do not expect appreciable changes. An exception to this is the limiting age of segment I, where a closer look at the geographic and spatial clustering of several of the older dates within this beach segment suggests that the existing digitized segment boundaries are incorrect, and inadequately reflect beach segment boundaries as intended by Gidding. This error results from issues of scale and resolution of the digitized figures as described in section 8.5. These issues are expected to be resolved in continued analysis of project data planned with Jim Jordan. For example, the collection locations of dated samples from TestIDs 1294B, 1303B, and 2503B are located close to one another and to the segment I and II boundary (Figure 47). A fourth date on *Picea* charcoal from TestID 2590B is not as close to the current segment boundary but falls about 500 years outside (and older than) the rest of the dates in segment I, with a calibrated age range of 1509 to 1305 cal BP[2]. This discrepancy, along with the underlying orthophoto, suggests that the derived segment boundary is incorrect. Pending the addition of geomorphologic units and final edits to these archaeological chronological units, we propose that the upper limiting age for occupation of this beach segment to be 1045 cal BP.

Table 18. Archaeological chronological units/beach segments

Beach segment [Mason and Jordan 1993]	**New limiting date (cal BP)**	**Prior age range (cal BP)** *	**Archaeological culture**
I [VII]	1045	900 to present	Thule, Kotzebue, Historic Inupiat
II [VI]	1990	1500 to 1000	Ipiutak, Birnirk, Thule
III [V]	2780	2500 to 2000	Norton/Near-Ipiutak
IV [IV/III]	3215	2900 to 2500	Choris (incl. Old Whaling)
V [II/III]	4068	3500 to 3000	Denbigh, Early Choris
VI [I]	4238	4200 to 3500	Early - Classic Denbigh

*Complied from Giddings and Anderson (1986); Mason and Ludwig (1990); Mason and Jordan (1993); Darwent and Darwent (2005)

[2] All calibration of radiocarbon ages performed using OxCal 4.1 (Bronk Ramsey 2009a) software, calibration curves of IntCal09 (Reimer et al. 2009) or Marine09 (Reimer et al. 2009).

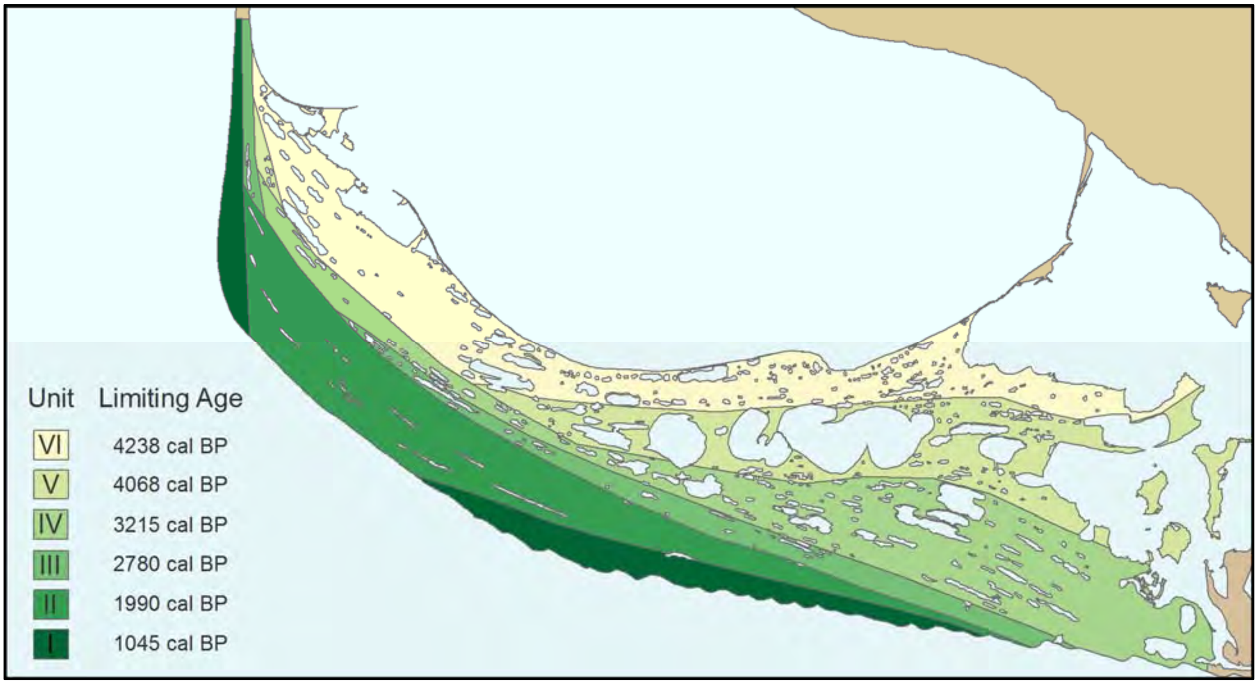

Figure 46. Beach ridge segments and new upper limiting ages using Giddings'(1966) numbering sequence; limiting age derived from bottom (oldest) of two sigma calibrated age range

At present, an expanded sample of dated cultural occupations indicates human presence on each segment earlier than previously thought (Figure 48). The differences range from less than 40 years in segment VI to over 500 years difference in dates for segment V. Because few diagnostic artifacts were recovered during survey and limited testing, it is difficult to discern what this means for cultural chronology at this time. However, older limiting dates from cultural occupations must also mean older beach ridge formation dates. As a result, these new dates will undoubtedly require a re-evaluation of the causes of the paleoenvironmental changes or events, including stormy periods, which shaped the beach ridge erosional sequence.

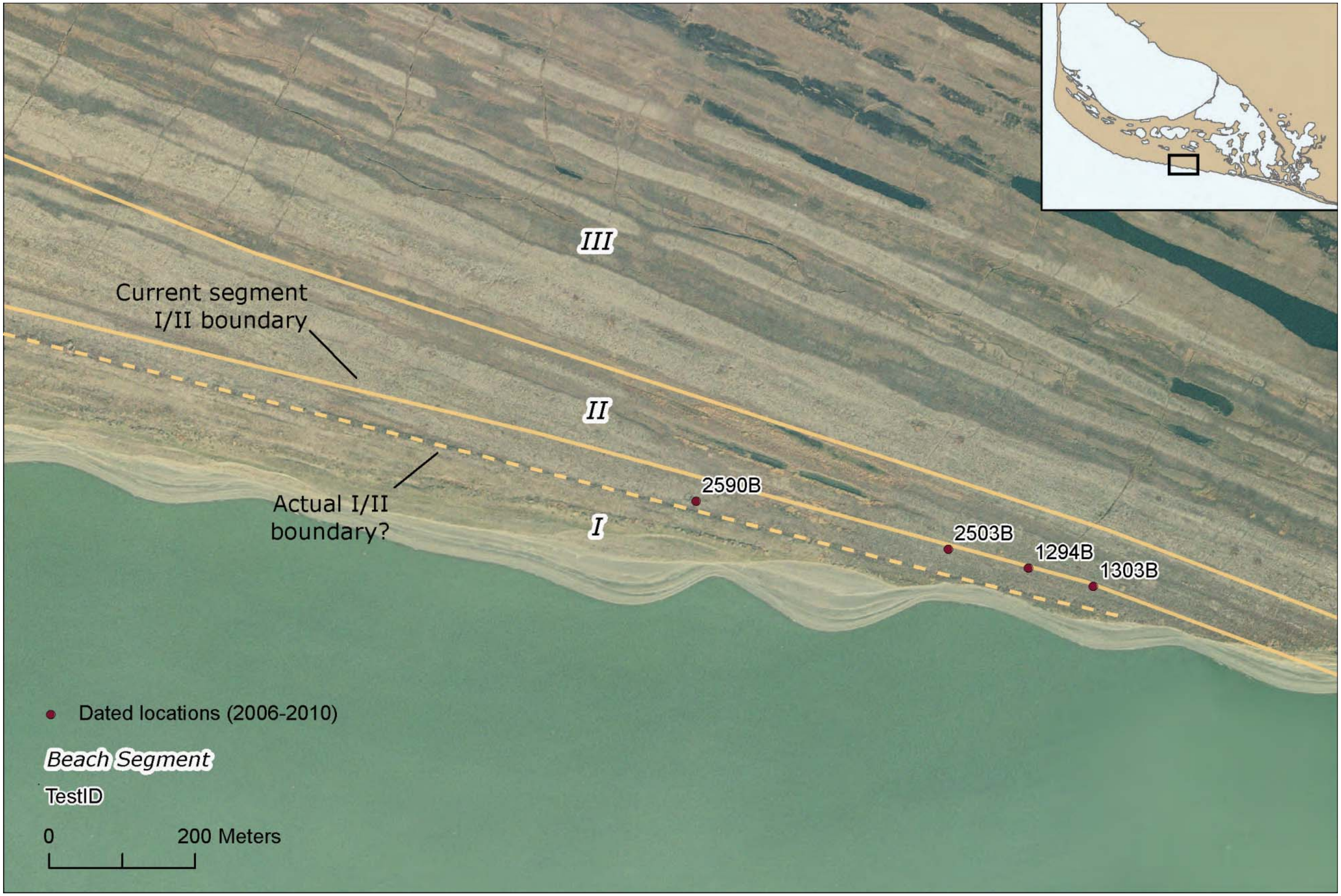

Figure 47. Example of beach segment discrepancies as determined by new dating results

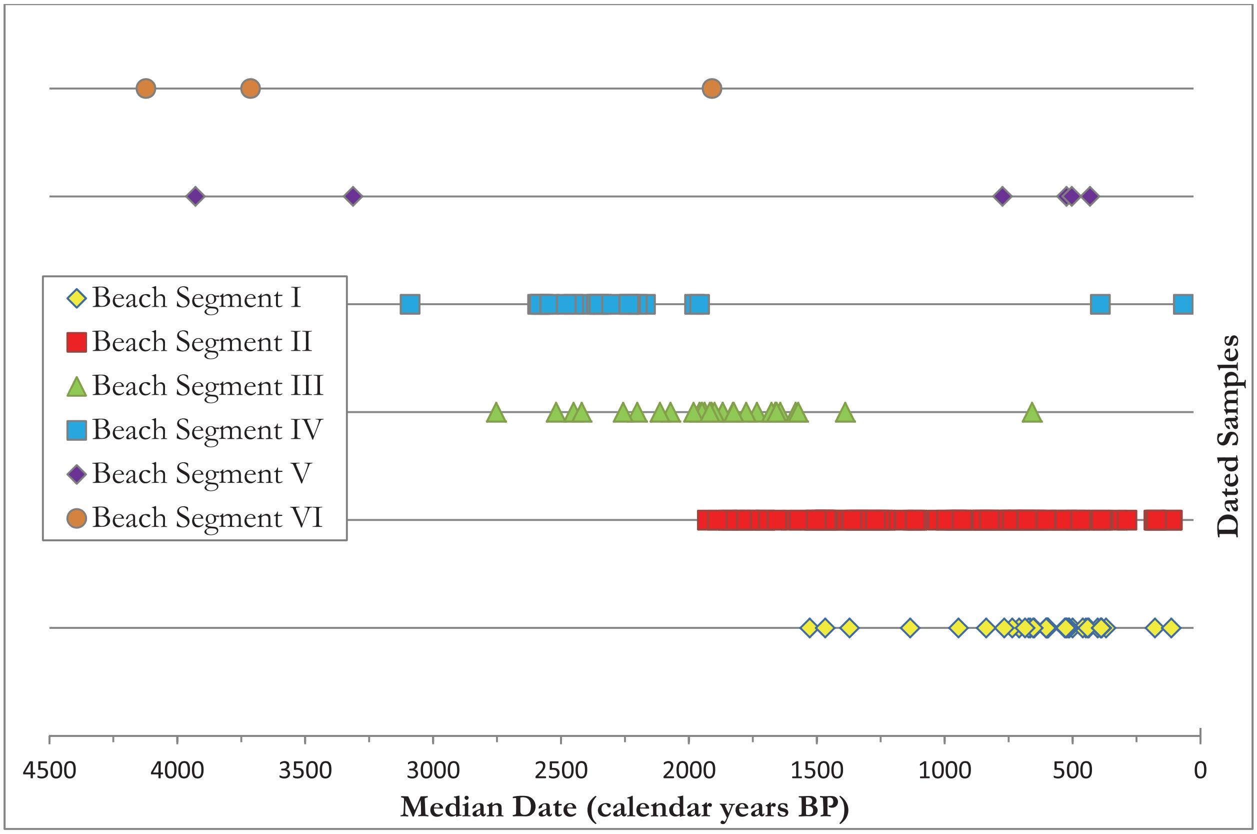

Figure 48. Calibrated median ages of newly acquired archaeological radiocarbon samples from Cape Krusenstern graphed by beach segment; n=242, outliers discussed in Section 8.2 excluded

The extensive survey coverage has yielded more features within the Cape Krusenstern beach ridges than were previously known. Radiocarbon dates from a sample of these features show that cultural occupation of the beaches, even if only seasonal, was nearly continuous from 3000 cal BP until the present day. The underlying principle of "beach ridge archaeology" and its use of horizontal stratigraphy as a chronological proxy was proposed by Giddings (1966, 1967; Giddings and Anderson 1986). It is based on the assumption that marine-adapted people will want to live close to the active beach. While this is assumption is adequate for tracking general chronology, it must not be confused with a pattern of landscape use. The radiocarbon dates presented in Figure 48 show that cultural use of the different beach segments overlapped in time for periods of 500 years or more. This reinforces the notion that prehistoric inhabitants of Cape Krusenstern may have built dwelling structures near the active beach but continued to utilize the whole landscape during their occupation.

Lastly, dates on materials from previously known settlements indicate that occupations spanned more time than was formerly thought. Most, if not all, of these settlements may be multi-component sites with occupations spanning several centuries. For instance, comparison of the published dates from the Early Western Thule settlement with newly acquired dates from non-house features (Figure 38, Table 16) obliges a reevaluation of the duration and other details of occupation of this locality. Based on artifact styles, Giddings and Anderson (1986) believe Houses 7 and 8 were probably occupied concurrently. They reported a date from House 7 as "about A.D. 1000" (Giddings and Anderson 1986:71), though this date is not included in their radiocarbon results table (Giddings and Anderson 1986:30). Houses 4 and 5 also share artifact styles and were thought to have been occupied more recently than Houses 7 and 8. House 6 is cautiously considered part of the House 4 and 5 group though charcoal from it dates to 1070 ± 100 BP (995 ± 115 cal BP). Six new dates were acquired from features thought to be cache pits on the same ridge as, and just west of, House 5 and one date was acquired from a feature thought to be associated with House 7 (Figure 38). As could be expected, the increase of dated materials and sample locations yielded a wider range of dates than the two dates previously published. The date from the feature associated with House 7 is younger than both the previous House 6 and House 4 dates. Because all of the houses were previously excavated, one way to approach questions of contemporaneity on a settlement level would be to subject existing house collections to radiocarbon dating. Additional dates from the house features themselves could then be compared to the stylistic analysis of the artifacts to help test hypotheses of contemporaneity. The dating of organic artifacts made from terrestrial mammal bone or antler might help eliminate issues confounding age range overlap, such as old wood. However, if terrestrial mammals were ingesting marine-derived carbon in the form of seaweed and other marine plants while near the coast, they may create additional problems. Unfortunately, we were not able to date existing collections at Brown, and so are unable to test these hypotheses at this time.

9.2 Settlement Patterns

Through their research at Cape Krusenstern, Giddings and Anderson (1986) identified a pattern of settlement change over the last 4500 years in coastal northwest Alaska. In general, people lived at or visited the cape for short periods of time between about 4500 and 2000 years ago. Evidence for this consists of small "campsites" – hearths, lithics, and pottery scatters – that indicate small groups of people spent a limited amount of time at the site until about 2000 years ago. There is no faunal preservation at the earliest sites, but lithic technology and data from other sites in the region led Giddings and Anderson (1986) to the conclusion that the site complex was probably seasonally occupied in spring or early summer. As discussed previously, the Old Whaling site, dated to around 2800 years ago, is a single exception to this pattern. The large semi-subterranean houses, shallow campsites, faunal material, and artifact assemblages at this unique site indicate that these people were living at Cape Krusenstern year-round. After 2000 years ago, the presence of semi-subterranean houses and associated features – particularly storage areas – indicate winter habitation at Krusenstern, along with continued spring/early summer use. Faunal and technological evidence indicates an increased focus and reliance on marine mammals. After about 1000 years ago, evidence from around the region suggests a dispersion of coastal peoples into the interior (Anderson 1984). About 500 years ago, settlement patterns change; in general the houses and settlements are smaller and somewhat dispersed. Around the region, sites of this period are located in previously unoccupied areas (Giddings and Anderson 1986). Giddings and Anderson (1986) conclude that more excavation of houses dating to this period at Krusenstern is needed in order to understand these changing settlement patterns.

Our study supports the general pattern identified through prior research. Early sites, dating to before 2000 years ago, are relatively few and are confined to hearth and surface scatters of lithics and ceramics. Later sites, particularly after 1000 years ago, include semi-subterranean residence structures and many associated features. Some associated features are probably storage features or cache pits directly connected to winter occupation of semi-subterranean houses. Other features probably represent activity areas and also spring and summer habitation. Faunal preservation at sites older than 2000 BP is poor or non-existent but post-2000 BP, faunal assemblages are much better preserved. Considerable potential exists for further evaluating hypotheses about season of occupation and subsistence activities through analysis of these faunal assemblages.

The number of features dating to after 2000 BP indicate increasing population at Cape Krusenstern, in addition to decreased mobility and multi-season or year round occupation of the coast. In general, feature tallies by beach segment, normalized by surveyed area, show much of the story (Figure 49). More features overall are found on each successively younger segment. The only exception to this trend is beach segment V, which has more features than either VI or IV. Hearths and surface scatters are the most abundant features in segment V, which are the same types as the vast majority of previously recorded features in this segment (Table 14). That there are more previously recorded features in segment IV than newly recorded features may be the result of site preservation, the location of the newly surveyed areas, or site visibility factors, including increased vegetation that has been observed within the beach ridges (Bob Gal, personal communication, 2012). While unidentified features make up most of the features in segments I, II, and III, houses and cache pits also increase through time. Of special interest is the number of cache pits in segment I with respect to houses. While frequencies of both are greater than in any preceding segment, cache pit frequency more than doubles in the last 1000 years. This is interpreted as further indication of increased duration of occupation and/or population increase, although this observation should be tempered with the data presented in the discussion of chronology. Since occupation of these beach segments was near continuous after initial occupation, these data are most conservatively interpreted as an overall increase in occupation of the site over time.

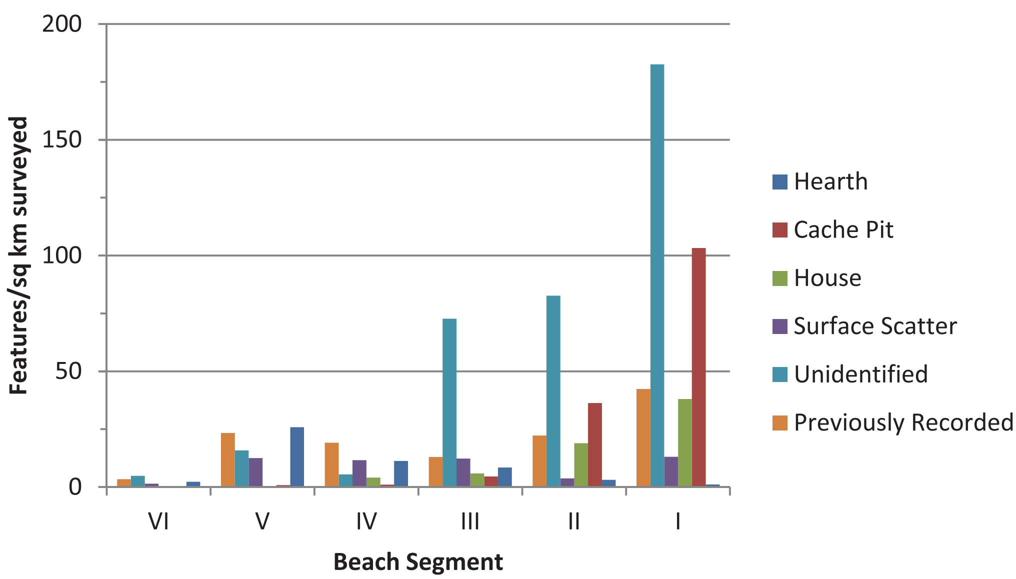

Figure 49. Feature types by beach segment

9.2.1 Newly recorded settlements

Western Thule/Kotzebue Periods

A possible new settlement (or settlements) at Cape Krusenstern was reported by Freeburg and Anderson (2011a). The features that comprise this newly reported area are stretched over 500 linear meters across five or more beach ridges (Figure 50; dated locations labeled with TestIDs may be cross referenced with dating results provided in Appendix VII). Based on beach ridge position alone, it was proposed that some of the features may date to the Western Thule period (1000-550 cal BP), while others are likely from the Kotzebue period (550-250 cal BP). Artifacts recovered from limited testing provide evidence of fishing in the form of net sinkers and fish bone. Initial faunal counts showed that fish bones were as much as 30% of NISP from this settlement. Previously reported faunal counts for Kotzebue period settlements at Krusenstern had the most fish recovered of any period, though the frequency was approximately 15% (counts on "minimum number of animals" [Giddings and Anderson 1986:318]). Fishing equipment is known from the Ipiutak period, though it is rare in the Cape Krusenstern collections, and no fish remains have reported. Planned tests of factors such as density mediated attrition may shed light whether or not this lack of faunal material is due to bias in the archaeological record or is a true reflection of subsistence practices.

Dating results for these features and those in the surrounding area reveal an interesting pattern (Figure 51). A small number of features on a prominent ridge 70 meters behind (lagoonward of) the small feature group are now dated to within the Western Thule period. The closest dated feature on this back ridge is approximately 500 meters from Early Western Thule (EWT) House 6. These features could indicate a small settlement possibly contemporaneous with occupations in the EWT settlements, or could be the result of EWT settlement inhabitants engaging in "off-site" activities. Excavation of these features would likely assist the interpretation of their function and role with regard to the EWT settlement.

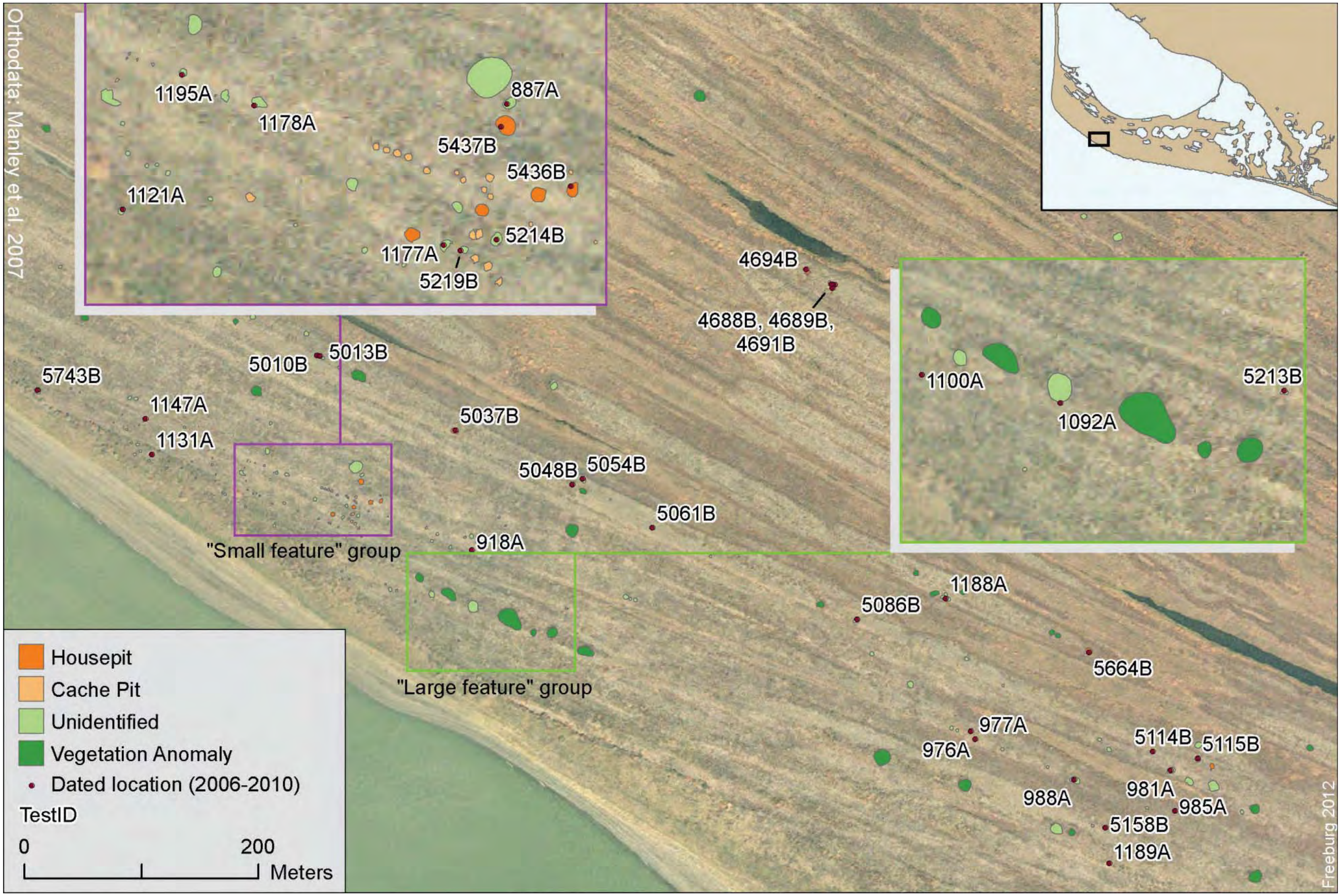

Figure 50. Locations of radiocarbon results from new settlement areas discovered in 2010

While faunal and artifact analyses at present indicate a Kotzebue period-related occupation of some of these features, the dating results also put some features into this period of prehistory (Figure 51). These results reinforce our hypotheses of multicomponent sites at Cape Krusenstern. It appears that locations, or individual features could have been used and re-used, over long periods of time. About 400 meters northeast of the “large feature” group is a set of features that date from approximately 500 to 100 cal BP (TestIDs 4688B, 4689B, 4691B, and 4694B; see Figure 50). Without excavation, it is difficult to interpret these features’ function with confidence, though one was classified as a house during survey. Regardless, this indicates that activity areas, and possibly settlements, were not always positioned on the front most beach ridge. With the help of an increase in the number of radiocarbon dates from the these features, further consideration and analyses of contemporaneous features across the complex may yield additional insights into landscape use during certain periods.

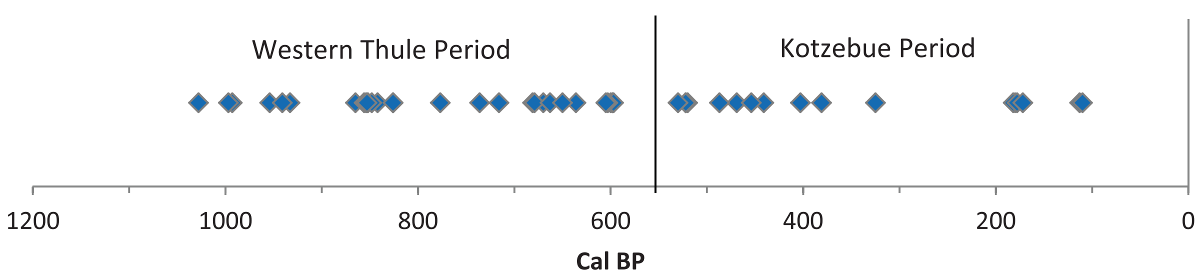

Figure 51. Calibrated median ages for the features shown in Figure 50

<u>Historic period</u>

In 2008, survey was carried out in the vicinity of Anigaaq, including on private tract CAKR-04-129, with the permission of the landowner (Anderson and Freeburg 2009a). Numerous houses and associated features were recorded on the south bank of the Tukrok River (Figure 52). Preliminary testing indicates that these features date to the era immediately before and/or during early contact with Euro-Americans or Russians (Table 19). Lithic debitage and bone and ivory tools were recovered from these features, in addition to blue glass Russian trade beads , various metal objects, and glass. The features recorded at the northern edge of this site, along the Tukrok River, are most likely historic in origin, based on information from community members living at a nearby camp.

Figure 52. Archaeological features on allotment CAKR-04-129

Table 19. Radiocarbon results from allotment CAKR-04-129

TestID	Catalog Number	Lab Accession	Material Type	Material Description	RC Age†	$\delta^{13}C$ (‰)	Calibrated Date§
346A	CAKR 13450	Beta-326110	Bone	*R. tarandus,* left palatine	163.5 pMC	-19.9	Modern
346A	CAKR 13454	OS-96755	Charcoal	*Salix*	175 ± 50	-27.4	A.D. 1649 - A.D. 1954
347A	CAKR 13475	OS-78544	Charcoal	*Picea*	175 ± 25	-24.01	A.D. 1661 - A.D. 1954
347A	CAKR 13477	OS-81438	Plant/Wood	Bark	130 ± 25	-24.13	A.D. 1678 - A.D. 1940
348A	CAKR 13490	OS-78545	Charcoal	*Picea*	260 ± 30	-25.27	A.D. 1520 - A.D. 1954
1723B	CAKR 13535	Beta-326111	Bone	*Phoca, cf. hispida,* left innominate	880 ± 30	-13.2	A.D. 1407 - A.D. 1502†
1723B	CAKR 13536	Beta-326112	Bone	*R. tarandus,* right humerus	60 ± 30	-17.4	A.D. 1693 - A.D. 1920
1736B	CAKR 13514	OS-78547	Charcoal	*Salicaceae-Populus/Salix*	175 ± 25	-24.67	A.D. 1661 - A.D. 1954

†Conventional radiocarbon age and standard error from NOSAMS and Beta Analytic results

§ Calibrated two sigma range using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 and Marine09 (Reimer et al. 2009)

9.3 Mitigating Factors

As mentioned above, there are limits to the interpretation of settlement patterns inherent in the use of survey level data. Relying on the surface expression of features for both estimates of original size and function is imprecise at best. It is well known that archaeological features at Cape Krusenstern can be subsumed by the formation of subsequent beach ridges. Additionally, the coarse gravel substrate is not ideal for preserving clean, crisp shapes over any length of time. It is possible that larger mapped features with adjacent smaller features are in fact multi-roomed houses with connecting passageways now obscured by post-occupation gravel deposition. House tunnels could have been similarly filled in, resulting in mis-classification of the present-day surface feature to cache pit or unidentified types. Unfortunately, this problem can only be solved through excavation. We found that one meter by one meter square test units were often insufficient for determining feature type, in part because of the depth of occupation layers and the tendency for the unconsolidated gravel to collapse when excavating. Confident determination of feature type will be the result of extensive excavation of a whole feature or a significant portion of it. Two feature types are particularly problematic: cache pits and unidentified features.

"Cache pit" is the most abundant identified feature type in our survey data. While the use of this term follows common usage in Northwest Alaskan archaeology, there are several issues to keep in mind. The term "cache pit" generally refers to subterranean storage features that often accompany house features and less permanent campsite features such as hearths or tent rings. At Cape Krusenstern, it is assumed that beach ridge inhabitants excavated these features within or adjacent to their settlement in order to store resources such as meat, blubber, or plant materials. Historic and ethnographic observations show that these features were sometimes lined with wood. Feature definitions followed by the current project, however, used size (less than 4 square meters, see Appendix I), regularity of shape, and spatial association with surrounding features as factors in classifying these features. Often, testing in these features yielded negative results, perhaps because contents were removed prior to the feature's abandonment. If wood lining was found, this supported the interpretation of the feature as a cache pit. However, cache pits, as with any feature, could have been reused and repurposed by their original creator or later peoples. Already existing pits could have been used for many things, including storage or refuse disposal. Later use as a midden could have sometimes prevented our identification of the original feature as a cache pit. These cautions imply that the interpretations of site duration and occupancy derived from new radiocarbon results could be misleading and reinforce the obvious point that feature types assigned from survey-level data collection are imprecise. That said, survey data can cover larger areas and a greater number of features, allowing for more robust statistical analyses. Keeping these cautions in mind, surveys such as this can provide significant data to complement existing or future excavation efforts.

The most abundant feature type in the survey data is "unidentified." For the first three beach segments, unidentified features are the most prevalent feature type, up to 5 times greater than the next known feature type (Figure 49). Unlike vegetation anomalies, unidentified features are clearly archaeological in origin (i.e. tested positive for archaeological material, or were deemed of cultural origin and closely associated with other known feature types), but their nature (e.g. house, storage) was not apparent when tested. The designation "unidentified" is therefore misleading. It is very probable that some of these features are houses, cache pits, burials, etc.

In order to better understand settlement patterns, and investigate the nature of unidentified features without further testing, the sizes of the recorded features were assessed. When viewing the frequency distribution of unidentified features by size, a trend is apparent (Figure 53). While large unidentified features were documented –11 unidentified features were over 100 m^2, and the largest feature was 288 m^2– the greatest number of unidentified features are less than or equal to one square meter in area. This may be partly due to GPS data collection errors, as some features recorded were smaller than the accuracy tolerances of the GPS unit. Some features also displayed a negative area in GIS. This occurred when polygon feature boundaries crossed themselves, resulting in an area calculation error. Often, this problem occurred on features with areas over one square meter in area that could easily be corrected. At other times, the unedited data was in the form of a "bird's nest polygon," in which there are numerous instances of the polygon's boundary crossing itself. Where possible, these features were redrawn in the lab using attribute data recorded in the field (Figure 54). The attributes of UnID 409C list the feature as a bermed oval depression approximately two meters in diameter. Because the GPS recorded feature was a bird's nest polygon (with an area of 0.00031 m^2) , the feature was redrawn to an oval with a diameter of two meters. If the shape of a feature was not able to be reconstructed from the attributes of a rogue polygon, the bird's nest was redrawn but kept to a small areal extent. In either case, a gross change in feature shape or size was recorded in the attribute data of the feature. Further analysis of areal and spatial trends of features is planned for forthcoming publications, since attributing unidentified features to other identified types has the potential to significantly change ideas of settlement patterning and population at Cape Krusenstern.

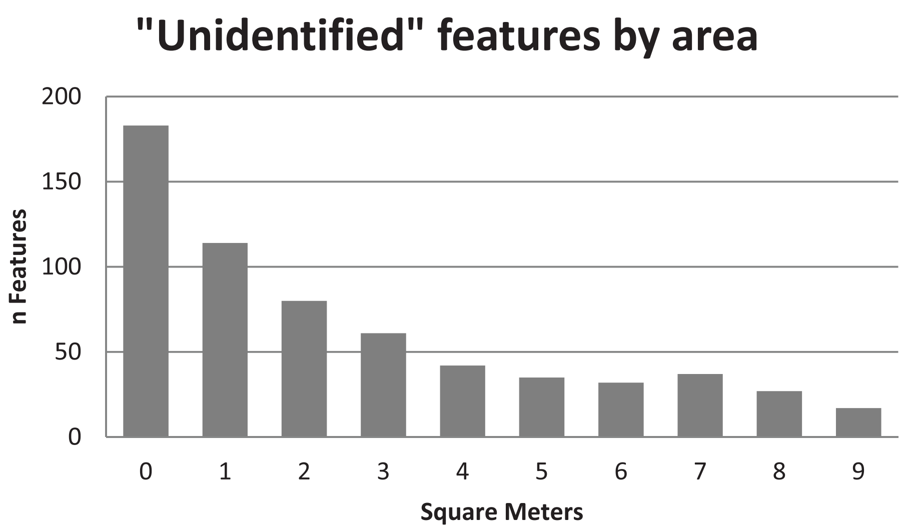

Figure 53. Frequency distribution of unidentified features by area

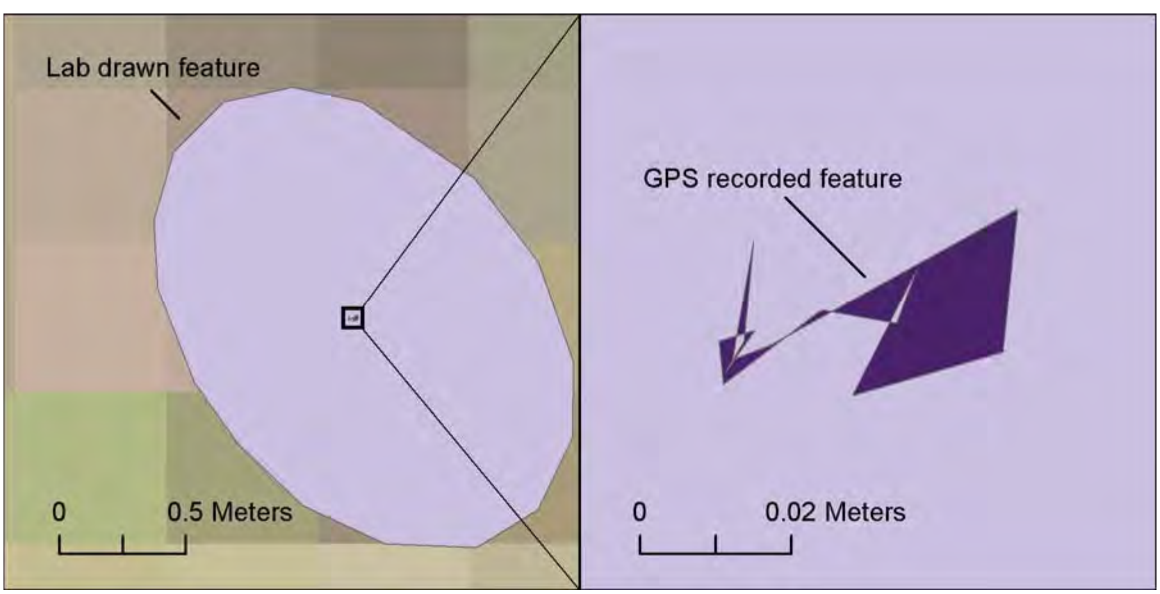

Figure 54. Unidentified feature shape derived from attribute data (left) and original differentially corrected GPS data (right)

A similar problem exists with the feature type "vegetation anomaly." A vegetation anomaly was defined as a vegetated area over five square meters that was different from the surrounding vegetation. Often these vegetation anomalies had a depression or mound within the vegetated area. A vegetation anomaly is a depression or mound for which no cultural materials were present on the surface or found within it during subsurface testing. Most vegetation anomalies are fairly large when compared to surface expressions of other feature types; less than 14% of vegetation anomalies recorded are under five square meters. All vegetation anomalies of this smaller size were recorded in 2006 as unidentified features. They were transferred to the "vegetation anomaly" type because they tested negative for cultural material. If the features included in this type are indeed of cultural origin, implications for population estimates through feature number and density must be considered. Over 85% of the vegetation anomalies were recorded in beach segments I or II (see Table 10). If even some of these features are actually cultural in origin, then the use of the Cape over the last 1000 years is even more intensive than our current analysis indicates. If vegetation anomalies are indeed cultural features, then possible explanations for the lack of cultural materials and/or stratigraphy must be considered. Faunal turbation from squirrel or fox burrowing and poor preservation conditions are possible culprits. If cultural material was present at one time, the complete absence of identifiable materials in any of these features would be surprising given the number of recorded vegetation anomalies. It is also possible that they are just better preserved in the more recent beach deposits. For example, if organic enrichment due to midden dumping is responsible for some or all of the vegetation anomalies, the nutrients would become exhausted over time and the surface cover would eventually revert to the normal vegetation cover. Shelby Anderson is currently working on a geochemical analysis that will assist in the evaluation of vegetation anomalies for cultural traces.

Additional considerations are warranted regarding the geological nature of the substrate and landscape evolution. The permeable nature of the large clastic substrate of the beaches allows the water table to fluctuate freely and rapidly. This may lead to poor preservation of organic materials over time. Large quantities of moisture within or near a cultural deposit may also affect some artifacts with seasonal freezing. This is especially a concern with permafrost levels that are currently falling across the Arctic. Previous recounting of archaeological excavation mention high permafrost levels in the beach ridges, such that excavation was sometimes halted for days at a time in order to let the deposits thaw. This was only observed a few times during the current project and shovel tests often reached one meter in depth without encountering permafrost.

Lastly, the chance exists for deeply buried deposits to be intact beyond the depth reachable with small test units. This possibility was explored in test units by digging a shovel test into the final level of excavation, which was by definition culturally sterile. The discovery of additional cultural deposits in excavated Old Whaling houses (Darwent 2006; Darwent and Darwent 2005) demonstrates the need to recognize the effects of rapid beach burial or other mechanisms that may cause deeply buried deposits.

10.0 Management Findings

A total of 194 sites were defined according to the criteria outlined above for the purposes of reporting to Alaska SHPO. Although ASMIS data was collected and entered in the NPS system by feature within site defined by the project – according to NPS guidelines – we summarize the data on a project-wide scale here to give the NPS a more holistic idea of the site preservation challenges within the entire beach ridge complex. ASMIS data collected included categories such as condition of the features, depositional integrity, threat level, and data potential. Summaries are given below for "Condition" and "Threat Type." These data, as well as those for other ASMIS categories, are available in the project GIS.

Condition of features ranged from "Good" to "Destroyed", with the most common condition of evaluated features being "Fair" (Table 20, see Appendix X for ASMIS condition definitions). Most of the features in the "Unknown" condition category are from the "Unidentified" feature type, with a large number also coming from "Cache Pit." The vast majority of these features were untested, providing no subsurface information with which to assess condition, integrity, and/or data potential. Only six percent of the cache pits and fourteen percent of the unidentified features in this category were tested.

Table 20. Feature tallies by ASMIS condition status

	Feature Type						
Condition	House	Cache Pit	Surface Scatter	Burial	Hearth	UnID	Totals
Good	34	118	12	3	4	123	294
Fair	32	34	7	1	9	280	363
Poor	13	10	13	1	5	31	73
Destroyed	19	13	2	3	20	16	73
Unknown	55	154	3	3	4	294	513
No Data	30	42	68	2	59	100	301
	183	371	105	13	101	844	1617

Of the ASMIS threat types identified as having potential impact on the documented archaeological features, a variety of types within the "Natural Forces" category were most often cited. Since the UW crew received no training in ASMIS evaluation, consistency in ASMIS data collection and recording was an issue. For instance, the difference between ASMIS code "NF01, Animals" and "NF29, Bioturbation" was not obvious. Similarly, "NF04, Rodent Activities" could be considered nearly the same as "NF29, Bioturbation", since the most frequent bioturbation encountered in archaeological sites at Cape Krusenstern involve arctic ground squirrels (order *Rodentia*). However, musk oxen were also found to be responsible for disturbances in some sites. In cases where more than one threat type was found to be possible, the code "NF00, Natural Forces – General" was used. Therefore, disturbance from animal activity could be represented by any of these codes using our interpretation and application of threat types. Few ASMIS data were collected in 2006, and have a "Null" entry in GIS file attribute tables. These cases, and where this information was inadvertently omitted in subsequent years, were counted as "No data." in Table 20 and Figure 55. Additionally, some features were recorded as being subjected to several threat types instead of being assigned the "NF00" code, and so may be tallied in several threat types. In addition to the codes shown in Figure 55, other types of threats recorded in numbers too small to be graphed can be seen in Table 21.

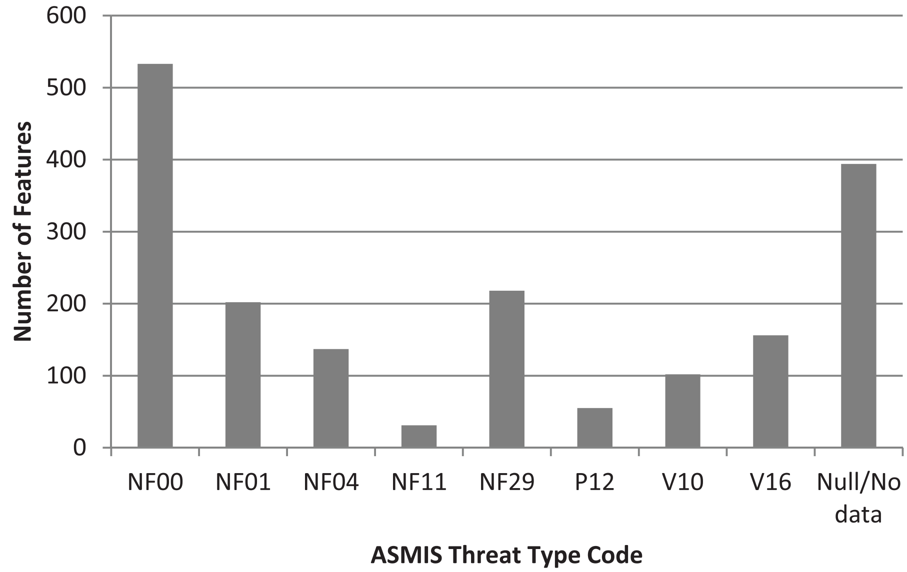

Figure 55. Feature tallies by ASMIS Threat/Disturbance Type

Table 21. Feature tallies by ASMIS Threat/Disturbance Type

Threat Code	Threat Description	Totals
NF00	Natural Forces - General	533
NF01	Animals	212
NF04	Rodent Activities	137
NF11	Tsunami	68
NF12	Erosion - General	3
NF13	Erosion - Wind	3
NF14	Erosion - Water	1
NF24	Marine Environment	1
NF27	Cryoturbation	1
NF29	Bioturbation	218
P12	Previous Scientific Research	55
V10	Theft or Looting	102
V16	Social Trails	158
Null/No data		399

Along with threats from natural forces, we found two other categories of threat types present. Under the category of “Park Operations” is code “P12, Previous Scientific Research.” This code was used in cases where we observed features that were confirmed, or suspected to a high degree, to have been excavated by prior archaeological research projects. These were also the features assigned the condition “Destroyed.” However, Darwent’s (2006) discovery of cultural materials beneath an excavation floor in an Old Whaling winter house indicates that even features perceived as destroyed may still have archaeological potential. The other perceived threats to the archaeological features come in the form of visitors to the Monument. Very few of the features encountered showed signs of “subsistence digging.” However, archaeological features can have very obvious surface expressions, and the threat of future looting must be considered. Possibly of greater and more pressing importance is the disturbance caused by local ATV trails, especially those near or along the active beach that see frequent seasonal use. In several cases, ATV trails went directly through archaeological sites or features. In one instance, the disturbance caused disinterment of a skeletal element from a human burial. Snowmobile tracks were also documented as disturbing features in the central ridges of the complex, which is the location of a winter coastal trail (Figure 56). This will be an increasingly encountered factor in management, as coastal erosion is removing large portions of the well-established ORV trail along the seaward ridges. As trail sections are eroded, the trail is forced to an alternate route farther inland. This has the potential to disturb additional cultural features.


Figure 56. Snowmobile track through an excavated hearth (Photo: P. Reed)

Two additional threat/disturbance codes were included in the project data dictionary in 2006 and briefly in 2008, but UW does not have definitions for them. Code “NP11” was used primarily in 2006, but is not present in the ASMIS definitions provided to UW. The code was also used a handful of times in the 2008 season. We believe that the code was entered incorrectly into the project data dictionary and is meant to be “NF11, Tsunami.” This error was likely noticed in the field and changed early in the 2008 season, but no documentation can be found that refers to this alteration. Since tsunamis are highly unlikely to have impact sites in this region, use of this code may have been in error. Code “OT06” was also used twice in 2006 data. We believe this is meant to be “O06, Motorized Equipment”, which we interpret to document similar threats as “V16.”, so “OT06” entries are included in the “V16” total. These codes are encountered through a drop-down menu within a data entry field when collecting spatial and attribute feature data on a GPS unit. An incorrect code (e.g. NP11 instead of NF11) cannot be changed on the GPS unit without a computer interface. Additionally, the codes displayed by the

GPS do not include their definitions (e.g. motorized equipment, tsunami). Data entry errors could come from the GPS user entering an incorrect or misremembered code, as well as the existence of a non-existent code that mistakenly appears as a choice in the drop down menu.

11.0 RECOMMENDATIONS FOR FUTURE WORK

11.1 Research Recommendations

The work presented here is only the latest in a long series of research and management activities carried out on the lands that are now within the Cape Krusenstern National Monument. This effort builds on prior work, and suggests some interesting and exciting new directions for activities outlined below.

Of critical importance is the incorporation of geomorphological data with the archaeological data presented here in order to address questions about past human-environment interactions. We expect some alteration of the units of analysis used in this report based on new information about depositional units to be outlined as a result of the geomorphological work. The authors are currently engaged in efforts to integrate archaeological and geomorphological results with Jim Jordan, the project paleoecologist/geomorphologist.

A comprehensive ethnographic study of local place names and history at Cape Krusenstern is needed, with some of this work directed toward collecting data about subsistence, climate/environmental change, and general land use practices. Collation and publication of unpublished enthographic data would alone be a significant contribution. As the older generation who lived permanently or seasonally at Cape Krusenstern dwindles, the need to interview these elders takes on increasing urgency. Existing data includes a NANA place names study conducted in the 1990s and likely archives of Tiger Burch's work (Eileen Devinney, personal communication 2012).

Areas of the beach ridge complex not investigated by the current project should be surveyed for archaeological resources (see Figure 8). Based on legacy data, the area between the main survey areas of 2008 and 2009 is expected to have a high density of cultural features. Fewer resources are likely to be found in the low-lying eastern portions of the beach ridges that remain unsurveyed. However, the possibility exists for additional Denbigh period sites on ridges closer to the lagoon in this part of the beach ridge complex. Since fewer sites overall were found in the older beach segments, each one maintains an increased importance to the archaeological record. In younger segments, we expect the eastern portion of beach ridges to have a low probability of archaeological resources, but a few high ridges are present in these areas that could hold as yet unknown sites. A probable Kotzebue period settlement located on private property was observed on the east bank of the Tukrok River. This find suggests that survey of the shores of the river may be more productive than previously thought. In addition to seeking permission from allotment owners to investigate this site, future researchers could survey for additional sites along the river edge. Forthcoming geomorphological data on the age and evolution of landforms within the river system at the western edge of the beach ridge complex would further inform this type of survey.

Additional analyses of recovered material would be productive. Several derivative research projects are in process or planned (e.g. lithic, ceramic, and soil geochemical analyses by Shelby Anderson, faunal and subsistence analyses by Adam Freeburg). Analysis of existing collections at Brown, including basic documentation and publication of the other materials housed there (e.g. bags of unanalyzed lithic debitage, faunal material), would greatly enhance the existing body of research conducted at Cape Krusenstern. On-going efforts by Haffenreffer Museum staff and other researchers (e.g. Christyann Darwent) to further organize and analyze these collections, coupled with the new spatial data yielded by the current project, means that analysis of previous collections from the beach ridge complex will yield valuable new data.

Still, some questions are not answerable with existing collections, either those at Brown or those collected by the current project. The research potential of the older collections will always be limited by the lack of information on collection methodology. Non-systematic collection of fauna and other artifacts (Doug Anderson, personal communication, 2008), though accepted methodological standards at the time, biases future analyses of those collections. As such, excavation is recommended as an avenue to further address some of the research questions outlined in this report as well as those raised by the broader research community. It would be logical to follow this project's survey-level investigation with partial excavations of house and midden features from each culture period to systematically recover well-provenienced artifacts for study. In particular, the lack of records and data from Kotzebue period settlements makes interpretation of culture change after the Western Thule period difficult. Better understanding of these transitional periods would help address larger questions about past human-environment interactions. Giddings and Anderson first recommended additional excavation more than 20 years ago (Giddings and Anderson 1986:56), recognizing the limitations of their own work. The same holds true for the current effort.

Some of the earliest coastal sites in northern Alaska are found at Cape Krusenstern, and these sites may hold keys to improving the understanding of the development of maritime adaptations in the North American/Beringian Arctic. The antiquity of these coastal sites, coupled with the near continuous subsequent occupation, make further investigation of Choris, Norton-Near Ipiutak, and Denbigh sites at Cape Krusenstern important. Although the number of sites dating to these cultures is currently small, additional survey in un-surveyed regions of the beach ridge complex and analysis of existing collections could do much to contribute to questions about the development of coastal lifeways in this region. Data thus far suggests that the beach ridge complex was not ideally situated for whaling in comparison to settlements on the outer coast such as Wales and Point Hope. As such, a regional comparison of subsistence activities and technology between these locations and contemporaneous occupations at Cape Krusenstern could further contribute to study of maritime adaptations, particularly the development of whaling. Related to these questions is the fact that much remains to be learned about the cultural relationships between Ipiutak, Birnik, and Thule peoples on the mainland and other Bering Straits cultures (e.g. OBS, Okvik, and Punuk). Future excavation at Cape Krusenstern could address this issue through studies of interaction with the broader region.

In addition to Jim Jordan's geomorphological and paleoecological work in connection to the current project, continued paleoecological work at Cape Krusenstern and in the surrounding region will be important in further addressing questions about changing climate and environment over the last 4000 years. Recent paleoecological research in northwest Alaska, outlined in the background section of this report, indicates that the environment was particularly variable in this mid-to-late Holocene period. Additional research directed at collecting and analyzing paleoecological data from the Cape (e.g. pollen, macrofossils, diatoms, etc.) would likely be productive, particularly with respect to developing a local record of the highly regionalized late prehistoric paleoenvironment.

11.2 Management Recommendations

Results of this research indicate some key areas and directions for future management of the archaeological resources within the beach ridge complex of Cape Krusenstern National Monument. Recommendations include the mitigation of natural destructive processes, additional legacy data compilation, continued collaboration with local community members, and use and maintenance of the archaeological GIS.

Archaeological features along the active beach are currently subjected to coastal erosion and should be of immediate concern. Coastal erosion is expected to increase in the future, with climate change related shifts in storm systems, sea level, and permafrost. In areas where our survey included the interface with the active beach, we found rapid erosion occurring (Figure 57). However, portions of the active beach interface remains unsurveyed (Figure 8), so archaeological remains being threatened and actively disturbed may be yet undocumented. An initial response may focus on survey of the active erosion scarp by foot and ATV to locate, map, and record all features currently disturbed by or under threat from erosion. This would greatly aid mitigation efforts and decisions on data recovery and/or acceptable losses of the archaeological record.


Figure 57. House feature eroding at active beach scarp (Photo: S. Anderson)

To complete legacy work as compiled by this project, and to aid in future management – including the facilitation of researcher access to collections– we recommend that NPS create a catalog of artifacts from Cape Krusenstern at the Haffenreffer Museum. These collection files should be incorporated into the legacy GIS created by the current project. Additional information held by the Haffenreffer and any other institutions should also be added to make the GIS a more comprehensive instrument for research and management. Documents not recovered or accessed by the current project but known to exist include field notes, photographs, and possibly video film (Giddings and Anderson 1986). These materials could be used to provide insight into questions of prior field and laboratory methodology as well as clarify some of the discrepancies regarding legacy features and artifacts that cannot be resolved at this time. These materials are also an important part of the research history at Cape Krusenstern, and could be useful for NPS staff in interpreting the site and research history to the public. This older documentation could be used to further assess long-term changes to site condition, vegetation, and/or permafrost levels over the past 60 years.

As part of this effort, the NPS should work with the Bureau of Land Management and Brown University/Haffenreffer Museum staff to establish ownership rights and responsibilities for the Cape Krusenstern collections held at Brown. It is unclear to interested researchers whose permission and/or collaboration is needed in order to obtain research access to collections. Online access to photographs and digital catalogs (as many other institution now offer) for the Cape Krusenstern collections at the Haffenreffer would do much to enhance engagement with these materials by the research community and the public.

Continued communication and collaboration with private allotment holders, especially those who have yet to give permission for archaeological survey, is recommended. Together with the completion of the beach ridge complex survey as mentioned above, access to private allotments is needed to provide a complete inventory of archaeological resources within the beach ridge complex. This continued work with private landholders should also include conversations regarding resource stewardship and prevention of site degredation due to non-systematic excavation. While few, if any, features we identified had been subjected to recent subsistence digging, looting, or other modern disturbance, the possibility of future destruction still exists, and destructive digging in archaeological sites by non-archaeologists is almost surely occurring. Working with landowners on the documentation of their private collections may be one way to mitigate the impacts of digging and to educate Monument visitors and the community about the importance of site preservation. Any future research at Cape Krusenstern should build on the community involvement efforts of the current project; there is a strong desire on the part of the community to have community members, particularly middle and high school students, involved in archaeological research. Given the proximity of the beach ridge complex to camps, both locally and at Sisualik, as well as the town of Kotzebue, it should be relatively easy from a logistics perspective to further include community members in fieldwork.

More training and park specific guidelines on ASMIS and ANCS+ data collection/entry for NPS collaborators would improve these aspects of the project, particularly with regard to reporting efficiency. NPS staff worked closely with us over the course of the project in an effort to assist us producing the management data requested as part of the project. Nevertheless, changes in NPS procedures over the course of this 5 year project and lack of training for the UW team in these NPS-specific processes may have reduced consistency in ASMIS data collection and in cataloging procedures. Simplified guidelines developed for the WEAR parks, and specific to cultural resources found in these parks, would be an asset in future collaborative efforts. The lengthy, nation-wide resource documents for ASMIS and ANCS+ are too non-specific to use effectively for WEAR purposes by collaborators.

Despite the high financial costs of mapping grade GPS equipment, it is becoming more common in archaeological practice. The financial cost is heavily outweighed by the spatial accuracy yielded, as well as by the speed with which complex attribute data can be recorded. There are additional reasons why the use of mapping grade GPS is valuable within the Cape Krusenstern beach ridge complex. First, it increases the efficiency of data collection so that more spatial data can be collected in less time. For example, because the speed of recording simple points with minimal attribute data can be limited to less than 15 seconds, the location of negative shovel test pits excavated during this project were recorded in addition to positive ones. The recording of all subsurface tests aids the documentation of the location and amount of disturbance of biological resources such as vegetation and soils. Second, it has the added benefit of providing precise survey coverage areas that will prove helpful for management and future research. We recommend that this procedure be followed in future investigations here. Additionally, now that a GIS exists for archaeological research at Cape Krusenstern, it behooves both park managers and researchers to integrate all activities and findings into this GIS. This is most efficiently done by recording positions, and ideally attribute data, with a mapping grade GPS. The accuracy of attribute data is best when collected at the same time as the spatial data. While only limited attribute data can be entered into the GPS data field, more extensive information can be recorded in field notes and added at a later date within the GIS.

Finally, we strongly suggest continued use and maintenance of the Cape Krusenstern archaeological GIS. The GIS is best considered a living database that should be continually updated as work is performed. The areal limits of future survey coverage can be added, as can future mapping and excavation activities. Continued inclusion of ASMIS categories within feature attribute tables will be useful for both planning and reporting purposes, as shown by this project.

12.0 Conclusions

Field and laboratory research of the Cape Krusenstern beach ridge complex since 2006 has contributed to archaeological research by providing greater understanding of prehistoric human activities across a landscape that is only afforded by large scale, systematic survey. This project has:

- Identified numerous previously unknown archaeological sites and features
- Refined the site settlement model and chronology
- Collected highly accurate geospatial data for over 2500 features, both newly identified and verified legacy locations, that are important for research and management purposes
- Successfully integrated legacy data, which both contributes to the findings detailed here and expands the potential of future research on existing collections
- Created an archaeological GIS that can be utilized for research and management needs
- Raised community awareness of archaeological research at Cape Krusenstern and increased local involvement in and knowledge of archaeological research

In reference to the goals set for this project (see Section 4.0), the extensive radiocarbon dating effort afforded by newly collected materials as well as the reintegration of legacy data completed through the course of this project allows a strong re-evaluation of settlement patterns and culture history as proposed by Objective 1. Logistical and technological support from NPS during the three field seasons permitted UW crews to efficiently collect spatial and condition information outlined in Objective 6. This information is called upon directly in our management recommendations (see Section 11.2) and will be accessible to resource managers after the transfer of the project GIS to NPS. Together, the successful completion of these objectives contribute significantly to continuing efforts to evaluate human and environmental interactions as stated in Objective 2. Lastly, we feel that the community outreach portion of this project, Objective 7, has been very successful. Unfortunately, NPS staffing changes and other administrative difficulties prevented local volunteer participation in fieldwork. However, the participation of Northwest Arctic Borough School District administrators, teachers, and students, as well as federal and local agency members, in the planning and execution of outreach products has been a rewarding experience, and we look forward to continued collaboration.

Recognizing the possibilities and limitations with regard to the work presented here, we recommend the following:

- A ethnographic study of Cape Krusenstern and vicinity, focusing on place names and history, conducted in collaboration with local residents
- Completion of archaeological survey in areas of the beach ridge complex not investigated by the current project
- Continued archaeological work, including artifact analysis with existing collections, new excavation, and legacy data integration
- Resolution of ownership and curatorial rights and responsibilities of Cape Krusenstern National Monument collections at Brown University
- Expedient action on sites threatened or actively disturbed by coastal erosion
- Continued data collection with mapping grade GPS, and integration of new data into the existing GIS
- Continued communication and collaboration with local communities, in particular private allotment holders within the Cape Krusenstern National Monument

13.0 Acknowledgements

The project "Human-Environmental Dynamics at Cape Krusenstern" has been a successful and rewarding endeavor thanks to the contributions of many people. The work would not have been possible without support from Bob Gal, Eileen Devinney, and Ben Fitzhugh. NPS-WEAR staff provided assistance in a myriad of ways. Maintenance staff Ed Viglione and Alfred Weyiouanna maintained ATVs and boats, and assisted with field camp set up in 2009. Along with Ed, NPS biologist Marcy Johnson helped organize the 2010 in-field ATV training. NPS ranger/pilot Dan Stevenson provided bear and firearms safety training annually. Sarah Miller, Valerie Atkinson, Robbie Everett, Chip Fields, and Lois Miller helped with day to day safety checks and logistics. Linda Jeschke and Gina Hernandez assisted with various aspects of this project, including coordination of public presentations and outreach product development. We appreciate the support and assistance given to this project by Mike Holt. Computing services were provided by the Center for Studies in Demography and Ecology at UW. Thanks to Tim Rast, Kim Franklin, and Roswell Schaffer for arranging and carrying out artifact replication for the education kit. The Burke Museum Education Department was integral in developing educational outreach products. Legacy data work would not have been possible without the invaluable assistance of Doug Anderson and the access to materials housed in the Circumpolar Studies Lab at the Haffenreffer Museum at Brown University provided by him and Kevin Smith. Thanks, of course, to our field crews, lab students, and hourly workers. Many thanks to the Kotzebue and Krusenstern communities, including Herbert Foster and his family, as well as the Wilson family.

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15.0 APPENDICES

Appendix I

Feature Definitions

(From Human-Environmental Dynamics at Cape Krusenstern: Archaeological Field Methods and Procedures, Summer 2010)

Feature Definitions used in the field to determine how features will be recorded

Artifact:

1) Isolated surface artifacts
2) Diagnostic surface artifacts either w/in or outside of other features (eg. Surface scatters).
3) Surface artifacts found in association w/features or other surface artifacts but at a very low density ($<3/25m^2$).

Fauna:

1) Isolated surface faunal material, eg. Single whale vertebra
2) Surface faunal material found in association w/features or other surface artifacts but at a very low density ($<3/25m^2$).

Hearths: recorded as points rather than polygons because they are typically small enough that a polygon would be within the error on the GPS collection resolution.

1) Concentration ($\geq 5/1m^2$) of any or all of the following: fire modified rock, charcoal, burnt artifacts (eg. burnt bone).
2) Other – possible hearth

Human Remains:

1) Human remains exposed on the surface
2) Inadvertently discovered human remains

Monument: NGS, BLM allotment marker (brass/rebar/jelly plate), NPS tidal control, archaeological datums (rebar and cap), other (wood).

1) official survey and archaeological monuments

Point Generic:

1) Objects/points that do not fit in any other categories

Test Pits: Shovel Test (<50cm diameter round hole), Shovel Scrape (shovel used to remove sod from 1-2 m^2 area), Test Unit (1x1 m or 2 x 1 m square units excavated w/shovel and trowel), Previous Excavation (previously excavated shovel tests, shovel scrapes or test units), results left blank for previous excavations.

Vertical Posts:

1) vertical posts buried in ground. Could be dog stakes, trail markers, old drying racks (partial), etc., usually wooden.

Burial: Buried w/marker (wood, bone, rock, other: then describe), Buried w/o marker (subsurface), Surface Open, Surface coffin.

1) Known burials – report in oral history or written documentation as burials

2) Burial – indicated by stacked wood, whale bone, or other ethnographically (or archaeologically) known burial marker
3) Inadvertently discovered burial

Surface Scatter: Lithic, Rock Alignment, Pottery, Faunal, Historic, other
1) Surface artifacts found together at a moderate to high density ($>3/25m^2$).

Vegetation Anomalies:
1) Vegetated areas ($>5m^2$) that are different than the surrounding vegetation, with a regular shape/appearance. May have a slight or deep depression or mound w/in the vegetated area. Have the appearance of cultural features, but no cultural materials are found upon further investigation (surface examination or subsurface testing).

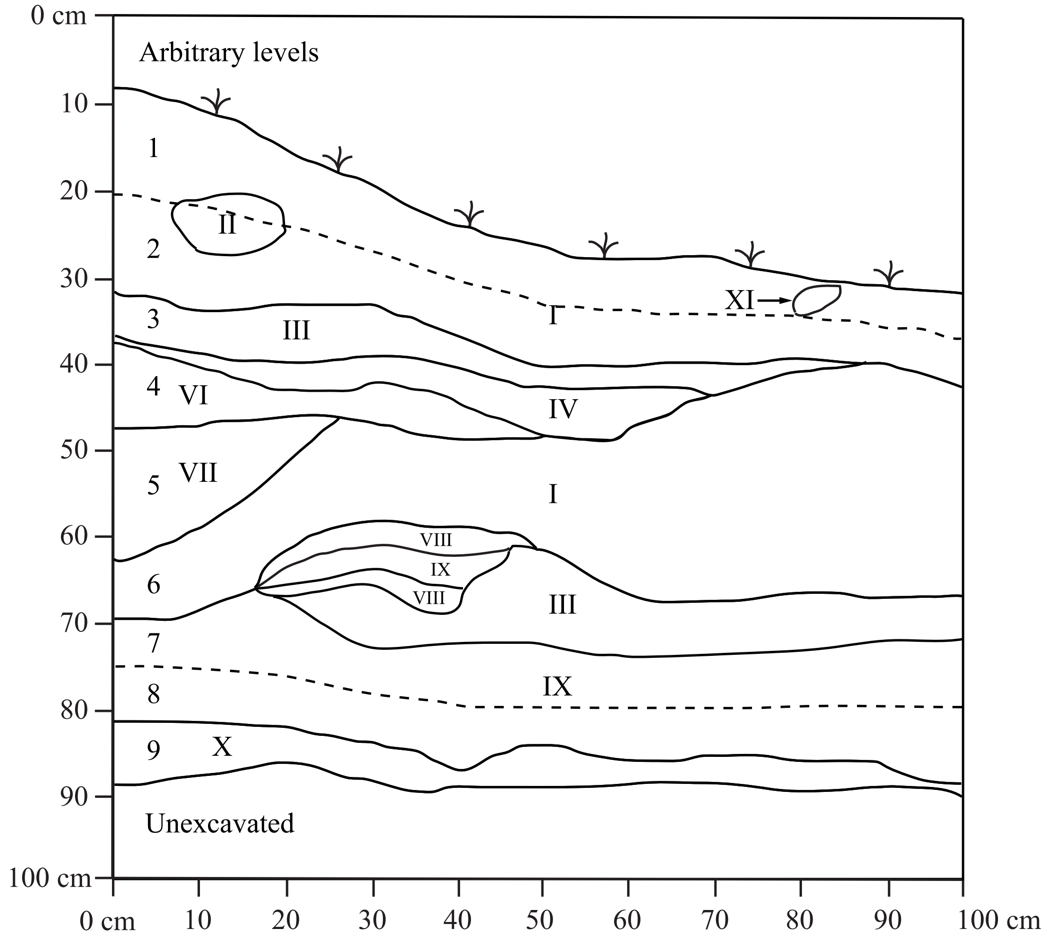
Unidentified Features:
1) Isolated depression feature – could be a single house, could be storage features associated w/more ephemeral occupations. Can't tell the difference w/o further testing.
2) Surface or subsurface cultural features that do not fit in any of the other feature categories.

House Pit: Minimum arbitrary house dimensions derived from data on previous house excavations at CAKR (Anderson 1962).
1) Large (≥ 4 m^2) surface depressions that may have the following features: multiple rooms, tunnel(s), and/or associated features such as cache pits, surface scatters, or vertical posts.

Cache Pit
1) Small ($<4m^2$ when unexcavated) surface depressions that may be circular or square in shape, and are usually associated with a house feature, other cache features, or other features.

Appendix II

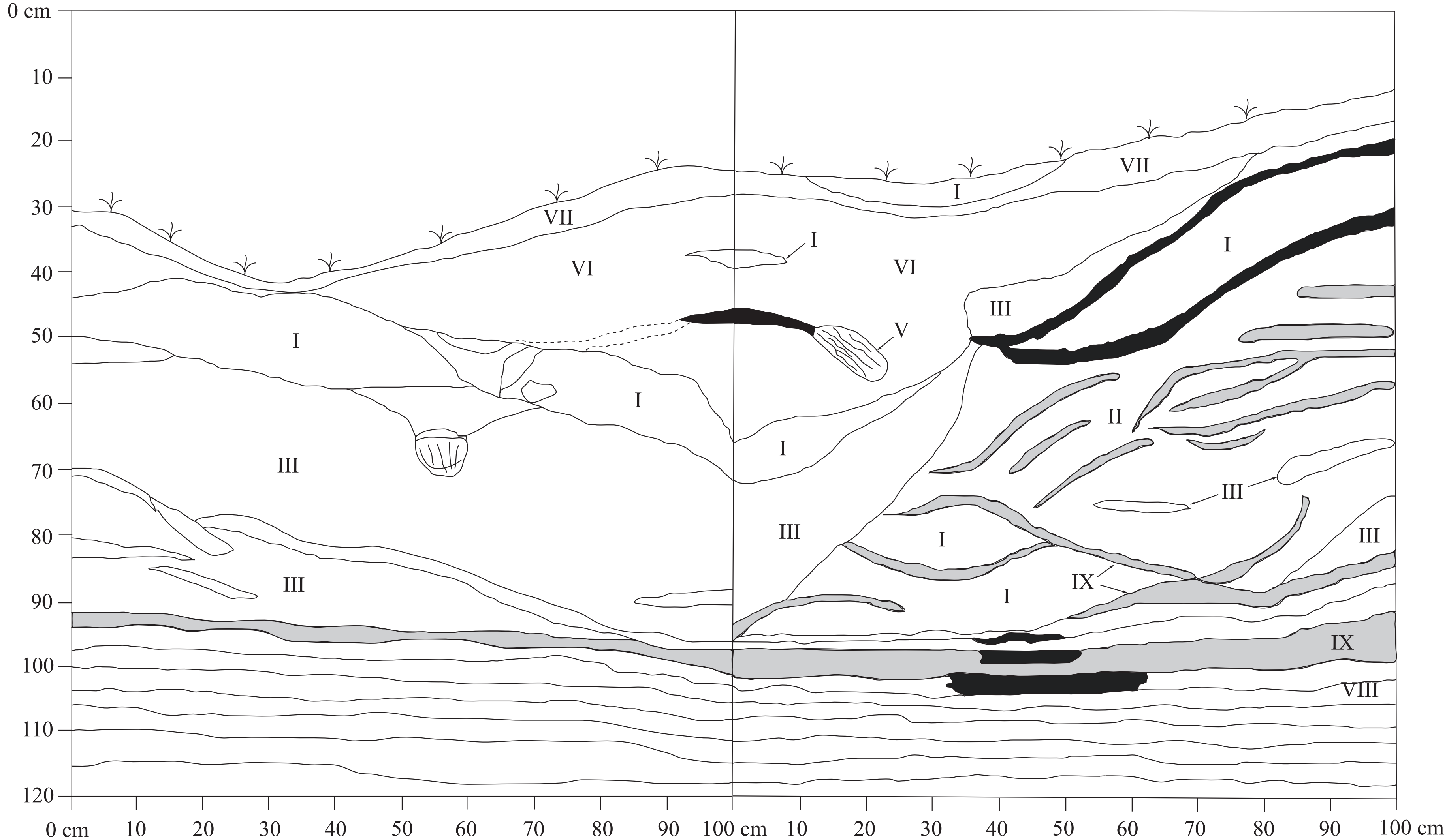
Test unit profiles



I. Gravel
II. Dark gravel
III. Gravel with roots
IV. Condensed wood and roots
V. Wood layer
VI. Gravel and sand
VII. Dark soil with roots
VIII. Gray sand
IX. Small gravel
X. Large gravel
XI. Wood

CAKR 2008
2XH072209A
Test ID 346A
East Wall Profile
RBW/JKG 7/25/08

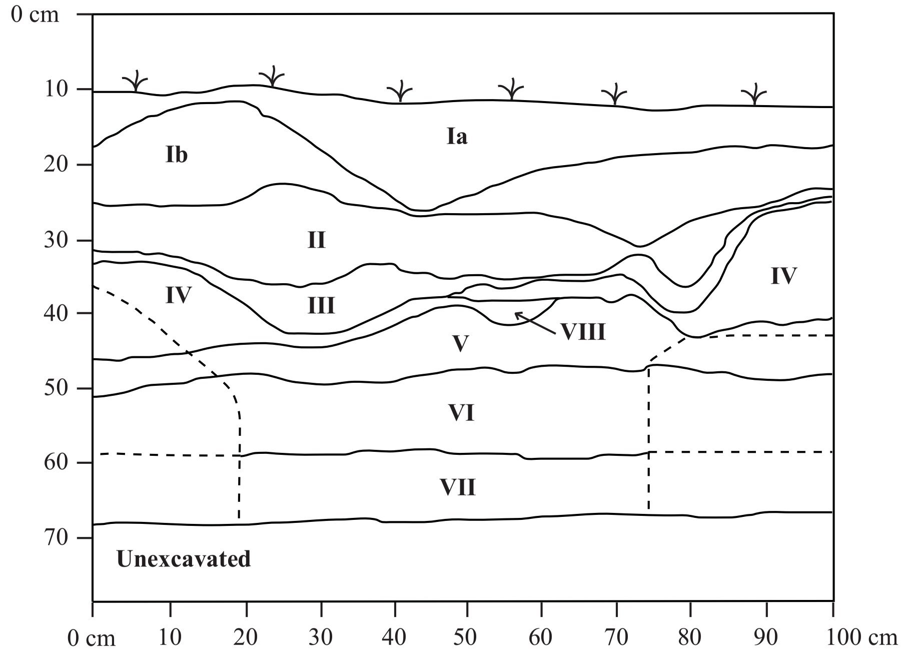
Figure by Dave Hunt 2/27/2010



I. Gravel
II. Gravel with light brown sand lenses, with deposits slanting down from the NE to the SW
III. Sand and gravel
IV. Dark sed organics
V. Wood
VI. Brown sediment wtih gravel (< 1/4 inch)
VII. Sod
VIII. Bedded gravel, sand, and sandy gravel, with orientation more horizontal than upper deposits. Dark, organic rich deposits (IV) found at center of north wall.
IX. Sand

CAKR 2008
08GEOXH 072209A
Test ID 347A
West and North Wall Profiles
PWR/NCR 7/24/08

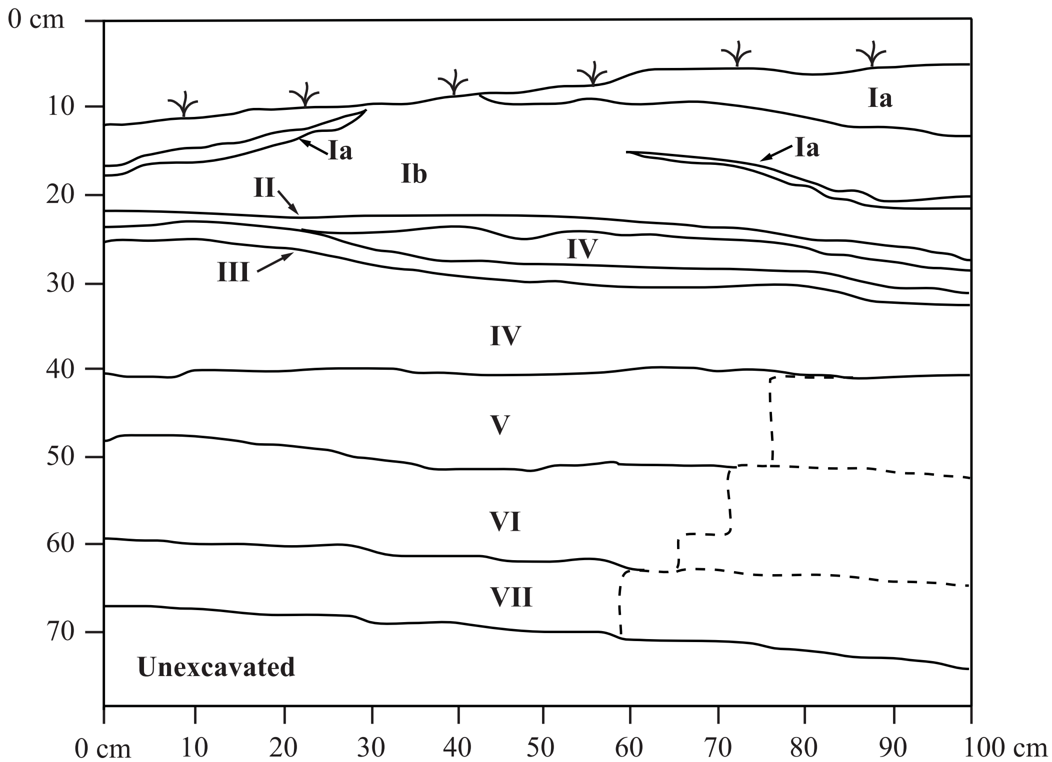
Figure by Dave Hunt 3/12/2010



Ia. Sod: 10 YR 2/2: very dark brown
Ib. Sand: 10YR 4/3: Brown
II. 10 YR 5/1: gray
III. 10 YR 3/2: very dark grayish brown
IV. 10 YR 5/1: gray
V. 10 YR 3/2: very dark grayish brown
VI. 10 YR 5/1: gray
VII. 10 YR 3/2 very dark grayish brown
VIII. Pink patch: 10 YR 3/3: dusky red
- - - - Step ins

CAKR 2008
no rover
Test ID 351A
North Wall Profile
SLA/PWR 8/1/2008

Figure by Dave Hunt 1/29/2010

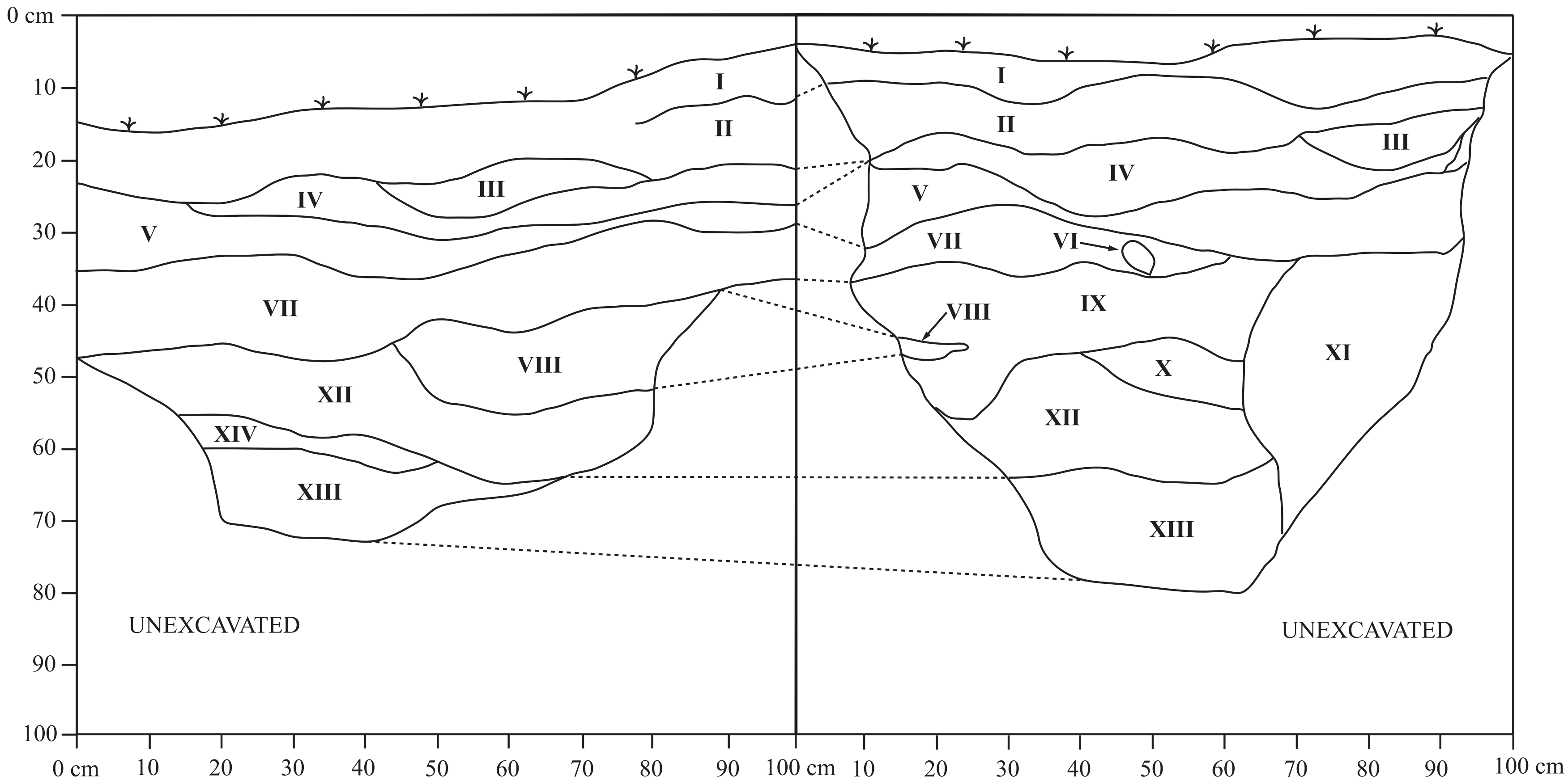


Ia. Sod: 10 YR 2/2: very dark brown
Ib. Sand: 10YR 4/3: Brown
II. 10 YR 5/1: gray
III. 10 YR 3/2: very dark grayish brown
IV. 10 YR 5/1: gray
V. 10 YR 3/2: very dark grayish brown
VI. 10 YR 5/1: gray
VII. 10 YR 3/2 very dark grayish brown

- - - - Step ins

CAKR 2008
08GEOXH073110A
Test ID 351A
South Wall Profile
PWR 8/1/08

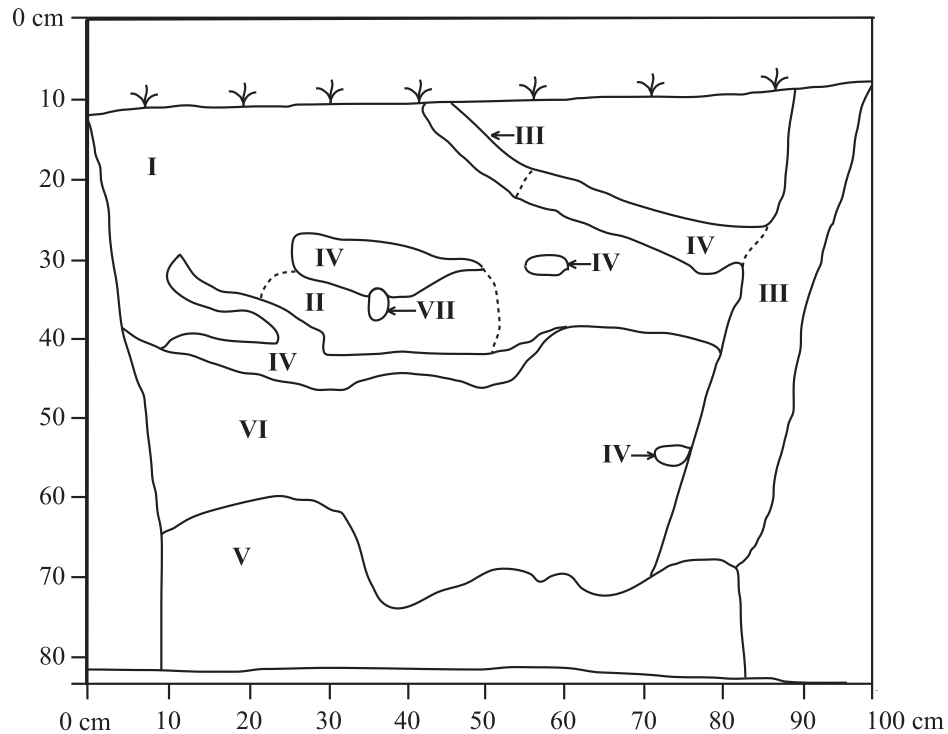
Figure by Dave Hunt 2/27/2010



I. Brown organic soil with roots, 10 YR 2/2
II. Dark black organic soil with some gravel 10 YR 2/1
III. Dark soil (same as II) but with more gravel
IV. Light grey medium loose gravel with little sand
V. Dark brown soil/sand with medium to small gravel
VI. Pocket of medium loose gravel
VII. Light grey medium loose gravel mixed with little sand
VIII. Mammal bone
IX. Dark brown/black soil with medium and small gravel
X. Dark brown/black with some medium gravel and little small gravel
XI. Medium and small loose gravel
XII Fine loose gravel
XIII. Mostly medium gravel with little small (loose)
XIV. Sand

CAKR 2008
2XH073110A
Test ID 352A
West and NorthWall Profiles
JKG & RBW 8/2/09

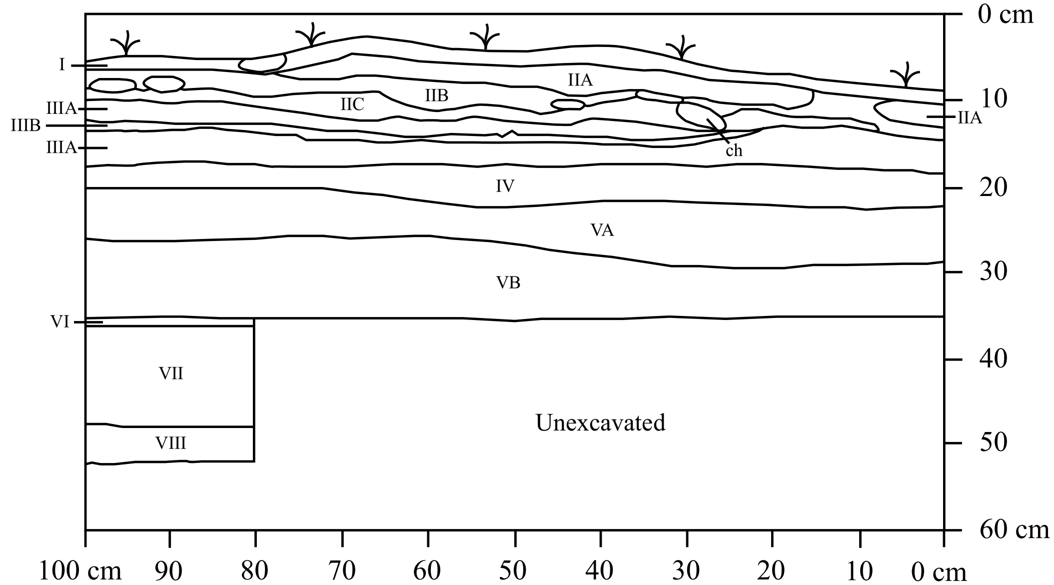
Figure by Dave Hunt 3/7/2010



I.	Black, organic rich, loam with gravel (<40%) (10 YR 2/1)
II.	Black, very dark and organic rich, loam with gravel (<40%) (10 YR 2/1)
III.	Black, organic rich loam with gravel (<40%), moss (10 YR 2/1)
IV.	Gravel with loam (<40%)
V.	Gravel, sand and silt matrix (<20%), fairly sorted, sub angular, 0.3 - 1 cm
VI.	Very dark brown loam with gravel (<50%), compact, dry, low organic content (10 YR 2/2)
VII.	FCR

CAKR 2008
2XH080213A
Test ID 353A
North Wall Profile
NCR 8/04/08

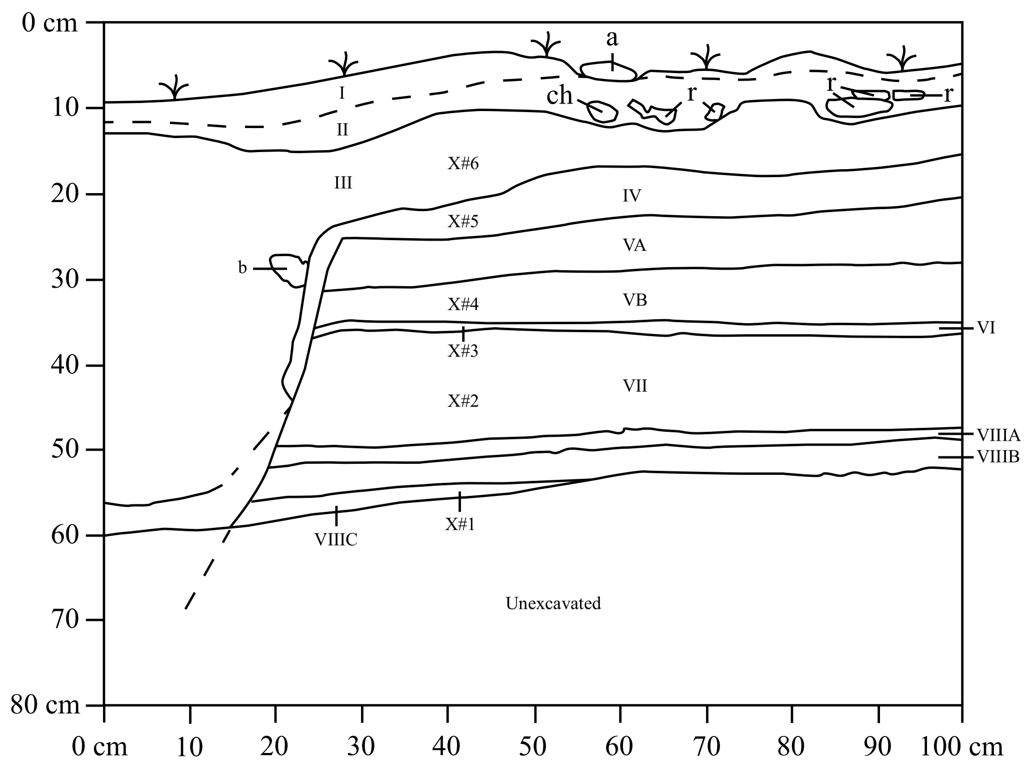
Figure by Dave Hunt 1/29/2010



CAKR 2009
09GEOXH080214A
Test ID 437A
East Wall Profile
JBF 8/04/09

Figure by Sarah Ashmore 1/28/2011

I.	Loose or chunky moss vegetation - growing over and around hearth stones
II.	Hearth 2B composed of three sub layers
	IIA. Gray to beige fine silt (fire ash?)
	IIB. Red brown fine silt-could be fire as well, but thick
	IIC. Charcoal stained silt with charcoal chunks
	Flat pebbles appear primarily in the top two layers (IIA and IIB)
III.	Sand layers with smallish pebble layer
	IIIA. Mixed with charcoal in pockets within the excavation
	IIIB. Orange and black grains
IV.	Pebble layer with little sand, pebbles to 1cm in diameter average pebble size = 0.5cm diameter and flat
VA/VB.	Two strata of independently “fining upwards” sands, both layers start with very coarse sand (to 3mm diameter/average 1.5mm) and grains become smaller up the layer to average of 0.5mm or smaller
VI.	0.5 to 1cm thick lens of fine silt or mud with sand filling the space between pebbles below and forming a completely horizontal surface, color is medium brown
VII.	Dense pebble layer-original beach? Pebbles 0.75 to 1cm average diameter
VIII.	Three layers of sand - two fine bracketing one coarse sand
ch.	Charcoal



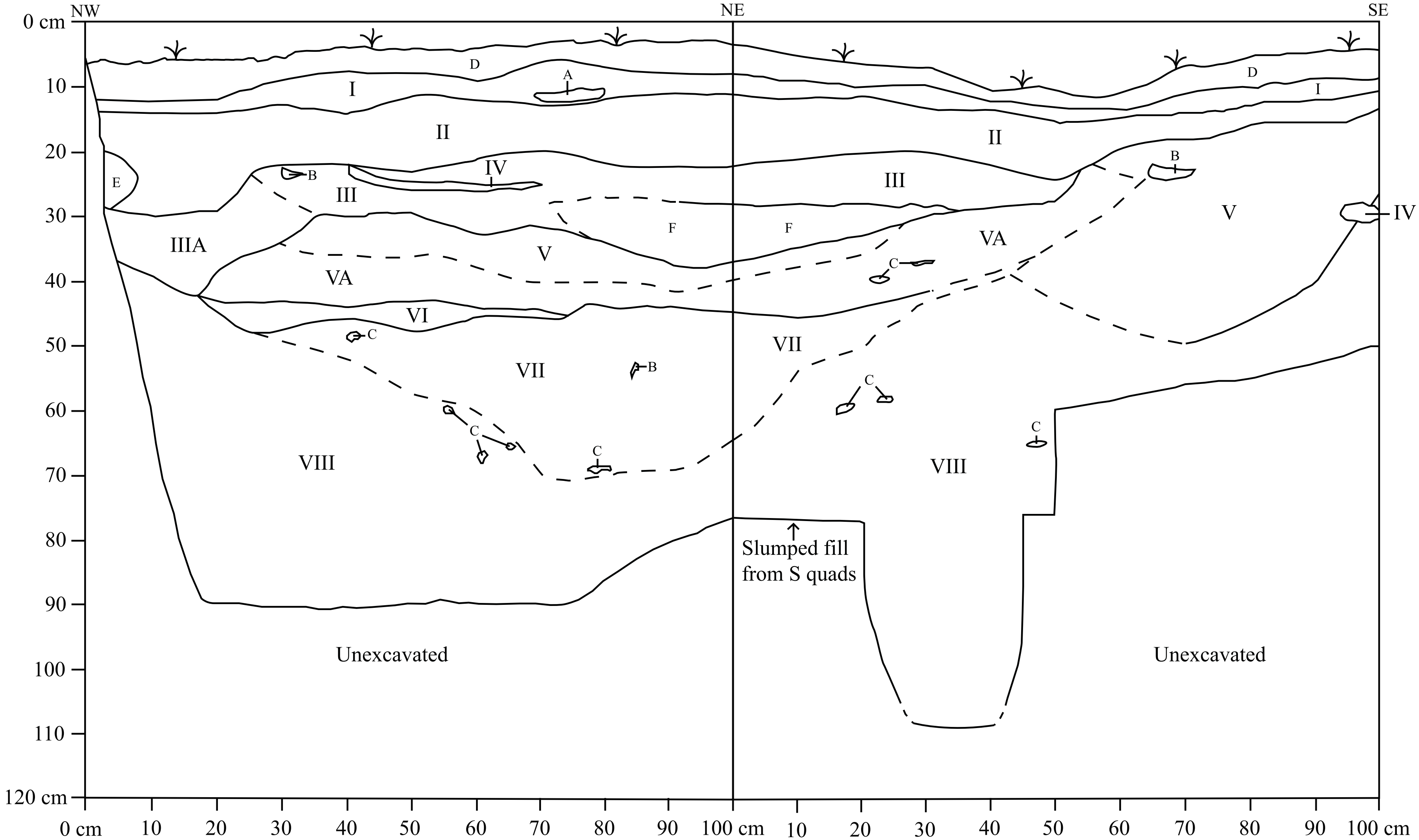
I.	Loose or chunky moss vegetation - growing over and around hearth stones
II.	Hearth 2B composed of three sub layers; beige brown silt
III.	Sand layers with smallish pebble layer; medium sand (brown to orange)
IV.	Pebble layer with little sand, pebbles to 1cm in diameter average pebble size = 0.5cm diameter and flat
VA/VA.	Two strata of independently "fining upwards" sands, both layers start with very coarse sand (to 3mm diameter/average 1.5mm) and grains become smaller up the layer to average of 0.5mm or smaller
VI.	0.5 to 1cm thick lens of fine silt or mud with sand filling the space between pebbles below and forming a completely horizontal surface, color is medium brown
VII	Dense pebble layer-original beach? Pebbles 0.75 to 1cm average diameter
VIII.	Three layers of sand - two fine bracketing one coarse sand
	VIIIA. Fine sand
	VIIIB. Coarse sand
	VIIIC. Fine sand
ch.	Charcoal
r.	Rock
a.	Pebble cavity
b.	Chunk, dark brown silt clay

Diatom samples collected at X# locations:

X#1. Fine sand in VIIIC
X#2. Dense pebbles in VII
X#3. Silt mud lens VI
X#4. Coarse sand near base of VB
X#5. Dense pebbles in IV
X#6. Coarse sand in III (just below cultural feature)

CAKR 2009
09GEOXH080214A
Test ID 437A
North Wall Profile
JBF 8/04/09

Figure by Sarah Ashmore 4/15/2011

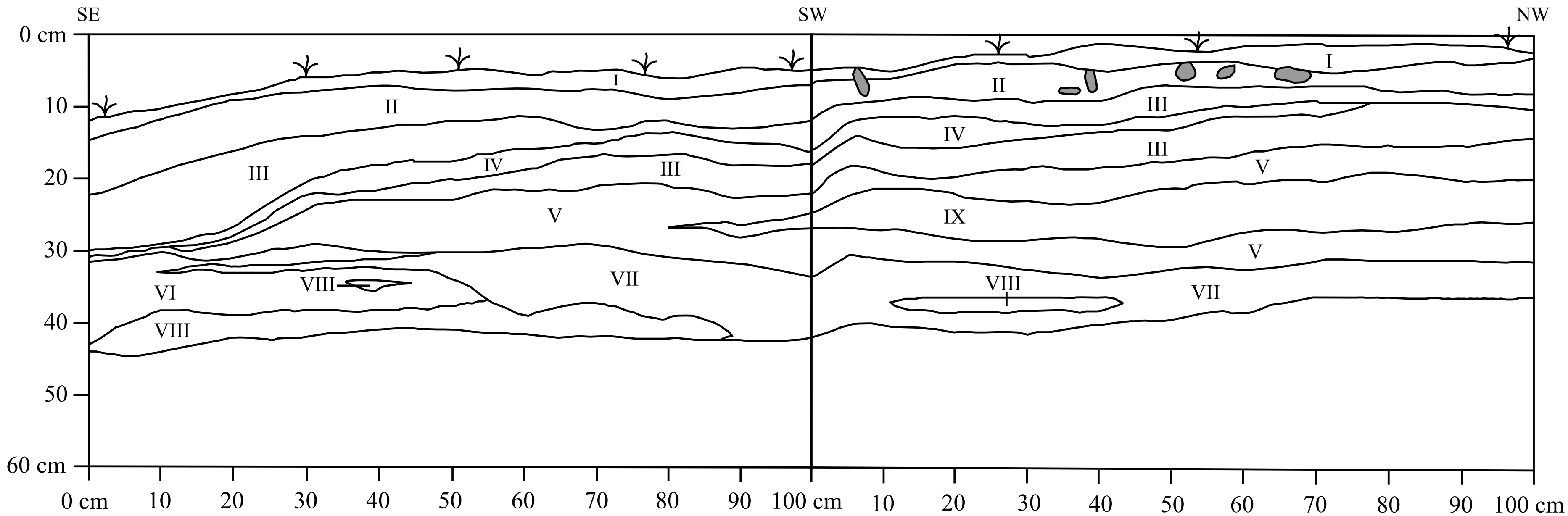


I. Reddish brown root mat
II. Very dark brown silty sod with roots, charcoal, and charred wood
III. Grayish brown sand (and ash?) with subrounded to rounded pebbles 1-20 mm; very compact, contains majority of cultural material
IIIA. Brown sand with pebbles and III, no apparent cultural material
IV. Unconsolidated subrounded to rounded pebbles 4-12 mm
V. Subangular to rounded pebbles 2-10 mm with brown sand, medium grained; rootlet consolidated, contains cultural material
VA. Matrix as V, unconsolidated with cultural material
VI. Coarse sand with subangular to rounded pebbles 1-10 mm
VII. Unconsolidated subrounded to rounded pebbles 1-30 mm with sporadic cultural material
VIII. Dark yellowish brown medium coarse sand with subrounded to rounded pebbles 1-15 mm

A. Root
B. Bone
C. Wood fragments
D. Crownberry and willow vegetation
E. Squirrel disturbance
F. Bone, FCR, and charcoal

CAKR 2009
09GEOXH080410A
Test ID 440A
North and East Wall Profile
AKF 8/05/09

Figure by Sarah Ashmore 1/20/2011

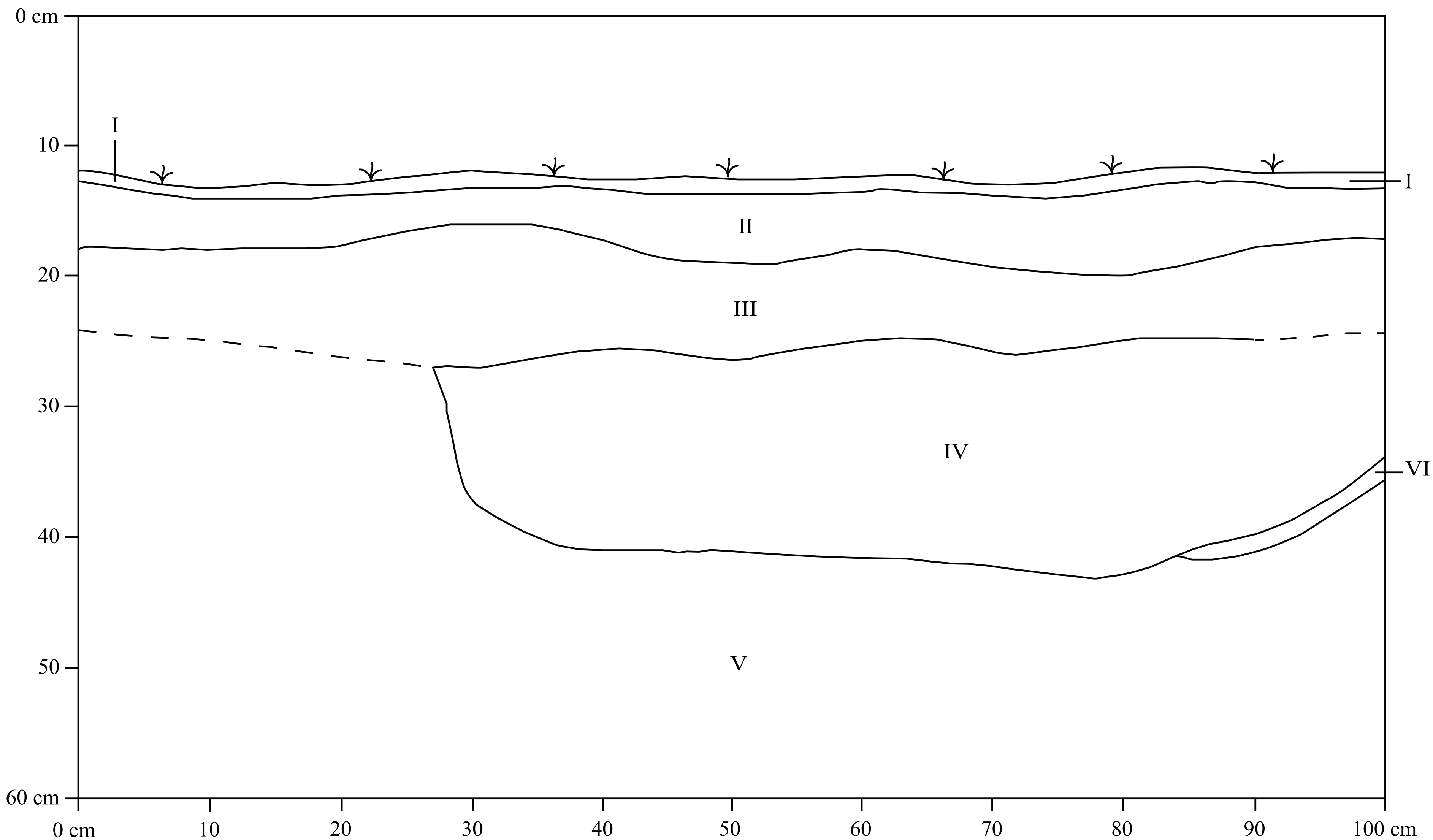


I. Sod layer 10 yr 2/1
II. Compact grayish sand 10 yr 5/2, some pebbles
III. Well-rounded well-sorted brown sand 10 yr 4/4
IV. Rounded gravel ~1cm in diameter
V. Mottling of gray and brown small pebbles (1-2mm), subangular, and sand 10 yr 5/4
VI. Dark brown, sandy with silt 10 yr 3/4
VII. Round gravelly
VIII. Gravel, subrounded
IX. Slightly larger pebbles than in V - subrounded to rounded 2-4mm pebbles

FCR

CAKR 2009
09GEOXH080508A
Test ID 454A
South and West Wall Profile
SJS 8/05/09

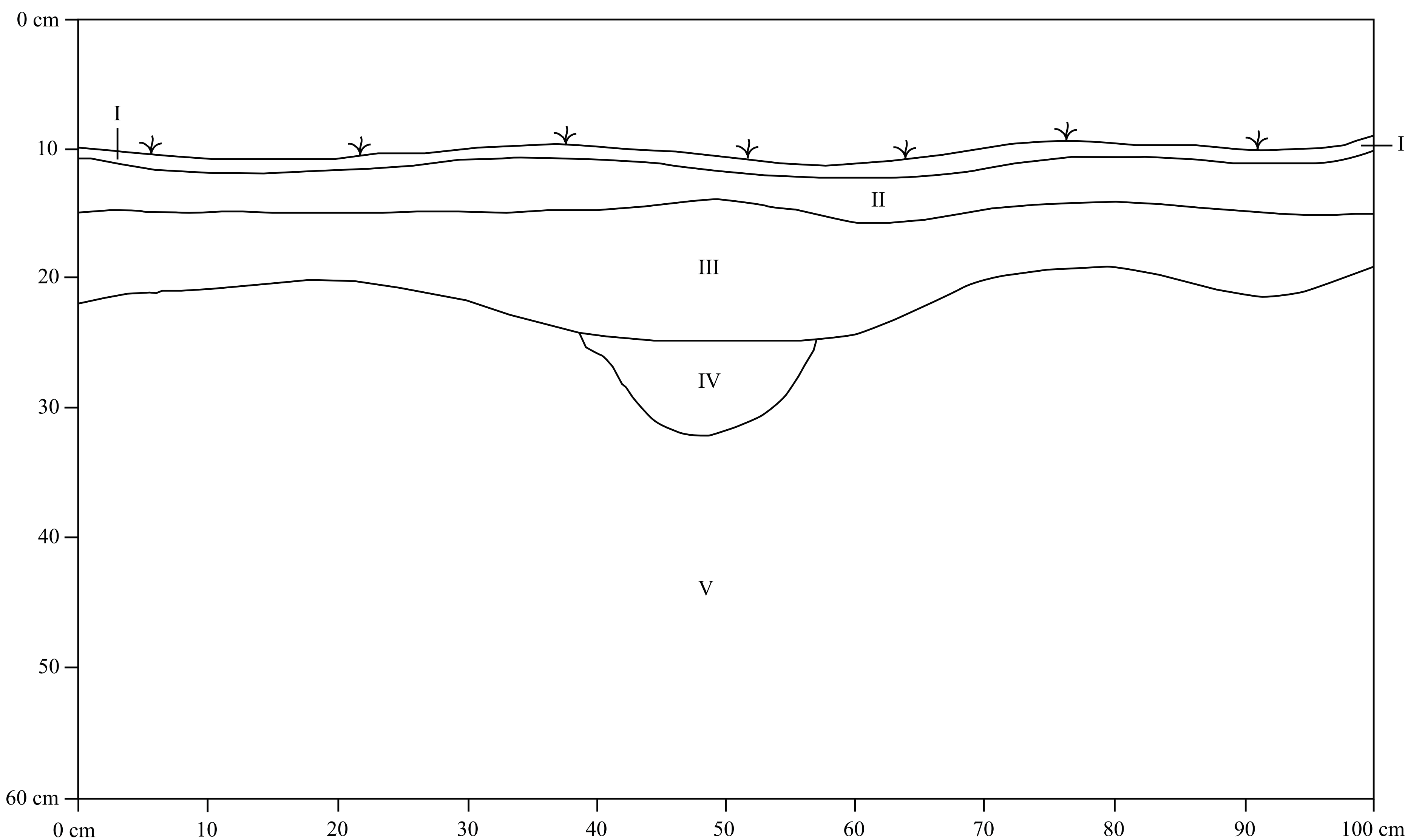
Figure by Sarah Ashmore 1/21/2011



I.	Vegetation mat	
II.	10 yr 2/2 dark brown silty loom	
III.	Coarse grained sand to medium sized gravel (< 1cm)(subangular), roots throughout, charcoal and FCR throughout this level (scattered)	
IV.	Brown silt with high density of bone (midden layer), few FCR, bone better preserved at the bottom, wood on north and southern extents	
V.	Unconsolidated gravel imbedded with coarse sands	
VI.	Wood	

CAKR 2009
09GE0XH080508A
Test ID 455A
East Wall Profile
SJS/SLA 8/06/09

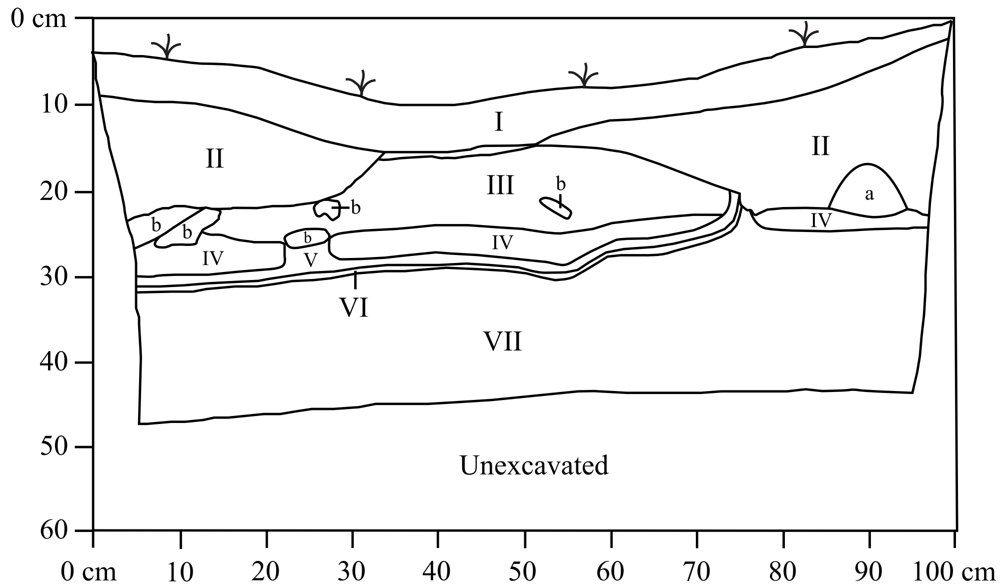
Figure by Sarah Ashmore 1/21/2011



I. Vegetation mat
II. 10 yr 2/2 dark brown silty loom
III. Coarse grain sand to medium sized gravel (< 1cm diameter) (subangular) roots throughout, charcoal and FCR throught this level (scattered)
IV. Black (10 yr 2/1) coarse sand and gravel with high density of charcoal
V. Unconsolidated gravel imbedded with coarse sands

CAKR 2009
09GEOXH080509A
Test ID 455A
South Wall Profile
SLA/SJS 8/06/09

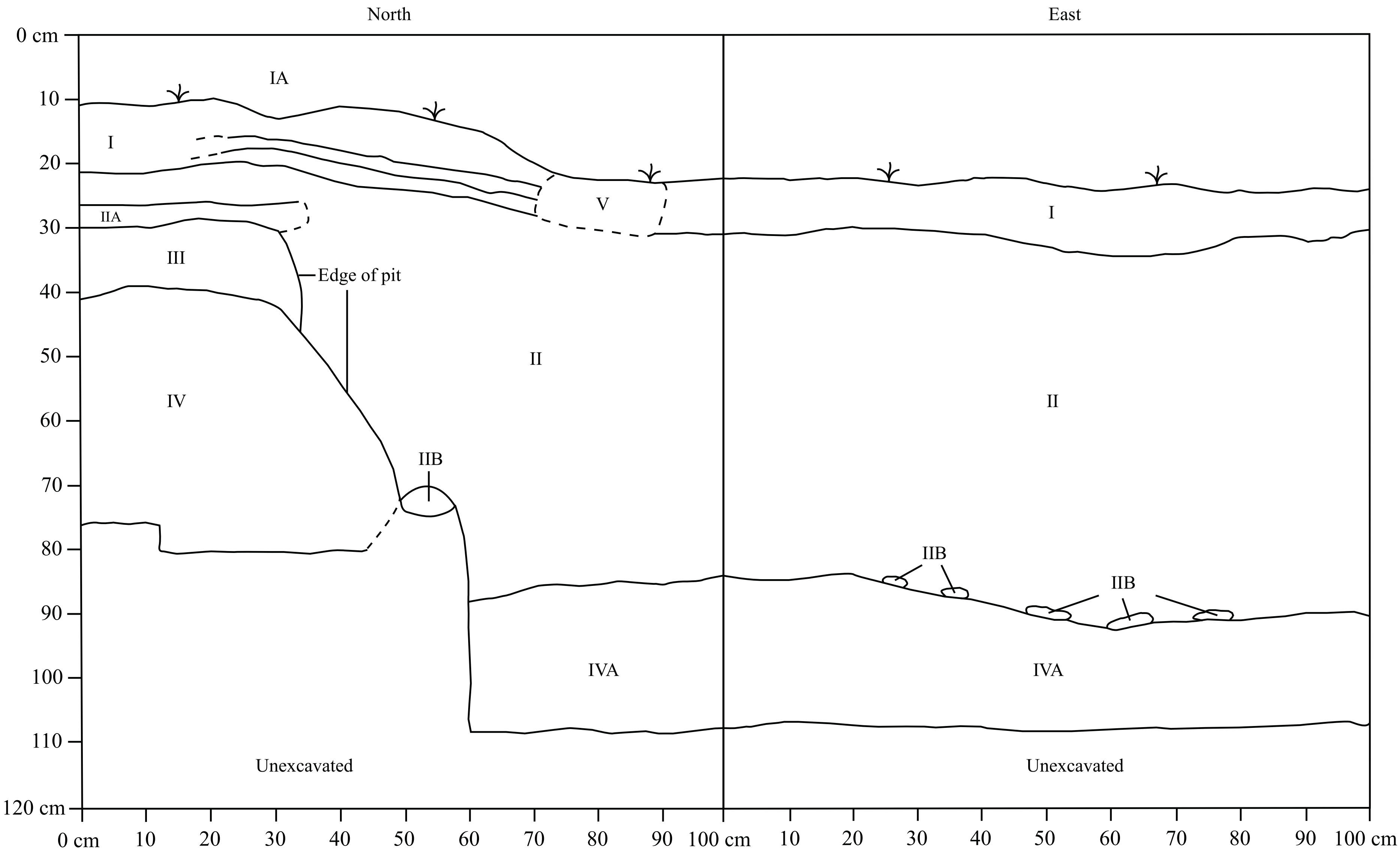
Figure by Sarah Ashmore 1/21/2011



I. Veg mat/sod
II. Dark brown organic silty soil, some bone, closer to “III” contact
III. Dark brown organic soil with sand and small gravel; numerous bones, occasional charcoal
IV. Fine gravel, 5cm average diameter
V. Medium to fine sand, yellow to gray grains
VI. Thin lens of very find gravel/coarse sand
VII. Multiple beds of coarse to fine sand, fining upwards; white, black, orange, gray grains
a. Rodent hole
b. Bone

CAKR 2009
09GEOXH080608A
Test ID 456A
West Wall Profile
JBF/AKF 8/06/09

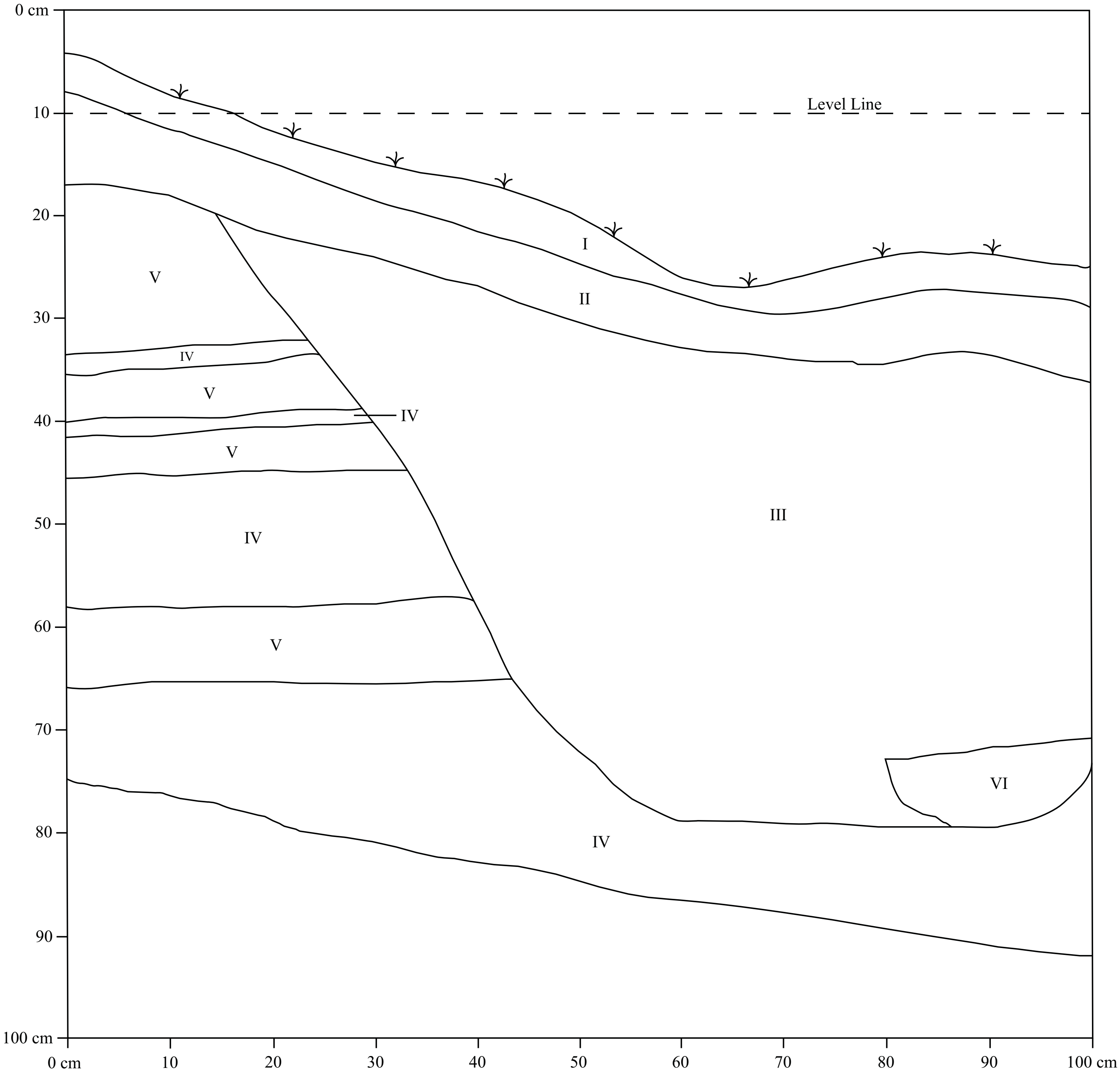
Figure by Sarah Ashmore 1/26/2011



I. Very dark brown (10 yr 2/2); silty soil with matted rootlets throughout, cultural material at base of I / top of II interface
IA. Grayish brown, fine grained deposit, possibly ash sample collected from profile
II. Bedded gravel and sand deposits with lenses of compact material, sometimes with burnt bone, bone, charcoal, and (probable) oil soaked and hardened sediment, cultural material found throughout this deposit, which appears to be naturally-rather than culturally-bedded or layered, sand is fine to medium grained with medium gravel (2-5 cm diameter) when present, all subrounded, lenses of compact material diffuse and difficult to map
IIA. Particularly thick, extensive, and hard deposit of cultral material (burnt bone, charcoal) noted and bulk sampled separately during excavation
IIB. Wood lining side and bottom of pit feature
III. Sterile gravel and sand layers (same texture as above) outside of pit feature
IV. Unconsolidated gravel deposits, gravel 5-10cm diameter, subrounded, sterile
IVA. Sterile, somewhat compact sand and gravel deposits below pit feature
V. Area of root disturbance

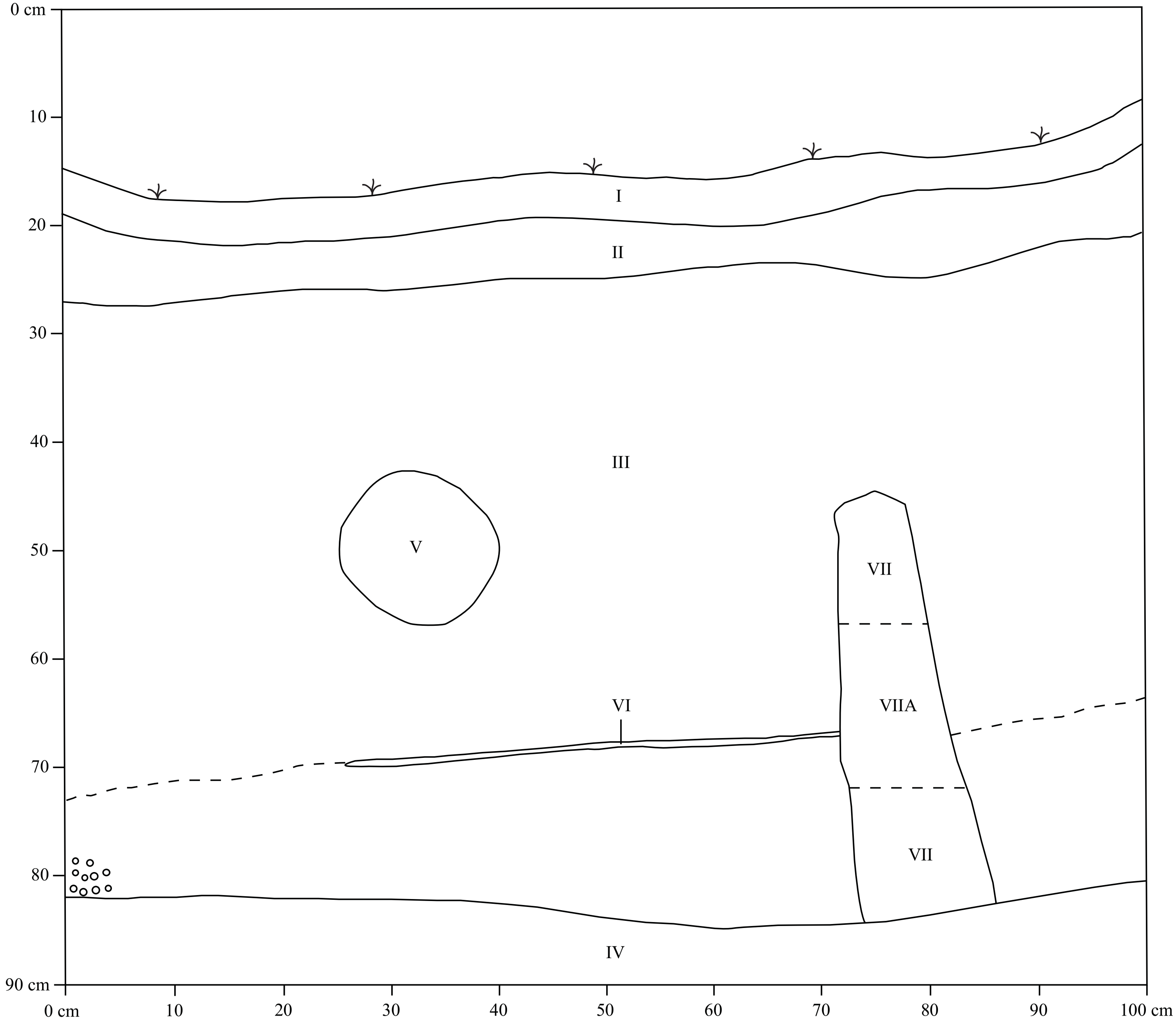
CAKR 2009
09GEOXH080909A
Test ID 457A
North and East Wall Profile
SLA 8/11/09

Figure by Sarah Ashmore 1/27/2011



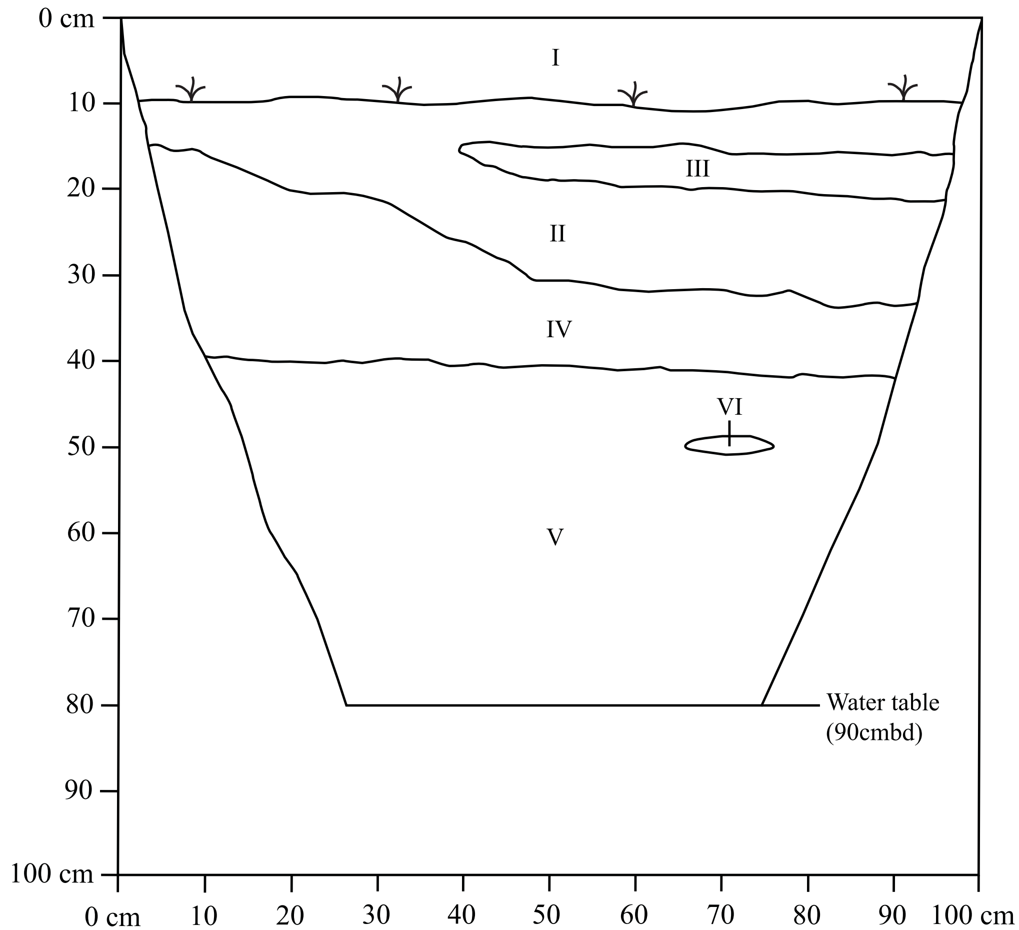
I. Modern organic root mat
II. 10 yr 2/2 very dark brown silty loam (sod layer)
III. Feature fill, 10 yr 3/2, grayish brown sandy gravel with areas of this silty loam, gravel is mostly < 1cm, more compact than surrounding layers
IV. Loose gravel, most are 1cm in diameter or less
V. 10 yr 4/3, sandy gravel, gravel is very small (< .5cm), abundance of fine rootlets
VI. Wood

CAKR 2009
09GEOXH080909A
Test ID 458A
West Wall Profile
SJS/AKF 8/11/09
Figure by Sarah Ashmore 1/27/2011



I. Modern organic root mat
II. 10 yr 2/2 very dark brown silty loam (sod layer)
III. Feature fill, grayish brown (10 yr 3/2) sandy gravel with areas of thin silty loam mixed in, gravel small, mostly < 1cm, compact
IV. Loose gravel, small mostly < 1cm, natural beach gravels below feature floor
V. STP fill
VI. Thin layer of wood or bark
VII. Vertical post
VIIA. Area in between the dotted lines on the vertical post was sampled

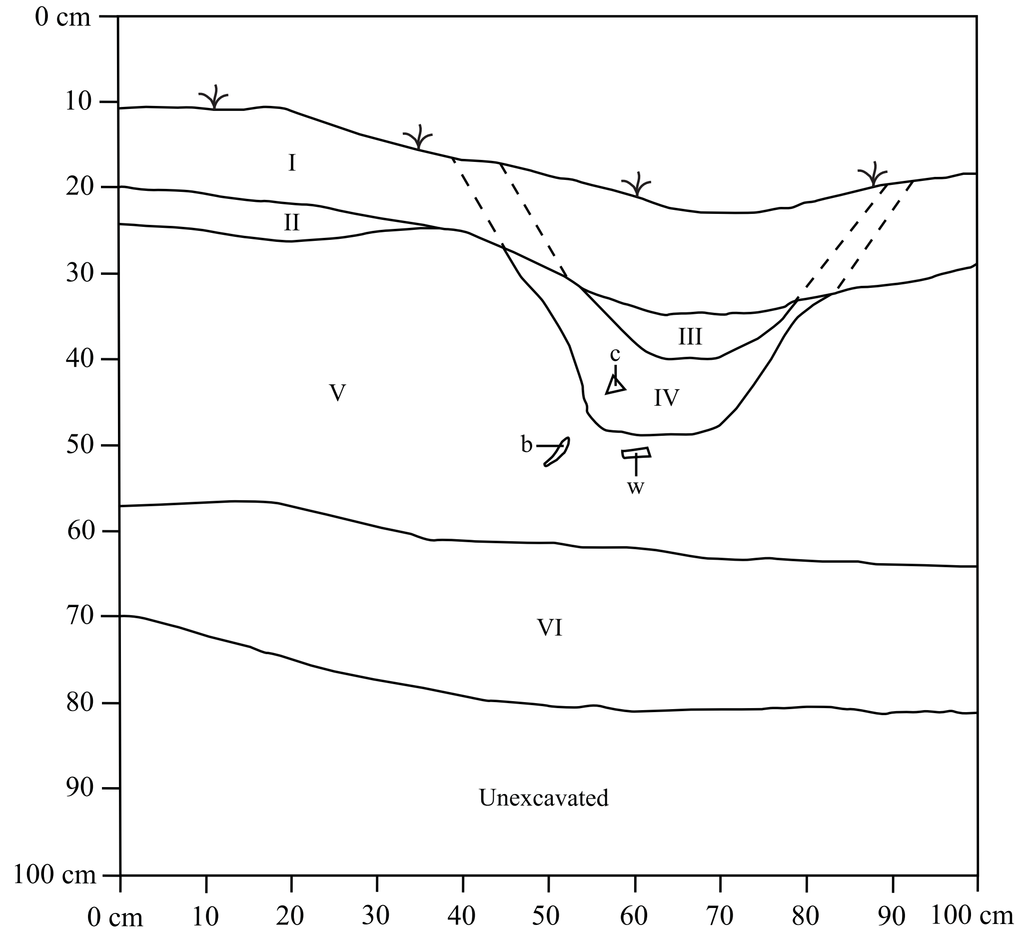
CAKR 2009
09GEOXH080909A
Test ID 458A
West Wall Profile
SJS/AKF 8/11/09
Figure by Sarah Ashmore 1/27/2011



I. Sod, rootlets
II. Sand/gravel
III. Shallow ‘midden’ layer-organic-heavy soil
IV. ‘Midden’ layer-organic-rich soil
V. Loose med/large gravel, sand
VI. Fish bone pocket

CAKR 2010
10GEOXH071013A
Test ID 1177A
South Wall Profile
SMC/EAP 7/15/10

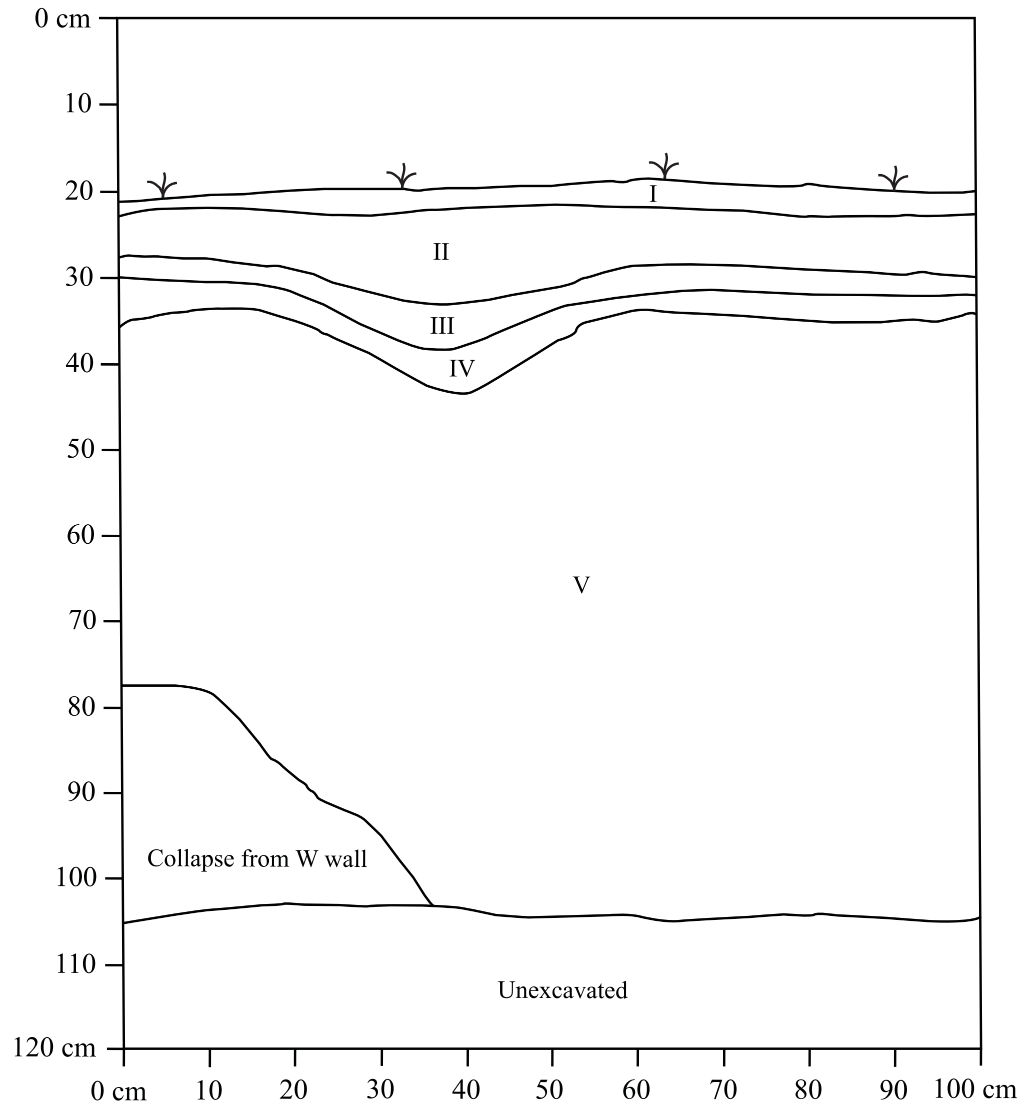
Figure by Sarah Ashmore 2/09/2011



I. Dark brown loamy soil with roots, sod cap, had one lithic in sod cap
II. Decaying wood deposit, light brown/orange soil with charcoal flecks throughout
III. Small to medium gravel with some organic deposits, sand interlayered
IV. Brown/black organic soil had bone and decaying wood in lens, bottom of a small pit feature, a piece of wood and bone are in the wall directly below this deposit, the small pit deposit is where the majority of cultral materials were encountered
V. Small to medium rounded gravel interlayered with sand
VI More compact medium to course sand interlayered with pebbles and small gravel
c. Charcoal sample
b. Bone
w. Wood sample

CAKR 2010
10GEOXH071215A
Test ID 1178A
East Wall Profile
KEF 7/14/10

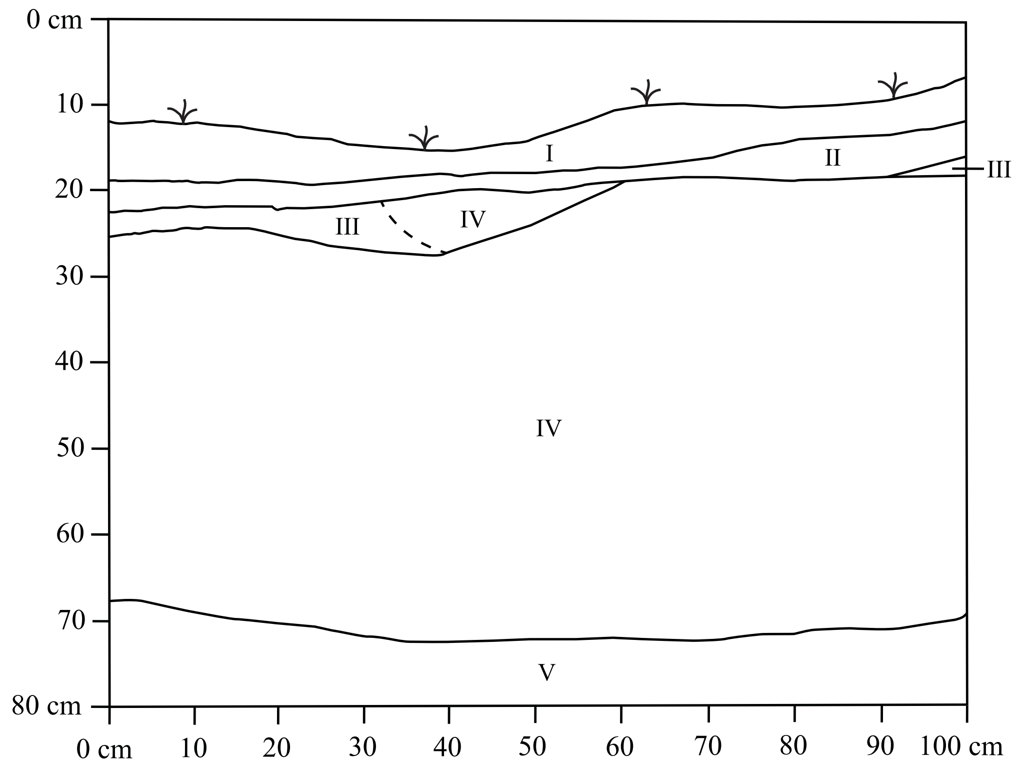
Figure by Sarah Ashmore 2/09/2011



I. Dark brown loamy soil with sand and roots, vegetation layer
II. Medium to coarse sand with pebbles and gravel, roots throughout, bone frags found in this layer
III. Hard compact light gray layer with noticable freeze crack as seen through depression in profile, cultural material mostly encountered in this layer full of lithic flakes and some biface PP, possibly old ground surface
IV. Yellow brown organic soil, possible old soil development beneath ground surface
V. Small to medium rounded gravel interlayered with medium gain sand

CAKR 2010
10GEOXH071508A
Test ID 1179A
North Wall Profile
KEF/AET 7/19/10

Figure by Sarah Ashmore 2/09/2011



I. Thick vegetation mat

II. Dark brown loam with roots and organic material throughout, cultural material at sod/gravel (II/III) interface, discontinuous, ~ .5cm thick band of grayish brown silty loam, roots throughout

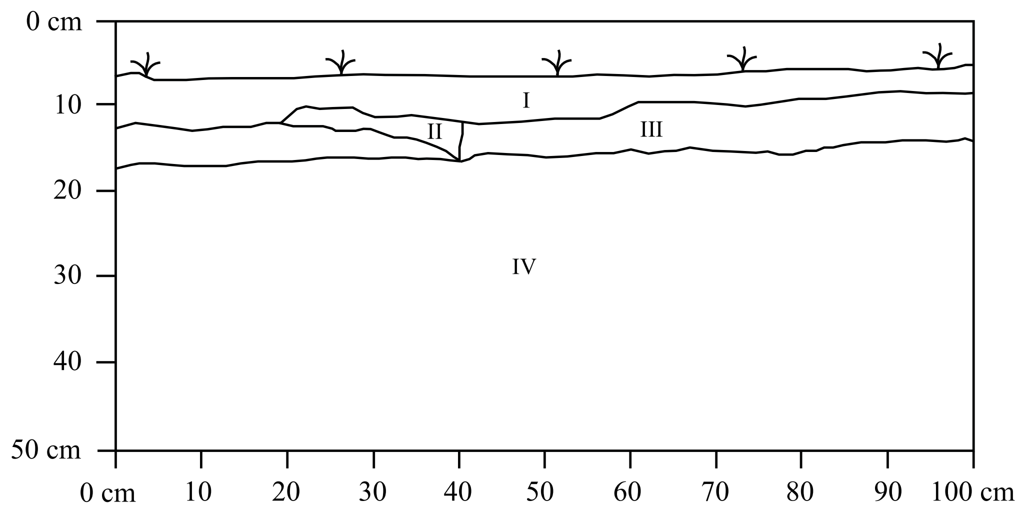
III. Unconsolidated subangular-rounded gravel (small), well sorted, with no soil development

IV. Dark brown sandy loam with high % of coarse sand and small gravel, subangular-rounded, well sorted, decomposing wood, bone and some charcoal throughout, flakes and tools, CULTURAL DEPOSIT

V. Unconsolidated coarse sand and gravel, rounded, well sorted, sterile water table ~ 80 cm BD

CAKR 2010
10GEOXH071508A
Test ID 1180A
West Wall Profile
SLA 7/20/10

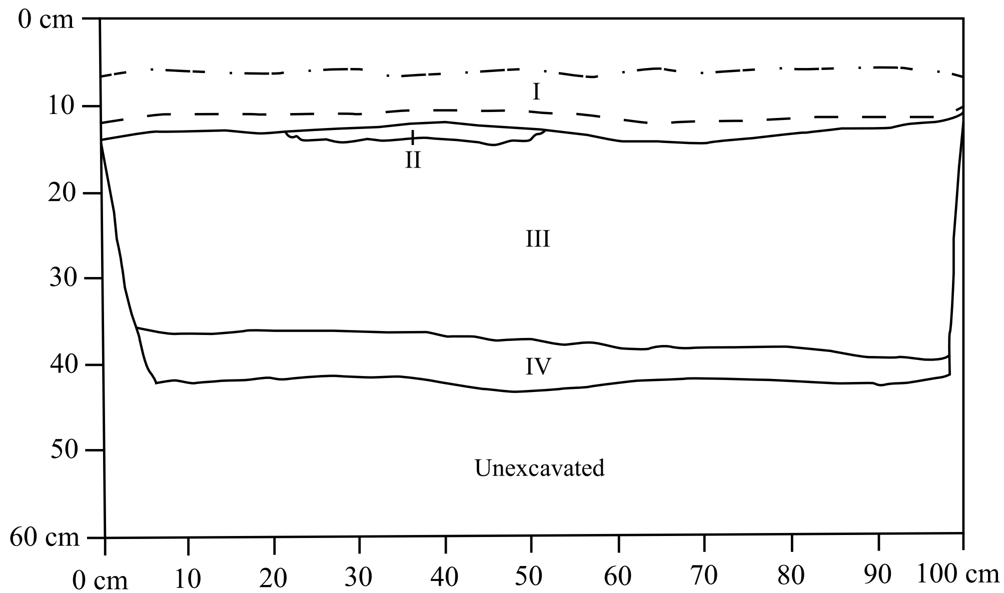
Figure by Sarah Ashmore 2/03/2011



I. Vegetation and sod layer
II. Large stone, 45x27 cm and approx. 4cm in thickness, lies partially in south half of unit and partially in north
III. Loose medium/large rounded gravels with soil dispersed througout, directly underneath vegetation and sod layer, charcoal found here
IV. Laminated sand and gravel layers, lithics found here

CAKR 2010
10GEOXH071508A
Test ID 1181A
North Wall Profile (of South Half)
SMC/EAP 7/19/10

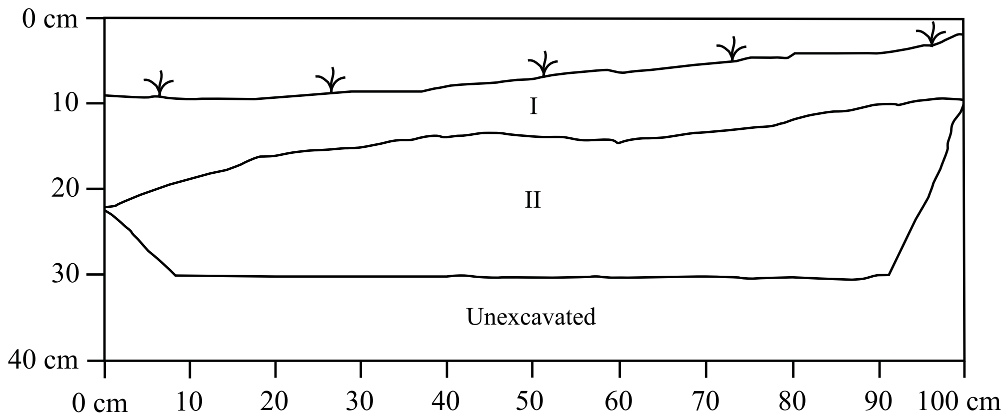
Figure by Sarah Ashmore 1/19/2010



I. Sod and organic dark soils beneath
II. Organic (lighter) soils
III. Sand - gravel interchanging strata, each layer is between 2-6 cm, no cultural material found
IV. Sand; soft, fine sand

CAKR 2010
10GEOXH072008A
Test ID 1182A
East Wall Profile
AET/SMC 7/20/10

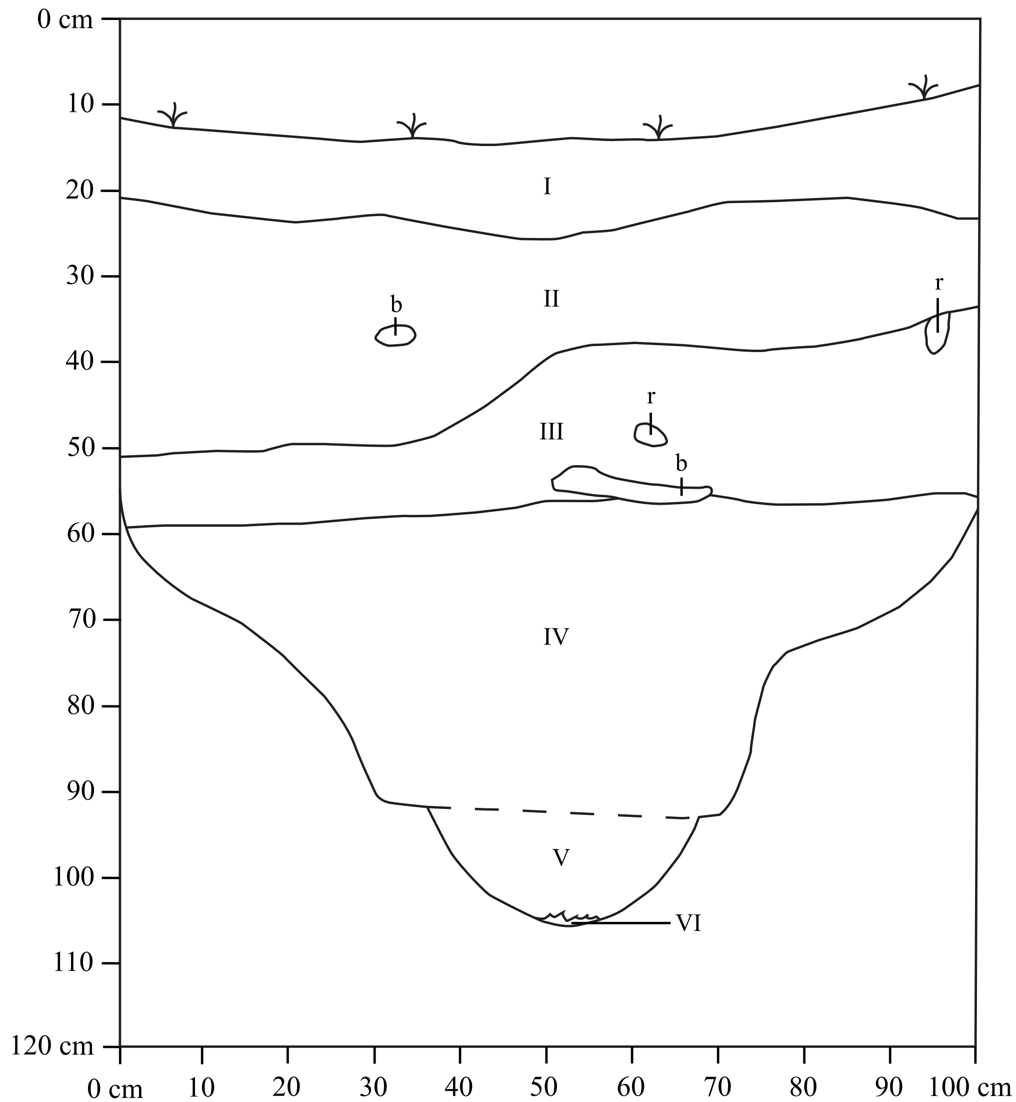
Figure by Sarah Ashmore 2/03/2011



I. Sod and soil layer, no cultural material found
II. Sandy gravels with some soil near the top, no cultural material found

CAKR 2010
10GEOXH072108A
Test ID 1184A
North Wall Profile
AET/SMC 7/21/10

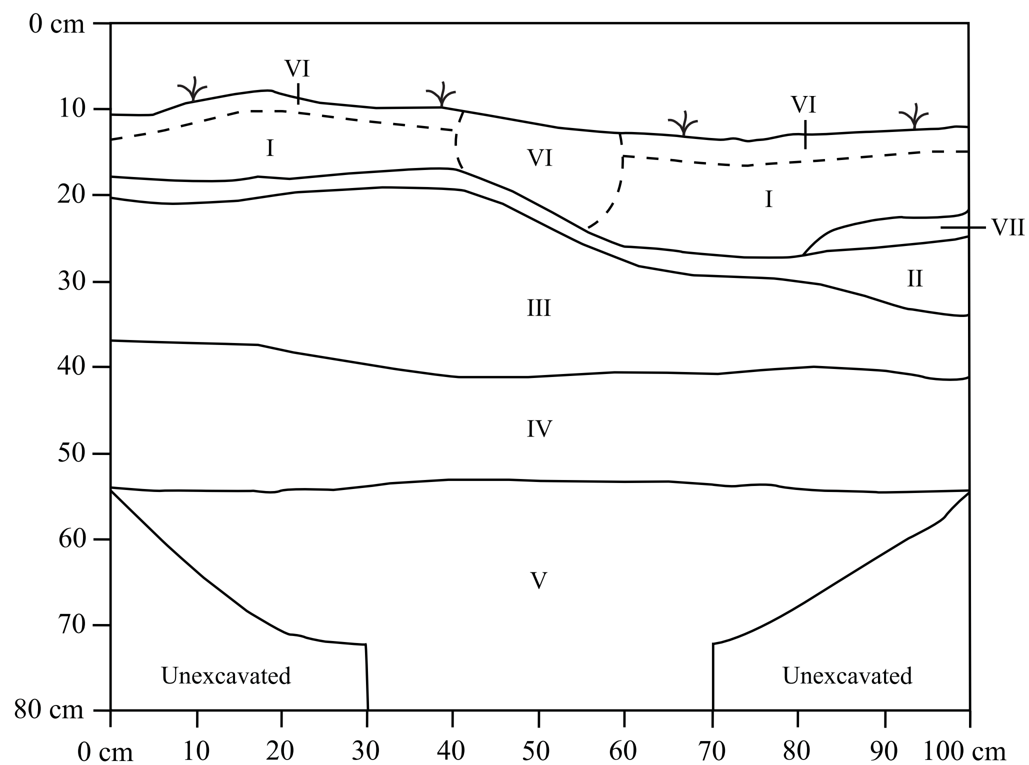
Figure by Sarah Ashmore 2/03/2011



I. Dark (black) silty sediment, abundant roots
II. Light gray gravel, round to subround, ~ 2-20 mm
III. Fine brown/reddish gravel, round to subround, ~ 2-5mm
IV. Gray to brown gravel, 5-30 mm, very little fine sediment
V. Shovel test
VI. Water
b. Bone
r. Rock, not cultural

CAKR 2010
10GEOXH072108A
Test ID 1185A
West Wall Profile
JDD/EAP 7/23/10

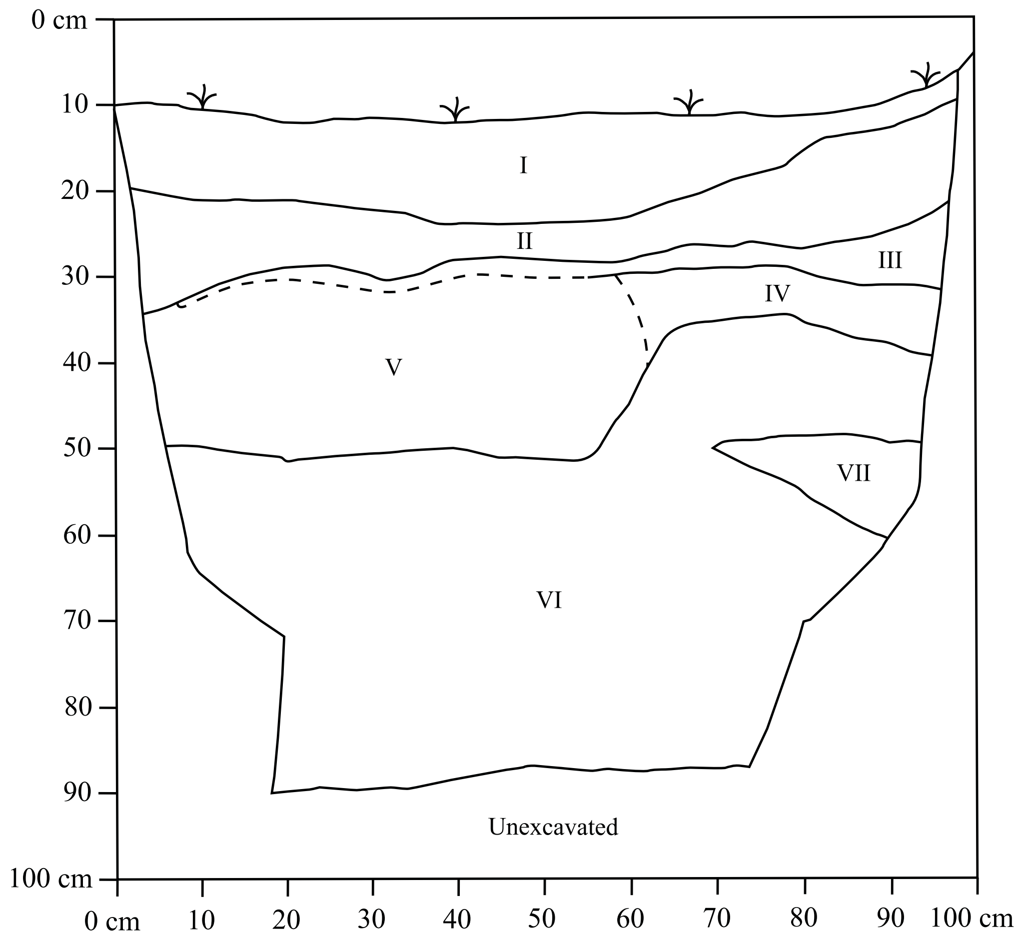
Figure by Sarah Ashmore 2/03/2011



I. Dark brown loam with thick vegetation mat in top ~ 4 cm, gravel lease in NW corner, roots throughout
II. Thin layer of unconsolidated subangular to subrounded well sorted small gravel, little cultural material, some roots
III. Coarse sand to medium size gravel, subrounded, somewhat unconsolidated, with bands of finer sand and sandy loam in association with roots and some faunal material, roots throughout
IV. Very dense faunal deposit in dark brown - black sandy loam matrix with small - medium gravel, good faunal preservation, concentrated in W and SE area of unit
V. Unconsolidated medium to coarse gravel, well sorted and rounded, corners and ~ 10 cm in from walls not excavated due to collapse, excavation ended at 80 cm BD
VI. Root disturbance
VII. Gravel lense

CAKR 2010
10GEOXH072108A
Test ID 1186A
West Wall Profile
SLA 7/24/10

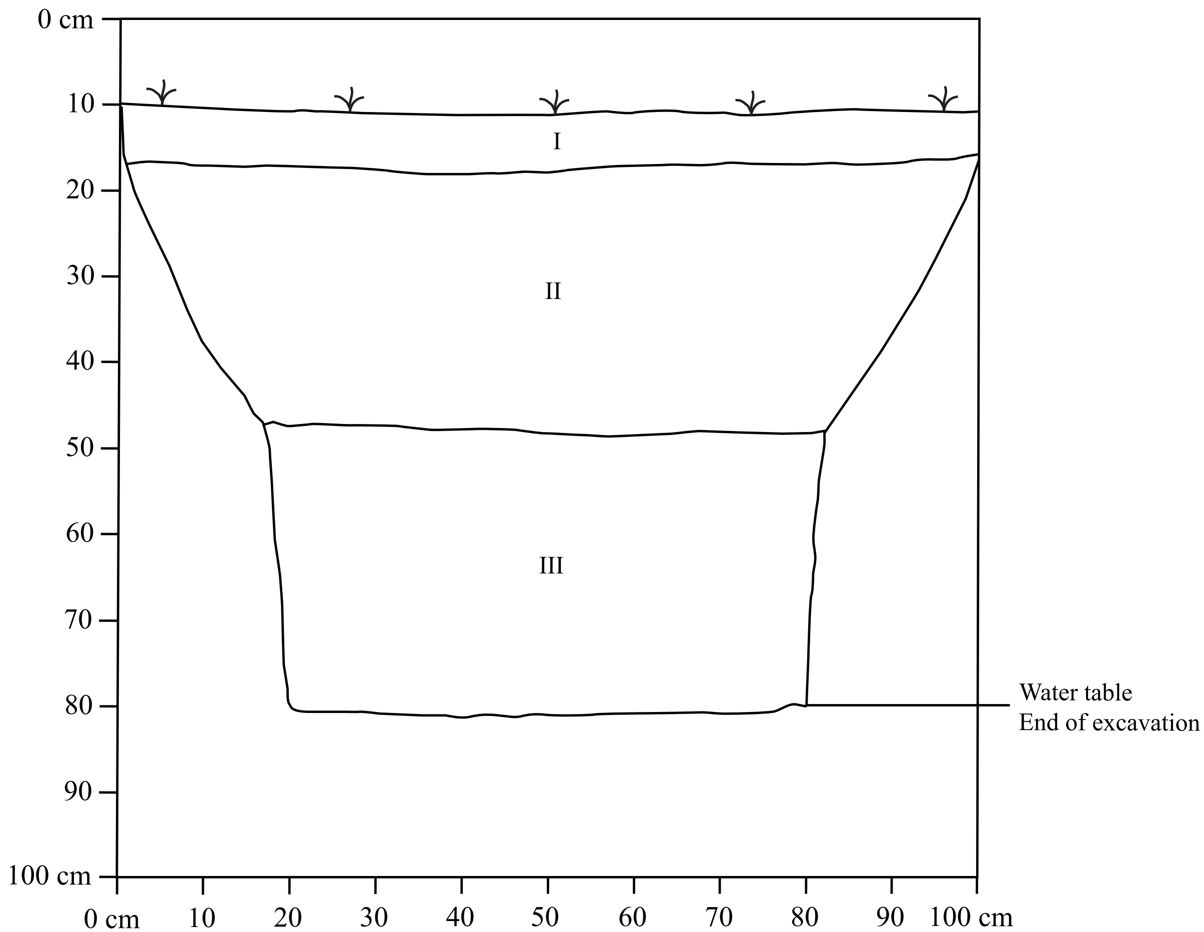
Figure by Sarah Ashmore 2/03/2011



I. Vegetation/sod and roots
II. Sod and organic soils
III. Gravel, loose, medium to small structure
IV. Organic soil, very dark black, moist
V. Midden, area full of faunal material intermixed with medium sized gravel and dark organic soils
VI. Sand and gravel matrix (interchanging)
VII. Gray, wet sand

CAKR 2010
10GEOXH072108A
Test ID 1187A
West Wall Profile
AET/SMC 7/24/10

Figure by Sarah Ashmore 2/03/2011

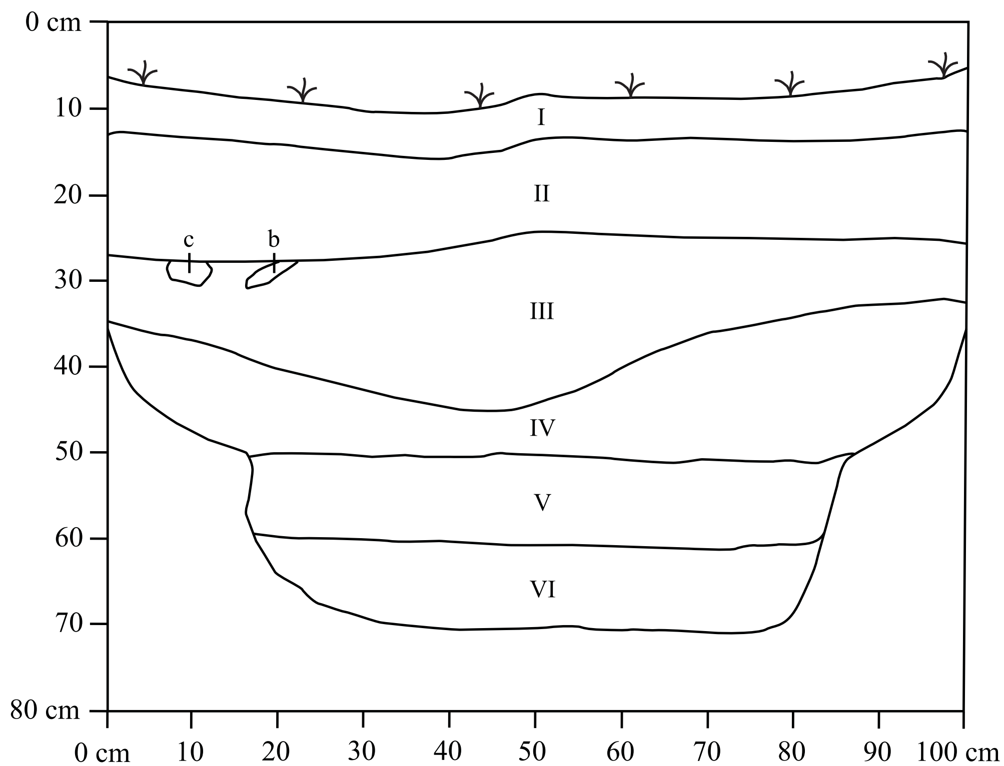


Original depth below datum 71cm. New datum is ~10 cm above old datum, so profile wall is 81 cmbd

I. Sod layer, rootlets, organic-rich
II. Banded sand and medium/small (< 10mm) gravel, unconsolidated, loose
III. Banded sand and medium/large gravel (< 3cm) gravel, semi-consolidated, (whale vertebra retrieved from this layer)

CAKR 2010
10GEOXH062808A
Test ID 1188A
North Wall Profile
EAP 7/26/10

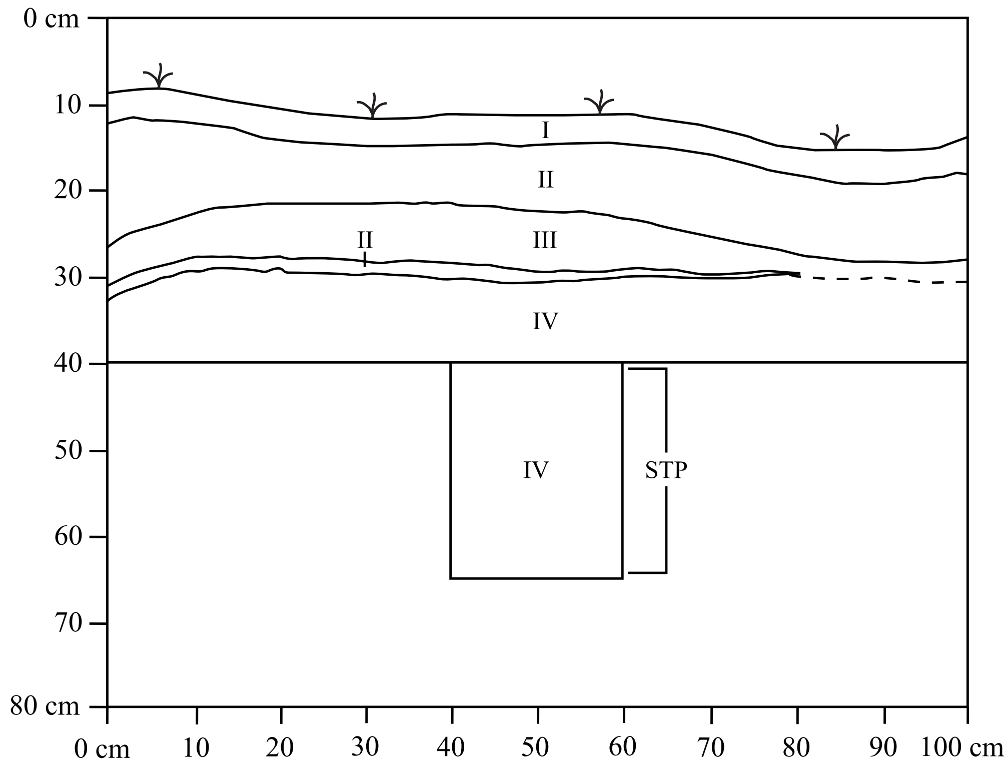
Figure by Sarah Ashmore 2/03/2011



I. Dark, organic rich sod
II. Coarse gray sand
III. Dark silty layer, abundant calcine, bone, cemented sediment, and charcoal
IV. Unconsolidated gravels, angular to subangular
V. Large pebbles in sand matrix
VI. Unconsolidated gravels, round to subrounded
c. Cemented sediment
b. Bone

CAKR 2010
10GEOXH072413A
Test ID 1189A
West Wall Profile
JDD 7/27/10

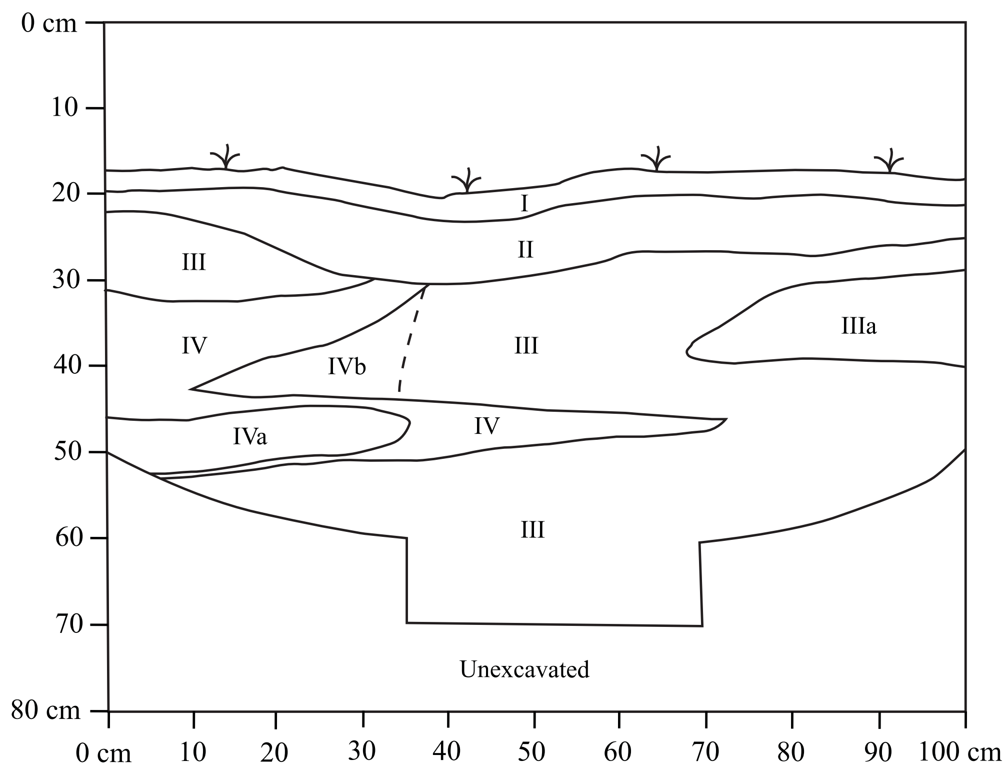
Figure by Sarah Ashmore 2/03/2011



I. Vegetation mat
II. Dark brown - black sandy loam
III. Unconsolidated coarse sand and small gravel, sub-rounded, well sorted
IV. Coarse-grained sub-angular sorted sand with some gravel and pebbles (< 5%) throughout, increase in gravel and pebble size with depth and deposit becomes more unconsolidated, STP stopped at 65 cmbd due to gravel collapse

CAKR 2010
10GEOXH072413A
Test ID 1190A
South Wall Profile
SLA 7/26/10

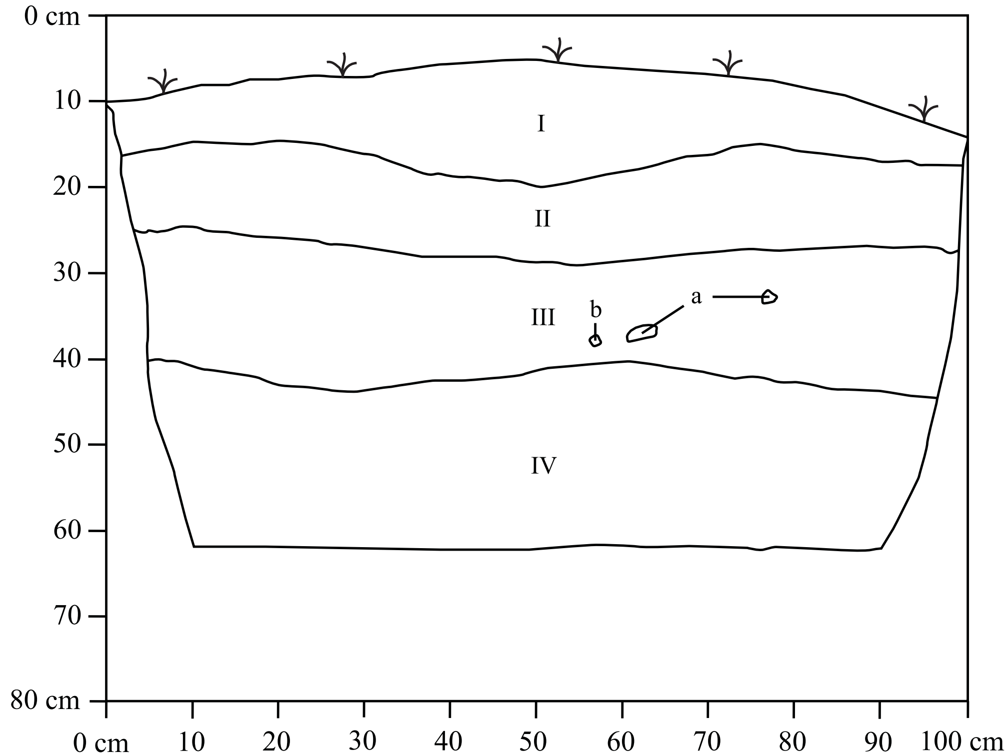
Figure by Sarah Ashmore 2/03/2011



I. Vegetation mat
II. Dark brown-black vegetation mat
III. Unconsolidated sub-angular gravel, no cultural material, bands of compact sand
IIIa. Fine-coarse grained compact sand, no cultural material
IV. Black organic rich cultural deposit with bone, burnt bone, charcoal, decomposing wood and one flake, hardened in some areas
IVa. Same as above but dark reddish-brown color, stained by decomposing bone?
IVb. Unconsolidated gravel (same as III) but with some cultural material

CAKR 2010
10GEOXH072614A
Test ID 1192A
North Wall Profile
SLA 7/27/10

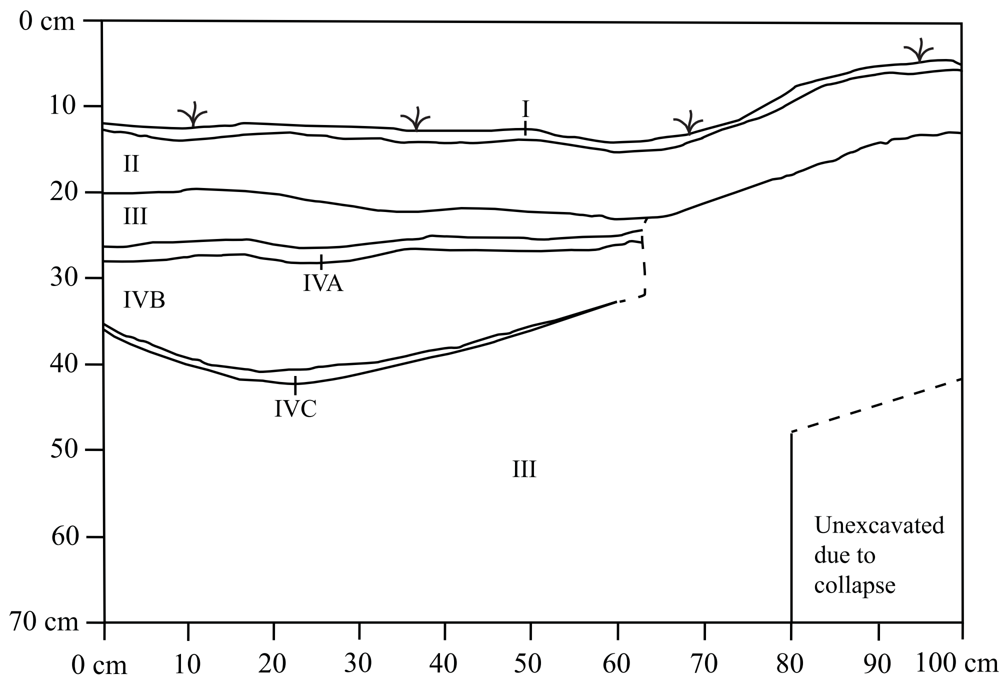
Figure by Sarah Ashmore 2/04/2011



I. Sand and small gravel below vegetation, soil mixed; associated with sod (level 1)
II. Sod and dense organic layer, some stones (< 3cm)
III. Mixed sand and gravel, some soil development near bones, however extent of cultural depoit not clearly delineated
IV. Unconsolidated medium subround gravel
a. Bone in wall
b. Burnt/calcined bone in wall

CAKR 2010
10GEOXH072715A
Test ID 1194A
East Wall Profile
EAP 7/28/10

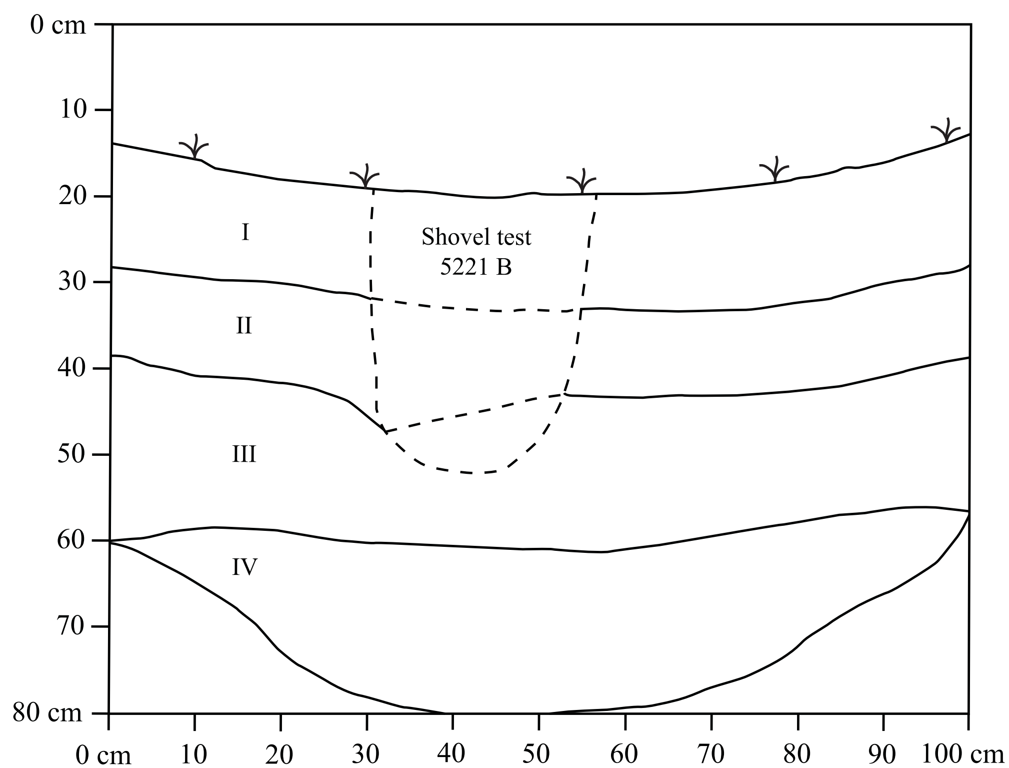
Figure by Sarah Ashmore 2/04/2011



I. Thin vegetation mat, roots throughout
II. Dark brown-black sandy loam, roots throughout, cultural material at II/III interface
III. Sterile gravel and sand
IVA. Dark brown-black sandy loam with cultural material
IVB. Gravel and sand with cultural material throughout, areas of hardened sediment as well as looser gravel and sand with well-preserved faunal, charcoal, calcined bone and decomposing wood
IVC. Fire hardened sand and gravel in N and NW quad at base of cooking feature

CAKR 2010
10GEOXH072715A
Test ID 1195A
North Wall Profile
SLA 7/29/10

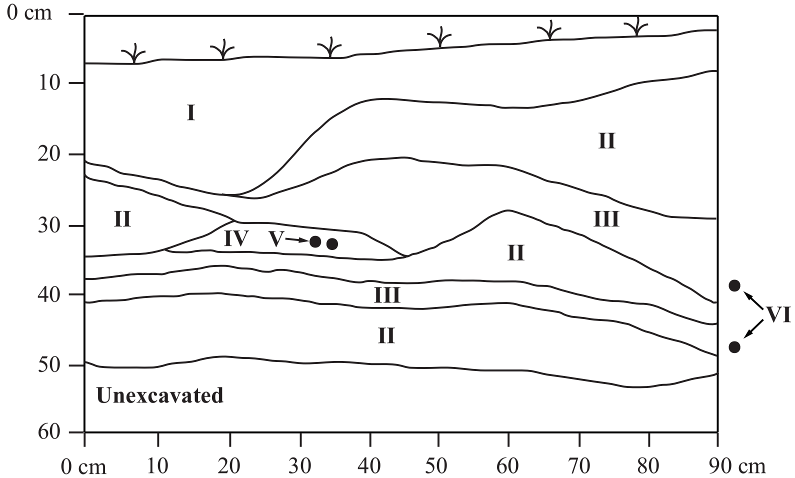
Figure by Sarah Ashmore 2/09/2011



I. Sod, organic rich dark soil
II. Sandy, organic rich soil, abundant roots, some round to subround gravel, 2-10 mm
III. Round to subround gravel in a sandy matrix, dark sands, gray gravel
IV. Unconsolidated round to subround gravel, 5-40 mm

CAKR 2010
10GEOXH072415A
Test ID 1196A
East Wall Profile
JDD 7/29/10

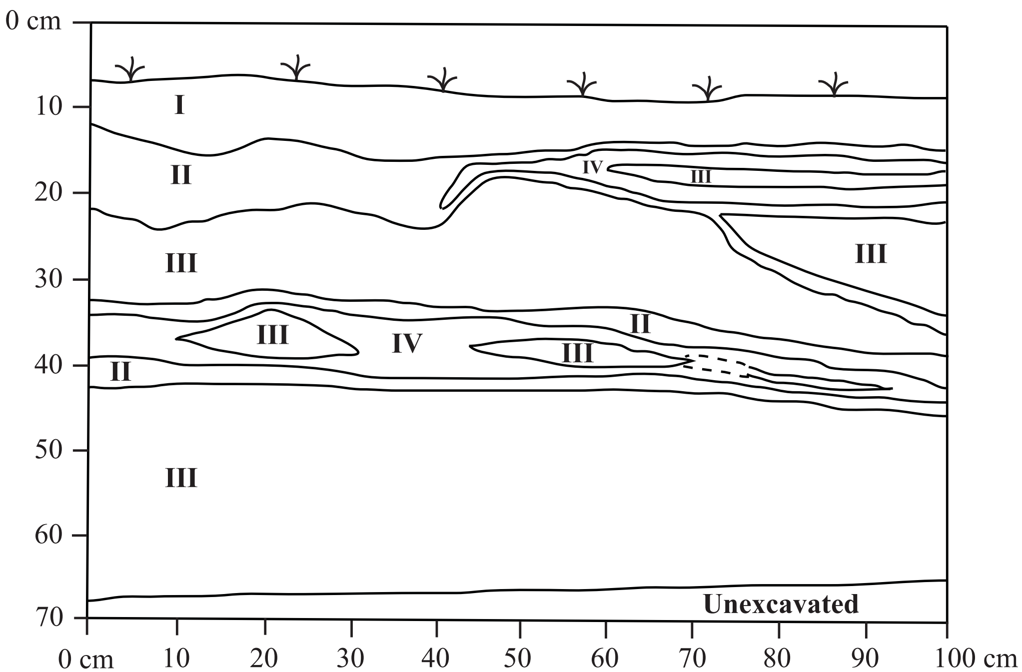
Figure by Sarah Ashmore 2/04/2011



I. Sod and soil, some sand, silt, and gravel, organics
II. Gravel, fairly sorted, 0.5 - 2 cm, subangular - subrounded, lithic
III. Dark, organic rich, silty sand with gravel
IV. Brown/orange (FeO2), silty sand with charcoal
V. Charcoal
VI. Wood on south wall

CAKR 2008
08PROXH070509A
Test ID 696B
East Wall Profile
JKG & NCR 7/7/09

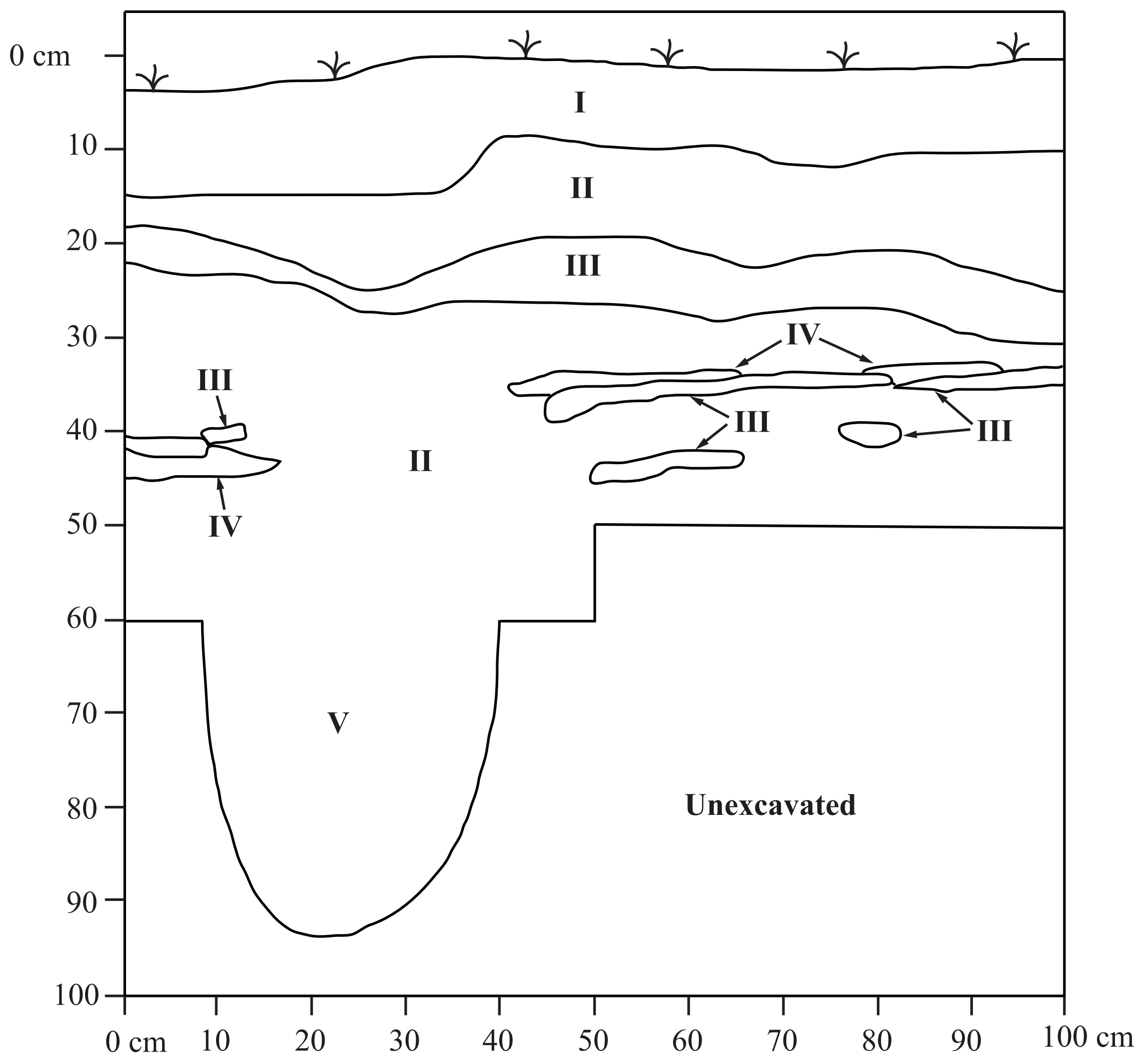
Figure by Dave Hunt 2/19/2010



I. Sod
II. Dark, sandy soil
III. Gravel
IV. Tan-brown sandy soil

CAKR 2008
08PROXH070509A
Test ID 697B
West Wall Profile
PWR 7/8/09

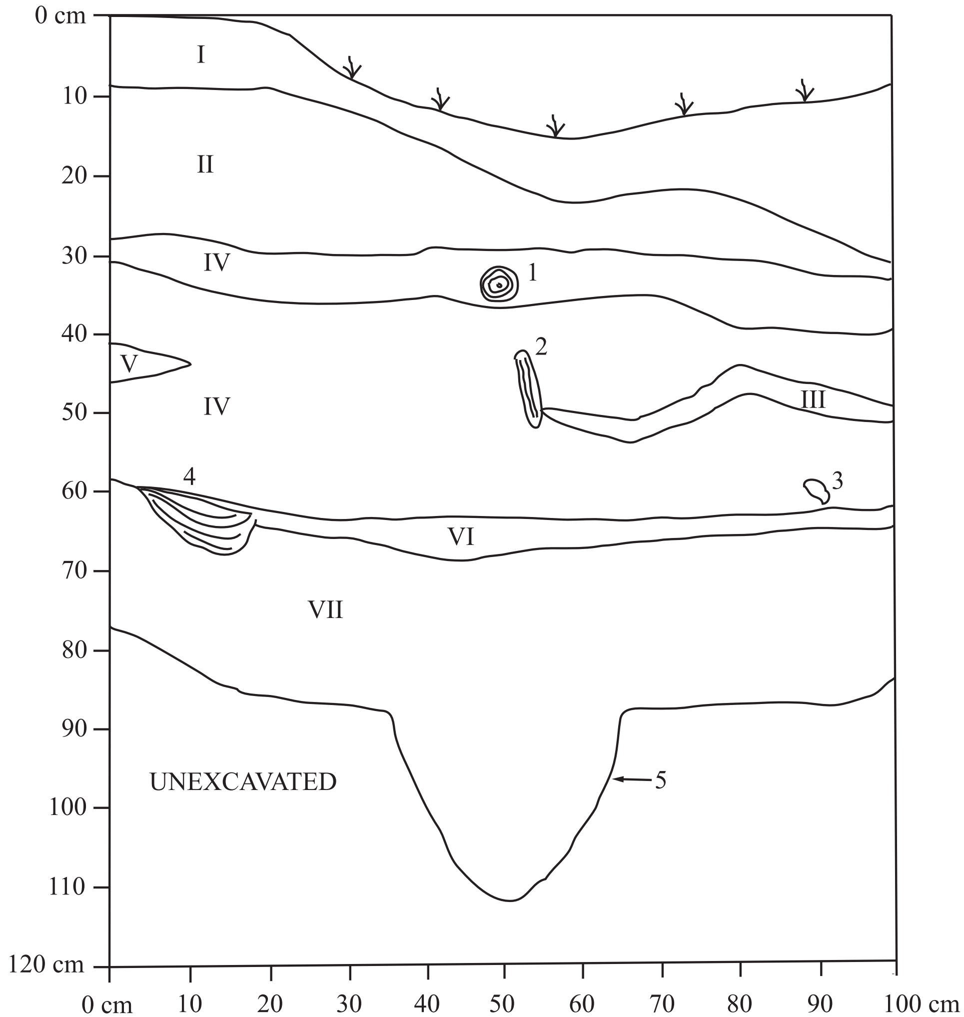
Figure by Dave Hunt 2/27/2010



I. Organic duff
II. Small pebbles in brown silty soil
III. Very dark brown sandy silt (probably cultural)
IV. Light grayish brown sand
V. Unconsolidated gravel

CAKR 2008
08PROXH070708A
Test ID 698B
South Wall Profile
AKF 7/8/08

Figure by Dave Hunt 2/19/2010

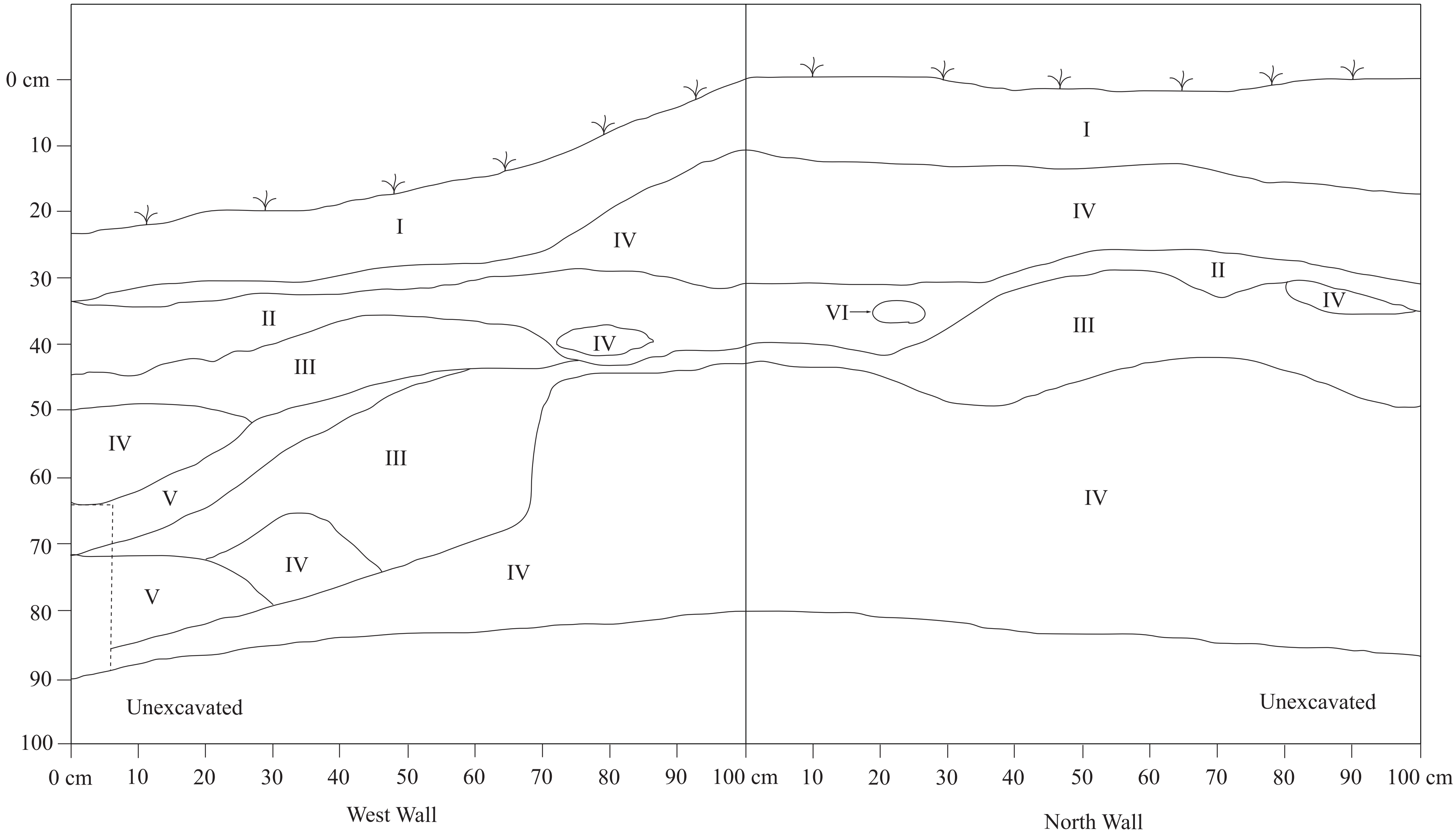


I. Organic sod cap
II. Unconsolidated (subangular to subrounded) gravel
III. Dark brown organic silt with woody fragments
IV. Unconsolidated subangular gravel
V. Dark gray sand
VI. Reddish brown organic silt with small gravel, mottled with black organic rich silt
Collected charcoal and faunal samples from this layer
VII. Unconsolidated subrounded gravel, interbedded with dark gray sandy gravel layers

1. Structural wood cross-section
2. Wood fragment
3. Wood fragment
4. Large worked wood cross-section
5. STP in center of unit

CAKR 2008
PROXH072308A
Test ID 1723B
West Wall Profile
AKF 7/24/08

Figure by Dave Hunt 2/27/2010

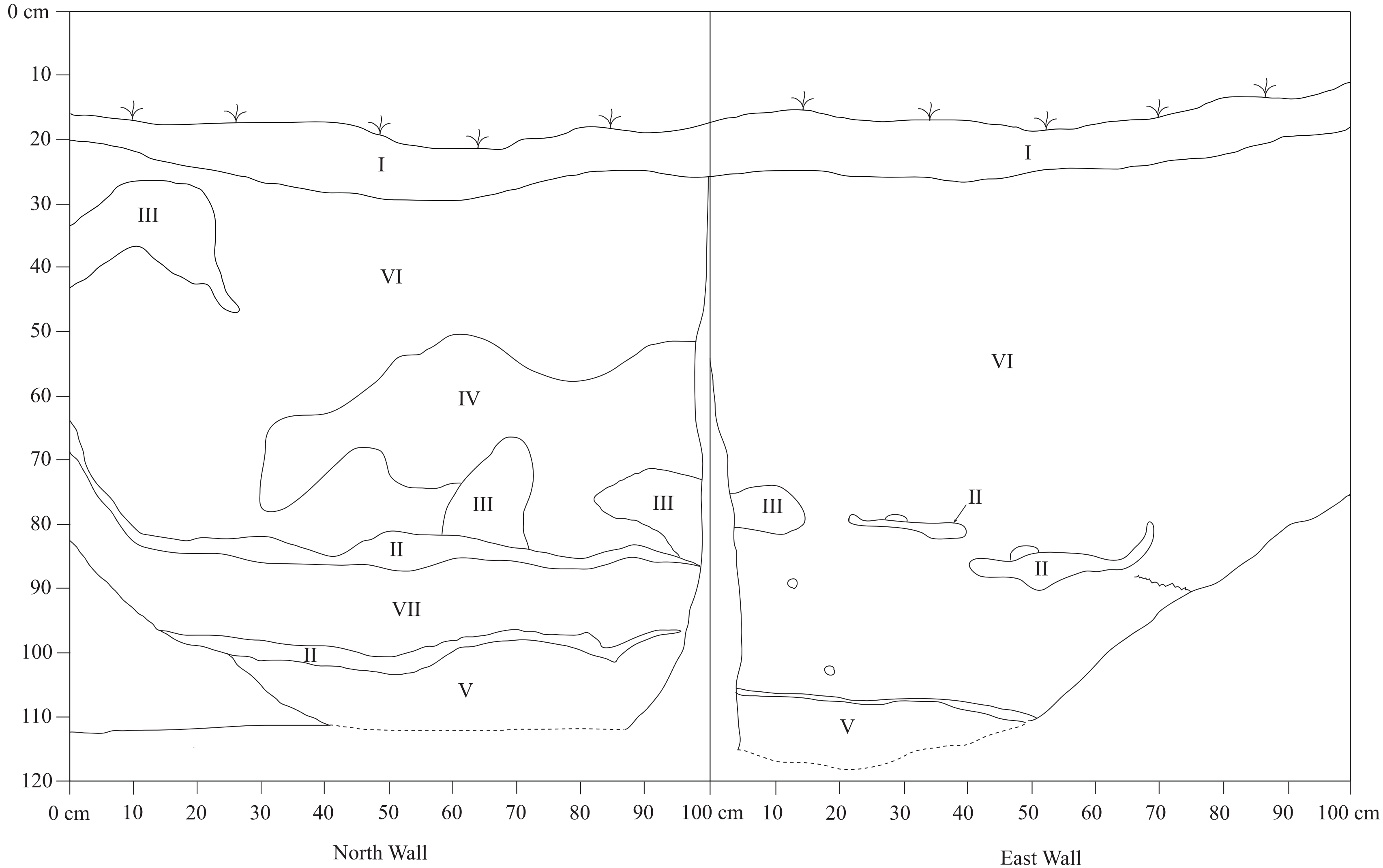


I. Sod (often mixed with dark organic soil)
II. Dark organic soil
III. Sandy gravel
IV. Gravel
V. Sand
VI. Rock (rock is FRM)

Dashed line is fall ins

CAKR 2008
no rover
Test ID 2347B
West & North Wall Profiles
no initials / no date

Figure by Dave Hunt 3/7/2010

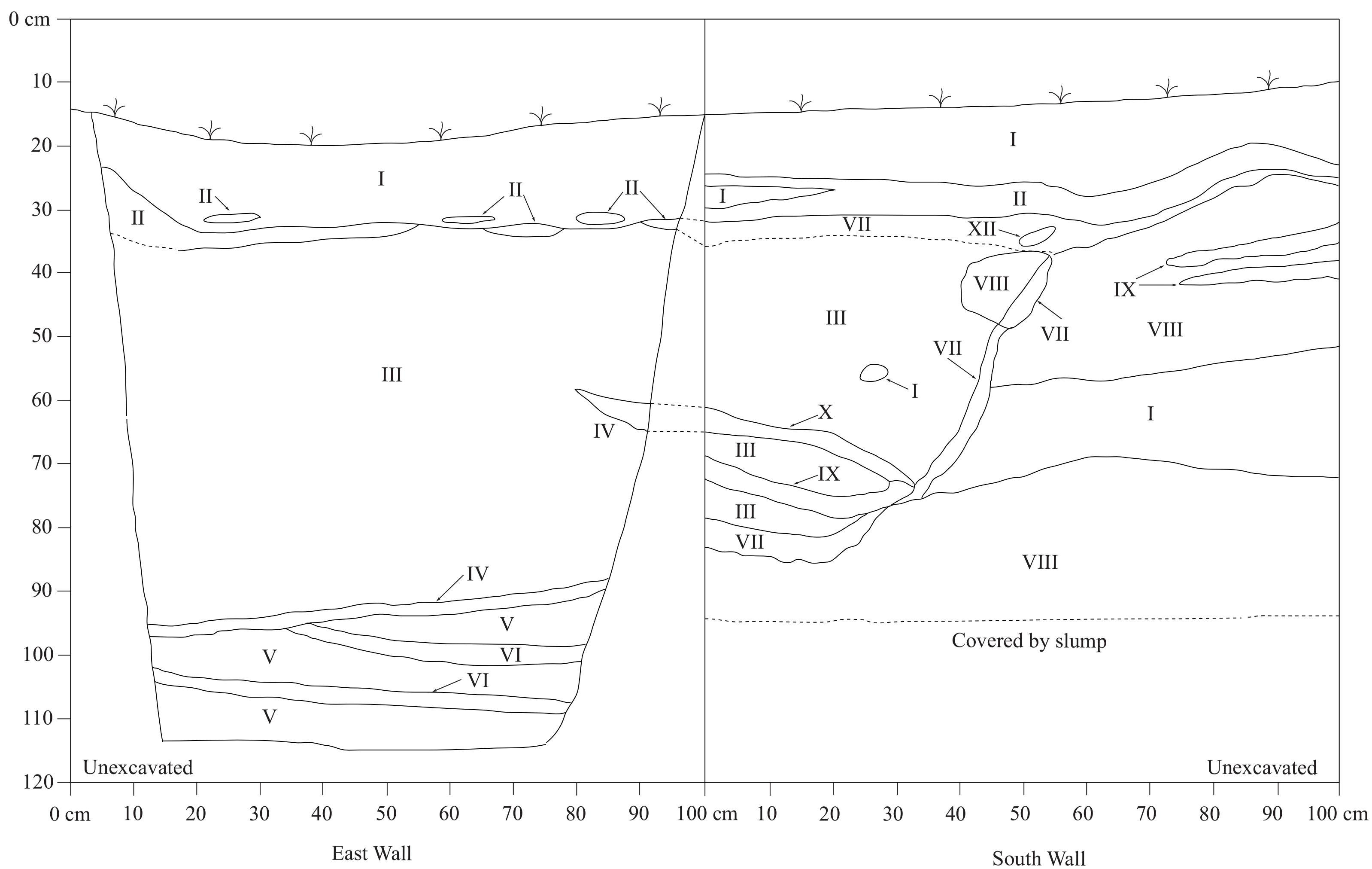


I. Organic black soil 10YR 2/1
II. Cultural black layer 10YR 2/1
III. Dark organic soil mixed with gravel 10YR 2/1
IV. Loose gravel with little sand
V. Compact sand with large pebbles
VI. Layer of med-fine grain sand matrix mixed with fine to medium well rounded gravel with layers of loose, well-rounded gravel throughout
VII. Fine to medium loose gravel with little sand

Thin cultural layer
Bottom of unit

CAKR 2008
PROXH080410A
Test ID 2352B
North & East Wall Profiles
JKG & SLA / no date

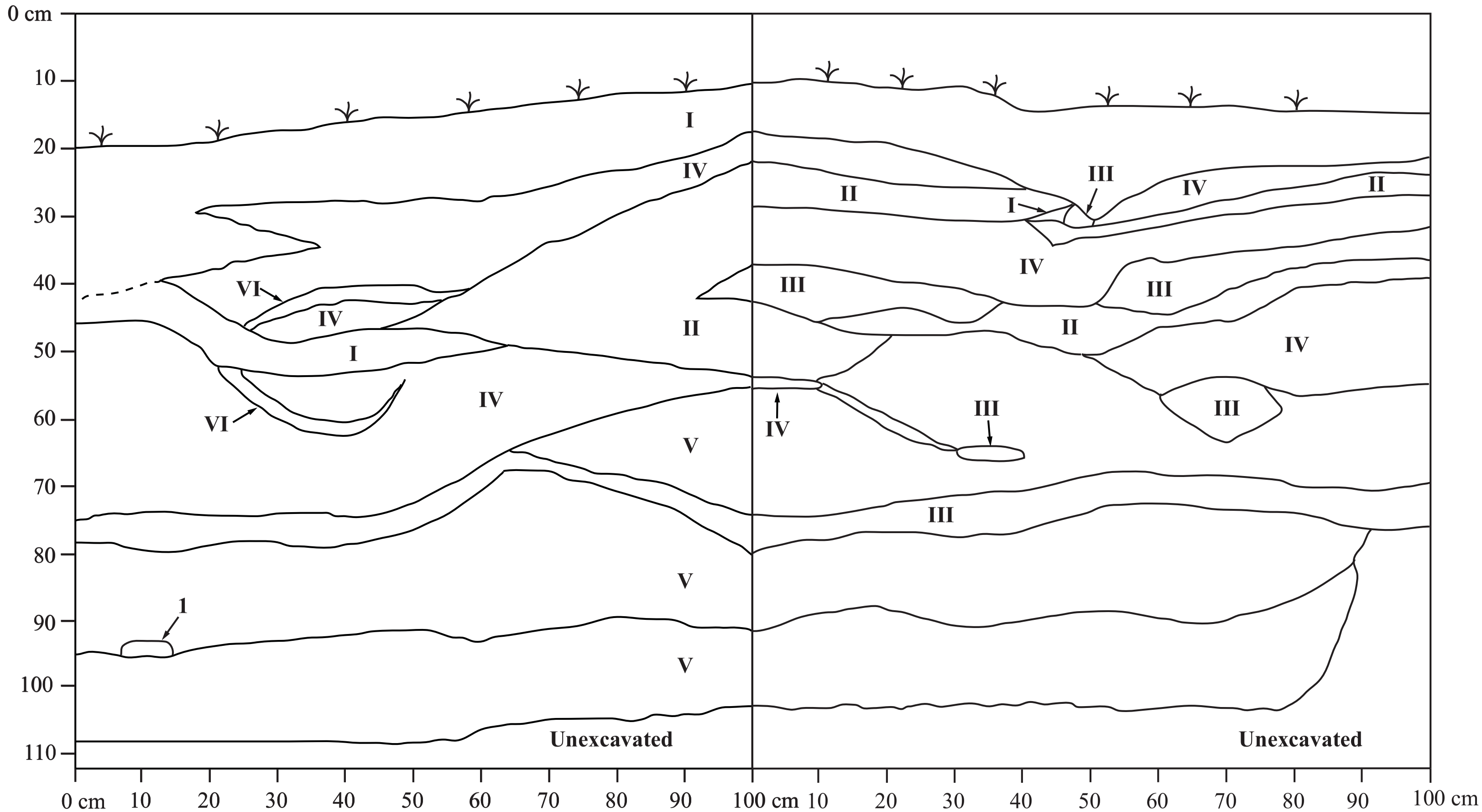
Figure by Dave Hunt 3/7/2010



I. Sod
II. Fine gravel (0.2 - 0.5 cm) with sand (<30%)
III. Mixed fill, sand, gravel, loam, churned up / mottled look
IV. Dark, compact, organic rich, plentiful twigs, sod-like soil, possible floor
V. Gravel (1 - 2 cm), little matrix (<10%), some lithic sand and small gravel (0.1 - 0.5 cm)
VI. Sand, some gravel (0 - 20%), quartz
VII. Sand, fine gravel (0.2 - 0.5 cm), loam, compact, organic rich
VIII. Clean beach gravel (0.5+ cm), little matrix (<10%), natural stratigraphy is clear
IX. Gravel with sand (>40%), natural stratigraphy is clear
X. Sod with sand and fine gravel, compact, organic rich
XI. Sod with wood, compact, organic rich
XII. FCR

CAKR 2008
PROXH080410A
Test ID 2353B
East & South Wall Profiles
NCR 8/7/08

Figure by Dave Hunt 3/12/2010

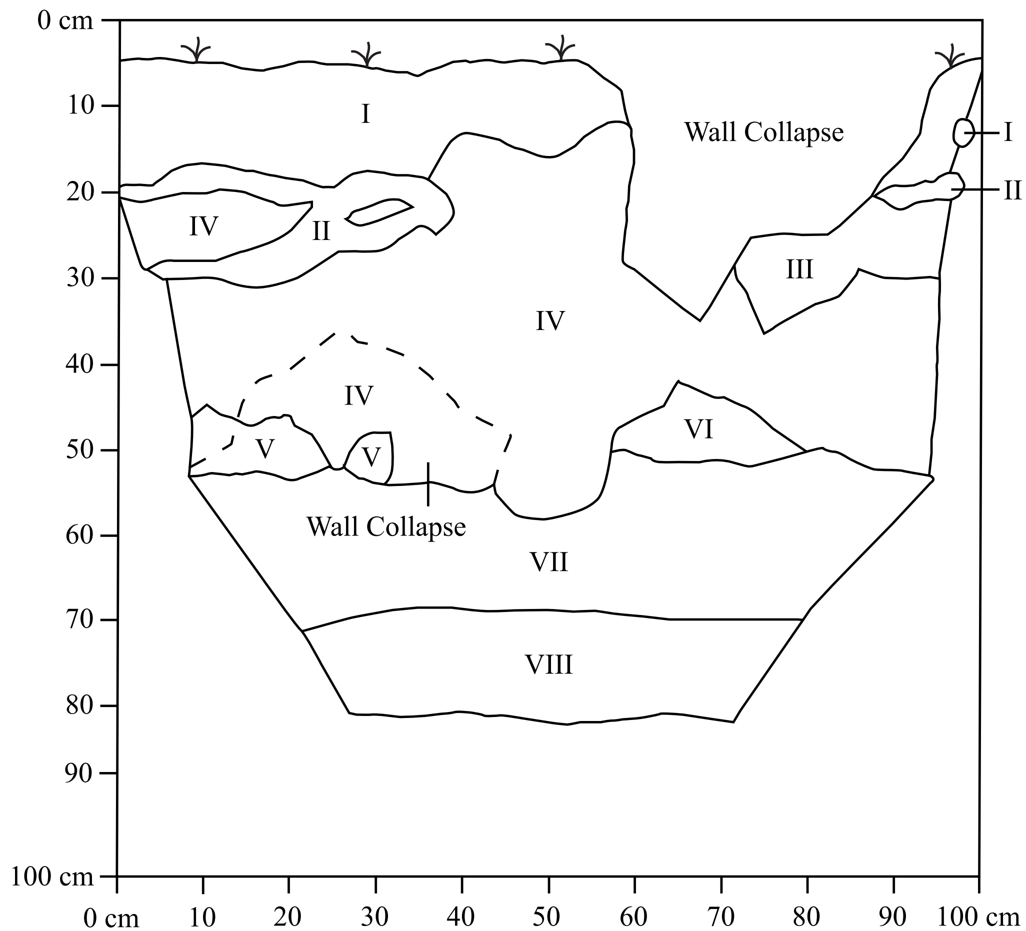


I. Dark organic soil
II. Dark organic mixed with gravel
III. Sand
IV. Gravel sand mix
V. Gravel
VI. Stains of dark organic soil

1. Wood

CAKR 2008
PROXH080611A
Test ID 2356B
West and North Wall Profiles
PWR/RBW 8/7/08

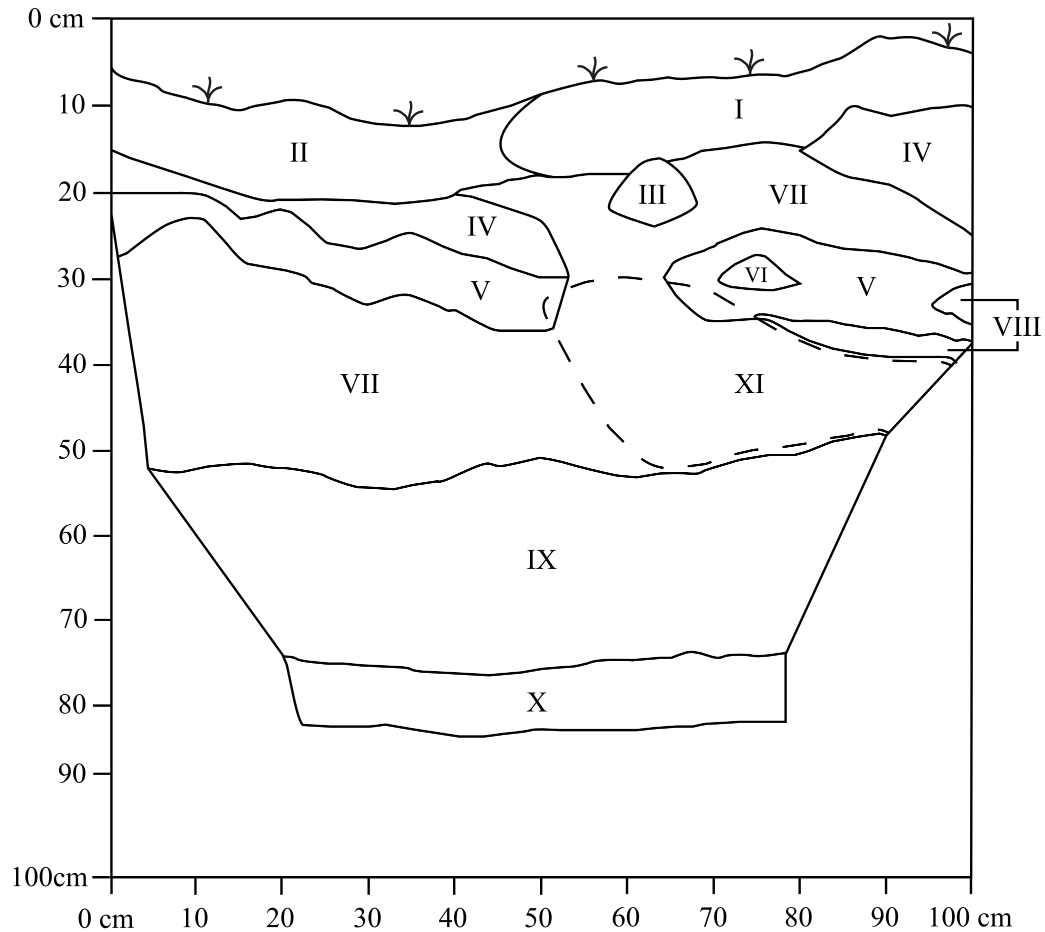
Figure by Dave Hunt 2/27/2010



I. 7.5 yr 4/3 sod with some roots
II. 7.5 yr 3/2 sod
III. 10 yr 3/2 sod
IV. 10 yr 3/3 sandy gravel
V. 7.5 yr 3/2 sand
VI. Gravel and 7.5 yr 3/2 sand
VII. Unconsolidated rounded to subrounded gravel 2-30 mm
VIII. 7.5 yr 4/6 rounded to subrounded gravel 2-10mm

CAKR 2009
09PROXH062709A
Test ID 2601B
East Wall Profile
AKF/LMT 7/01/09

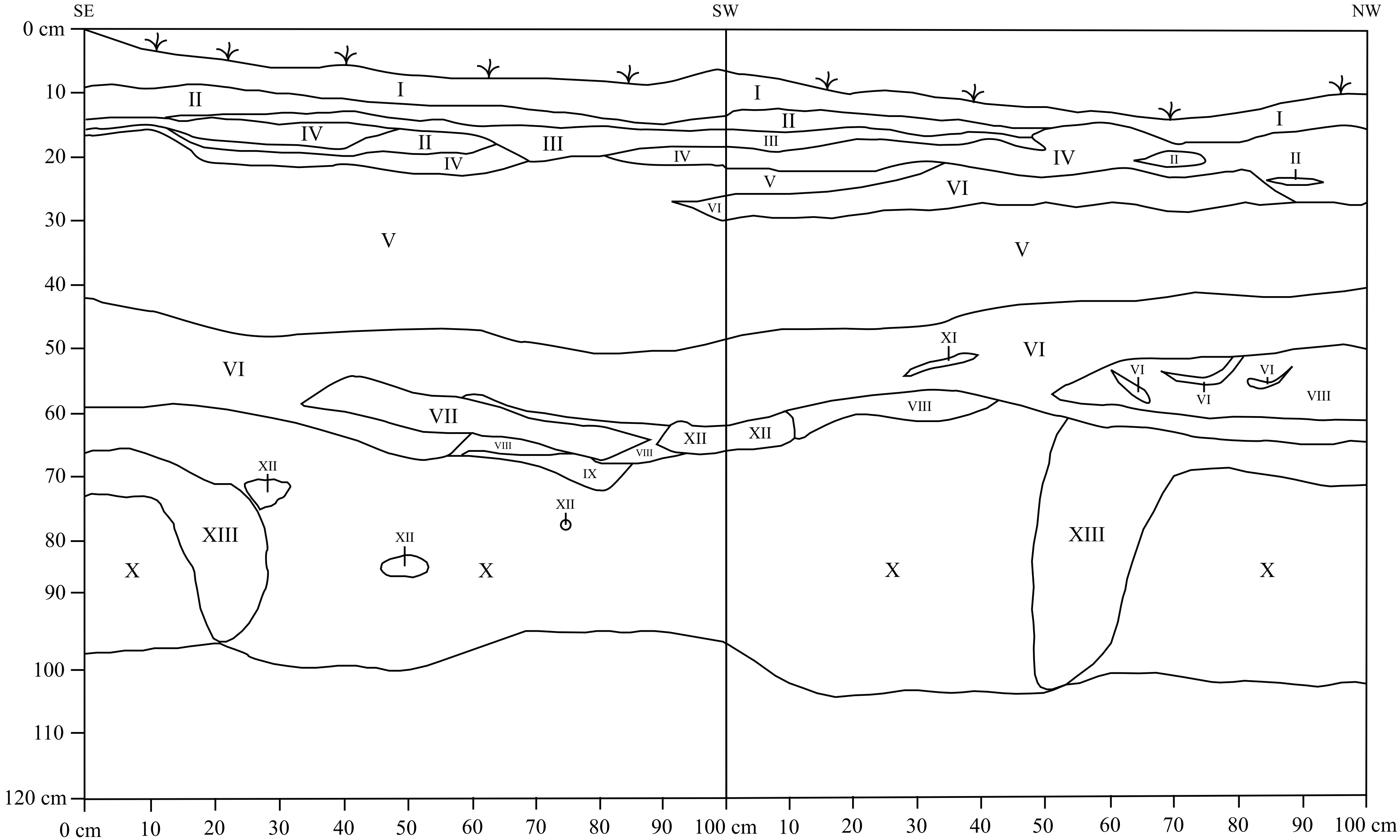
Figure by Sarah Ashmore 1/27/2011



I. 7.5 yr 2.5/2 sod with birch roots
II. 7.5 yr 4/2 subangular to rounded gravels in sand
III. Squirrel hole
IV. 7.5 yr 3/2 silty sand with roots
V. 10 yr 2/1 organic (?) silt with subangular to rounded gravels
VI. 10 yr 2/2 sand
VII. 10 yr 3/2 sandy gravels, subrounded to rounded
VIII. 10 yr 2/1 silt and sand
IX. Unconsolidated gravels, subrounded to rounded
X. 5 yr 3/3 unconsolidated gravels
XI. Rootlets predominant

CAKR 2009
09PROXH062709A
Test ID 2601B
South Wall Profile
AKF/LMT 7/01/09

Figure by Sarah Ashmore 1/27/2011

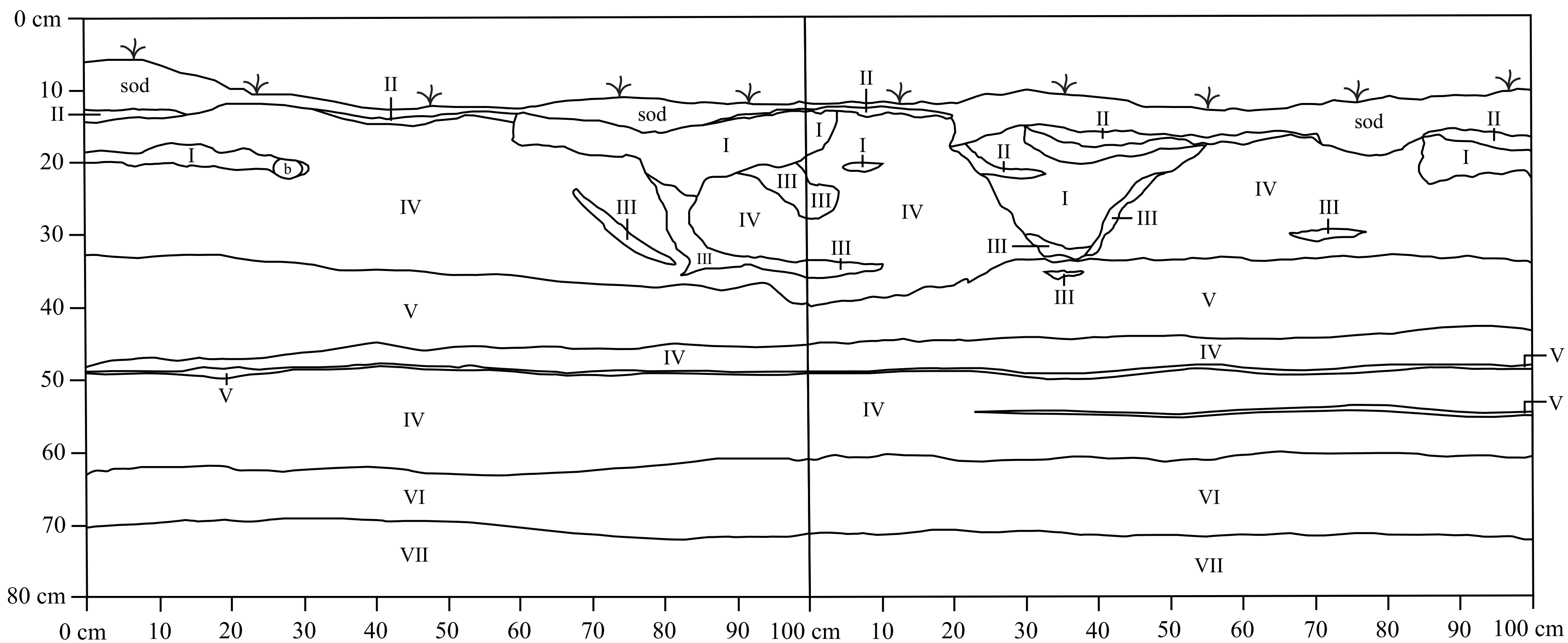


I. Sod later, matted rootlets, 5 yr 3/2 dark reddish brown, no cultural material found
II. Coarse sand and dirt
III. Rooty sod layer, 7.5 yr 2.5/2 very dark brown, pottery sherds
IV. Organic rich soil layer, 10 yr 2/1 black, charcoal, bone
V. Gravel, slight fining with depth, charcoal, fire modified rock, bone, pottery and tested lithic, wood, seal oil cemented gravel
VI. Gravelly soil 10 yr 2/1 black, coarse grained, slate, charcoal, fire modified rock, and bone; also collected some ash?
VII. Gravel with some soil mixed in
VIII. Moderately sorted gravel with some soil, 7.5 yr 3/1 very dark gray
IX. Soil layer, structural wood, charcoal, and decomposing bone, 10 yr 2/1 black
X. Coarse gravel, size diminishes with depth, wood, and a slate piece
XI. Silt? Ash? 5 yr 4/1 dark gray
XII. Wood
XIII. Krotovina

Unable to draw in actual bottom (where we hit permafrost) because of walls collapsing

CAKR 2009
09PROXH062709A
Test ID 2602A
South and West Wall Profile
KMO/FMC 7/02/09

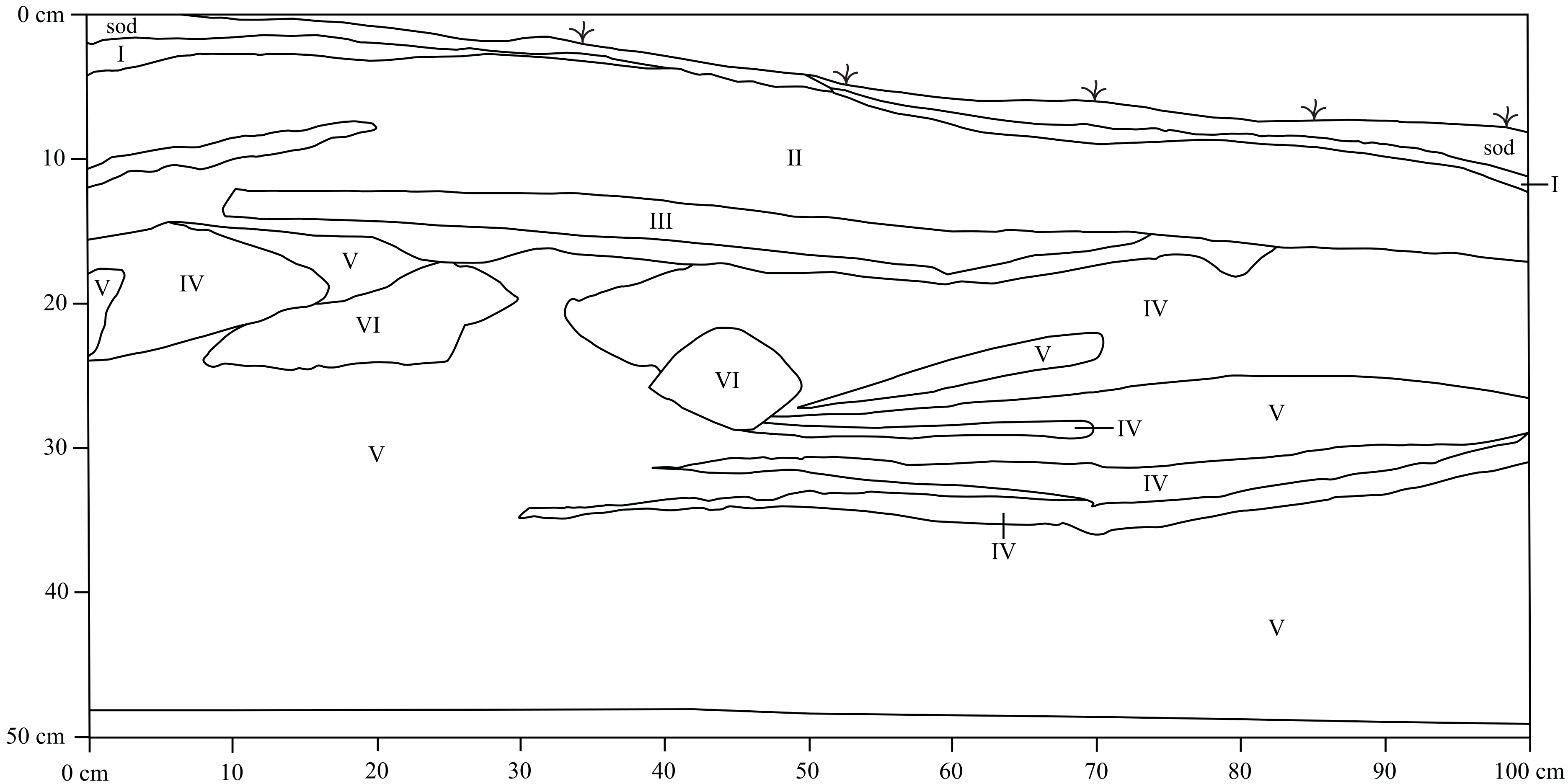
Figure by Sarah Ashmore 1/20/2011



Sod - 10 yr 2/2 - very dark brown

I. Black to dark brown organic sediment - 7.5 yr 2.5/1 - black
II. Gray dense sand mixture - 10 yr 4/2 dark grayish brown
III. Pebbles organic stained - consolidated - 10 yr 2/1 black
IV. Small pebbles loose - 10 yr 6/3 pale brown
V. Consolidated sand/small pebble mix - 10 yr 3/1 very dark gray
VI. Dark pebbles with sheen - 10 yr 2/1 black
VII. Iron stained pebbles - 7.5 yr 3/4 dark brown
b. Decaying bone

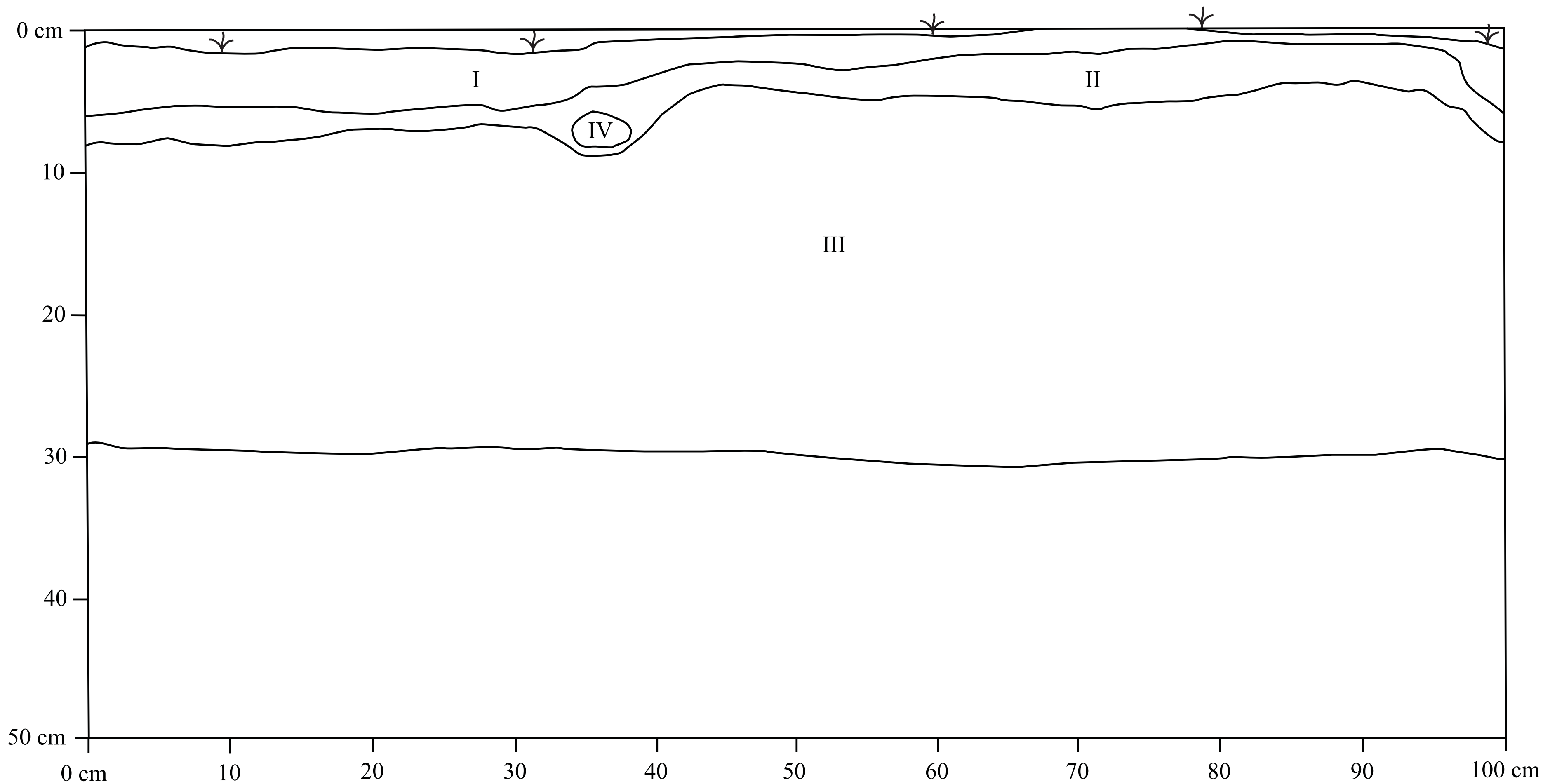
CAKR 2009
09PROXH062910A
Test ID 2603B
East and South Wall Profile
PWR 7/2/2009
Figure by Sarah Ashmore 1/27/2011



I. 10 yr 4/2, dark grayish brown, sandy silt size particles
II. 10 yr 4/2, silt size particles with sand and small gravel ~ < 1cm
III. 10 yr 2/2, very dark brown, silt sized particles
IV. 10 yr 4/3, brown
V. Gravel ~ .5cm
VI. Krotovina

CAKR 2009
09PROXH070308A
Test ID 2604B
East Wall Profile
AKF/PWR/LMT 7/03/09

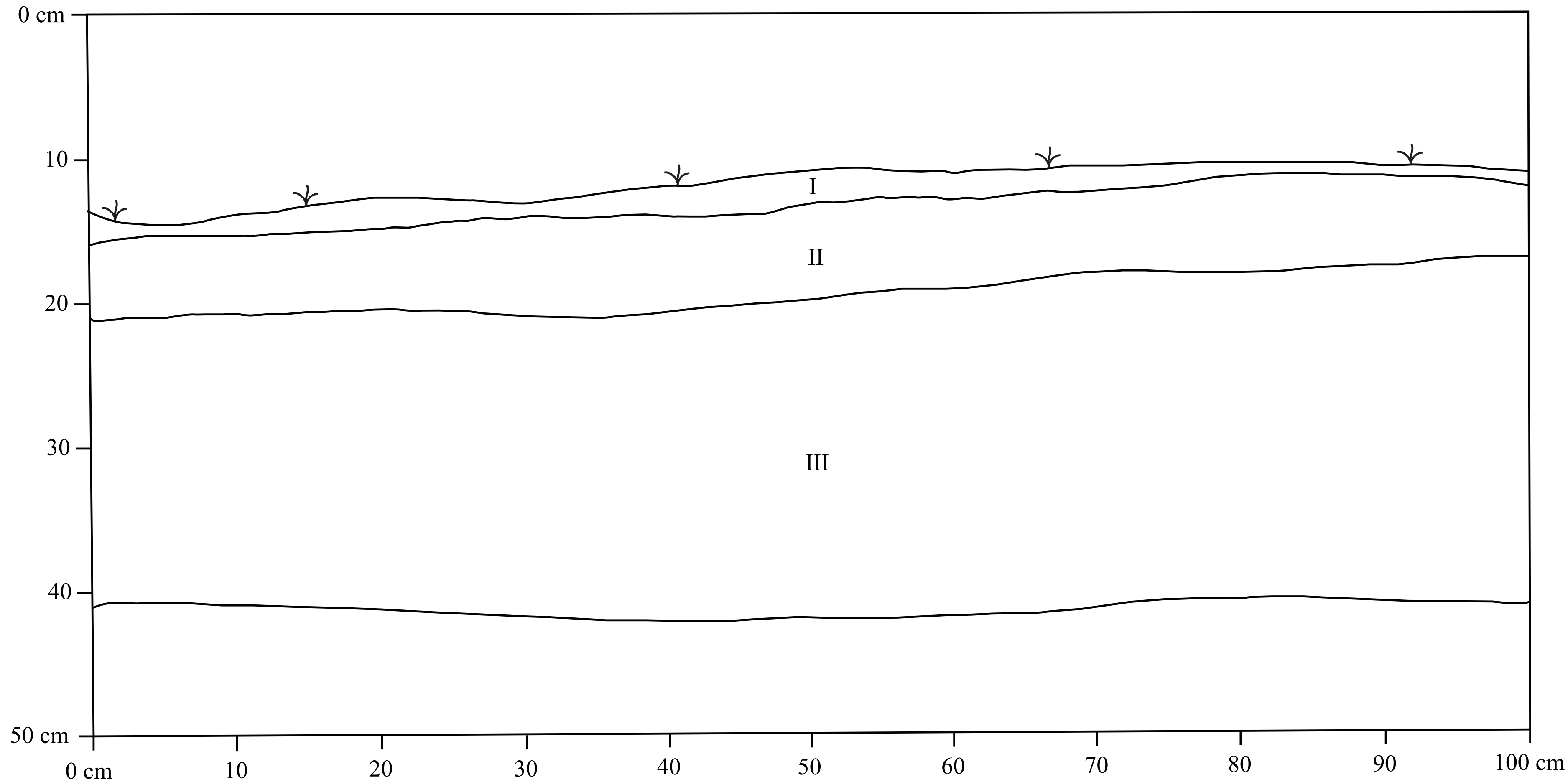
Figure by Sarah Ashmore 2/02/2011



I. Very dark brown 10 yr 2/2, organic with roots, little to no gravel
II. Grayish brown 10 yr 5/2, silt sized particles with coarse sand, compacted
III. Very dark grayish brown 10 yr 3/2, small pebbles mixed with sand, some compaction
IV. Dense silt sized particles, no gravel

CAKR 2009
09PROXH071008A
Test ID 2925B
North Wall Profile
PWR/LMT 7/18/09

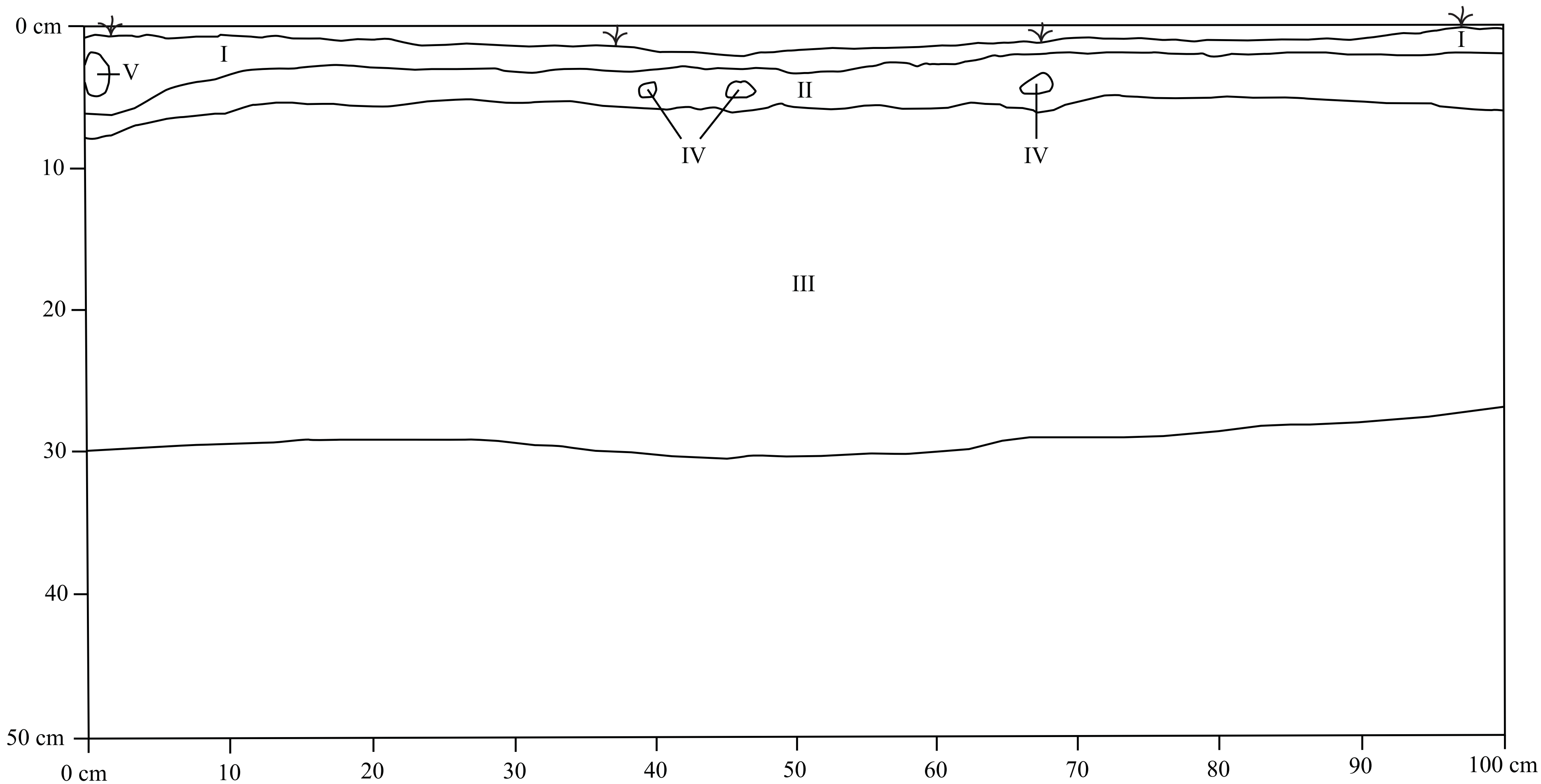
Figure by Sarah Ashmore 2/02/2011



I. Very dark brown 10 yr 2/2, organic, roots little to no gravel
II. Grayish brown 10 yr 5/2, silt sized particles with coarse sand compacted
III. Very dark grayish brown 10 yr 3/2, small pebbles mixed with sand, some compaction

CAKR 2009
09PROXH071008A
Test ID 2926B
East Wall Profile
PWR/LMT 7/10/09

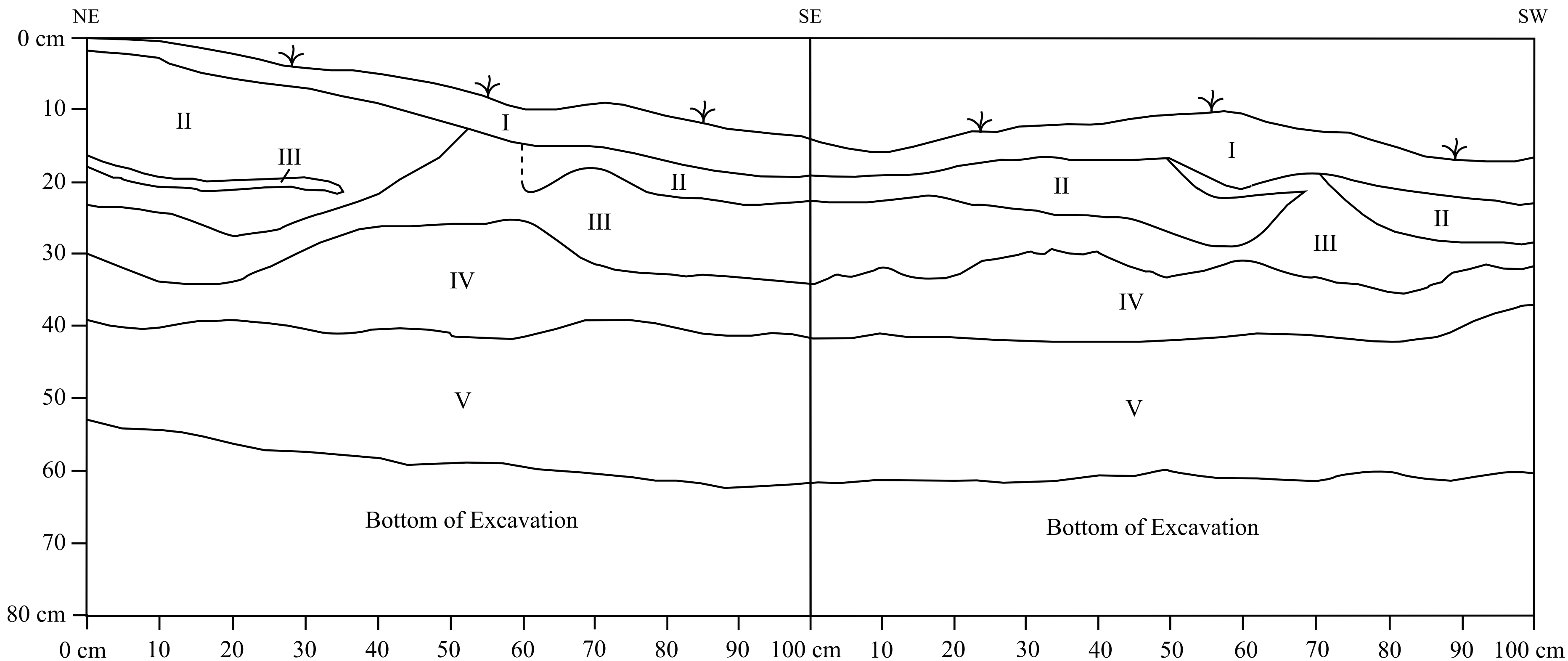
Figure by Sarah Ashmore 2/02/2011



I. Very dark brown 10 YR 2/2, organic, roots little to no gravel
II. Grayish brown 10 YR 5/2, silt sized particles with coarse sand, compacted
III. Very dark grayish brown 10 YR 3/2 small pebbles mixed with sand, some compaction
IV. Dark grayish brown 10 YR 4/2, compacted silt sized particles
V. Roots

CAKR 2009
09PROXH071008A
Test ID 2926B
North Wall Profile
PWR/LMT 7/10/09

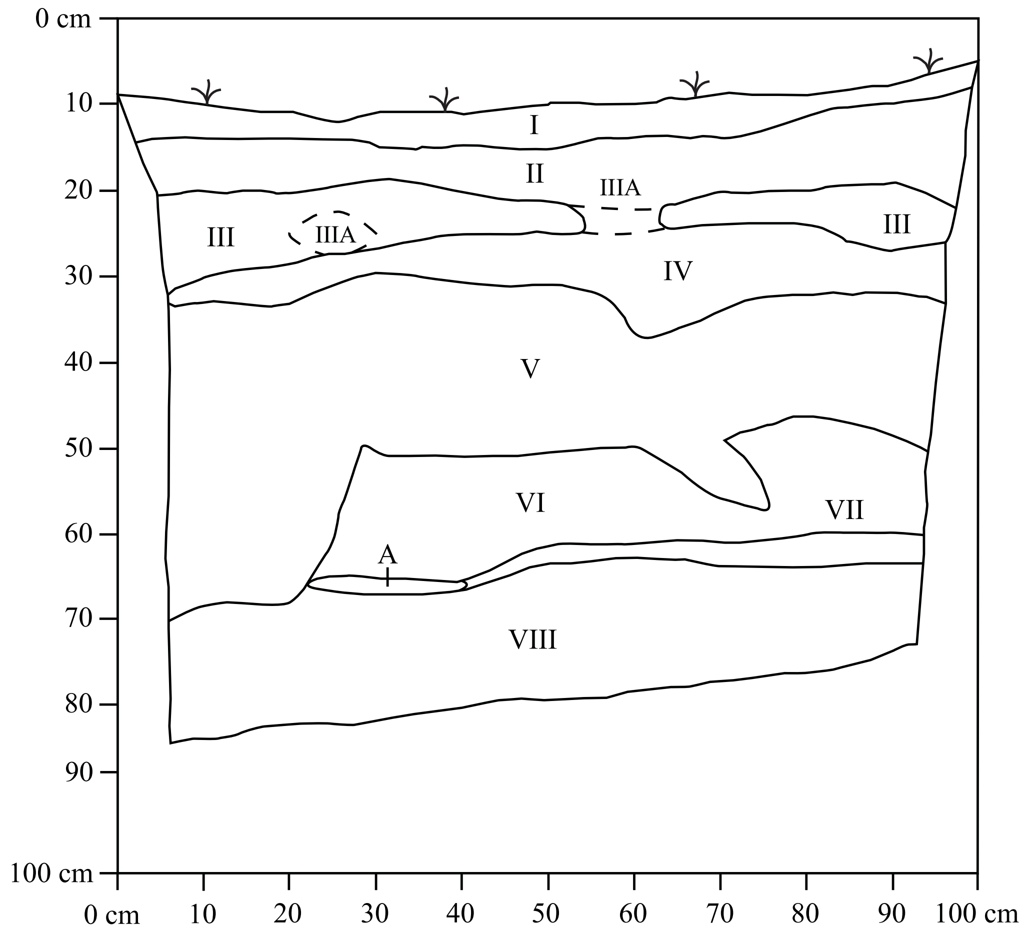
Figure by Sarah Ashmore 2/02/2011



I. Sod layer, silty sod 7.5 YR 2.5/3 very dark brown
II. Gravel with silt and fine sand matrix, subangular
III. Predominant color 10 YR 2/2 very dark brown, silty soil with some sand and patches of decomposing bone, (7.5 YR 4/7 strong brown in bone patches), found cultural material mostly in very dark brown silty soil
IV. Subangular unconsolidated gravel mixed with patches of III mixed in, also patches of unconsolidated sand, cultural material primarily from patches of III and consolidated sand
V. Interbedded unconsolidated coarse sand and gravel, subangular, poorly sorted, and unconsolidated gravel, subrounded and poorly sorted

CAKR 2009
09PROXH071708A
Test ID 3405B
East and South Wall Profile
SLA/KMO 7/20/09

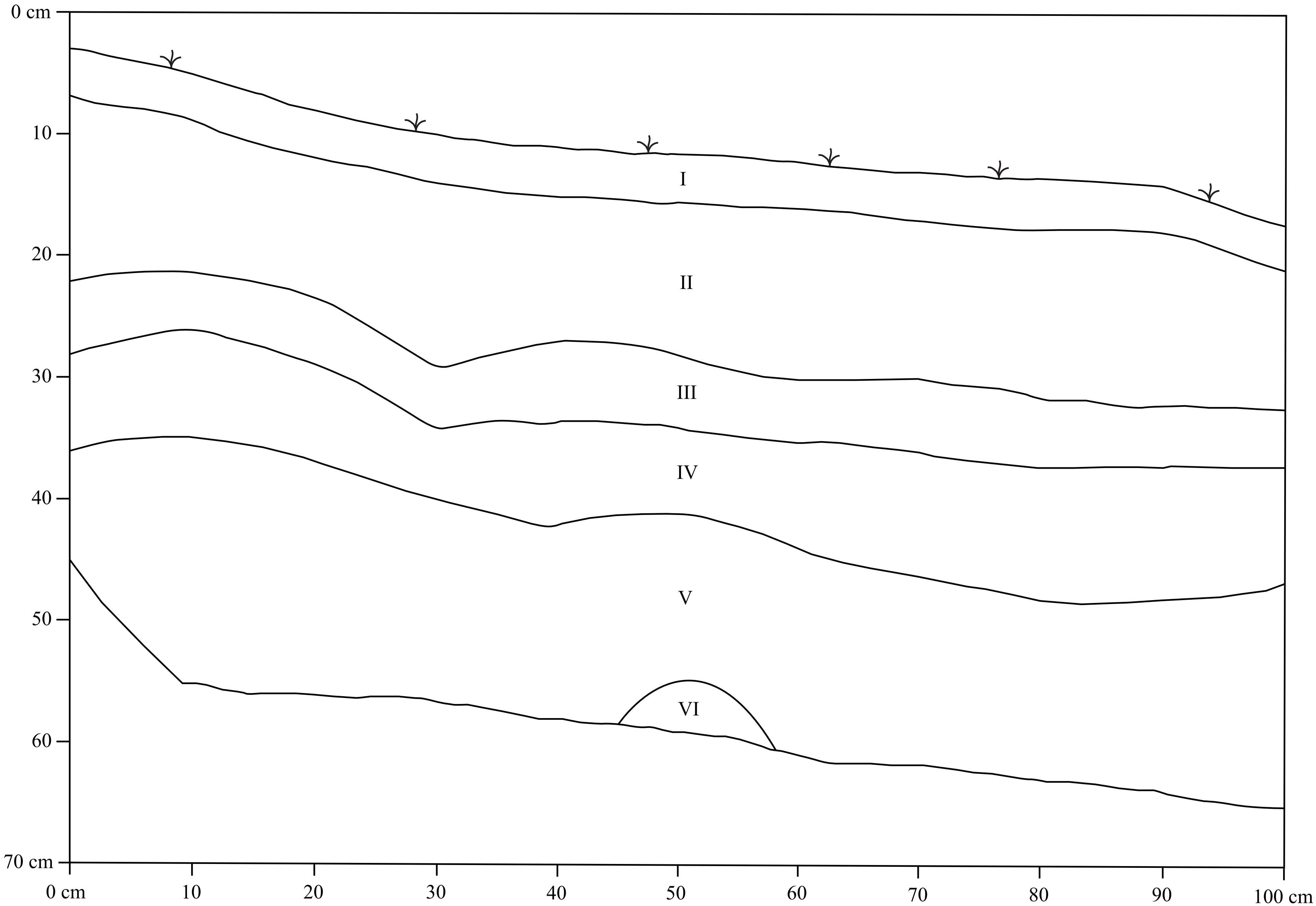
Figure by Sarah Ashmore 1/19/2011



I. Organic root mat, reddish brown
II. Dark brown silty loam and pebbles < 10 mm with rootlets
III. Dark brown compacted silt/sod with rootlets and pebbles < 10mm
IIIA. Very dark brown organic silt, loose and uncompacted
IV. Subangular to rounded pebbles 1-10mm with sandy loam; varying compactness throughout layer
V. Dark brown silty loam with sand and pebbles < 10mm, compacted with pocket of loose and loam/pebbles
VI. Unconsolidated pebbles, subangular to rounded 1-15mm with sand and loam
VII. Brown loam with pebbles 1-10mm
VIII. Unconsolidated pebbles, subangular to rounded, 1-20mm with sand
A. Wood

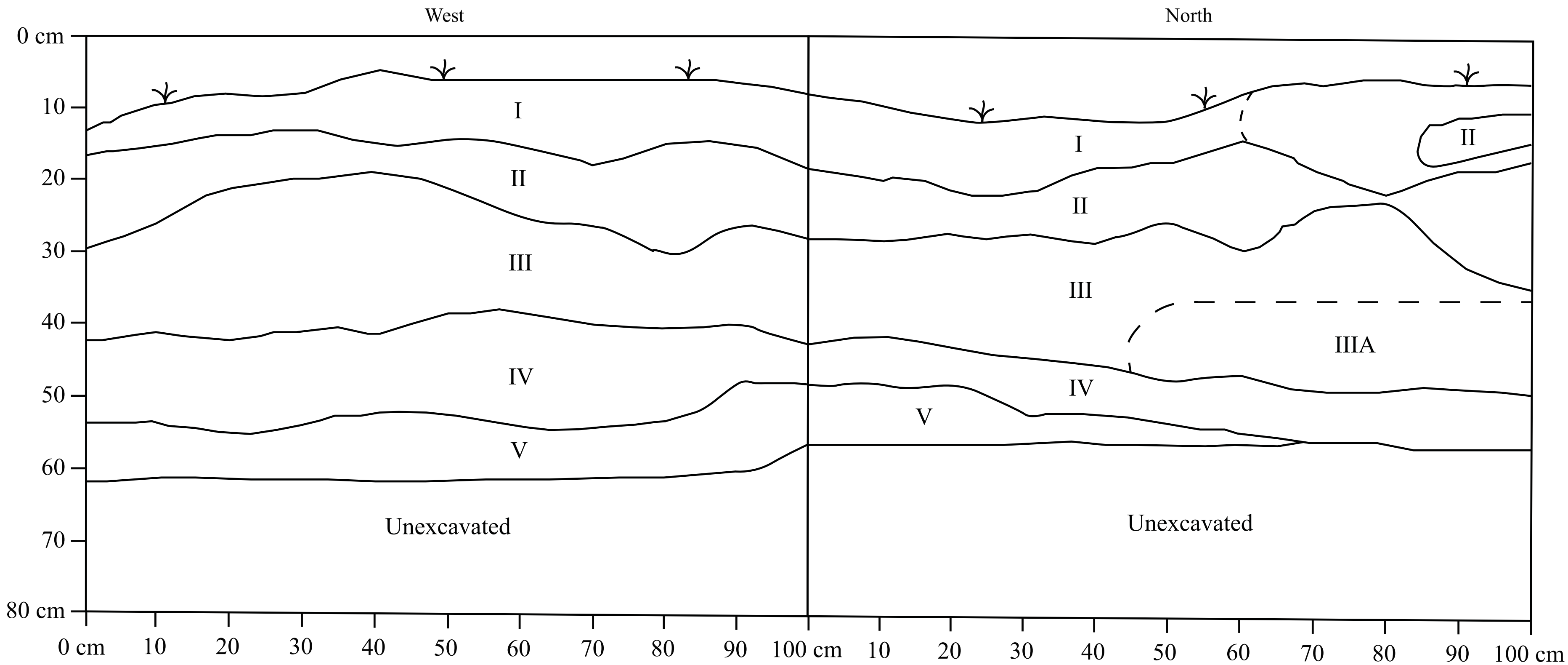
CAKR 2009
09PROXH081210A
Test ID 4561B
East Wall Profile
AKF 8/14/09

Figure by Sarah Ashmore 1/27/2011



I. Modern root mat
II. Dark brown silty loam, abundant gravels (< 1cm), fine roots
III. Dark brown organic silt/sod, abundant small roots, some gravels (< 1cm)
IV. Dark brown (< 1cm) mixed with small amounts of sand, moderately compact, some small roots
V. Dark brown gravels (< 1cm), much more sandy than layer IV, loosely compacted, continues to ~74-77 cmbd across unit then unconsolidated gravels below (AKF 8/14)
VI. Rodent hole

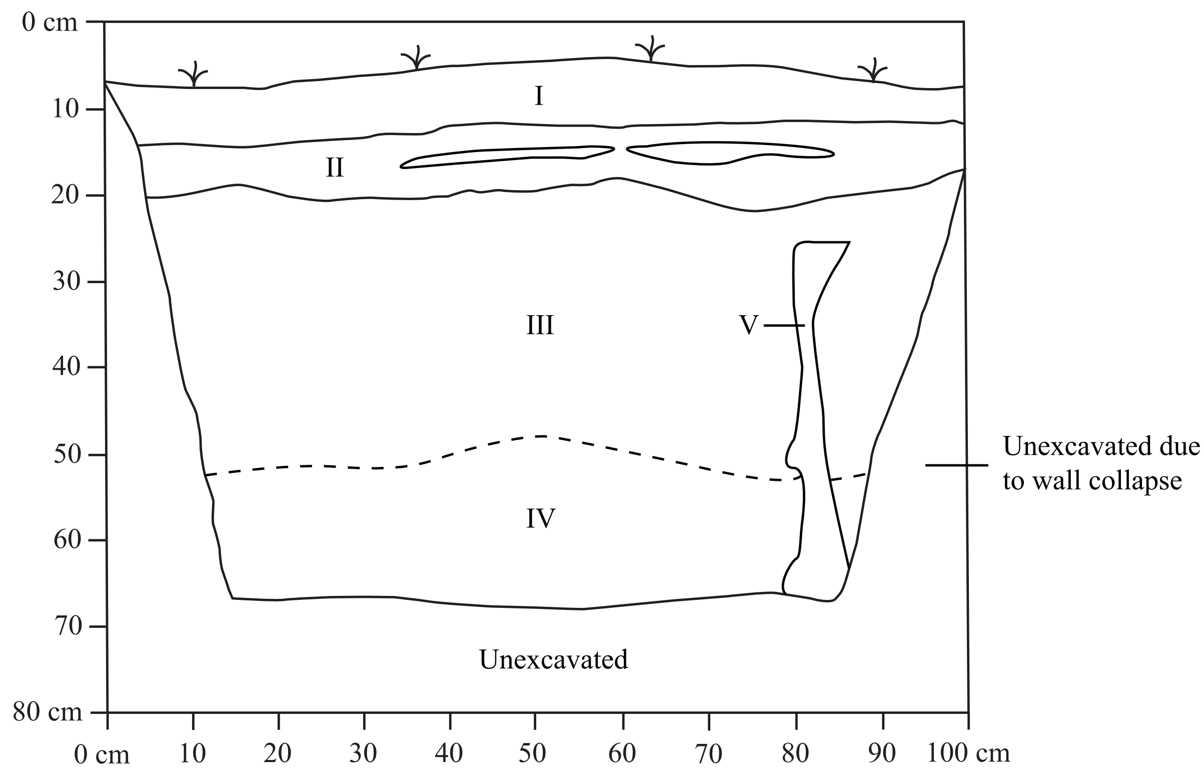
CAKR 2009
09PROXH081210A
Test ID 4561B
West Wall Profile
SJS/AKF 8/13/09
Figure by Sarah Ashmore 1/20/2011



- **I.** Very dark grayish brown to very dark brown sandy silt, 10YR 3/2-2/2, with extensive root growth throughout
- **II.** Fine sand matrix with subround, small to medium (<1cm diameter) gravel throughout, with some soil development throughout as well. Extensive root growth throughout as well.
- **III.** Unconsolidated coarse sand to medium gravel (<2cm diameter), all subrounded. Cultural material in teh NE quad, within the gravel deposit. Soil development in association with cultural material; very dark brown (10YR2/2) sandy soil where present. Difficult to see in profile because of unconsolidated gravel. May also be reaching edge of cultural deposit in north wall where it thins.
- **IIIA.** Cultural deposit- see above description (III). Boundary approximate.
- **IV.** Medium to caorse grained sand with some small subrounded (,1cm diameter) gravel lenses. Roots throughout layer make these deposits somewhat more consolidated. Sterile.
- **V.** Unconsolidated gravel, subrounded, small to medium size (<3 cmdiameter). Sterile.

CAKR 2009
09PROXH081210A
Test ID 4562B
North and West Wall Profile
SLA 8/14/09

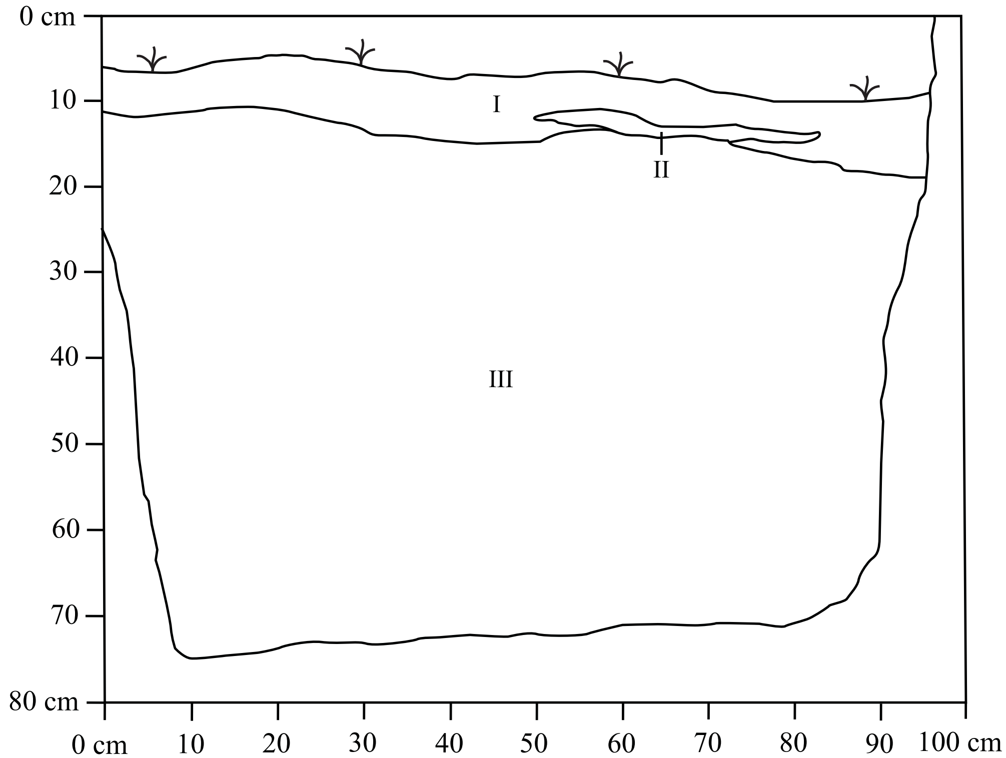
Figure by Sarah Ashmore 1/26/2011



I. Sod
II. Organic sod with light streaks
III. Gravel-sand matrix
IV. Gravel-sand matrix (same as III) but stained orange, bottom of IV is the water table
V. Wood, was excavated throughout III and IV, mostly located in the Northern half of the unit

CAKR 2010
10PROXH071309A
Test ID 5664B
North Wall Profile
AET 7/14/10

Figure by Sarah Ashmore 4/21/2011



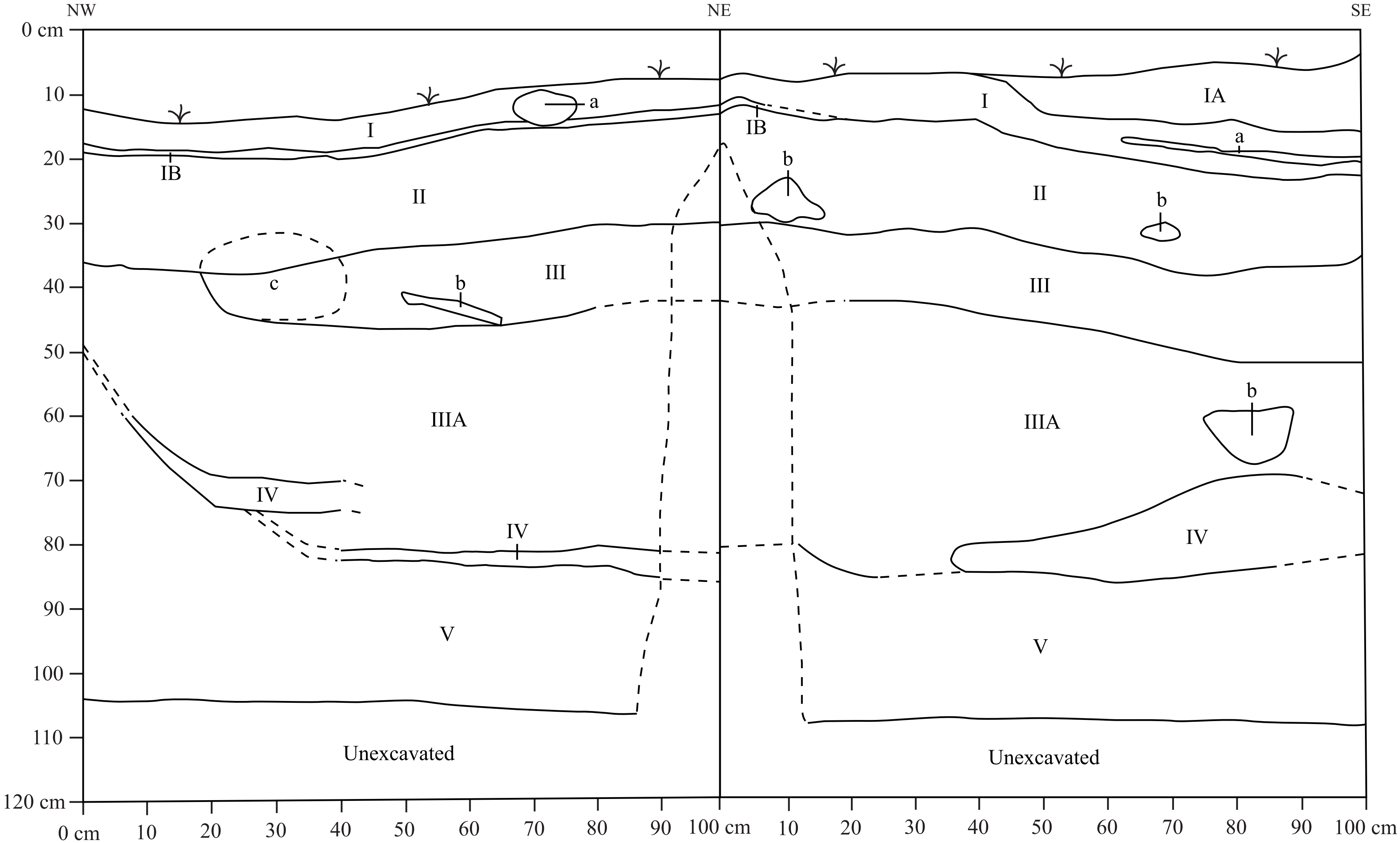
I. Sod/ roots from grasses, willow and soil near bottom of sod is brown silt, some mixing with gravel below, abrupt boundry below, bone, lithic artifacts were found in this layer

II. Dark gray brown silt with some rounded medium gravels, no artifacts or charcoal found in this sediment semi abrupt boundary above and abrupt boundary below

III. Natural beach sediments, consists of alternating layers of beach sand and gravel, mixed gravel and sand at the top with two alternating layers of sand and small gravels below, below this is layer gravel, rounded

CAKR 2010
10PROXH070808A
Test ID 5436B
North Wall Profile
ARH/SMC 7/10/10

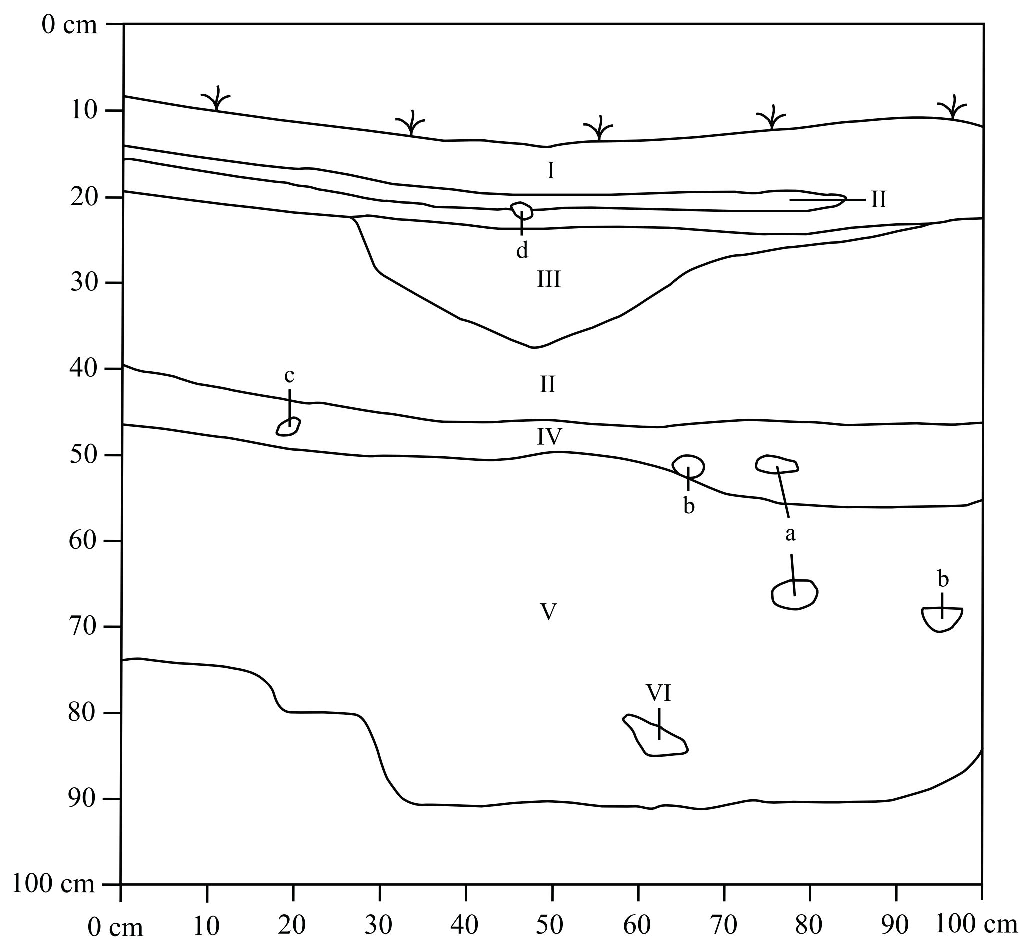
Figure by Sarah Ashmore 2/09/2011



I. Dark brown sandy loam with 1-2 cm vegetation mat at top, wood (structure) visible in NE quad profile
IA. Pocket of sand and gravel
IB. Gray fine sand-silt band at bottom of layer
II. Fine sand and brown soil matrix with small to medium gravel, roots throughout beginning of midden deposit, gravel rounded-well rounded
III. Same at II but with fewer roots; bone, lithics, fur, and cultural material throughout
IIIA. Banded midden deposit - lenses of more compact sand throughout
IV. Bottom of cultural deposits - very dark brown to black loam with decomposing wood throughout
V. Sterile sand and gravel, horizontal bedding
a. Wood
b. Bone
c. Area of root disturbance

CAKR 2010
10PROXH070808A
Test ID 5437B
North and East Wall Profile
SLA/KEF 7/12/10

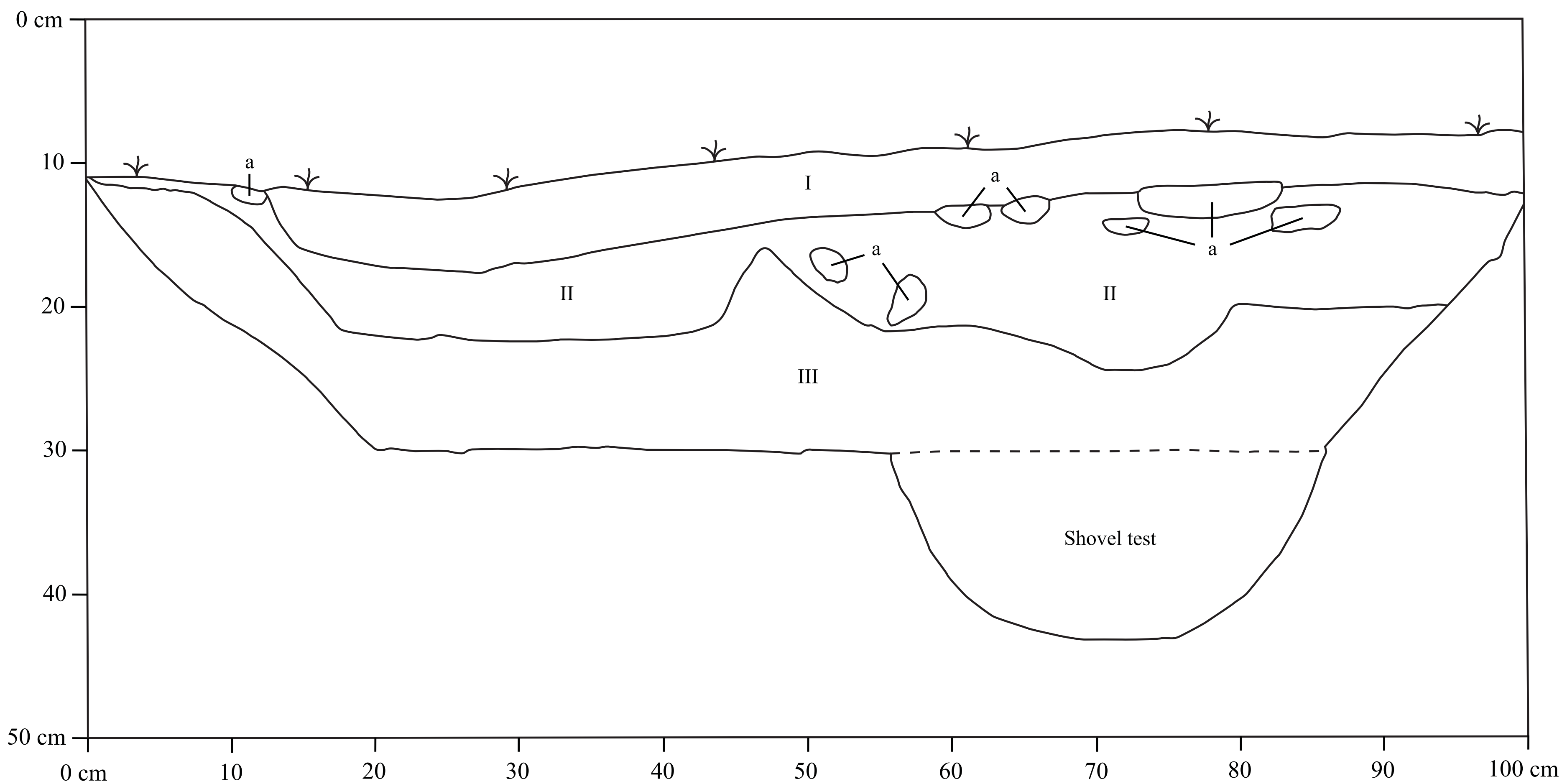
Figure by Sarah Ashmore 4/21/2011



I. Loamy, dark brown, abundant roots, micro roots
II. Gravels rounded to subrounded, 1mm - 20mm
III. Loamy dark brown soil with round to subround gravels, 1mm - 10mm, loamy
IV. Dark gray/black sediment, silty, extremely compact, cultural layer
V. Brown to gray gravel, 1mm - 5mm in a matrix of sand
VI. Gray, black loamy sediment
a. Ceramic
b. FCR
c. Rock
d. Root

CAKR 2010
10PROXH071409A
Test ID 5703B
North Wall Profile
JDD 7/20/10

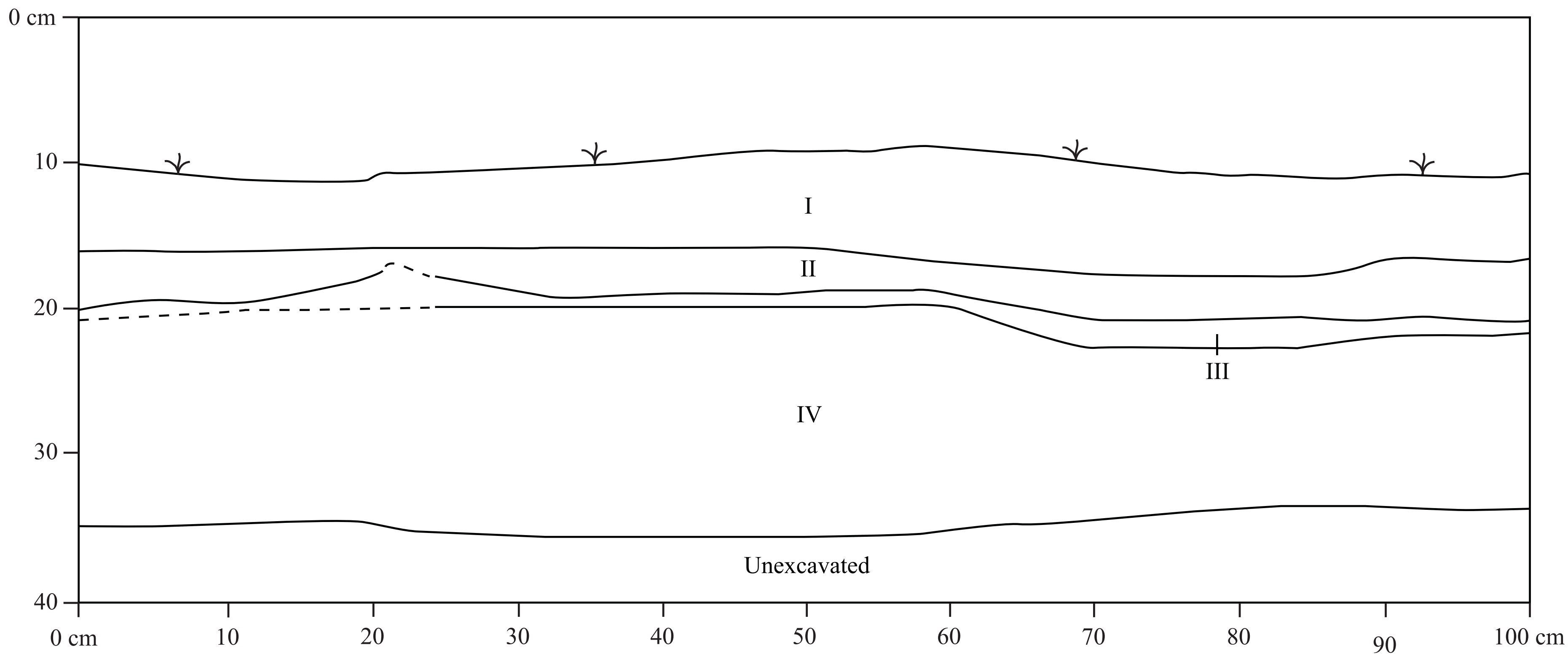
Figure by Sarah Ashmore 2/04/2011



I. Soil, dark brown black, abundant roots, silty
II. Gravel, brown/reddish, angular to subangular ~ 2mm - 20mm, some sand and roots
III. Coarse gravel, gray to brown, angular to subangular, ~ 2mm - 30mm, almost no fine sediment
a. FCR

CAKR 2010
10PROXH072010A
Test ID 5704B
North Wall Profile
JDD 7/21/10

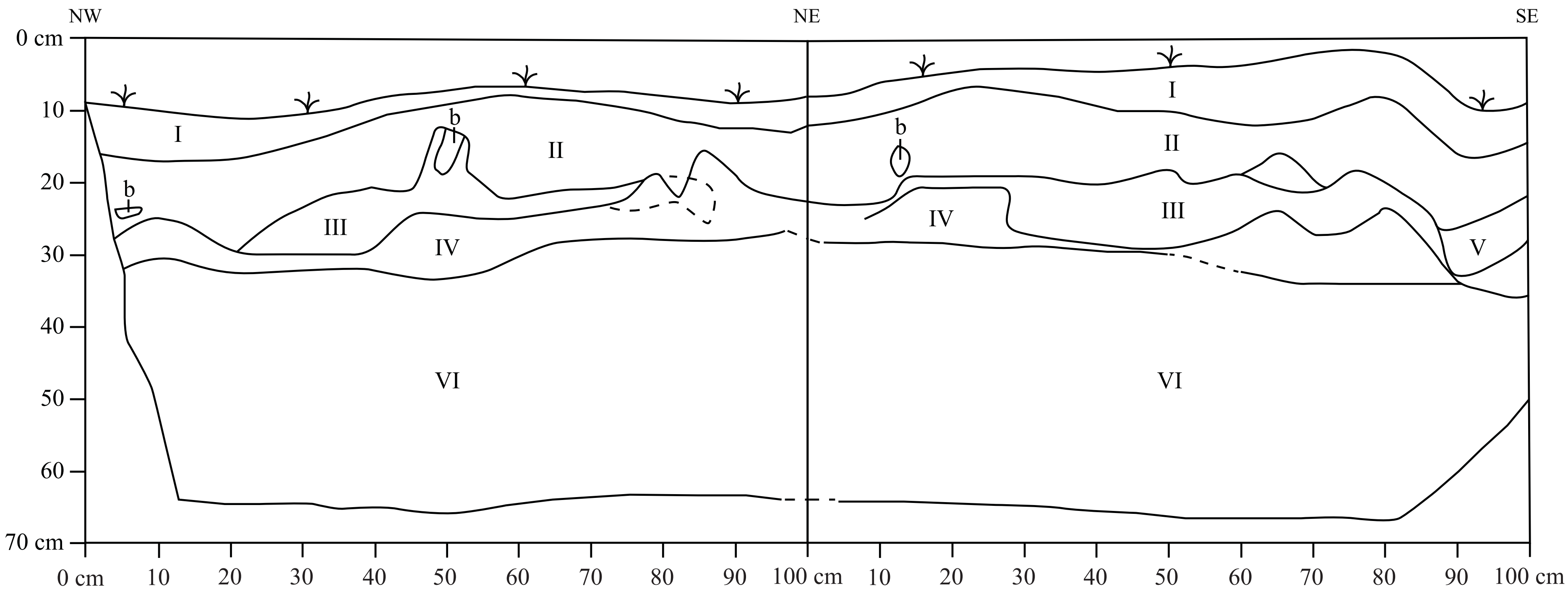
Figure by Sarah Ashmore 2/04/2011



I.	Brown to dark brown organic loamy sod with abundant roots
II.	Light gray compact sand, mottled in color, interface between this layer and layer I had highest concentration of lithics/cultural materials
III.	Dark brown loamy soil with some pebbles
IV.	Lighter brown medium to coarse sand interlayered with small to medium rounded/subangular gravel, no cultural material were found in this layer

CAKR 2010
10PROXH072309A
Test ID 5718B
East Wall Profile
KEF/AKF 7/24/10

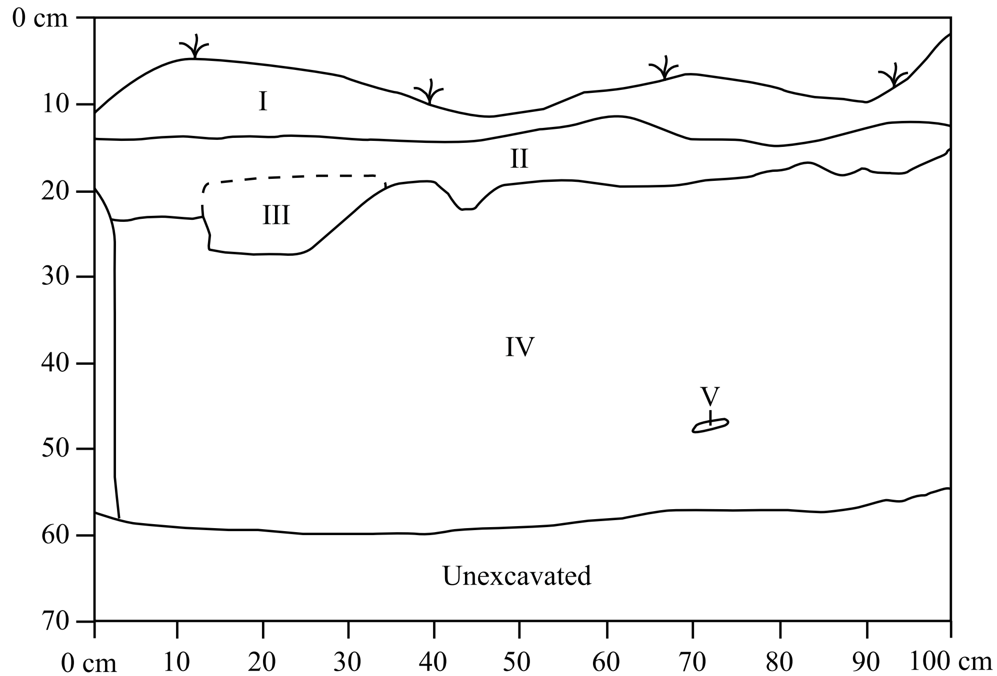
Figure by Sarah Ashmore 4/14/2011



I. Brown organic mat with rootlets
II. Compact organic-rich sod, varying from dark reddish brown to very, very dark brown
III. Faunal material mixed with sod and gravels
IV. Small unconsolidated subangular to rounded gravels approximately 1-5mm
V. Moderately compacted subangular to rounded gravels approximately 5-10mm intermixed with organic rich dark brown sod
VI. Layered sands and gravel
b. Bone

CAKR 2010
10PROXH072408A
Test ID 5719B
North and East Wall Profile
SMC/AKF 7/28/10

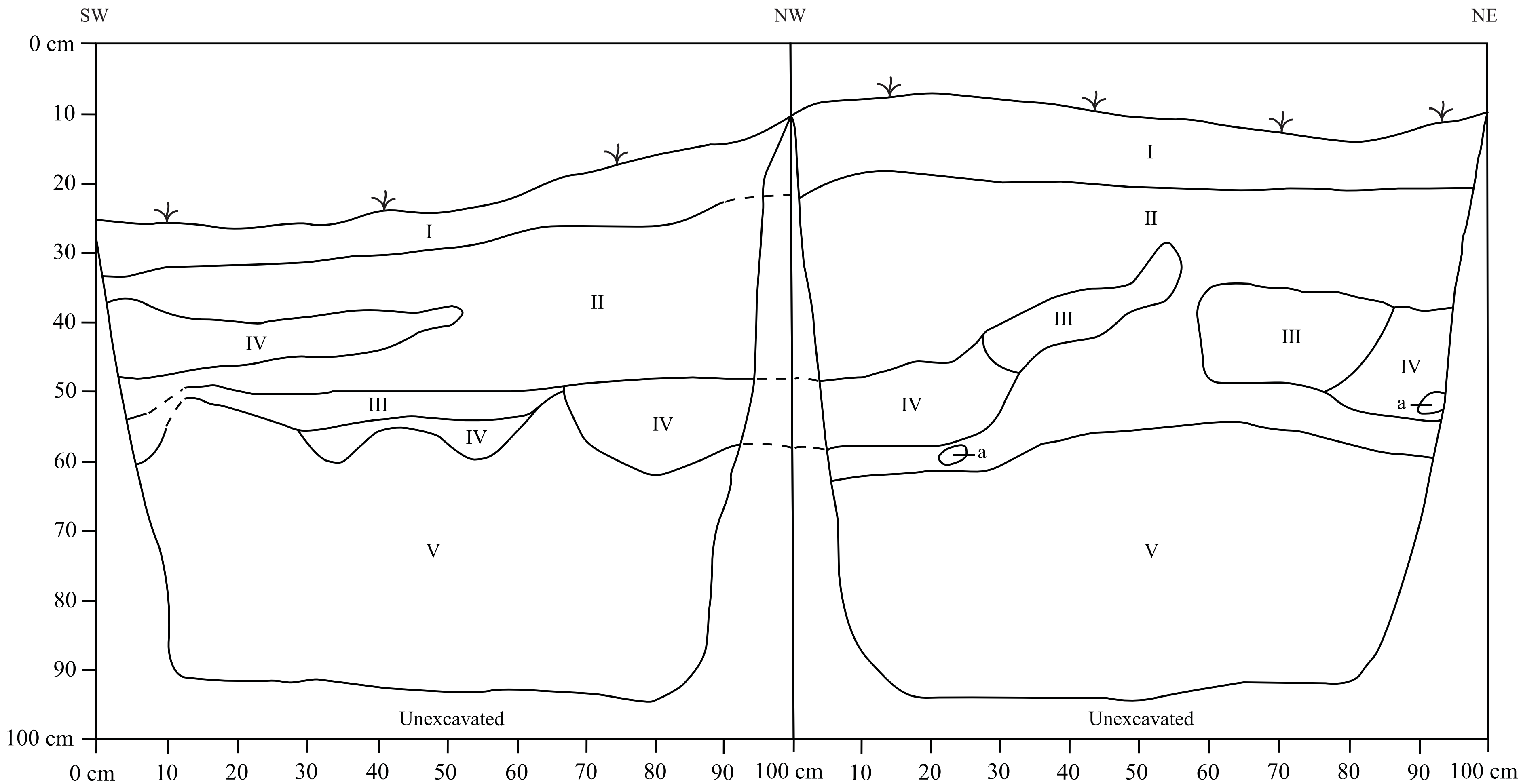
Figure by Sarah Ashmore 4/15/2011



I. Vegetation mat and sod
II. Rich, organic sediments (full of faunal bone throughout unit)
III. Faunal bone pocket in wall profile
IV. Interchanging sand and gravel strata
V. Wood (level V)

CAKR 2010
10PROXH072609A
Test ID 5720B
North Wall Profile
AET/KEF 7/27/10

Figure by Sarah Ashmore 4/14/2011



I. Sod cap. dark brown loamy soil with abundant roots, some coarse sand intermixed, charcoal and single flake found in sod
II. Mixed sand and pebbles motted in color with burnt orange, brown, light gray; little cultural material found in this level though some charcoal still present
III. Rich organic black moist soil, dense with no gravel sand mixed in, cultural material abundant, a great deal of charcoal deposits within
IV. Dark brown organic layer intermixed with small gravel and sand, cultural materials present
V. Small to medium gravel interlayered with medium to coarse sand, mostly sterile
a. FCR

CAKR 2010
10PROXH072712A
Test ID 5721B
North and West Wall Profile
AET/KEF 7/29/10

Figure by Sarah Ashmore 4/15/2011

Appendix III

GPS data dictionary

```
WEAR_CR_v25
CAKR 2008 Archy Mapping

Test_pt                 Point Feature, Label 1 = TestID
                        subsurface test probes, pits, or scrapes
   TestID               Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 999AB, Step Value = 1
                        Required, Normal
   ProbeType            Menu, Normal, Normal
      Shovel Test
      Shovel Scrape
      Test unit
      Bucket Auger
      Probe
      PrevExc
      Other
   Results              Menu, Normal, Normal
      Positive
      Negative
   Sample               Menu, Normal, Normal, Material type of samples if collected
      None
      Charcoal
      Wood
      Sed/Soil
      Bone
      Antler
      Ivory
      Lithic
      Ceramic
      Other
   DepthCm              Numeric, Decimal Places = 2, maximum depth of the pit in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Housepit                Area Feature, Label 1 = HouseID
                        believed to be semi-subterranean house
   HouseID              Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   HouseType            Menu, Normal, Required, general configuration of the housepit
      One Room w/ Tunnel
      Multiroom w/ Tunnel
      One Room NoTunnel
      Multiroom No Tunnel
      Other
   DepthCm              Numeric, Decimal Places = 2, maximum depth of feature in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Excavation           Menu, Normal, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType              Menu, Normal, Normal, Excavation type
      None
      STP
      Test Unit
      Full excav
      Other
   PrimeVeg             Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
```

```
   Shrub Tundra
   Spruce
   None Sand
   None Gravel
   None Regolith
   Other
SecVeg              Menu, Normal, Normal, Secondary vegetation cover on site
   Beach Grass
   Beach Pea
   Shrub Willow
   Dwarf Birch
   Birch
   Cottonwood
   Dryas/Lichen/Berry
   Fireweed
   Grasses
   Shrub Tundra
   Spruce
   None
   None Sand
   None Gravel
   None Regolith
   Other
Photo               Menu, Normal, Normal, Was a photograph taken?
   No
   Yes
Comments            Text, Maximum Length = 100
                    Normal, Normal
ASMIS               Separator
Condition           Menu, Normal, Normal, ASMIS condition assessment
   Good
   Fair
   Poor
   Destroyed
   Unknown
DepInteg            Menu, Normal, Normal, depositional integrity for ASMIS
   Exceptional
   Well Preserved
   Substanial
   Moderate
   Poor
   Lacking
   Unevaluated
DataPot             Menu, Normal, Normal, data potential for ASMIS
   Exceptional
   High
   Medium
   Modest
   Low
   None
   Unevaluated
DisturbLev          Menu, Normal, Normal, level of disturbance for ASMIS
   Unknown
   Low
   Moderate
   Severe
   NA
ThreatClass         Menu, Normal, Normal, class of threat for ASMIS
   Threat
   Disturbance
   None
   Undetermined
ThreatType          Menu, Normal, Normal, type of threat for ASMIS
   NF00
   NF01
   NF12
   NF13
   NF14
   NP11
   OT06
   VS09
ThreatLvl           Menu, Normal, Normal, level of threat for ASMIS
   Destroyed
   Severe
   Moderate
   Low
```

```
      Undetermined
      NA
   TimePeriod          Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown

Cache_pit              Area Feature, depression associated with but < house
   CacheID             Text, Maximum Length = 5, alphanumeric feature identification
                       Default Value = 1AB, Step Value = 1
                       Required, Normal
   CacheShape          Menu, Normal, Normal, shape of the cache pit
      Round
      Square
      Rectangular
      Oval
      Other
   DepthCm             Numeric, Decimal Places = 2, maximum depth of feature in centimeters
                       Minimum = 0, Maximum = 10000, Default Value = 0
                       Normal, Normal
   Excavation          Menu, Normal, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType             Menu, Normal, Normal, Excavation type
      None
      STP
      Test Unit
      Full excav
      Other
   PrimeVeg            Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None Sand
      None Gravel
      None Regolith
      Other
   SecVeg              Menu, Normal, Normal, Secondary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None
      None Sand
      None Gravel
      None Regolith
      Other
   Photo               Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments            Text, Maximum Length = 100
                       Normal, Normal
   ASMIS               Separator
   Condition           Menu, Normal, Normal, ASMIS condition assessment
      Good
```

```
      Fair
      Poor
      Destroyed
      Unknown
   DepInteg              Menu, Normal, Normal, depositional integrity for ASMIS
      Exceptional
      Well Preserved
      Substanial
      Moderate
      Poor
      Lacking
      Unevaluated
   DataPot               Menu, Normal, Normal, data potential for ASMIS
      Exceptional
      High
      Medium
      Modest
      Low
      None
      Unevaluated
   DisturbLev            Menu, Normal, Normal, level of disturbance for ASMIS
      Unknown
      Low
      Moderate
      Severe
      NA
   ThreatClass           Menu, Normal, Normal, class of threat for ASMIS
      Threat
      Disturbance
      None
      Undetermined
   ThreatType            Menu, Normal, Normal, type of threat for ASMIS
      NF00
      NF01
      NF12
      NF13
      NF14
      NP11
      OT06
      VS09
   ThreatLvl             Menu, Normal, Normal, level of threat for ASMIS
      Destroyed
      Severe
      Moderate
      Low
      Undetermined
      NA
   TimePeriod            Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown

Un_Ident                 Area Feature, any unclassified depression
   UnidID                Text, Maximum Length = 5, alphanumeric feature identification
                         Default Value = 1AB, Step Value = 1
                         Required, Normal
   Shape                 Menu, Normal, Normal, Recorder's first impression of shape
      Round
      Square
      Oval
      Multilobed
      Amorphous
      Other
   DepthCm               Numeric, Decimal Places = 2, maximum depth of feature in centimeters
                         Minimum = 0, Maximum = 10000, Default Value = 0
                         Normal, Normal
   Excavation            Menu, Normal, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType               Menu, Normal, Normal, Excavation type
```

```
   None
   STP
   Test Unit
   Full excav
   Other
PrimeVeg            Menu, Normal, Normal, Primary vegetation cover on site
   Beach Grass
   Beach Pea
   Shrub Willow
   Dwarf Birch
   Birch
   Cottonwood
   Dryas/Lichen/Berry
   Fireweed
   Grasses
   Shrub Tundra
   Spruce
   None Sand
   None Gravel
   None Regolith
   Other
SecVeg              Menu, Normal, Normal, Secondary vegetation cover on site
   Beach Grass
   Beach Pea
   Shrub Willow
   Dwarf Birch
   Birch
   Cottonwood
   Dryas/Lichen/Berry
   Fireweed
   Grasses
   Shrub Tundra
   Spruce
   None
   None Sand
   None Gravel
   None Regolith
   Other
Photo               Menu, Normal, Normal, Was a photograph taken?
   No
   Yes
Comments            Text, Maximum Length = 100
                    Normal, Normal
ASMIS               Separator
Condition           Menu, Normal, Normal, ASMIS condition assessment
   Good
   Fair
   Poor
   Destroyed
   Unknown
DepInteg            Menu, Normal, Normal, depositional integrity for ASMIS
   Exceptional
   Well Preserved
   Substanial
   Moderate
   Poor
   Lacking
   Unevaluated
DataPot             Menu, Normal, Normal, data potential for ASMIS
   Exceptional
   High
   Medium
   Modest
   Low
   None
   Unevaluated
DisturbLev          Menu, Normal, Normal, level of disturbance for ASMIS
   Unknown
   Low
   Moderate
   Severe
   NA
ThreatClass         Menu, Normal, Normal, class of threat for ASMIS
   Threat
   Disturbance
   None
```

```
      Undetermined
   ThreatType          Menu, Normal, Normal, type of threat for ASMIS
      NF00
      NF01
      NF12
      NF13
      NF14
      NP11
      OT06
      VS09
   ThreatLvl           Menu, Normal, Normal, level of threat for ASMIS
      Destroyed
      Severe
      Moderate
      Low
      Undetermined
      NA
   TimePeriod          Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown

Artifact               Point Feature, archaeological specimens
   ArtifID             Text, Maximum Length = 5, alphanumeric feature identification
                       Default Value = 1AB, Step Value = 1
                       Required, Normal
   ChipStone           Menu, Normal, Normal, Chipped stone artifacts
      Projectile point
      Biface
      End Blade
      Side Blade
      Blade
      Microblade
      Microblade Core
      Microcore Tablet
      Core
      Burin
      Burin Spall
      End Scraper
      Side Scraper
      Drill
      Flake
      Shatter
      Tci-tho
      Other
   ThermalYN           Menu, Normal, Normal, Is the artifact altered from fire heat
      No
      Yes
   GrndStone           Menu, Normal, Normal, ground stone artifacts
      Adze
      Bead
      Blade
      Labret
      Lamp
      Netweight
      Whetstone
      Other
   Organic             Menu, Normal, Normal, artifacts of bone antler ivory or wood
      Arrowhead
      Awl
      Bead
      Bird Blunt
      Bola Weight
      Fishing Lure
      Harpoon Head
      Harpoon Socket
      Ice Pick
      Knife Handle
      Mattock
      Needle
      Net Weight
      Shovel
      Splitting Wedge
      Worked Object
```

```
      Ulu Handle
      Other
   OthStoneArt          Menu, Normal, Normal, other stone artifact
      FCR
      Hammerstone
      Etched Pebble
      Other
   Pottery              Menu, Normal, Normal, pottery artifact
      Plain Ware
      Check Stamped
      Curvilinear
      Cord  Impressed
      Unidentified
      Other
   Wood                 Menu, Normal, Normal, wooden artifacts
      Bird Blunt
      Bow Fragment
      Bowl or Tray
      Hide Stake
      Kayak or Boat Part
      Sled Part
      Other
   CementSed            Menu, Normal, Normal, cemented or oil-soaked sediment
      Seal oil cache
      Seal skin poke
      Unknown
      Other
   Historic             Menu, Normal, Normal, not prehistoric artifacts
      Animal Trap
      Blazo Can
      Bottle Glass
      Bottle
      Can
      Cartridge
      Ceramics
      China
      Enamel Ware
      Fuel Drum
      Ladder
      Log
      Metal Other
      Milled Lumber
      Rifle or Gun Part
      Shoe or Boot
      Shovel
      Textile
      Window Glass
      Wood Other
      Other
   CollectYN            Menu, Normal, Normal, Was the artifact collected?
      No
      Yes
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Hearth                  Point Feature, cultural point objects
   HearthID             Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   Type                 Menu, Normal, Normal, campfire or fire pit
      Tabular Stones
      Open
      Rock Surround
      Slab Lined
      Other
   DiaCm                Numeric, Decimal Places = 2, Diameter of feature in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Sample               Menu, Normal, Normal, Material type of samples if collected
      None
      Charcoal
      Wood
      Sed/Soil
```

```
      Bone
      Antler
      Ivory
      Lithic
      Ceramic
      Other
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Surf_scat               Area Feature, Concentration of artifacts on surface
   SurfID               Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   ScatterMat           Menu, Normal, Normal, Main material type of scatter
      LithicScat
      RockAlign
      PotScat
      ButcherArea
      Combo
      Midden
      Can Dump
      HistoricScat
      Other
   Excavation           Menu, Normal, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType              Menu, Normal, Normal, Excavation type
      None
      STP
      Test Unit
      Full excav
      Other
   PrimeVeg             Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None Sand
      None Gravel
      None Regolith
      Other
   SecVeg               Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None
      None Sand
      None Gravel
      None Regolith
      Other
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
```

```
                       Normal, Normal
   ASMIS               Separator
   Condition           Menu, Normal, Normal, ASMIS condition assessment
      Good
      Fair
      Poor
      Destroyed
      Unknown
   DepInteg            Menu, Normal, Normal, depositional integrity for ASMIS
      Exceptional
      Well Preserved
      Substanial
      Moderate
      Poor
      Lacking
      Unevaluated
   DataPot             Menu, Normal, Normal, data potential for ASMIS
      Exceptional
      High
      Medium
      Modest
      Low
      None
      Unevaluated
   DisturbLev          Menu, Normal, Normal, level of disturbance for ASMIS
      Unknown
      Low
      Moderate
      Severe
      NA
   ThreatClass         Menu, Normal, Normal, class of threat for ASMIS
      Threat
      Disturbance
      None
      Undetermined
   ThreatType          Menu, Normal, Normal, type of threat for ASMIS
      NF00
      NF01
      NF12
      NF13
      NF14
      NP11
      OT06
      VS09
   ThreatLvl           Menu, Normal, Normal, level of threat for ASMIS
      Destroyed
      Severe
      Moderate
      Low
      Undetermined
      NA
   TimePeriod          Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown

Fauna                  Point Feature, cultural point objects
   FaunID              Text, Maximum Length = 5, alphanumeric feature identification
                       Default Value = 1AB, Step Value = 1
                       Required, Normal
   Type                Menu, Normal, Normal, animal bone location
      Whale Skull
      Whale Jaw
      Whale Vertebrae
      Sea Mammal
      Land Mammal
      Unknown
      Other
   IsolateYN           Menu, Normal, Normal, Isolated find?
      No
      Yes
   CollectYN           Menu, Normal, Normal, was the artifact collected
      No
      Yes
```

```
   Photo               Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments            Text, Maximum Length = 100
                       Normal, Normal

Veg_Anom               Area Feature, vegetation anomolies
   VegAnID             Text, Maximum Length = 5, alphanumeric feature identification
                       Default Value = 1AB, Step Value = 1
                       Required, Normal
   VegType             Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen/Berry
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None Sand
      None Gravel
      None Regolith
      Other
   Excavation          Menu, Normal, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType             Menu, Normal, Normal, Excavation type
      None
      STP
      Test Unit
      Full excav
      Other
   Photo               Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments            Text, Maximum Length = 100
                       Normal, Normal

Monument               Point Feature, survey or other monuments
   MonType             Menu, Required, Normal, survey or other monuments
      Archaeological Datum
      BLM Allotment Marker
      NGS Marker
      NPS Tidal Control
      NPS Boundary
      Photo Panel Center
      USGS Benchmark
      Other
   MonMat              Menu, Normal, Normal, monument material
      Jelly Plate
      Brass Cap
      Rebar and Cap
      Aluminum Tag Only
      Rebar and Alum Tag
      Rebar Only
      Concrete
      Wood Lathe
      Nail
      Flagging
      Other
   MonCon              Menu, Normal, Normal, monument condition
      Firmly in Place
      Loose in Ground
      Laying on Surface
      Destroyed
      Other
   Photo               Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
```

```
   MonInfo              Text, Maximum Length = 100, Type in all cap info here
                        Normal, Normal
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Burial                  Area Feature, Label 1 = Marker
                        any human remains
   BurID                Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   BurialType           Menu, Normal, Normal, any human remains or interment
      Buried w/ Marker
      Buried w/out Marker
      Surface Coffin
      Surface Open
      Other
   Marker               Menu, Normal, Normal, Marker Type
      Wood
      Stone
      Bone
      Other
      None
   DepthCm              Numeric, Decimal Places = 2, maximum depth of feature in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Excavation           Menu, Required, Normal, Has excavation occured in feature?
      None
      Previous
      2006
      2008
      2009
      2010
   ExcType              Menu, Normal, Normal, Excavation type
      None
      STP
      Test Unit
      Full excav
      Other
   PrimeVeg             Menu, Normal, Normal, Primary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None Sand
      None Gravel
      None Regolith
      Other
   SecVeg               Menu, Normal, Normal, Secondary vegetation cover on site
      Beach Grass
      Beach Pea
      Shrub Willow
      Dwarf Birch
      Birch
      Cottonwood
      Dryas/Lichen
      Fireweed
      Grasses
      Shrub Tundra
      Spruce
      None
      None Sand
      None Gravel
      None Regolith
      Other
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal
```

```
   ASMIS                Separator
   Condition            Menu, Normal, Normal, ASMIS condition assessment
      Good
      Fair
      Poor
      Destroyed
      Unknown
   DepInteg             Menu, Normal, Normal, depositional integrity for ASMIS
      Exceptional
      Well Preserved
      Substanial
      Moderate
      Poor
      Lacking
      Unevaluated
   DataPot              Menu, Normal, Normal, data potential for ASMIS
      Exceptional
      High
      Medium
      Modest
      Low
      None
      Unevaluated
   DisturbLev           Menu, Normal, Normal, level of disturbance for ASMIS
      Unknown
      Low
      Moderate
      Severe
      NA
   ThreatClass          Menu, Normal, Normal, class of threat for ASMIS
      Threat
      Disturbance
      None
      Undetermined
   ThreatType           Menu, Normal, Normal, type of threat for ASMIS
      NF00
      NF01
      NF12
      NF13
      NF14
      NP11
      OT06
      VS09
   ThreatLvl            Menu, Normal, Normal, level of threat for ASMIS
      Destroyed
      Severe
      Moderate
      Low
      Undetermined
      NA
   TimePeriod           Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown

Hum_rem                 Point Feature, Label 1 = Collected
                        any human remains
   HumRemID             Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   Element              Menu, Normal, Normal, Seletal element
      Cranium
      Mandible
      Vertebra
      Clavicle
      Scapula
      Humerus
      Ulna
      Radius
      Carpal
      Metacarpal
      Rib
      Sternum
      Pelvis
```

```
      Femur
      Tibia
      Fibula
      Tarsal
      Metatarsal
      Other
      Unknown
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Collected            Menu, Required, Normal, Were HR collected?
      No   Default
      Yes
   Comments             Text, Maximum Length = 100, Include context, location, threats, etc.
                        Required, Normal

Cairn                   Point Feature, any type of marker pile or mound
   CairnID              Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   Type                 Menu, Normal, Normal, what type of cairn is it?
      Upright Slab
      Stacked  Courses
      Other
   HeightCm             Numeric, Decimal Places = 2, maximum height of feature in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Geo_Sample              Point Feature, geological sample
   GeoID                Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   Context              Menu, Normal, Normal, Setting sample taken from
      Cultural
      Control
   Dosimeter            Menu, Normal, Normal, Dosimeter left behind
      Yes
      No
   DepthCm              Numeric, Decimal Places = 2, maximum depth of the pit in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Moisture             Menu, Normal, Normal, Moisture sample collected?
      Yes
      No
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Ver_Post                Point Feature, Cultural Point objects
   VerpostID            Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   HeightCm             Numeric, Decimal Places = 2, maximum height of feature in centimeters
                        Minimum = 0, Maximum = 10000, Default Value = 0
                        Normal, Normal
   Photo                Menu, Normal, Normal, Was a photograph taken?
      No
      Yes
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Structure               Line Feature, line edge of structure for GIS footprint
   StructID             Text, Maximum Length = 5, alphanumeric feature identification
                        Default Value = 1AB, Step Value = 1
                        Required, Normal
   StructType           Menu, Normal, Normal, Category of Structure
      Cabin
      Outhouse
      Tent Platform
```

```
   Weatherport
   Meat Cellar
   Drying Rack
   Other
BldEdge             Text, Maximum Length = 3, side of building GPSed (N, S, E,W)
                    Normal, Normal
WidthFt             Numeric, Decimal Places = 1, width of the structure in feet
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
HeightFt            Numeric, Decimal Places = 1, max height of wall in feet
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Condition           Menu, Normal, Normal, General impression of condition
   Good
   Fair
   Poor
   Destroyed
   Other
WallMat             Menu, Normal, Normal, exterior wall material
   Horizontal Logs
   Vertical Logs
   Horiz Wood Planks
   Vet Wood Planks
   Plywood
   Tin Sheeting
   Tar Paper
   Combination
   Other
RoofType            Menu, Normal, Normal, Type of roof
   Gabled
   Flat
   Pitched
   Other
RoofMat             Menu, Normal, Normal
   Tin Sheeting
   Tar Paper
   Wood Plank
   Wood Shake
   Plywood
   Other
Windows             Menu, Normal, Normal, number of windows in structure
   None
   1
   2
   3
   4
   Other
Doors               Menu, Normal, Normal, Number of doors structure has
   1
   2
   3
Ownership           Text, Maximum Length = 100
                    Normal, Normal
Comments            Text, Maximum Length = 100, Notes about the feature
                    Normal, Normal
ASMIS               Separator
Condition           Menu, Normal, Normal, ASMIS condition assessment
   Good
   Fair
   Poor
   Destroyed
   Unknown
DepInteg            Menu, Normal, Normal, depositional integrity for ASMIS
   Exceptional
   Well Preserved
   Substanial
   Moderate
   Poor
   Lacking
   Unevaluated
DataPot             Menu, Normal, Normal, data potential for ASMIS
   Exceptional
   High
   Medium
   Modest
   Low
```

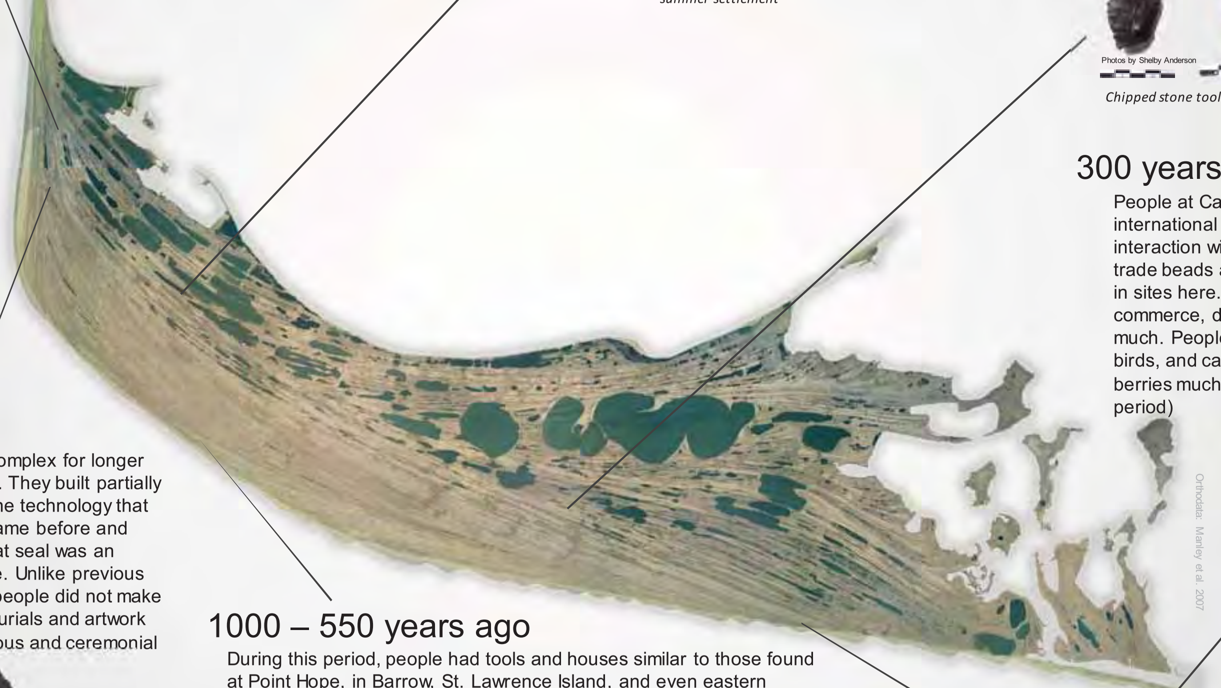
```
      None
      Unevaluated
   DisturbLev          Menu, Normal, Normal, level of disturbance for ASMIS
      Unknown
      Low
      Moderate
      Severe
      NA
   ThreatClass         Menu, Normal, Normal, class of threat for ASMIS
      Threat
      Disturbance
      None
      Undetermined
   ThreatType          Menu, Normal, Normal, type of threat for ASMIS
      NF00
      NF01
      NF12
      NF13
      NF14
      NP11
      OT06
      VS09
   ThreatLvl           Menu, Normal, Normal, level of threat for ASMIS
      Destroyed
      Severe
      Moderate
      Low
      Undetermined
      NA
   TimePeriod          Menu, Normal, Normal, time period for ASMIS
      Prehistoric
      Protohistoric
      Historic
      Modern
      Unknown
   Photo               Menu, Normal, Normal, Was a photograph taken?
      No
      Yes

Natl_feat              Line Feature, Natural Feature Lines (cliff edges)
   Type                Menu, Normal, Normal, natural linear features
      Top of Bluff Edge
      Base of Bluff Edge
      Water Edge
      Mean High Water Mark
      Drainage Margin
      Creek Centerline
      Beach Berm Center
      Other
   Comments            Text, Maximum Length = 100
                       Normal, Normal

Topo_tran              Line Feature, transect walked to get topo data
   Location            Menu, Normal, Normal, Where is the topo work being done?
      Archaeological Site
      NPS Facility
      NPS general
      Allotment
      Other
   Comments            Text, Maximum Length = 100
                       Normal, Normal

Trail                  Line Feature, ATV or game trail
   Type                Menu, Normal, Normal, ATV tracks or trail or game trail
      ATV
      Game
      Other
   Comments            Text, Maximum Length = 100
                       Normal, Normal
```

Appendix IV

Public outreach products

Human Environmental Dynamics at Cape Krusenstern

200 Generations: On the Beach of Their Time



4200 – 2800 years ago

The earliest occupants of the Cape Krusenstern beach ridge complex camped seasonally, probably in the summer. They left behind small campsites that include hearths, stone tools, and debris from making stone tools. (Denbigh Flint complex)

Microblade

Hearth feature

2800 years ago

For the first time, at least one group of people lived most of the year at the beach ridge complex. They left behind a single unique settlement. The house forms and artifacts left at this settlement are unlike any other known site. A few large stone points from this site are interpreted by some archaeologists as early evidence of whaling activities and technologies. This topic is highly debated. (Old Whaling culture)

Crew at one of the excavated features at the Old Whaling site summer settlement

2800 – 2300 years ago

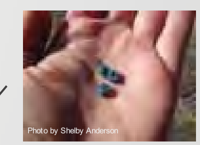
With the exception of the group living at the Old Whaling site, people continued to live at the beach ridge complex for short periods of time, perhaps from late spring to early fall. The artifacts and materials they left behind indicate an increased reliance on marine resources such as seals. Some of the oldest pottery , cooking vessel fragments in Alaska are found at these sites. (Choris culture)

Chipped stone tools

Fragments of pottery cooking vessels

300 years ago

People at Cape Krusenstern were connected to international trade networks. Although direct interaction with Europeans had yet to occur, glass trade beads and other historic material were found in sites here. Aside from this entry into global commerce, daily life probably did not change very much. People still made their living hunting seals, birds, and caribou, catching fish, and picking berries much like their ancestors. (Proto-historic period)



Blue glass beads

1750 – 1150 years ago

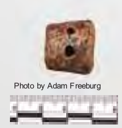
People began living at the beach ridge complex for longer periods of time over the course of a year. They built partially underground houses and had a new stone technology that differed from that made by people that came before and after them. Remains left behind show that seal was an important food for people during this time. Unlike previous inhabitants of Cape Krusenstern, these people did not make pottery, lamps or slate tools. Elaborate burials and artwork from this time are evidence of new religious and ceremonial practices. (Ipiutak culture)

Slotted knife handle

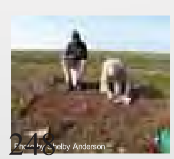
Chipped stone tool

1000 – 550 years ago

During this period, people had tools and houses similar to those found at Point Hope, in Barrow, St. Lawrence Island, and even eastern Russia and Greenland. Much of the technology was focused on specialized marine mammal hunting equipment and there was clear evidence of whale hunting. People lived in big settlements, often in large houses with multiple rooms. This indicates a change in social organization that could have been related to the coordination and teamwork needed in whale hunting. People here still hunted seals as well as caribou, ducks, and other birds. They used kayaks, umiaks, dogs and dogsleds for transportation. (Thule culture)



Drilled bone toggle



Close up pottery vessel fragment (L) and a scatter of broken pottery (R)

550 years ago

There was a shift in settlement patterns. Houses became smaller and are more dispersed so there were no longer large settlements. People adopted new fishing and bird-hunting technologies, including a greater variety of hooks and nets. (Kotzebue period)

Notched cobble net sinker

Today

People use the cape seasonally, staying at camps or visiting for the day from nearby towns and villages.

Foster family's camp

Project Goals

The goal of this project was to study the timing and character of past human settlement at the Cape Krusenstern beach ridge complex.

Study location within Cape Krusenstern National Monument

A Unique Coastal Record

The beach ridge complex at Cape Krusenstern is one of the oldest and most continuously occupied coastal sites in the North American Arctic.

The beach ridges began to form when local sea level stabilized about 5000 years ago. Over time, beach ridges built outwards into Kotzebue Sound and the Chukchi Sea. During periods of past storminess, sections of land were also eroded away. Today, the beach ridge landform itself is a record of past storminess and coastal currents.

Area of converging beach ridges adds complexity to assumptions of horizontal stratigraphy

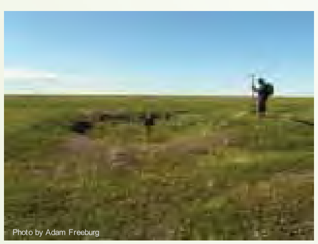
Crew returning to camp with whale bones recovered from a test unit

People occupied the beach ridges soon after they began to form. The oldest archaeological sites at the complex date to around 4200 years ago, making these ancient campsites some of the oldest coastal occupations in North America.

The Problem

Research in the 1950s and 60s established a timeline, or chronology, of human occupation at the beach ridge complex. The chronology was based on relatively few radiocarbon dates. Research was done on a large scale, but not systematically. This means some features, such as houses, were studied extensively, while others were not documented.

In the intervening years, spatial locations for many previously identified archaeological sites were lost. As a result, previously collected archaeological information could not be connected to new paleoenvironmental and archaeological data.



Mapping a previously excavated house

New radiocarbon dates and other data on past human settlement were needed to address questions about past human occupation at Cape Krusenstern.

Methods

Crews of archaeologists spent many months living and working at the beach ridge complex over a series of four field seasons: 2006, 2008-2010.

Screening sediment to recover artifacts

Field camp on Krusenstern Lagoon

Field methods included systematically surveying the beach ridge complex and collecting new samples for dating and analysis through small test excavations.

Mapping a test location

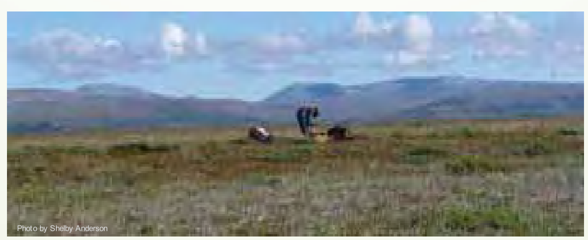
Measuring sample locations in a test excavation

Use of global positioning system (GPS) technology for quick and accurate data collection meant that the research team could collect more data in less time and that the resulting maps were reliable. A Geographic Information System (GIS) platform was used for data storage and analysis

Archaeology with the Sisualik culture camp

Findings

Fieldwork yielded many new artifacts, features, and archaeological sites. More than 1200 archaeological features were recorded in systematic survey of about 2900 acres, 33% of the entire beach ridge complex.

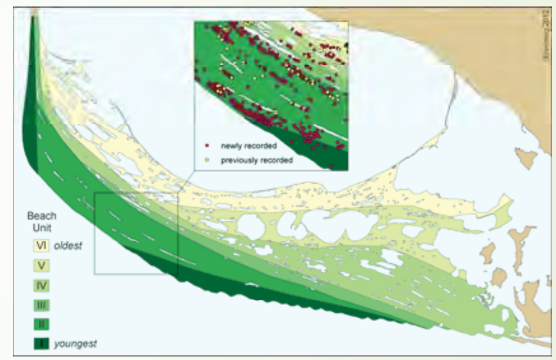


Fieldwork at Cape Krusenstern

Summary table of features and artifacts recorded by current project. In general, sites and artifacts found in Beach Segment VI are the oldest and those found in Beach Segment I are the youngest.

	Beach Segment							
Feature Type	**I**	**II**	**III**	**IV**	**V**	**VI**	**n/a**	**Total**
Hearth	1	15	13	31	31	6	0	97
Cache Pit	95	176	9	2	1	2	8	293
House	33	89	9	12	0	0	35	178
Surface Scatter	12	18	18	27	14	4	1	94
Burial	4	5	0	0	0	0	2	11
Surface Artifact	93	132	47	121	52	26	15	486
Isolated Fauna	47	72	11	22	4	4	9	169
Unidentified	161	402	107	16	19	15	111	831
Vegetation Anomaly	63	154	16	3	0	0	18	254
Total	509	1063	230	234	121	57	199	2413
*Previously Recorded**	*76*	*127*	*34*	*63*	*39*	*20*	*0*	*359*

The number of new sites indicates that settlement was denser than previously thought. New radiocarbon data indicates that occupation was nearly continuous over the last 4200 years. There are very small gaps in the sequence of 247 dates, indicating that people used the landscape continuously.



In general, the number of sites during later time periods indicate that population increased until about 1000 years ago, with people spending more time at the beach ridge complex in semi-permanent settlements after about 2000 years ago. The record for the last 1000 years is not as clear, and questions remain about possible changes in settlement patterns and subsistence during this time.

Significance

These important findings support and refine the existing ideas about past human settlement at Cape Krusenstern, and further our understanding of past human occupation in coastal areas of Northwest Alaska. We now know more about the timing of specific cultural changes during the last 4000 years.

Future research will explore the reasons for some of the changes in settlement patterns noted here, particularly the link between environmental and social change.

Poster designed by Shelby Anderson and Adam Freeburg, 2012.

This research was funded by the National Park Service and carried out by the University of Washington under cooperative agreement (J8W07070032) through the Pacific Northwest Ecosystem Studies Unit.

Appendix V

Ceramic residue analysis

Ancient Arctic Hunter-Gatherer Diet and Culinary Practices: Analysis of Lipid Residues in Ceramic Artifacts from Cape Krusenstern, Northwestern Alaska

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INTRODUCTION

To address questions about hunter-gatherer diet and food preparation practices in the past, 20 ceramic sherds from archaeological sites in Cape Krusenstern, southwestern Alaska were analyzed using gas chromatography-mass spectrometry (GC-MS) and compound specific stable isotope analysis.

The goal of this pilot project was to determine whether absorbed residues extracted from the ceramic sherds have a chemical signature associated with marine versus terrestrial foods, and, if so, whether there were any diachronic trends in these signatures which may reflect changes in diet and culinary practices through time.

Key animal foods in ethnographic northwestern Alaska diet include terrestrial mammals (caribou, bear), marine mammals (seals, sea lions, and walruses) and whales (Table 1). Marine and terrestrial fish were also in the diet. All of these foods can be separated into broad classes of food (marine vs. terrestrial and mammals/ fish/ birds). These broad classes may be discriminated in archaeological vessels. However, identification beyond these broad classes (i.e. at the species level) is highly unlikely as there are few biomarkers associated with specific foods that do not degrade over time and can potentially be detected in archaeological specimens.

Table 1. Key Animals in Northwestern Alaska

	Common Name	Scientific name
Terrestrial mammal	Barren ground caribou	*Rangifer tarandus granti*
Marine mammal	Ribbon seal	*Phoca fasciata*
Marine mammal	Harbor seal	*Phoca vitulina*
Marine mammal	Stellar sea lion	*Eumetopias jubatus*
Marine mammal	Bearded seal	*Erignathus barbatus*
Marine mammal	Ringed seal	*Phoc hispida*
Marine mammal	Spotted seal	*Phoca largha*
Whale	Bowhead whale	*Balaena mysticetus*
Whale	Gray whale	*Eschrichtius robustus*
Whale	Beluga whale	*Delphinapterus leucas*
Marine mammal	Walrus	*Odobenus rosmarus divergens*
Terrestrial mammal	Brown bear	*Ursus arctos*
Terrestrial mammal	Polar bear	*Ursus maritimus*

(Shelby Anderson, personal communication and Bursch 2006)

The study included process development, potential target compound research, residue extraction and sample derivitization, and targeted analyses of samples: gas chromatography-mass spectrometry (GC-MS) analysis to determine the overall chemical contents of each sample, and compound specific carbon isotopic analyses.

Archaeometric Studies

In this study we drew on the growing number of archaeometric studies specifically aimed at extracting and characterizing ancient residues. A wide variety of techniques have been employed to chemically characterize lipids absorbed in archaeological pots. Our approach in this study was to look for specific compound biomarkers, a relatively new technique as championed by Evershed (cf. Evershed et al 2002).

Studies discriminating ways in which lipids may be distinguished include those targeting marine mammals (cf. Coplety et al 2004; Evershed et al 2008; Hansel 2004; Solazzo and Erhardt 2007), aquatic foods (Craig et al 2012), fish oil (Brown and Heron 2005). We were able to draw upon this literature to determine which biomarkers were of interest in this particular study.

Discriminating shifts in marine versus terrestrial signatures is certainly possible. Overall, marine foods tend to have higher C12/ C13 ratios than terrestrial foods. As well, plants, fish, and mammals can potentially be discriminated according to their molecular content shown in chromatograms. Specific biomarkers tend to be associated with certain foods. For example, as demonstrated Evershed et al (2008) and Hansel et al (2004), biomarkers associated with marine mammals can include and can be detected in samples extracted from archaeological vessels.

MATERIALS AND METHODS

This section describes sample preparation and extraction and chemical characterization methods employed in the Cape Crusenstern study. A total of twenty pottery sherds from sites in Cape Crusenstern, Alaska were analyzed in the study (Table 2). All sherds were coarse tempered body fragments from ceramic vessels dating to various chronological components (I-X).

HPLC grade Chloroform, protein-sequencing grade methanol, methanolic HCL, etc were of analytical grade and were purchased from Sigma Aldrich, USA. Industrial grade nitrogen for sample evaporation was purchased from Praxair. Initial preparation, residue extraction, and derivitization of samples was completed at the UC Davis Archaeometry Laboratory, Young Hall, Davis, California. GC-MS and Compound Specific Stable Isotopic Analyses were completed at the UC Davis Stable Isotope Facility, Plant and Environmental Sciences Building, Davis California.

Methods were based on those developed in similar studies (c.f. Eerkens 2000; Evershed et al 2002; Tushingham et al 2010). Strict protocols were followed throughout sample preparation to avoid contamination.

Table 2. List of Analyzed Samples from Cape Krusenstern, Alaska

Accession #	Catalog #	Chronological Unit	Feature
CAKR-00060	CAKR 13418	I-III	PROXH071909A Surface Scatter 1B
CAKR-00063	CAKR 13877b	IX	House 1B of 09PROXH062508A
CAKR-00063	CAKR 13884e	IX	House 1B of 09PROXH062709A
CAKR-00063	CAKR 14026g	VII-IX	Surface Scatter 1B
CAKR-00063	CAKR 14106c	IX	Surface Scatter 2B
CAKR-00063	CAKR 14107c	IX	Surface Scatter 2B
CAKR-00063	CAKR 14109a	IX	Surface Scatter 2B
CAKR-00063	CAKR 14110a	**IX**	**Surface Scatter 2B**
CAKR-00063	CAKR 14112	IX	Surface Scatter 2B
CAKR-00063	CAKR 14113g	IX	Surface Scatter 2B
CAKR-00063	CAKR 14140a	IX	Surface Scatter 2B
CAKR-00063	CAKR 14141f	IX	Surface Scatter 2b
CAKR-00063	CAKR 14142a	IX	**Surface Scatter 2b**
CAKR-00063	CAKR 14143c	IX	Surface Scatter 2B
CAKR-00063	CAKR 14514c	VIII	G&A Late Western Thule House 25
CAKR-00063	CAKR 14515b	VIII	G&A Late Western Thule House 27
CAKR-00064	CAKR 14861b	VII-IX	House 1A of 10GEOXH063008A
CAKR-00064	CAKR 15110	IX-X	Unidentified 4B of 09PROXH062209A
CAKR-00064	CAKR 15146	IX-X	UNID 4B of 09PROXH062209A
CAKR-00064	CAKR 15151	VIII	LWT H27A

Sample Preparation

All artifacts were catalogued and inspected for visible residue. A small (~1cm diameter) fragment of each potsherd was broken off. To ensure no dirt or bacteria are left on sampled sherds the outer 1mm of all exposed surfaces of each sample was removed by burring, using an abrasive silicon carbide/ steel dremel drill bit. to remove any potential contamination due to handling or contact with the surrounding soil. Fragment is then crushed to a powder in small agate mortar and pestle; 400 mg is transferred to a 15 ml test tube teflon caps and labeled with unique catalog numbers. The mortar and pestle is cleaned with solvent following grinding of each sherd.

Residue Extraction and Derivatization to Fatty Acid Methyl Esters (FAMEs)

After transfer to the test tube, 200 ml of chloroform-methanol solvent (a 2:1 mixture of HPLC grade chloroform and protein-sequencing grade methanol) is added to each sample. The test tube is then gently agitated with a vortexing machine to mix the solvent and sherd powder. The test tubes are submersed in water in a sonicating machine and sonicated for 20 minutes. This step brings the lipids into solution while leaving behind any inorganics (crushed clay and temper matrix). Following sonication, the test tube is placed in a centrifuge for ten minutes to separate the solvent mixture, now containing lipids, from the fine clay particles. The solvent is pipetted from the first test tube and transferred to a second test tube. Lipids are evaporated by placing under a stream of nitrogen, leaving behind dried lipids.

The derivitization process begins by adding 100 μl of methanolic HCl to the dried samples. The samples are placed in a heating set at 60C for 1 hour, with the test tube capped. Samples are dried by placing under a stream of nitrogen, leaving behind dried derivitized samples. All samples were stored in a freezer until the next stage of analysis.

Chemical characterization

In addition to the twenty archaeological samples multiple replicates of a laboratory standard (shown as PUFA-3 in raw data) were analyzed. Laboratory standards are selected to be compositionally similar to the samples being analyzed and have been previously calibrated against NIST Standard Reference Materials.

Derivitized samples were then transferred in Submit samples in standard 2 mL GC vials to the UC Davis Stable Isotope facility for GC-MS analysis and compound-specific ^{13}C isotope analysis (CSIA) of suite of target compounds using GC-combustion isotope ratio mass spectrometry (GC-C-IRMS). Once separated chromatographically, each compound is entirely combusted to gases (CO_2) and subsequently introduced into the isotope ratio mass spectrometer.

Analysis was performed using a Thermo GC/C-IRMS system composed of a Trace GC Ultra gas chromatograph (Thermo Electron Corp., Milan, Italy) coupled to a Delta V Advantage isotope ratio mass spectrometer (IRMS) through a GC/C-III interface (Thermo Electron Corp., Bremen, Germany). Compound identification support for the CSIA laboratory is provided by a Varian CP3800 gas chromatograph coupled to a Saturn 2200 ion trap MS/MS (Varian, Inc., Walnut Creek, CA U.S.A.).

CSIA was completed of ^{13}C in fatty acid methyl esters (FAMEs) by dissolving FAMEs in hexane, then injecting in splitless mode and separating on a Varian factor FOUR VF-5ms column (30m X 0.25mm ID, 0.25 micron film thickness). Once separated, FAMEs are quantitatively converted to CO_2 in an oxidation reactor at 950°C. Following water removal through a nafion dryer, CO_2 enters the IRMS. δ^{13}values are corrected using working standards composed of several FAMEs calibrated against NIST standard reference materials. The column used in this study was a VF-5ms.

ANALYSIS AND RESULTS

Lipid residue was successfully extracted from all twenty archaeological samples, with a wide range of compounds detected. Raw CSIA and GC-C-IRMS data is reported in Appendix 1. Multiple peaks (range= 8-26) were detected in each of the twenty samples which were analyzed in multiple replicates. A table of average carbon C amount in nanograms (ng) is provided in Appendix 2. A table of the average d of 13C/12C is provided in Appendix 3. Note that in addition to the archaeological standard, a laboratory standard (shown as PUFA-3 in raw data) was also analyzed with the samples for internal instrument control. As some compounds tend to coelute from the chromatograph some of the molecular designators are given as a range (e.g. C18:1n9c/3n3).

Correction for Derivatization of Fatty Acids

Note that when preparing fatty acid methyl esters, one C is added to each fatty acid molecule. Thus, the measured isotope ratios include the C from the methanol used in the extraction and derivitization process. FAME ^{13}C results are corrected using an isotope ratio of methanol of approximately -60 per mil d13C. The exact ratio for the methanol used in the current project will be provided in a separate analysis from the Stable Isotope Facility. Once this is obtained, the correction for derivitization of fatty acids (Appendix 4) will be completed for the current raw data. It is recommended that this correction be made prior to publication of results, but this correction should not significantly change the general pattern outlined here as it makes only a small difference in resulting values.

Detected Compounds

Of the 24 compound specific isotopes analyzed here, a total of 17 different compounds were detected in the samples, including saturated, monounsaturated, and polyunsaturated fats and branched fatty acids.

The most commonly detected compounds were the saturated fats C12:0, C16:0, and C18:0, which were found in all of the archaeological samples. According to Chris Yarnes C12:0 is a reflection of the internal standard so will not help to discriminate sample content. C16:0 and C18:0 are the most common of saturated fats and, as expected, were present in all of the archaeological samples.

As noted by Evershed et al (2008) and Hansel et al (2004), ω o-alkylphenyl alkanoic acids with carbon lengths of C:18-C:20 including should be present in residue associated with marine derived animal fats. These compounds all of the samples. The compounds C18:1n9c/3n3 and C18:1n9t/7c/5c were especially common and were found in almost all samples. Both C16:1 ω 7t (an omega7 transfatty acid), and C16:1 ω9c/7c were only found in two samples. Such differences may reflect change in diet or cooking practices through time (see discussion below).

Compounds with carbon lengths of C:22 also seem to be associated with marine derived aquatic animal fats, if only in trace amounts (Evershed et al 2008). In the current analysis, C:22 fats were detected in about half of the samples. Samples that had both C:18-C:20 samples and meet the criteria for marine mammal derived fats include 14106C, 14113G, 14141F, (chronological unit=IX), 15110 (IX-X), 14514c, 14515b and 15151 (XIII).

Additional isotopic analyses designed to discriminate whether these samples contain at least one of the 3 isoprenoid fatty acids (phytanic, pristanic or 4,8, 12-TMTD) (as summarized in Evershed et al 2008) may help to discriminate this pattern.

Notably, C15:0, a branched fatty acid compound common in ruminant animals (e.g. caribou) was not detected in any of the samples. Another branched fatty acid compound, C17:0, is also common in ruminants but was not analyzed in the current study. Additional analysis may be required to determine whether the found chemical signatures are associated with aquatic fish versus mammals, but overall this preliminary work suggests most of the samples are consistent with marine (versus terrestrial foods). As discussed below, the strongest found marine signature is associated with pottery dating to the Late Thule period.

DISCUSSION

In terms of methodology, it is recommended that the sample size of the extracted material increase. This would likely help discriminate certain biomarkers, especially unsaturated fats.

Component variation

It appears that there may be some patterning in compounds found in samples from certain chronological units. Samples that had both C:18-C:20 and C:22 detected, suggesting a strong marine mammal fat signature, seem to mostly be associated with Late Thule period or later artifacts. They include 14106C, 14113G, 14141F, (chronological unit=IX), 15110 (IX-X) and 14514c, 14515b and 15151 (VIII).

Further, the found compound profile for samples listed in Chronological Unit VIII (14514c, 14515b and 15151), is very similar when compared to other samples. (Note that samples 14514c, 14515b were both found in Late Western Thule houses). Further, several compounds, including C14:0, C20:2/C20:3n3, and C20:4n3 were detected only in this group of samples. These are among the samples with a high proportion of polyunsaturated fatty acids that have a strong marine signature. Such patterning could potentially reflect some change in cooking practices or diet, but the data will have to be reviewed in detail with lead researchers.

CONCLUSION

This pilot study was successful in that we were able to chemically characterize and extract lipid residues from all of the Cape Krusenstern samples. The study has also provided us with a deeper understanding of the methods required to extract lipids from ancient Alaskan pottery. Further, the work demonstrates the potential for this type of work to help us better understand evolutionary trends in ancient Alaskan diet and cooking practices.

Most of the samples were consistent of being associated with pottery that was used to either cook or store marine (versus terrestrial). Markers associated with ruminant animals such as caribou were not detected in the study. Further, a smaller subset of samples, including samples dating the Late Western Thule have a high number of markers associated with marine mammals.

Future work with lead Cape Krusenstern researchers may discriminate additional patterning, for example analyses designed to discriminate C17:0 (a biomarker often associated with ruminant animals) and one of the 3 isoprenoid fatty acids (phytanic, pristanic or 4,8, 12-TMTD) (as summarized in Evershed et al 2008) may provide support for the evidence for marine mammal foods provided here.

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Date	Analysis	Identifier 1	Comment	Peak Nr	R 13C/12C	d 13C/12C	Area All	ng C	Rt	Component
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	1	0.0108088	-33.219	61.24	1749.714286	61.7	CO2 REF 1
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	64.969	1856.257143	111.2	CO2 REF 2
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	3	0.0108079	-33.296	65.001	1857.171429	161.1	CO2 REF 3
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	4	0.0108605	-28.597	5.794	165.5428571	667.5	c12:0
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	5	0.0108442	-30.049	19.748	564.2285714	1271.1	c16:0
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	6	0.0109032	-24.773	0.655	18.71428571	1508.8	c18:1n9c/3n3
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	7	0.010933	-22.112	1.462	41.77142857	1518	c18:1n9t/7c/5c
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	8	0.010857	-28.911	16.811	480.3142857	1548.5	c18:0
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	9	0.0108377	-30.638	0.525	15	1785.9	
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	10	0.0108803	-26.828	1.085	31	1869.9	
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	11	0.0109053	-24.586	0.488	13.94285714	2032.5	
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	12	0.0109043	-24.68	0.516	14.74285714	2136.4	
07/29/12	1301	14107c	10uL 12:0 in 300uL hexane	13	0.0108966	-25.364	3.669	104.8285714	2290.4	
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	1	0.010809	-33.198	62.993	1799.8	61.4	CO2 REF 1
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	63.653	1818.657143	111.4	CO2 REF 2
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	3	0.0108075	-33.333	64.199	1834.257143	161.1	CO2 REF 3
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	4	0.0108577	-28.85	7.112	203.2	667.1	c12:0
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	5	0.0108993	-25.122	1.113	31.8	970.8	c14:0
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	6	0.010868	-27.921	24.968	713.3714286	1271.8	c16:0
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	7	0.0101594	-23.761	0.964	27.54285714	1508.6	c18:1n9c/3n3
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	8	0.0109341	-22.009	3.346	95.6	1518.2	c18:1n9t/7c/5c
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	9	0.0108711	-27.643	15.496	442.7428571	1548.1	c18:0
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	10	0.0109271	-22.642	0.942	26.91428571	1754.6	c20:4n3
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	11	0.0109208	-23.203	3.146	89.88571429	1761	
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	12	0.0109139	-23.82	0.566	16.17142857	1779.4	c20:2/c20:3n3
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	13	0.0108666	-28.046	0.788	22.51428571	1785.9	
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	14	0.0109016	-24.916	0.902	25.77142857	1870.1	
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	15	0.0109298	-22.395	0.486	13.88571429	1907.3	-
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	16	0.0109294	-22.429	1.517	43.34285714	1912.6	c22:1n9/22:2
07/29/12	1300	14515b	10uL 12:0 in 300uL hexane	17	0.010908	-24.344	2.759	78.82857143	2292.1	
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	1	0.0108093	-33.171	62.517	1786.2	61.2	CO2 REF 1
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	64.935	1855.285714	111.4	CO2 REF 2
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	3	0.0108077	-33.318	64.251	1835.742857	161.1	CO2 REF 3
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	4	0.0108588	-28.745	7.179	205.1142857	667.3	c12:0
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	5	0.0108366	-30.734	14.902	425.7714286	1270.3	c16:0
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	6	0.0109311	-22.281	1.09	31.14285714	1518.4	c18:1n9t/7c/5c
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	7	0.0108509	-29.458	10.955	313	1547.4	c18:0
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	8	0.0109014	-24.938	0.78	22.28571429	1870.3	
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	9	0.0109156	-23.664	0.507	14.48571429	2136.6	
07/29/12	1299	15146	10uL 12:0 in 300uL hexane	10	0.0108927	-25.719	2.689	76.82857143	2292.1	
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	1	0.0108088	-33.216	61.642	1761.2	61.7	CO2 REF 1
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	63.779	1822.257143	111.4	CO2 REF 2
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	3	0.0108078	-33.311	62.949	1798.542857	161.1	CO2 REF 3
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	4	0.0108639	-28.294	7.166	204.7428571	667.1	c12:0
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	5	0.010846	-29.896	15.43	440.8571429	1270.1	c16:0
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	6	0.0108546	-29.119	11.114	317.5428571	1547.4	c18:0
07/29/12	1298	14026g	10uL 12:0 in 300uL hexane	7	0.0108909	-25.875	3.926	112.1714286	2292.1	
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	1	0.0108092	-33.186	62.433	1783.8	61.7	CO2 REF 1
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	65.116	1860.457143	111	CO2 REF 2
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	3	0.0108077	-33.317	64.431	1840.885714	161.1	CO2 REF 3
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	4	0.0108608	-28.57	7.381	210.8857143	667.1	c12:0
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	5	0.0108494	-29.59	14.272	407.7714286	1270.1	c16:0
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	6	0.0109525	-20.37	1.011	28.88571429	1518.4	c18:1n9t/7c/5c
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	7	0.0108589	-28.738	9.739	278.2571429	1547.2	c18:0
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	8	0.0108994	-25.113	0.496	14.17142857	2033.2	
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	9	0.0108865	-26.273	0.674	19.25714286	2136.8	
07/29/12	1297	13884e	10uL 12:0 in 300uL hexane	10	0.0108934	-25.651	2.621	74.88571429	2292.1	
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	1	0.0108091	-33.192	66.942	1912.628571	61.7	CO2 REF 1
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	65.43	1869.428571	111.4	CO2 REF 2
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	3	0.0108075	-33.336	65.235	1863.857143	160.9	CO2 REF 3
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	4	0.0108603	-28.611	6.632	189.4857143	667.3	c12:0

Date	Analysis	Identifier 1	Comment	Peak Nr	R 13C/12C	d 13C/12C	Area All	ng C	Rt	Component
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	5	0.0108542	-29.158	15.934	455.2571429	1270.5	c16:0
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	6	0.0109056	-24.559	0.508	14.51428571	1509.2	c18:1n9c/3n3
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	7	0.0109503	-20.561	1.277	36.48571429	1518.4	c18:1n9t/7c/5c
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	8	0.0108668	-28.028	11.636	332.4571429	1547.6	c18:0
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	9	0.0108342	-30.947	0.47	13.42857143	1786.1	
07/29/12	1296	14142a	10uL 12:0 in 300uL hexane	10	0.0108971	-25.318	1.884	53.82857143	2292.1	
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	1	0.0108091	-33.19	67.458	1927.371429	61.7	CO2 REF 1
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	67.394	1925.542857	111.4	CO2 REF 2
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	3	0.0108075	-33.333	67.691	1934.028571	161.1	CO2 REF 3
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	4	0.0108662	-28.089	7.264	207.5428571	664.4	c12:0
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	5	0.0108466	-29.835	15.101	431.4571429	1270.1	c16:0
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	6	0.0108399	-30.435	1.107	31.62857143	1509.4	c18:1n9c/3n3
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	7	0.0109262	-22.717	1.453	41.51428571	1518.4	c18:1n9t/7c/5c
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	8	0.0108577	-28.843	11.127	317.9142857	1547.4	c18:0
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	9	0.01082	-32.214	0.377	10.77142857	1786.1	
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	10	0.009338	-28.599	1.513	43.22857143	1812	c20:1n9
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	11	0.0109069	-24.443	0.979	27.97142857	1871.8	c22:6n3
07/29/12	1295	15110	10uL 12:0 in 300uL hexane	12	0.0108899	-25.962	4.545	129.8571429	2292.3	
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	1	0.0108089	-33.208	67.358	1924.514286	61.7	CO2 REF 1
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	67.789	1936.828571	111.4	CO2 REF 2
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	3	0.0108075	-33.339	67.862	1938.914286	161.1	CO2 REF 3
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	4	0.0108684	-27.886	6.88	196.5714286	666.7	c12:0
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	5	0.0108485	-29.67	13.511	386.0285714	1269.9	c16:0
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	6	0.0108581	-28.807	10.415	297.5714286	1547.2	c18:0
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	7	0.0108429	-30.168	0.438	12.51428571	1785.9	
07/29/12	1294	14112	10uL 12:0 in 300uL hexane	8	0.010895	-25.508	2.937	83.91428571	2292.1	
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	1	0.0108087	-33.231	66.257	1893.057143	61.7	CO2 REF 1
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.658	1904.514286	111.4	CO2 REF 2
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	3	0.0108079	-33.302	66.729	1906.542857	161.1	CO2 REF 3
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	4	0.0108481	-29.705	6.844	195.5428571	667.5	c12:0
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	5	0.0108165	-32.53	14.307	408.7714286	1270.3	c16:0
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	6	0.010932	-22.199	0.71	20.28571429	1517.5	c18:1n9t/7c/5c
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	7	0.0108439	-30.081	12.087	345.3428571	1547.4	c18:0
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	8	0.0108837	-26.523	0.425	12.14285714	2135.8	
07/28/12	1289	14140a	10uL 12:0 in 300uL hexane	9	0.0108951	-25.496	4.548	129.9428571	2292.1	
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	1	0.0108087	-33.227	66.239	1892.542857	61.7	CO2 REF 1
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.687	1905.342857	111.4	CO2 REF 2
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	3	0.0108077	-33.318	66.741	1906.885714	160.7	CO2 REF 3
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	4	0.01085	-29.537	7.405	211.5714286	667.5	c12:0
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	5	0.0108186	-32.346	13.256	378.7428571	1270.1	c16:0
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	6	0.0108572	-28.894	0.485	13.85714286	1508.1	c18:1n9c/3n3
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	7	0.0109365	-21.798	1.074	30.68571429	1517.5	c18:1n9t/7c/5c
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	8	0.0108494	-29.585	10.443	298.3714286	1547.2	c18:0
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	9	0.0108334	-31.022	0.397	11.34285714	1785.7	
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	10	0.0109035	-24.753	0.865	24.71428571	1869.7	
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	11	0.0108627	-28.396	0.499	14.25714286	1882	c22:5n3
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	12	0.0109097	-24.193	0.735	21	2032.1	
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	13	0.010915	-23.72	1.037	29.62857143	2136	
07/28/12	1288	14113G	10uL 12:0 in 300uL hexane	14	0.0108972	-25.31	3.26	93.14285714	2284	
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	1	0.0108088	-33.221	66.195	1891.285714	61.2	CO2 REF 1
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.659	1904.542857	111.4	CO2 REF 2
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	3	0.0108079	-33.302	66.727	1906.485714	161.1	CO2 REF 3
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	4	0.0108501	-29.525	7.42	212	667.5	c12:0
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	5	0.01082	-32.218	15.662	447.4857143	1270.5	c16:0
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	6	0.0109363	-21.813	1.068	30.51428571	1517.5	c18:1n9t/7c/5c
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	7	0.010843	-30.158	12.284	350.9714286	1547.6	c18:0
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	8	0.0108414	-30.305	0.572	16.34285714	1785.7	
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	9	0.0108924	-25.74	1.033	29.51428571	1869.7	
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	10	0.0108926	-25.72	0.37	10.57142857	2032.1	
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	11	0.0108981	-25.235	0.453	12.94285714	2136	
07/28/12	1287	14109a	10uL 12:0 in 300uL hexane	12	0.0108868	-26.246	4.172	119.2	2291.3	

Date	Analysis	Identifier 1	Comment	Peak Nr	R 13C/12C	d 13C/12C	Area All	ng C	Rt	Component
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	1	0.0108087	-33.228	66.076	1887.885714	61.7	CO2 REF 1
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.606	1903.028571	111.4	CO2 REF 2
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	3	0.010808	-33.291	66.651	1904.314286	161.1	CO2 REF 3
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	4	0.0108513	-29.42	6.657	190.2	667.5	c12:0
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	5	0.0108334	-31.019	17.63	503.7142857	1270.9	c16:0
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	6	0.0109093	-24.23	0.458	13.08571429	1508.4	c18:1n9c/3n3
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	7	0.0109501	-20.577	1.454	41.54285714	1517.8	c18:1n9t/7c/5c
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	8	0.0108567	-28.934	12.747	364.2	1547.9	c18:0
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	9	0.0108314	-31.197	0.539	15.4	1785.9	
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	10	0.0108973	-25.303	0.938	26.8	1869.9	
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	11	0.0109125	-23.941	0.49	14	2032.3	
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	12	0.0109157	-23.661	0.713	20.37142857	2136.2	
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	13	0.0109101	-24.155	0.91	26	2240.3	c28:0
07/28/12	1286	13148	10uL 12:0 in 300uL hexane	14	0.0108953	-25.485	5.3	151.4285714	2292.3	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	1	0.0108093	-33.173	66.747	1907.057143	61.7	CO2 REF 1
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.672	1904.914286	111.4	CO2 REF 2
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	3	0.0108081	-33.281	66.74	1906.857143	161.1	CO2 REF 3
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	4	0.0108549	-29.096	7.34	209.7142857	667.5	c12:0
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	5	0.0108305	-31.279	17.222	492.0571429	1270.9	c16:0
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	6	0.0108997	-25.092	0.746	21.31428571	1508.4	c18:1n9c/3n3
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	7	0.0109321	-22.195	2.833	80.94285714	1518.2	c18:1n9t/7c/5c
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	8	0.0108567	-28.935	11.822	337.7714286	1547.9	c18:0
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	9	0.0108604	-28.6	0.985	28.14285714	1786.1	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	10	0.0108922	-25.762	1.811	51.74285714	1870.8	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	11	0.0108977	-25.269	0.798	22.8	2032.3	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	12	0.0108898	-25.973	0.814	23.25714286	2124.5	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	13	0.0109037	-24.733	0.881	25.17142857	2136.2	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	14	0.0108929	-25.693	0.847	24.2	2231.5	
07/28/12	1285	14861B	10uL 12:0 in 300uL hexane	15	0.0108982	-25.222	4.023	114.9428571	2276.6	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	1	0.0108086	-33.234	66.364	1896.114286	61.7	CO2 REF 1
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.733	1906.657143	111.2	CO2 REF 2
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	3	0.0108081	-33.279	66.665	1904.714286	161.1	CO2 REF 3
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	4	0.0108581	-28.809	8.11	231.7142857	667.1	c12:0
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	5	0.0109037	-24.729	2.49	71.14285714	970.2	c14:0
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	6	0.0109597	-19.72	1.054	30.11428571	1235.2	c16:1w7t
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	7	0.0109583	-19.843	1.523	43.51428571	1242.1	c16:1w9c/7c
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	8	0.0108749	-27.305	25.433	726.6571429	1271.6	c16:0
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	9	0.0109604	-19.663	1.072	30.62857143	1302.9	i17:1w7c
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	10	0.0104227	-21.743	2.156	61.6	1508.6	c18:1n9c/3n3
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	11	0.0109422	-21.285	4.307	123.0571429	1517.5	c18:1n9t/7c/5c
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	12	0.0109008	-24.991	0.583	16.65714286	1532.8	un31
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	13	0.0108668	-28.034	12.705	363	1547.6	c18:0
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	14	0.0108739	-27.397	0.998	28.51428571	1564.2	br19:1a
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	15	0.0109238	-22.931	0.791	22.6	1754.1	c20:4n3
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	16	0.0109264	-22.696	1.674	47.82857143	1760.4	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	17	0.0109059	-24.534	0.657	18.77142857	1779	c20:2/c20:3n3
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	18	0.0108614	-28.517	0.77	22	1785.7	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	19	0.0108943	-25.575	0.646	18.45714286	1869.5	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	20	0.010854	-29.173	0.555	15.85714286	1882.9	c22:5n3
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	21	0.010885	-26.403	0.45	12.85714286	2135.8	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	22	0.0108939	-25.609	1.11	31.71428571	2234.6	c28:0
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	23	0.0108931	-25.677	3.106	88.74285714	2265.4	
07/28/12	1284	14514C	10uL 12:0 in 300uL hexane	24	0.0108964	-25.386	3.753	107.2285714	2292.3	
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	1	0.0108088	-33.219	66.259	1893.114286	61.7	CO2 REF 1
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.58	1902.285714	111.4	CO2 REF 2
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	3	0.010808	-33.294	66.527	1900.771429	160.9	CO2 REF 3
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	4	0.0108617	-28.491	8.124	232.1142857	667.1	c12:0
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	5	0.0108352	-30.855	14.878	425.0857143	1269.9	c16:0
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	6	0.0097218	-26.652	0.438	12.51428571	1508.1	c18:1n9c/3n3
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	7	0.0109265	-22.688	0.792	22.62857143	1517.3	c18:1n9t/7c/5c
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	8	0.0108527	-29.289	11.329	323.6857143	1547	c18:0

Date	Analysis	Identifier 1	Comment	Peak Nr	R 13C/12C	d 13C/12C	Area All	ng C	Rt	Component
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	9	0.0108843	-26.466	0.735	21	2135.8	
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	10	0.0108788	-26.958	2.133	60.94285714	2196.6	
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	11	0.0108773	-27.09	2.796	79.88571429	2238.2	c28:0
07/28/12	1283	14143C	10uL 12:0 in 300uL hexane	12	0.0108895	-26.001	5.173	147.8	2292.1	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	1	0.0108092	-33.181	66.281	1893.742857	61.4	CO2 REF 1
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.54	1901.142857	111.4	CO2 REF 2
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	3	0.0108082	-33.276	66.487	1899.628571	160.7	CO2 REF 3
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	4	0.0108673	-27.983	9.763	278.9428571	665.2	c12:0
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	5	0.0108491	-29.614	19.14	546.8571429	1270.5	c16:0
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	6	0.0109036	-24.736	0.59	16.85714286	1457.1	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	7	0.0095492	-23.173	0.687	19.62857143	1508.1	c18:1n9c/3n3
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	8	0.0109526	-20.362	2.973	84.94285714	1517.8	c18:1n9t/7c/5c
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	9	0.010866	-28.105	15.509	443.1142857	1547.9	c18:0
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	10	0.01085	-29.537	1.096	31.31428571	1785.9	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	11	0.0108908	-25.887	3.465	99	1872.2	c22:6n3
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	12	0.0108392	-30.501	1.433	40.94285714	1883.9	c22:5n3
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	13	0.0108814	-26.723	0.52	14.85714286	1912.3	c22:1n9/22:2
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	14	0.0108708	-27.678	0.499	14.25714286	1927.4	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	15	0.0109061	-24.513	2.015	57.57142857	2032.9	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	16	0.0109024	-24.85	1.944	55.54285714	2125.3	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	17	0.0109096	-24.2	3.937	112.4857143	2136.8	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	18	0.0108991	-25.141	1.429	40.82857143	2182.2	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	19	0.0108918	-25.799	1.575	45	2197	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	20	0.0108828	-26.598	1.439	41.11428571	2210.2	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	21	0.0108896	-25.994	1.02	29.14285714	2220.8	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	22	0.0108916	-25.817	1.841	52.6	2231.7	
07/28/12	1282	14141F	10uL 12:0 in 300uL hexane	23	0.0108996	-25.095	7.182	205.2	2276.6	
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	1	0.0108086	-33.237	66.32	1894.857143	61.7	CO2 REF 1
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.538	1901.085714	111.4	CO2 REF 2
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	3	0.0108078	-33.311	66.522	1900.628571	161.1	CO2 REF 3
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	4	0.0108654	-28.16	8.336	238.1714286	667.1	c12:0
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	5	0.0108484	-29.676	16.092	459.7714286	1270.3	c16:0
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	6	0.0109652	-19.233	1.098	31.37142857	1517.5	c18:1n9t/7c/5c
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	7	0.0108645	-28.24	11.708	334.5142857	1547.2	c18:0
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	8	0.0108486	-29.656	0.488	13.94285714	1785.7	
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	9	0.0108969	-25.339	0.659	18.82857143	2136.2	
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	10	0.010895	-25.509	2.138	61.08571429	2256.8	
07/28/12	1281	13877b	10uL 12:0 in 300uL hexane	11	0.0109028	-24.811	1.81	51.71428571	2292.1	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	1	0.0108087	-33.228	65.979	1885.114286	61.4	CO2 REF 1
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.354	1895.828571	111.4	CO2 REF 2
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	3	0.0108078	-33.305	66.368	1896.228571	161.1	CO2 REF 3
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	4	0.0108692	-27.815	9.52	272	666.7	c12:0
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	5	0.0109156	-23.663	2.242	64.05714286	970	c14:0
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	6	0.0109326	-22.144	1.227	35.05714286	1235.4	c16:1w7t
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	7	0.0109404	-21.451	1.07	30.57142857	1241.7	c16:1w9c/7c
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	8	0.0108818	-26.692	26.289	751.1142857	1271.6	c16:0
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	9	0.0109477	-20.792	0.385	11	1408.2	2-OH 16:1
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	10	0.0105404	-20.96	2.301	65.74285714	1508.6	c18:1n9c/3n3
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	11	0.0109519	-20.421	4.302	122.9142857	1517.3	c18:1n9t/7c/5c
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	12	0.0108827	-26.614	14.531	415.1714286	1547.6	c18:0
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	13	0.010939	-21.577	1.044	29.82857143	1754.1	c20:4n3
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	14	0.0109326	-22.15	1.17	33.42857143	1760.4	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	15	0.0109071	-24.429	0.431	12.31428571	1779	c20:2/c20:3n3
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	16	0.0108555	-29.045	0.675	19.28571429	1785.7	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	17	0.0108949	-25.515	0.875	25	1870.3	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	18	0.0108704	-27.713	0.846	24.17142857	1883.5	c22:5n3
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	19	0.0109254	-22.791	0.512	14.62857143	2032.3	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	20	0.0109162	-23.61	0.748	21.37142857	2136.2	
07/28/12	1280	15151	10uL 12:0 in 300uL hexane	21	0.0108889	-26.052	2.111	60.31428571	2292.3	
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	1	0.0108091	-33.193	66.317	1894.771429	61.4	CO2 REF 1
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	2	0.0108081	-33.282	66.479	1899.4	111.2	CO2 REF 2

Date	Analysis	Identifier 1	Comment	Peak Nr	R 13C/12C	d 13C/12C	Area All	ng C	Rt	Component
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	3	0.0108076	-33.327	66.414	1897.542857	161.1	CO2 REF 3
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	4	0.0108667	-28.045	8.451	241.4571429	666.3	c12:0
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	5	0.0108633	-28.346	20.04	572.5714286	1270.1	c16:0
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	6	0.0109695	-18.846	1.777	50.77142857	1517.8	c18:1n9t/7c/5c
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	7	0.0108737	-27.414	16.374	467.8285714	1547.4	c18:0
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	8	0.010838	-30.604	0.672	19.2	1785.7	
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	9	0.0109857	-17.394	0.821	23.45714286	1871	
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	10	0.0109083	-24.321	0.537	15.34285714	2136.2	
07/28/12	1279	14110a	10uL 12:0 in 300uL hexane	11	0.0108873	-26.195	3.257	93.05714286	2292.1	
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	1	0.0108092	-33.185	60.926	1740.742857	61.7	CO2 REF 1
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	2	0.0108081	-33.282	63.657	1818.771429	111.4	CO2 REF 2
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	3	0.010808	-33.295	63.128	1803.657143	161.1	CO2 REF 3
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	4	0.0108675	-27.97	5.114	146.1142857	668.2	c12:0
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	5	0.0108682	-27.906	10.8	308.5714286	1270.1	c16:0
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	6	0.0109575	-19.922	1.323	37.8	1520.1	c18:1n9t/7c/5c
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	7	0.010883	-26.584	8.942	255.4857143	1547.2	c18:0
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	8	0.0109205	-23.231	0.316	9.028571429	1928.4	
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	9	0.0109172	-23.521	0.636	18.17142857	2035.9	
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	10	0.0109162	-23.615	1.364	38.97142857	2138.3	
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	11	0.0108641	-28.271	1.193	34.08571429	2243.4	c28:0
07/28/12	1277	14106C	10uL 12:0 in 500uL hexane	12	0.0108838	-26.511	5.112	146.0571429	2291.1	
07/29/12	1292	PUFA-3		1	0.0108107	-33.047	70.347	2009.914286	61.7	CO2 REF 1
07/29/12	1292	PUFA-3		2	0.0108081	-33.282	72.246	2064.171429	111.4	CO2 REF 2
07/29/12	1292	PUFA-3		3	0.0108082	-33.275	71.498	2042.8	161.1	CO2 REF 3
07/29/12	1292	PUFA-3		4	0.0109002	-25.042	16.074	459.2571429	973.3	c14:0
07/29/12	1292	PUFA-3		5	0.0109039	-24.715	0.923	26.37142857	1122.7	c15:0
07/29/12	1292	PUFA-3		6	0.0108892	-26.03	1.109	31.68571429	1218.1	i16:0/c16:2n4
07/29/12	1292	PUFA-3		7	0.0108911	-25.857	22.93	655.1428571	1240.8	c16:1w9c/7c
07/29/12	1292	PUFA-3		8	0.0109265	-22.691	34.221	977.7428571	1273.6	c16:0
07/29/12	1292	PUFA-3		9	0.0109061	-24.514	0.564	16.11428571	1410.3	2-OH 16:1
07/29/12	1292	PUFA-3		10	0.010845	-29.981	0.98	28	1487.2	c18:4n3
07/29/12	1292	PUFA-3		11	0.0108974	-25.291	1.736	49.6	1500	c18:2n6c
07/29/12	1292	PUFA-3		12	0.0109072	-24.414	15.973	456.3714286	1514.2	c18:1n9c/3n3
07/29/12	1292	PUFA-3		13	0.0109144	-23.775	12.838	366.8	1520.5	c18:1n9t/7c/5c
07/29/12	1292	PUFA-3		14	0.0109318	-22.217	9.466	270.4571429	1547.2	c18:0
07/29/12	1292	PUFA-3		15	0.0108192	-32.289	6.956	198.7428571	1719.4	c20:5n3
07/29/12	1292	PUFA-3		16	0.0108634	-28.335	3.216	91.88571429	1736.8	c20:3n6
07/29/12	1292	PUFA-3		17	0.0109057	-24.555	5.751	164.3142857	1756.2	c20:4n3
07/29/12	1292	PUFA-3		18	0.0109107	-24.106	2.032	58.05714286	1780.5	c20:2/c20:3n3
07/29/12	1292	PUFA-3		19	0.0108401	-30.418	3.17	90.57142857	1876.2	c22:6n3
07/29/12	1292	PUFA-3		20	0.0108661	-28.098	3.298	94.22857143	1885.2	c22:5n3
07/29/12	1292	PUFA-3		21	0.0108959	-25.43	0.637	18.2	1910.9	c22:1n9/22:2
07/29/12	1292	PUFA-3		22	0.010896	-25.423	0.414	11.82857143	1915.5	

Appendix Two: FAME Raw Data--Average C amount in nanograms (ng)--Page 1

SAMPLE	2-OH 16:1	br19:1a	c12:0	c14:0	c15:0	c16:0	c16:1w7t	c16:1w9c/7c	c18:0
13148			190.2			503.7142857			364.2
13877b			238.1714286			459.7714286			334.5142857
13884e			210.8857143			407.7714286			278.2571429
14026g			204.7428571			440.8571429			317.5428571
14106C			146.1142857			308.5714286			255.4857143
14107c			165.5428571			564.2285714			480.3142857
14109a			212			447.4857143			350.9714286
14110a			241.4571429			572.5714286			467.8285714
14112			196.5714286			386.0285714			297.5714286
14113G			211.5714286			378.7428571			298.3714286
14140a			195.5428571			408.7714286			345.3428571
14141F			278.9428571			546.8571429			443.1142857
14142a			189.4857143			455.2571429			332.4571429
14143C			232.1142857			425.0857143			323.6857143
14514C		28.51428571	231.7142857	71.14285714		726.6571429	30.11428571	43.51428571	363
14515b			203.2	31.8		713.3714286			442.7428571
14861B			209.7142857			492.0571429			337.7714286
15110			207.5428571			431.4571429			317.9142857
15146			205.1142857			425.7714286			313
15151	11		272	64.05714286		751.1142857	35.05714286	30.57142857	415.1714286
PUFA-3	16.11428571			459.2571429	26.37142857	977.7428571		655.1428571	270.4571429

Appendix Two: FAME Raw Data--Average C amount in nanograms (ng)--Page 2

SAMPLE	c18:1n9c/3n3	c18:1n9t/7c/5c	c18:2n6c	c18:4n3	c20:1n9	c20:2/c20:3n3	c20:3n6	c20:4n3	c20:5n3	c22:1n9/22:2
13148	13.08571429	41.54285714								
13877b		31.37142857								
13884e		28.88571429								
14026g										
14106C		37.8								
14107c	18.71428571	41.77142857								
14109a		30.51428571								
14110a		50.77142857								
14112										
14113G	13.85714286	30.68571429								
14140a		20.28571429								
14141F	19.62857143	84.94285714								14.85714286
14142a	14.51428571	36.48571429								
14143C	12.51428571	22.62857143								
14514C	61.6	123.0571429				18.77142857		22.6		
14515b	27.54285714	95.6				16.17142857		26.91428571		43.34285714
14861B	21.31428571	80.94285714								
15110	31.62857143	41.51428571			43.22857143					
15146		31.14285714								
15151	65.74285714	122.9142857				12.31428571		29.82857143		
PUFA-3	456.3714286	366.8	49.6	28		58.05714286	91.88571429	164.3142857	198.7428571	18.2

Appendix Two: FAME Raw Data--Average C amount in nanograms (ng)--Page 3

SAMPLE	c22:5n3	c22:6n3	c28:0	i16:0/c16:2n4	i17:1w7c
13148			26		
13877b					
13884e					
14026g					
14106C			34.08571429		
14107c					
14109a					
14110a					
14112					
14113G	14.25714286				
14140a					
14141F	40.94285714	99			
14142a					
14143C			79.88571429		
14514C	15.85714286		31.71428571		30.62857143
14515b					
14861B					
15110		27.97142857			
15146					
15151	24.17142857				
PUFA-3	94.22857143	90.57142857		31.68571429	

Appendix Three: FAME Raw Data--Average of d 13C/12C--Page 1

SAMPLE	2-OH 16:1	br19:1a	c12:0	c14:0	c15:0	c16:0	c16:1w7t	c16:1w9c/7c	c18:0	c18:1n9c/3n3	c18:1n9t/7c/5c	c18:2n6c
13148			-29.42			-31.019			-28.934	-24.23	-20.577	
13877b			-28.16			-29.676			-28.24		-19.233	
13884e			-28.57			-29.59			-28.738		-20.37	
14026g			-28.294			-29.896			-29.119			
14106C			-27.97			-27.906			-26.584		-19.922	
14107c			-28.597			-30.049			-28.911	-24.773	-22.112	
14109a			-29.525			-32.218			-30.158		-21.813	
14110a			-28.045			-28.346			-27.414		-18.846	
14112			-27.886			-29.67			-28.807			
14113G			-29.537			-32.346			-29.585	-28.894	-21.798	
14140a			-29.705			-32.53			-30.081		-22.199	
14141F			-27.983			-29.614			-28.105	-23.173	-20.362	
14142a			-28.611			-29.158			-28.028	-24.559	-20.561	
14143C			-28.491			-30.855			-29.289	-26.652	-22.688	
14514C		-27.397	-28.809	-24.729		-27.305	-19.72	-19.843	-28.034	-21.743	-21.285	
14515b			-28.85	-25.122		-27.921			-27.643	-23.761	-22.009	
14861B			-29.096			-31.279			-28.935	-25.092	-22.195	
15110			-28.089			-29.835			-28.843	-30.435	-22.717	
15146			-28.745			-30.734			-29.458		-22.281	
15151	-20.792		-27.815	-23.663		-26.692	-22.144	-21.451	-26.614	-20.96	-20.421	
PUFA-3	-24.514			-25.042	-24.715	-22.691		-25.857	-22.217	-24.414	-23.775	-25.291

SD of Internal Standard (c12:0)=
0.597

SAMPLE	c18:4n3	c20:1n9	c20:2/c20:3n3	c20:3n6	c20:4n3	c20:5n3	c22:1n9/22:2	c22:5n3	c22:6n3	c28:0	i16:0/c16:2n4	i17:1w7c
13148										-24.155		
13877b												
13884e												
14026g												
14106C										-28.271		
14107c												
14109a												
14110a												
14112												
14113G								-28.396				
14140a												
14141F							-26.723	-30.501	-25.887			
14142a												
14143C										-27.09		
14514C			-24.534		-22.931			-29.173		-25.609		-19.663
14515b			-23.82		-22.642		-22.429					
14861B												
15110		-28.599							-24.443			
15146												
15151			-24.429		-21.577			-27.713				
PUFA-3	-29.981		-24.106	-28.335	-24.555	-32.289	-25.43	-28.098	-30.418		-26.03	

SD of Int
0.597

Correction for Derivatization of Fatty Acids

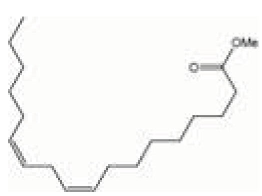
When preparing fatty acid methyl esters, one C is added to each fatty acid molecule. Thus, the isotope ratios we measure include the C from the methanol used in the derivitizatoin process. FAME ^{13}C results are corrected if you know the isotope ratio of the methanol. The Stable Isotope Facility will examine the methanol in nano-pure water to establish the exact correction ration for the current project. The isotopic value of methanol can vary among sources and batches but is approximately -60 per mil d13C. Once the exact ratio is obtained, the correction can be completed for the current raw data.

Equation:
Make the correction using either the $^{13}C/^{12}C$ ratio or atom % ^{13}C. Here we show the correction using atom %. The equation below can be rearranged to solve for fatty acid atom % ^{13}C, given the number of C atoms in the fatty acid molecule (#C), measured atom % ^{13}C of FAME (FAME At%), and measured atom % ^{13}C of the methanol (Me At%):

#C x FA At% + 1 C x Me At% = (#C+1) x FAME At%

FA At% = ((#C+1) x FAME At% - 1 x Me At%)/#C

Example:
Linoleic Acid (C18:2n6c, CAS# 60-33-3)



Methanol Atom % ^{13}C = 1.06272 (delta ^{13}C = -39.20) Methyl Linoleate (FAME) Atom % ^{13}C = 1.07366 (delta ^{13}C = -29.20)

Linoleic Acid Atom % ^{13}C = ((18+1) x 1.07366 – 1 x 1.06272)/18 = 1.07427 (delta ^{13}C = -28.64) In this case, the correction made only a small difference in the resulting value.

Appendix VI

Selected artifacts

Figure 1. CAKR 13833a, curvilinear stamped ceramic (Photo: S. Anderson)

Figure 2. CAKR 13390, chert stemmed biface (Photo: S. Anderson)

Figure 3. CAKR 13429, chert biface (Photo: S. Anderson)

Figure 4. CAKR 14926, chert biface (Photo: S. Anderson)

Figure 5. CAKR 13578, chert bifacial sideblade (Photo: S. Anderson)

Figure 6. CAKR 13959, chert bifacial bipoint (Photo: S. Anderson)

Figure 7. CAKR 13281, jade adze (Photo: S. Gilbert-Young)

Figure 8. CAKR 13279, slotted ivory knife handle (Photo: A. Freeburg)

Figure 9. CAKR 14747, antler harpoon point (Photo: A. Freeburg)

Figure 10. CAKR 13274, jet labret (Photo: S. Gilbert-Young)

Appendix VII

Radiocarbon Dating Results

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 13237	4D	Beta-223219	Charcoal	*Populus sp.*	-25.6	280	40	A.D. 1482 - A.D. 1952
CAKR 13240	3D	Beta-226692	Charcoal	*Populus sp./Salix sp. Cf. Populus sp.*	-25.6	390	40	A.D. 1436 - A.D. 1634
CAKR 13242	19D	Beta-223222	Charcoal	not identified	-26.4	6420	50	5478 B.C. - 5318 B.C.
CAKR 13243	20D	Beta-226693	Charcoal	*Picea sp./Larix sp.*	-25.4	1780	40	A.D. 130 - A.D. 379
CAKR 13245	22D	OS-81429	Charcoal	*Salicaceae, cf. Salix*	-27.08	1780	25	A.D. 137 - A.D. 335
CAKR 13246	628D	OS-81428	Charcoal	*Salicaceae, cf. Populus*	-24.45	1850	30	A.D. 85 - A.D. 235
CAKR 13255	661D	OS-81279	Charcoal	*Picea*	-23.54	1350	25	A.D. 640 - A.D. 765
CAKR 13256	112D	Beta-223220	Charcoal	*Salix sp.*	-26.4	1590	40	A.D. 392 - A.D. 562
CAKR 13259	231D	OS-81431	Charcoal	*Picea*	-24.45	540	30	A.D. 1316 - A.D. 1437
CAKR 13260	2483D	OS-78454	Charcoal	*Salicaceae*	-26.17	2160	30	359 B.C. - 107 B.C.
CAKR 13268	289D	Beta-226148	Charcoal	*Salix sp.*	-27.5	380	40	A.D. 1441 - A.D. 1635
CAKR 13269	323D	OS-81281	Charcoal	*Picea*	-24.85	430	25	A.D. 1426 - A.D. 1609
CAKR 13270	2492D	Beta-226694	Charcoal	*Populus sp./Salix sp. Cf. Populus sp.*	-27.4	2320	40	514 B.C. - 212 B.C.
CAKR 13272	2493D	Beta-226695	Charcoal	*Populus sp./Salix sp. Cf. Populus sp.*	-25.5	2930	40	1266 B.C. - 1009 B.C.
CAKR 13277	327D	Beta-226149	Charcoal	*Picea sp./Larix sp. Cf. Picea sp.*	-23.7	400	40	A.D. 1432 - A.D. 1633
CAKR 13282	328D	Beta-226150	Charcoal	*Pinaceae Cf. Picea/Larix sp.*	-24.2	190	40	A.D. 1644 - A.D. 1955
CAKR 13284	335D	Beta-226151	Charcoal	*Picea sp./Larix sp.*	-24.9	570	40	A.D. 1298 - A.D. 1429
CAKR 13286	357D	Beta-226152	Charcoal	*Picea sp./Larix sp.*	-25.1	1050	40	A.D. 891 - A.D. 1036
CAKR 13288	859D	Beta-226153	Charcoal	*Picea sp./Larix sp.*	-25.2	320	40	A.D. 1468 - A.D. 1649
CAKR 13292	881D	Beta-226687	Plant/Wood	*Pinaceae*	-23.4	470	40	A.D. 1330 - A.D. 1608
CAKR 13293	914D	OS-81284	Charcoal	*Salicaceae, cf. Salix*	-26.11	1600	25	A.D. 412 - A.D. 537
CAKR 13294	498D	OS-81282	Charcoal	*Picea*	-22.96	1820	30	A.D. 91 - A.D. 318
CAKR 13295	506D	OS-78455	Charcoal	*Salicaceae-Salix/Populus*	-26.87	1410	25	A.D. 601 - A.D. 662
CAKR 13296	513D	OS-81280	Charcoal	*Picea*	-24.51	1600	25	A.D. 412 - A.D. 537
CAKR 13298	1050D	Beta-226154	Charcoal	*Picea sp./Larix sp.*	-26.9	1200	40	A.D. 690 - A.D. 946
CAKR 13301	1100D	OS-78456	Charcoal	*Salicaceae*	-25.67	1330	35	A.D. 646 - A.D. 772
CAKR 13304	1642D	Beta-226688	Plant/Wood	*Picea sp./Larix sp.*	-24.8	1030	40	A.D. 895 - A.D. 1150
CAKR 13305	1275D	OS-81277	Charcoal	*Picea*	-24.71	830	35	A.D. 1058 - A.D. 1272

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 13307	1340D	OS-81278	Charcoal	*Picea*	-25.01	1800	25	A.D. 131 - A.D. 323
CAKR 13308	1708D	OS-78457	Charcoal	*Picea*	-24.62	1300	35	A.D. 656 - A.D. 776
CAKR 13309	1678D	OS-81430	Charcoal	*Picea*	-25.94	1230	25	A.D. 690 - A.D. 880
CAKR 13310	2502D	Beta-226689	Charcoal	*Picea sp./Larix sp.*	-24.2	1440	40	A.D. 551 - A.D. 659
CAKR 13312	1378D	OS-81426	Charcoal	*Picea*	-25.18	1870	25	A.D. 76 - A.D. 222
CAKR 13313	1369D	OS-81425	Charcoal	*Picea*	-22.65	1620	25	A.D. 389 - A.D. 535
CAKR 13314	2503D	Beta-226690	Charcoal	*Picea sp./Larix sp.*	-22.9	1800	40	A.D. 92 - A.D. 339
CAKR 13315	2504D	OS-78458	Charcoal	*Picea*	-25.40	2450	40	756 B.C. - 409 B.C.
CAKR 13316	2505D	OS-78459	Charcoal	*Picea*	-24.45	2630	25	831 B.C. - 786 B.C.
CAKR 13317	1440D	OS-81427	Charcoal	*Picea*	-25.05	1390	30	A.D. 602 - A.D. 674
CAKR 13319	1444D	Beta-226155	Charcoal	*Pinaceae cf. Picea/Larix sp.*	-26.5	1510	40	A.D. 433 - A.D. 637
CAKR 13321	1443D	OS-81283	Charcoal	*Picea*	-25.48	1470	25	A.D. 552 - A.D. 642
CAKR 13323	1446D	OS-78460	Charcoal	*Salicaceae*	-26.30	1510	30	A.D. 435 - A.D. 623
CAKR 13325	112D	Beta-326105	Bone	*E. barbatus*, left innominate	-12.7	2230	30	A.D. 31 - A.D. 220
CAKR 13328	327D	Beta-326106	Bone	*Phoca, cf. hispida*, right humerus	-12.8	1020	30	A.D. 1299 - A.D. 1415
CAKR 13330	335D	Beta-326107	Bone	*Phoca, cf. hispida*, right calcaneus	-13.4	1110	30	A.D. 1221 - A.D. 1334
CAKR 13333	1050D	Beta-326108	Bone	*Phoca, cf. hispida*, left femur	-13.2	1920	30	A.D. 402 - A.D. 576
CAKR 13335	4D	Beta-326109	Bone	*Phoca, cf. hispida*, left fibula	-13.5	1170	30	A.D. 1171 - A.D. 1296
CAKR 13339	197B	OS-78461	Charcoal	*Picea*	-24.64	1920	30	A.D. 2 - A.D. 206
CAKR 13340	189B	OS-81437	Charcoal	*Picea*	-25.15	1880	30	A.D. 65 - A.D. 224
CAKR 13343	696B	OS-78583	Charcoal	*Picea*	-29.20	675	25	A.D. 1275 - A.D. 1389
CAKR 13355	697B	OS-81582	Charcoal	*Salicaceae* - twig	-27.33	570	25	A.D. 1307 - A.D. 1420
CAKR 13356	697B	OS-81440	Charcoal	*Salicaceae, cf. Salix*	-26.23	595	25	A.D. 1298 - A.D. 1410
CAKR 13362	720B	OS-81743	Charcoal	*Salicaceae, cf. Salix*	-25.85	720	25	A.D. 1256 - A.D. 1381
CAKR 13367	777B	OS-78584	Charcoal	*Salicaceae*	-25.69	330	25	A.D. 1482 - A.D. 1642
CAKR 13381	726B	OS-78585	Charcoal	*Salicaceae*	-26.51	590	35	A.D. 1296 - A.D. 1415
CAKR 13384	747B	OS-81434	Charcoal	*Picea*	-24.57	830	30	A.D. 1160 - A.D. 1265
CAKR 13385	740B	OS-81442	Charcoal	*Salicaceae* - twig	-27.26	625	25	A.D. 1290 - A.D. 1398

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 13386	706B	OS-81441	Charcoal	*Salicaceae, cf. Salix* - twig	-27.42	510	30	A.D. 1328 - A.D. 1445
CAKR 13389	1039B	OS-78586	Charcoal	*Picea*	-22.87	3450	30	1880 B.C. - 1688 B.C.
CAKR 13401	1303B	OS-78587	Charcoal	*Salicaceae*	-25.61	1590	25	A.D. 416 - A.D. 540
CAKR 13404	1294B	OS-78588	Charcoal	*Salicaceae*	-26.03	1630	25	A.D. 350 - A.D. 534
CAKR 13409	1417B	OS-81433	Charcoal	Conifer	-26.18	1780	25	A.D. 137 - A.D. 335
CAKR 13416	1599B	OS-78589	Charcoal	*Salicaceae*	-26.46	2380	25	536 B.C. - 392 B.C.
CAKR 13427	23C	OS-78590	Charcoal	*Salicaceae-Salix/Populus*	-24.36	2100	25	191 B.C. - 50 B.C.
CAKR 13450	346A	Beta-326110	Bone	*R. tarandus*, left palatine	-19.9	163.5 pMC	0.4 pMC	- - -
CAKR 13454	346A	OS-96755	Charcoal	*Salix*	-27.4	175	50	A.D. 1649 - A.D. 1954
CAKR 13475	347A	OS-78544	Charcoal	*Picea*	-24.01	175	25	A.D. 1661 - A.D. 1954
CAKR 13477	347A	OS-81438	Plant/Wood	Bark	-24.13	130	25	A.D. 1678 - A.D. 1940
CAKR 13490	348A	OS-78545	Charcoal	*Picea*	-25.27	260	30	A.D. 1520 - A.D. 1954
CAKR 13495	20C	OS-78546	Charcoal	*Picea*	-25.14	1760	25	A.D. 182 - A.D. 381
CAKR 13514	1736B	OS-78547	Charcoal	*Salicaceae-Populus/Salix*	-24.67	175	25	A.D. 1661 - A.D. 1954
CAKR 13517	2098B	OS-78548	Charcoal	*Betula*	-25.64	670	25	A.D. 1276 - A.D. 1389
CAKR 13523	2147B	OS-78549	Charcoal	*Picea*	-25.00	995	25	A.D. 988 - A.D. 1152
CAKR 13535	1723B	Beta-326111	Bone	*Phoca, cf. hispida*, left innominate	-13.2	880	30	A.D. 1407 - A.D. 1502
CAKR 13536	1723B	Beta-326112	Bone	*R. tarandus*, right humerus	-17.4	60	30	A.D. 1693 - A.D. 1920
CAKR 13562	2030B	OS-81439	Charcoal	*Picea*	-25.09	1590	30	A.D. 411 - A.D. 543
CAKR 13569	1744B	OS-78550	Charcoal	*Salicaceae*	-25.17	1510	30	A.D. 435 - A.D. 623
CAKR 13580	21C	OS-78551	Charcoal	*Picea*	-24.39	3760	35	2289 B.C. - 2041 B.C.
CAKR 13583	2211B	OS-81744	Charcoal	*Picea*	-23.72	865	25	A.D. 1048 - A.D. 1252
CAKR 13585	1847B	OS-81436	Charcoal	*Picea*	-25.60	1410	30	A.D. 590 - A.D. 666
CAKR 13586	1868B	OS-78619	Charcoal	*Salicaceae*	-24.32	835	25	A.D. 1163 - A.D. 1259
CAKR 13594	2083B	OS-94113	Plant/Wood	Conifer	-24.68	1630	25	A.D. 350 - A.D. 534
CAKR 13601	1444B	OS-78620	Charcoal	*Salicaceae*	-25.14	690	30	A.D. 1265 - A.D. 1389
CAKR 13620	2256B	OS-81435	Charcoal	*Picea*	-26.14	615	25	A.D. 1295 - A.D. 1400

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 13624	2178B	OS-81432	Charcoal	*Picea*	-24.54	1310	25	A.D. 657 - A.D. 771
CAKR 13626	2282B	OS-78621	Charcoal	*Salicaceae*	-26.60	>Mod		- - -
CAKR 13810	2395B	OS-81746	Charcoal	*Picea*	-23.94	110	30	A.D. 1681 - A.D. 1938
CAKR 13814	2457B	OS-81645	Charcoal	*Salicaceae,cf.Populus*	-26.44	465	40	A.D. 1333 - A.D. 1613
CAKR 13828	2503B	OS-81968	Charcoal	*Picea*	-27.09	1210	80	A.D. 665 - A.D. 979
CAKR 13831	2499B	OS-81677	Charcoal	*Picea*	-24.00	1030	25	A.D. 906 - A.D. 1033
CAKR 13835	2478B	OS-81616	Charcoal	*Picea*	-25.35	355	30	A.D. 1453 - A.D. 1635
CAKR 13860	2590B	OS-81650	Charcoal	*Picea*	-25.48	1490	35	A.D. 441 - A.D. 646
CAKR 13879	2602B	OS-81679	Charcoal	*Picea*	-26.23	345	25	A.D. 1466 - A.D. 1636
CAKR 13891	2602B	OS-81644	Charcoal	*Salicaceae, cf. Populus*	-27.37	910	35	A.D. 1033 - A.D. 1208
CAKR 13919	2602B	OS-81678	Charcoal	*Salicaceae, cf. Salix* - twig	-26.29	650	30	A.D. 1280 - A.D. 1395
CAKR 13941	2601B	OS-81753	Charcoal	*Salicaceae*	-23.04	2430	25	747 B.C. - 404 B.C.
CAKR 13953A	2603B	OS-81621	Charcoal	*Betula*	-25.98	2520	25	790 B.C. - 543 B.C.
CAKR 13953B	2603B	OS-81573	Bone	*Phoca, cf. hispida*, left mandible	-14.53	2810	30	741 B.C. - 487 B.C.
CAKR 13975	2607B	OS-81647	Charcoal	*Picea*	-24.43	490	35	A.D. 1329 - A.D. 1455
CAKR 13990	2604B	OS-81610	Charcoal	*Picea*	-23.85	2480	25	768 B.C. - 419 B.C.
CAKR 14007	2928B	OS-81745	Charcoal	*Betula*	-24.84	435	25	A.D. 1425 - A.D. 1485
CAKR 14008	2927B	OS-81652	Charcoal	*Betula*	-23.94	375	40	A.D. 1443 - A.D. 1635
CAKR 14011	28C	OS-81685	Charcoal	*Salicaceae, cf. Salix*	-26.56	3620	30	2119 B.C. - 1893 B.C.
CAKR 14012	2925B	OS-81680	Charcoal	*Picea*	-23.57	495	25	A.D. 1407 - A.D. 1445
CAKR 14023	3016B	OS-94052	Charcoal	*Picea*	-25.00	2460	25	756 B.C. - 414 B.C.
CAKR 14035	2644B	OS-81618	Charcoal	*Salicaceae, cf. Populus*	-25.89	1960	25	39 B.C. - A.D. 115
CAKR 14041	3074B	OS-81751	Charcoal	*Picea*	-24.05	2350	25	510 B.C. - 382 B.C.
CAKR 14043	30C	OS-81653	Charcoal	*Picea*	-25.72	340	35	A.D. 1467 - A.D. 1641
CAKR 14046	3135B	OS-81657	Charcoal	*Picea*	-25.61	2170	35	365 B.C. - 111 B.C.
CAKR 14047	3160B	OS-81749	Charcoal	*Salicaceae, cf. Populus*	-25.30	2500	30	783 B.C. - 518 B.C.
CAKR 14049	373A	OS-81691	Charcoal	*Larix*	-26.76	2010	25	87 B.C. - A.D. 59
CAKR 14055	403A	OS-81684	Charcoal	*Salicaceae, cf. Salix*	-27.37	1770	25	A.D. 140 - A.D. 343

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 14058	3186B	OS-81683	Charcoal	*Salicaceae, cf. Salix*	-23.31	1730	25	A.D. 245 - A.D. 385
CAKR 14059	401A	OS-81646	Charcoal	*Picea*	-24.75	1840	35	A.D. 80 - A.D. 247
CAKR 14065	3165B	OS-81607	Charcoal	*Picea*	-24.11	2210	30	376 B.C. - 200 B.C.
CAKR 14067	3244B	OS-81755	Charcoal	*Picea*	-24.15	1990	25	44 B.C. - A.D. 64
CAKR 14072	3259B	OS-81779	Charcoal	*Picea*	-26.22	1750	35	A.D. 144 - A.D. 395
CAKR 14073	3259B	OS-94053	Plant/Wood	*cf.* Conifer	-26.71	1920	30	A.D. 2 - A.D. 206
CAKR 14075	3314B	OS-81617	Charcoal	*Picea*	-24.21	1900	25	A.D. 30 - A.D. 210
CAKR 14076	3314B	OS-94134	Plant/Wood	*Conifer*	-25.88	1860	25	A.D. 82 - A.D. 227
CAKR 14080	3316B	OS-81639	Charcoal	*Picea*	-23.85	1880	35	A.D. 59 - A.D. 229
CAKR 14081	3169B	OS-81659	Charcoal	*Picea*	-25.67	2340	35	523 B.C. - 259 B.C.
CAKR 14082	2992B	OS-81682	Charcoal	*Salicaceae,cf.Salix*	-25.36	2510	45	796 B.C. - 418 B.C.
CAKR 14085	3181B	OS-81635	Charcoal	*Picea*	-25.34	1960	40	43 B.C. - A.D. 126
CAKR 14094	3307B	OS-94153	Plant/Wood	*Picea*	-25.16	1950	30	37 B.C. - A.D. 125
CAKR 14117	3405B	OS-81584	Charcoal	*Salicaceae*	-24.99	1680	25	A.D. 259 - A.D. 423
CAKR 14125A	3405B	OS-81583	Charcoal	*Salicaceae, cf. Populus*	-26.66	2000	25	49 B.C. - A.D. 61
CAKR 14125B	3405B	OS-81579	Bone	*Phoca, cf. hispida*, right tibia	-14.35	2360	30	139 B.C. - A.D. 63
CAKR 14126A	3405B	OS-81619	Charcoal	*Picea*	-24.95	2130	25	347 B.C. - 56 B.C.
CAKR 14138	3405B	OS-81752	Charcoal	*Picea*	-24.59	1670	30	A.D. 258 - A.D. 430
CAKR 14159	3508B	OS-81643	Charcoal	Unidentifiable	-25.24	2280	35	403 B.C. - 209 B.C.
CAKR 14160	3426B	OS-81655	Charcoal	*Picea*	-25.81	2170	35	365 B.C. - 111 B.C.
CAKR 14163	3487B	OS-94135	Plant/Wood	*cf. Conifer*	-26.37	2400	25	723 B.C. - 398 B.C.
CAKR 14164	3329B	OS-81614	Charcoal	*Picea*	-24.63	1980	25	41 B.C. - A.D. 71
CAKR 14178	3454B	OS-81636	Charcoal	*Salicaceae, cf. Salix*	-24.73	2000	35	92 B.C. - A.D. 77
CAKR 14191	3641B	OS-81754	Charcoal	*Picea*	-21.77	1620	25	A.D. 389 - A.D. 535
CAKR 14202	3715B	OS-81676	Charcoal	*Salicaceae, cf. Salix*	-27.82	1610	25	A.D. 403 - A.D. 536
CAKR 14213	3666B	OS-81641	Charcoal	*Salicaceae* - twig, friable	-23.12	760	35	A.D. 1215 - A.D. 1289
CAKR 14215	3645B	OS-81620	Charcoal	*Picea*	-24.44	1700	25	A.D. 256 - A.D. 410
CAKR 14225	3763B	OS-81403	Charcoal	Unidentifiable	-24.52	1300	50	A.D. 646 - A.D. 865

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 14228	3754B	OS-81605	Charcoal	*Picea*	-23.85	1670	25	A.D. 261 - A.D. 427
CAKR 14231	3753B	OS-81613	Charcoal	*Picea*	-23.92	1620	30	A.D. 357 - A.D. 539
CAKR 14236	3766B	OS-81609	Charcoal	*Picea*	-24.74	1610	30	A.D. 393 - A.D. 539
CAKR 14238	3739B	OS-81649	Charcoal	*Picea*	-23.73	1600	35	A.D. 390 - A.D. 545
CAKR 14240	3939B	OS-81750	Charcoal	*Picea*	-23.49	1450	30	A.D. 561 - A.D. 651
CAKR 14245	3983B	OS-81611	Charcoal	*Picea*	-24.25	1460	25	A.D. 560 - A.D. 646
CAKR 14246	3971B	OS-81658	Charcoal	*Salicaceae, cf. Salix* - twig	-25.83	1560	45	A.D. 412 - A.D. 597
CAKR 14258	4029B	OS-81612	Charcoal	*Picea*	-25.45	1750	25	A.D. 231 - A.D. 382
CAKR 14260	3792B	OS-81638	Charcoal	*Picea*	-25.38	1290	35	A.D. 655 - A.D. 805
CAKR 14262	3792B	OS-81637	Charcoal	*Picea*	-24.54	1540	35	A.D. 429 - A.D. 594
CAKR 14271	3984B	OS-81756	Charcoal	*Picea*	-24.67	1590	25	A.D. 416 - A.D. 540
CAKR 14281	4010B	OS-81640	Charcoal	*Picea*	-23.95	1570	35	A.D. 415 - A.D. 565
CAKR 14285	4003B	OS-81615	Charcoal	*Picea*	-24.97	5020	30	3943 B.C. - 3710 B.C.
CAKR 14286	4003B	OS-81606	Charcoal	*cf. Picea*	-23.52	30700	180	34259 B.C. - 32780 B.C.
CAKR 14308	4132B	OS-81642	Charcoal	*Picea*	-25.11	1180	35	A.D. 722 - A.D. 969
CAKR 14329	4379B	OS-81651	Charcoal	*Salicaceae, cf. Salix*	-26.81	3090	35	1432 B.C. - 1269 B.C.
CAKR 14335	437A	OS-81654	Charcoal	*Picea*	-23.47	2420	35	750 B.C. - 400 B.C.
CAKR 14336	437A	OS-81648	Charcoal	*Picea*	-25.86	2350	35	703 B.C. - 368 B.C.
CAKR 14346	440A	OS-81681	Plant/Wood	*Picea*	-25.99	110	25	A.D. 1682 - A.D. 1935
CAKR 14369	440A	OS-81656	Charcoal	*Picea*	-24.59	890	35	A.D. 1040 - A.D. 1218
CAKR 14379	455A	OS-81608	Charcoal	*Picea*	-26.66	1820	30	A.D. 91 - A.D. 318
CAKR 14414	457A	OS-81581	Charcoal	*Picea*	-24.86	1010	25	A.D. 981 - A.D. 1148
CAKR 14428	458A	OS-81578	Bone	*R. tarandus*, left tibia	-19.52	840	25	A.D. 1160 - A.D. 1259
CAKR 14432	458A	Beta-326113	Bone	*cf. E. barbatus*, rib	-13.0	1550	30	A.D. 745 - A.D. 940
CAKR 14449	448A	OS-81575	Bone	*R. tarandus*, mid long bone	-18.59	830	30	A.D. 1160 - A.D. 1265
CAKR 14458	441A	OS-81576	Bone	*R. tarandus*, distal radius	-19.18	875	25	A.D. 1046 - A.D. 1222
CAKR 14516	4561B	OS-81574	Bone	*R. tarandus*, metapodial	-19.36	805	25	A.D. 1185 - A.D. 1273
CAKR 14533	4382B	OS-81577	Bone	*R. tarandus*, mandible	-18.71	875	20	A.D. 1051 - A.D. 1219

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 14611	4688B	OS-93710	Plant/Wood	*Picea*	-25.85	170	25	A.D. 1662 - A.D. 1954
CAKR 14615	4691B	OS-93686	Charcoal	*Picea*	-23.17	485	25	A.D. 1411 - A.D. 1447
CAKR 14618	4689B	OS-93687	Charcoal	*Picea*	-26.93	115	25	A.D. 1681 - A.D. 1938
CAKR 14619	4694B	OS-93688	Charcoal	*Picea*	-24.11	410	25	A.D. 1435 - A.D. 1618
CAKR 14620	4689B	Beta-326114	Bone	*R. tarandus*, left astragalus	-17.8	210	30	A.D. 1646 - A.D. 1954
CAKR 14624	4950B	OS-94054	Plant/Wood	*Picea*	-26.99	355	35	A.D. 1453 - A.D. 1635
CAKR 14625	4923B	OS-93711	Plant/Wood	*Picea*	-25.84	1040	30	A.D. 898 - A.D. 1033
CAKR 14631	5013B	OS-93689	Charcoal	*Picea*	-25.13	965	25	A.D. 1018 - A.D. 1155
CAKR 14639	5010B	OS-93712	Plant/Wood	*Picea*	-26.10	975	25	A.D. 1015 - A.D. 1155
CAKR 14647	5037B	OS-93713	Charcoal	*Picea*	-23.62	810	25	A.D. 1180 - A.D. 1270
CAKR 14648	5048B	OS-93714	Charcoal	*Picea*	-25.74	830	30	A.D. 1160 - A.D. 1265
CAKR 14650	5061B	OS-93715	Charcoal	*Picea*	-27.07	1010	25	A.D. 981 - A.D. 1148
CAKR 14654	5086B	OS-94112	Plant/Wood	*Picea*	-24.27	1140	25	A.D. 782 - A.D. 981
CAKR 14657	5054B	OS-93716	Charcoal	*Picea*	-25.18	910	30	A.D. 1034 - A.D. 1207
CAKR 14669	918A	OS-93717	Plant/Wood	*Picea*	-24.88	100	25	A.D. 1686 - A.D. 1927
CAKR 14679	5114B	OS-93718	Plant/Wood	Conifer	-25.42	955	25	A.D. 1022 - A.D. 1155
CAKR 14688A	5158B	OS-93719	Charcoal	*Picea*	-23.30	630	25	A.D. 1288 - A.D. 1397
CAKR 14688B	5158B	OS-93897	Charcoal	*Salicaceae*	-27.27	585	30	A.D. 1299 - A.D. 1416
CAKR 14689	5158B	OS-93720	Charcoal	*Salix*	-26.00	490	25	A.D. 1410 - A.D. 1446
CAKR 14705	977A	OS-93721	Plant/Wood	*Picea*	-25.48	675	25	A.D. 1275 - A.D. 1389
CAKR 14712	976A	OS-93748	Charcoal	*Salix*	-25.60	695	25	A.D. 1266 - A.D. 1385
CAKR 14717	985A	OS-93749	Charcoal	*Betula*	-25.52	875	25	A.D. 1046 - A.D. 1222
CAKR 14740	1121A	OS-93750	Plant/Wood	*Picea*	-25.42	390	25	A.D. 1441 - A.D. 1625
CAKR 14744	1092A	OS-93751	Plant/Wood	*Picea*	-26.00	920	25	A.D. 1030 - A.D. 1173
CAKR 14745	1172A	OS-93752	Plant/Wood	*Salicaceae*	-25.93	220	25	A.D. 1644 - A.D. 1955
CAKR 14750	1131A	OS-93753	Charcoal	*Picea*	-24.34	275	25	A.D. 1520 - A.D. 1795
CAKR 14765	5214B	OS-93754	Charcoal	*Salicaceae*	-26.90	665	25	A.D. 1278 - A.D. 1390
CAKR 14770	5213B	OS-93755	Charcoal	*Picea*	-24.75	715	25	A.D. 1259 - A.D. 1380

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 14779	988A	OS-93756	Charcoal	*Picea*	-26.41	950	25	A.D. 1024 - A.D. 1155
CAKR 14780	5115B	OS-93757	Plant/Wood	*Picea*	-24.05	1020	25	A.D. 974 - A.D. 1115
CAKR 14794	5219B	OS-93758	Charcoal	*Salix*	-27.72	745	25	A.D. 1226 - A.D. 1287
CAKR 14800	1100A	OS-93759	Charcoal	*Betula*	-23.67	370	25	A.D. 1449 - A.D. 1632
CAKR 14803	981A	OS-93760	Charcoal	*Picea*	-25.70	1090	25	A.D. 893 - A.D. 1013
CAKR 14814	887A	OS-93761	Charcoal	*Salicaceae*	-25.63	925	35	A.D. 1025 - A.D. 1185
CAKR 14846	5561B	OS-93762	Charcoal	*Picea*	-26.95	2440	30	752 B.C. - 407 B.C.
CAKR 14848	5437B	OS-93763	Charcoal	*Picea*	-26.90	290	35	A.D. 1486 - A.D. 1793
CAKR 14862	5437B	Beta-326115	Antler	*R. tarandus*, antler	-20.1	510	30	A.D. 1328 - A.D. 1445
CAKR 14864	5437B	Beta-326116	Bone	*Phoca, cf. hispida*, right navicular	-12.8	1450	30	A.D. 876 - A.D. 1034
CAKR 14893	1147A	OS-93764	Charcoal	*Betula*	-27.73	160	25	A.D. 1665 - A.D. 1954
CAKR 14906	5436B	OS-93879	Charcoal	*Salicaceae*	-25.07	585	25	A.D. 1303 - A.D. 1413
CAKR 14921	5437B	OS-93880	Plant/Wood	*Picea*	-25.27	740	25	A.D. 1226 - A.D. 1290
CAKR 14939	1178A	OS-93932	Charcoal	*Salix*	-24.45	645	30	A.D. 1281 - A.D. 1396
CAKR 14952	5664B	OS-94384	Plant/Wood	*Picea*	-26.95	900	30	A.D. 1040 - A.D. 1211
CAKR 14973	1177A	Beta-326117	Bone	*Phoca, cf. hispida*, left 4th metacarpal	-13.1	1410	30	A.D. 909 - A.D. 1054
CAKR 14991	1179A	OS-93943	Charcoal	*Picea*	-25.79	1900	30	A.D. 28 - A.D. 214
CAKR 14999	1177A	OS-94064	Plant/Wood	*Salicaceae*	-26.41	490	30	A.D. 1403 - A.D. 1450
CAKR 15012	5613B	OS-94374	Plant/Wood	*Betula*	-25.00	5410	100	4450 B.C. - 3998 B.C.
CAKR 15023	1181A	OS-93944	Charcoal	*Salix*	-27.69	1970	25	41 B.C. - A.D. 79
CAKR 15047	1180A	OS-93942	Plant/Wood	*cf.* Conifer	-23.16	1440	30	A.D. 566 - A.D. 655
CAKR 15052	1182A	OS-93945	Charcoal	*Salicaceae*	-26.02	2030	25	152 B.C. - A.D. 51
CAKR 15056	1183A	OS-93946	Charcoal	*Picea*	-25.97	2220	25	381 B.C. - 203 B.C.
CAKR 15087	1187A	OS-93933	Plant/Wood	*Salicaceae*	-25.53	610	25	A.D. 1296 - A.D. 1403
CAKR 15099	5703B	OS-93947	Charcoal	*Salix*	-28.24	305	25	A.D. 1492 - A.D. 1649
CAKR 15114	5703B	OS-93948	Charcoal	*Salix*	-26.96	685	30	A.D. 1267 - A.D. 1389
CAKR 15143	5704B	OS-93949	Charcoal	*Betula*	-26.34	2270	30	399 B.C. - 209 B.C.
CAKR 15147	5703B	OS-93934	Charcoal	*Salix*	-25.50	755	25	A.D. 1224 - A.D. 1283

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VII - Cape Krusenstern radiocarbon dating results

Catalog umber	TestID	ab Accession	Material Type	Material Description	$\delta^{13}C$	Con entional RC Age	Age rror	Cal ears .C. A.D. 2σ range
CAKR 15149	5713B	OS-93935	Plant/Wood	*Picea*	-25.40	1010	25	A.D. 981 - A.D. 1148
CAKR 15213	1189A	OS-93936	Charcoal	*Salicaceae*	-25.31	570	30	A.D. 1304 - A.D. 1423
CAKR 15219	1188A	OS-93937	Plant/Wood	*Salicaceae*	-24.51	9430	40	8812 B.C. - 8617 B.C.
CAKR 15233	1186A	OS-93938	Plant/Wood	*Picea*	-27.03	1320	40	A.D. 647 - A.D. 775
CAKR 15247	5728B	OS-93939	Charcoal	Unidentified hardwood	-26.42	55	25	A.D. 1695 - A.D. 1919
CAKR 15257	1195A	OS-93940	Charcoal	*Salicaceae*	-25.24	715	25	A.D. 1259 - A.D. 1380
CAKR 15267	1195A	Beta-326118	Bone	*Phoca, cf. hispida*, rib	-13.0	1280	30	A.D. 1046 - A.D. 1212
CAKR 15267	1195A	OS-96756	Charcoal	*Salix*	-26.1	765	35	A.D. 1212 - A.D. 1288
CAKR 15281	1205A	OS-93950	Charcoal	*Picea*	-24.89	1190	25	A.D. 771 - A.D. 937
CAKR 15291	5729B	OS-93951	Charcoal	*Picea*	-24.51	2200	30	376 B.C. - 186 B.C.
CAKR 15296	5743B	OS-93952	Charcoal	*Picea*	-23.22	210	25	A.D. 1646 - A.D. 1955
CAKR 15297	5736B	OS-93953	Charcoal	*Salicaceae*	-26.06	505	25	A.D. 1400 - A.D. 1445
CAKR 15303	1240A	OS-93954	Charcoal	*Salix*	-25.38	745	35	A.D. 1217 - A.D. 1294
CAKR 15309	5733B	OS-93955	Charcoal	*Picea*	-24.50	1620	35	A.D. 348 - A.D. 540
CAKR 15312	5737B	OS-93975	Charcoal	*Salicaceae*	-25.18	325	30	A.D. 1478 - A.D. 1644
CAKR 15313A	5737B	OS-96757	Charcoal	*Betula*	-26.52	385	20	A.D. 1445 - A.D. 1620
CAKR 15321	1248A	OS-93956	Charcoal	*Salicaceae*	-25.04	875	25	A.D. 1046 - A.D. 1222
CAKR 15326	5734B	OS-93957	Charcoal	*Betula*	-26.03	1330	30	A.D. 647 - A.D. 770
CAKR 15365	5720B	OS-94063	Plant/Wood	*Picea*	-23.41	1940	25	A.D. 5 - A.D. 125
CAKR 15382	1198A	OS-94049	Plant/Wood	*Picea*	-26.33	240	25	A.D. 1529 - A.D. 1955
CAKR 15389	5721B	OS-94050	Charcoal	*Picea*	-25.45	2010	25	87 B.C. - A.D. 59
CAKR 15404	1199A	OS-94051	Charcoal	*Picea*	-24.65	1480	30	A.D. 540 - A.D. 644
CAKR 15465	4689B	Beta-326119	Bone	*Phoca, cf. hispida*, right tibia-fibula proximal epiphysis	-14.8	810	30	A.D. 1442 - A.D. 1576
CAKR 15466	1177A	Beta-326120	Bone	*R. tarandus*, C-2 vertebra	-18.1	640	30	A.D. 1283 - A.D. 1396

Calibrated using OxCal 4.1 (Bronk Ramsey 2009a), IntCal09 (Reimer et al., 2009) except where noted
Marine mammal bone calibrated using Marine09 (Reimer et al. 2009)

Appendix VIII

Marine mammal isotope analysis

Archaeological Center Research Facility

Laboratory protocol for collagen and/or dentin extraction and purification for $\delta^{13}C$, $\delta^{15}N$ and AMS radiocarbon dating

A whole bone or antler sample weighing ~500 mg is demineralized in 0.6N HCl at 4°C. The supernatant is decanted and replaced daily until a density gradient is no longer visible. ddH_2O is used throughout in glassware that had been baked out at 550° C for 3 hours. Demineralizing whole rather than crushed material produces a chemical fraction known as a collagen pseudomorph. This process allows preservation to be closely monitored and is complete when the supernatant is free of calcium phosphate, visible as a density gradient, and the sample is "spongy" when probed.

The pseudomorph is then rinsed to neutrality and soaked in 5% KOH, poured off and replaced daily until the supernatant is clear. This procedure removes organic contaminants such as humic and fulvic acids. After acid and base extraction, the collagen pseudomorph is rinsed to neutrality and gelatinized in 5 ml of degassed H_2O (pH 3) for 24 hours at 120°C. Water-soluble and -insoluble phases are separated by filtration using a PVDF membrane 0.45-micron syringe filter. The water-soluble phase is then lyophilized and weighed to obtain a final collagen yield.

$\delta^{13}C$ and $\delta^{15}N$ values are determined relative to PDB on acid and base extracted protein (bone collagen) by flash combustion to produce CO_2 and N_2 and measured against the appropriate reference gas on a Finnigan Delta Plus mass spectrometer with Carlo Erba EA118 CHN interface at the Stable Isotope Ratio Facility for Environmental Research (SIRFER) on the University of Utah campus. Stable carbon and nitrogen isotope measurements and weight percent C:N values are obtained from a single sample combustion. (Analytical precision is ± 0.1 ‰ for carbon and ± 0.2 ‰ for nitrogen.)

Please find attached a spreadsheet listing samples submitted for AMS dating with $\delta^{13}C$ values and other preservation criteria. **We request that you use the $\delta^{13}C$ measurements provided.** If questions arise regarding these collagen samples, please contact me.

Joan Brenner Coltrain, Ph.D.
Research Associate Professor
Department of Anthropology
University of Utah
Office (801) 581-8366
Lab (801) 808-9885
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Appendix VIII - Cape Krusenstern istope results from U. Utah Archaeological Center Research Facility

ACRF No	Curation No	Sample Taxon	d^{13}C ‰ v. PDB	d^{15}N ‰ v. Air	Wt% N	Wt% C	C:N ratio	Atomic C:N	Weight % Collagen	
2516	CAKR 13325	E. barbatus	-12.7	15.1	17.6	49.4	2.8	3.3	16.7	
2517	CAKR 13328	phocid seal	-12.8	17.9	16.3	44.2	2.7	3.2	12.8	
2518	CAKR 13330	phocid seal	-13.4	18.3	14.1	39.4	2.8	3.3	10.1	
2519	CAKR 13333	phocid seal	-13.2	17.3	15.3	42.6	2.8	3.3	12.0	
2520	CAKR 13335	phocid seal	-13.5	18.4	15.4	43.0	2.8	3.3	19.6	
2521	CAKR 13450	Rangifer tarandus	-19.9	1.7	15.3	41.5	2.7	3.2	25.5	
2522	CAKR-13466	phocid seal	**No collagen yield**							
2523	CAKR 13535	phocid seal	-13.2	18.3	16.3	44.5	2.7	3.2	17.1	
2524	CAKR 13536	Rangifer tarandus	-17.4	2.6	16.4	44.4	2.7	3.2	19.9	
2525	CAKR 14432	cf. E. barbatus	-13.0	15.5	15.6	42.7	2.7	3.2	23.8	**Duplicate run**
2525	CAKR-14432	cf. E. barbatus	-12.9	15.3	16.1	44.3	2.8	3.2	23.8	**Duplicate run**
2526	CAKR 14620	Rangifer tarandus	-17.8	2.9	15.6	43.5	2.8	3.2	23.0	
2527	CAKR 14862	Rangifer tarandus	-20.1	2.2	15.1	42.6	2.8	3.3	16.0	
2528	CAKR 14864	phocid seal	-12.8	17.7	16.5	44.8	2.7	3.2	14.3	
2529	CAKR 14973	phocid seal	-13.1	18.0	16.3	45.4	2.8	3.2	23.6	
2530	CAKR 15267	phocid seal	-13.0	19.0	13.4	38.8	2.9	3.4	13.9	
2531	CAKR-15313	phocid seal	**No collagen yield**							
2532	CAKR 15465	phocid seal	-14.8	18.8	13.9	41.4	3.0	3.5	13.0	
2533	CAKR 15466	Rangifer tarandus	-18.1	3.7	15.0	41.9	2.8	3.3	17.0	

Both d13C and d15N nicely separate pinnipeds and caribou. Atomic C:N ratios are well within the range considered indicative of adequately preserved bone collagen. Collagen yields are also high to moderate and indicate protein preservation is adequate to yield reliable, diagnostic AMS dates.

Seal isotope values are in keeping with numerous other data on marine seals and reflect the high trophic level diets characteristic of these marine mammals.
In constrast, caribou isotope data indicate terrestrial diets that may include tundra forage associated with a nitrogen fixing symbiont.

Appendix IX

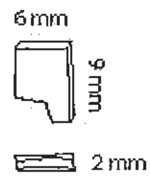
Wood identification

Results of charcoal Identifications

To C. Young NPS, Kotzebue

CA KR 06 – 0025

One fragment measuring about 6 x 9 mm
3 relatively large growth rings with visible curvature.



Salix sp.

CA KR 06 – 0004
One large fragment measuring 15 x 8 x 6 mm cubic in shape

Populus sp.

KOVA 06 001 – 1
One fragment measuring 18x6x3.
½ twig, the pith is missing

Salix sp.

KOVA 06 001 – 2
One fragment measuring 10x6x7
More than 8 growth rings. Fragment of a broken small branch, no pith, no bark.

Salix sp.

Claire Alix,
January 7, 2007, Fairbanks

DendroArch Unlimited

[illegible] Old Nenana Highway
Fairbanks, AK [illegible]
[illegible]
[illegible]

To Bob Gal
National Park Service
240 W. 5th Avenue
Anchorage, Alaska 99501

Fairbanks, August 09, 2007

Dear Bob,

Enclosed are wood and charcoal samples from Cape Krusenstern and the result of their identifications. Last winter, before Chris Young left Kotzebue, he asked me to identify these samples when I would have some time, and I finally did.
I am including in this mailing a copy of the letter he had sent with the samples and an invoice for my work.

Hope you are having a good summer. My fieldwork on the Yukon River this past June was productive and between my river trip of 2002 and this summer, we have now a good tree-ring coverage of the Yukon river floodplain where so much of the coastal driftwood originate.

I wish you a good end of summer,
Best

Claire Alix

REPORT ON CHARCOAL AND WOOD IDENTIFICATIONS FROM CAPE KRUSENSTERN, ALASKA

TO NATIONAL PARK SERVICE, WESTERN ARCTIC NATIONAL PARKLANDS

Claire Alix (DendroArch Unlimited)

Fairbanks, Alaska August 8, 2007

Sixteen samples of wood and charcoal were given for analysis. Results are presented in Table 1.

Procedure

Microscopic analysis of wood and charcoal fragments requires observation of the wood structure in three sections (cross section [C], longitudinal tangential [Tg] and longitudinal radial [Rd]). Microscopic observation of charcoal was performed with high magnification reflected light microscope at various magnifications (x100, x200, and x400). When necessary, fragments were carefully broken by hand in order to get a fresh surface to observe. Microscopic observation of wood samples was performed with high magnification transmitted light microscope at same magnifications.

Results

Charcoal fragments as a rule were well preserved. Wood fragments on the other hand were dry with a badly preserved anatomical structure.

Site	Year	#	C/W*	Identification	Comments
CAKR	06	0007	C	*Populus* sp./*Salix* sp. *Cf. Populus* sp.	Fragment, over 7 growth rings preserved
CAKR	06	0010	C	*Picea* sp./*Larix* sp.	Fragment, about 22 narrow growth rings, resin canals, drying splits
CAKR	06	0037	C	*Salix* sp.	Fragment with 2 growth rings
CAKR	06	0041	C	*Populus* sp./*Salix* sp. *Cf. Populus* sp.	Fragment
CAKR	06	0043	C	*Populus* sp./*Salix* sp. *Cf. Populus* sp.	Small fragment
CAKR	06	0048	C	*Picea* sp./*Larix* sp. Cf. *Picea* sp.	Small fragment, structure is relatively well preserved
CAKR	06	0054	C	Pinaceae Cf. *Picea/Larix* sp.	Fragment
CAKR	06	0057	C	*Picea* sp./*Larix* sp.	Fragment
CAKR	06	0060	C	*Picea* sp./*Larix* sp.	Fragment, resin canals, light late wood
CAKR	06	0064	C	*Picea* sp./*Larix* sp.	Fragment
CAKR	06	0068	W	Pinaceae	Fragment, very dry and badly preserved
CAKR	06	0075	C	*Picea* sp./*Larix* sp.	Fragment
CAKR	06	0081	W	*Picea* sp./*Larix* sp.	Fragment, very dry and badly preserved
CAKR	06	0087	C	*Picea* sp./*Larix* sp.	Fragment
CAKR	06	0091	C	*Picea* sp./*Larix* sp.	Fragment, resin canals
CAKR	06	0096	C	Pinaceae Cf. *Picea/Larix* sp.	Small fragment, 2 growth rings

* C/W: Charcoal or Wood fragment

Table 1 – Results of wood and charcoal identifications from Cape Krusenstern, Alaska

United States Department of the Interior

NATIONAL PARK SERVICE
Western Arctic National Parklands
PO Box 1029
Kotzebue, Alaska 99752
(907) 442-3890

H24

February 12, 2007

Claire Alix
3751 Old Nenana Highway
Fairbanks, AK 99709

Claire:

Enclosed are 16 charcoal/wood specimens for you to identify. All of the specimens were extracted from the beach ridges at Cape Krusenstern. Please complete ASAP but there is no rush.

Please forward your findings and the invoice to Bob Gal (bob_gal@nps.gov) and return the samples to him:

Bob Gal
National Park Service
240 W. 5th Avenue
Anchorage, Alaska 99501

If you have any further questions, I will still be in Kotzebue through February 26 and down at the NPS offices in Anchorage through March 2. After then you will need to contact Bob.

Thanks for your efforts.

Sincerely,

Christopher Young

Enclosures

WOOD AND CHARCOAL IDENTIFICATION OF SAMPLES FROM THE CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

By

Kathryn Puseman

With Assistance from
Peter Kováčik

PaleoResearch Institute
Golden, Colorado

PaleoResearch Institute Technical Report 09-75

Prepared For

University of Washington
Department of Anthropology
Seattle, Washington

November 2009

INTRODUCTION

A total of 54 charcoal and wood samples from the Cape Krusenstern beach ridge archaeological site complex were submitted for identification. This site complex is located within Cape Krusenstern National Monument in Northwest Alaska. Charcoal was examined in order to identify the types of wood available to and used by the prehistoric occupants of this site complex, as well as to provide identifications for charcoal samples submitted for radiocarbon dating.

METHODS

Charcoal Identification

Each sample was weighed, then passed through a graduated screen (US Standard Sieve) with a 2-mm opening. The charcoal remaining in the 2-mm sieve was separated from the other sample debris and weighed. A representative sample of these charcoal pieces was broken to expose a fresh cross section and examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at a magnification of 400-800x. The weights of each charcoal type within the representative sample also were recorded. Charcoal fragments were identified using manuals (Hoadley 1990; Panshin and Zeeuw 1980) and by comparison with modern and archaeological references.

DISCUSSION

The Cape Krusenstern beach ridge complex is noted to contain, “over 70 distinct beach ridges forming a ‘horizontal stratigraphy’ with archaeological remains becoming progressively older from the active beach to the lagoon” (Anderson 2009). These beach ridges are noted to have developed over the last 4,000-5,000 years and are characterized by low topography with numerous lakes and ponds. The Igichuk Hills found north of the site contain an alpine arctic tundra community with vegetation that includes willows (*Salix*), alder (*Alnus*), birch (*Betula*), other shrubs, mountain avens (*Geum peckii*), heathers (*Calluna*), grasses (Poaceae), sedges (Cyperaceae), mat-forming herbs, lichens, and mosses (Viereck 2007). The south-facing slopes of the Igichuk Hills and the Mulgrave Hills, as well as the Noatak River drainage, support closed spruce-hardwood and white spruce (*Picea glauca*) forests (McClenahan 1993).

Charcoal samples were collected from a variety of contexts and submitted for identification. Samples CAKR 13475, CAKR 13477, AND CAKR 13486 were recovered from Cache Pit 1A of 2XH071608A (Table 1). Samples CAKR 13475 and CAKR 13459 contained fragments of *Picea* charcoal, reflecting local spruce trees (Table 2, Table 3). Sample CAKR 13477 yielded a partially charred piece of bark.

Sample CAKR 13427 from Surface Scatter 1B yielded 6 fragments of Salicaceae charcoal from a woody member of the willow family, such as willow, aspen, or balsam poplar. Two fragments of conifer charcoal were noted in sample CAKR 13401 from Surface Scatter 2. These charcoal fragments were too small for further identification. Samples CAKR 13414 and CAKR 13416 were taken from Surface Scatter 2B/Hearth 2B. Sample CAKR 13414 contained numerous fragments of *Picea* charcoal, while three small pieces of Salicaceae charcoal were noted in sample CAKR 13416.

Samples CAKR 13389, CAKR 13495, and CAKR 13580 were collected from Hearth 1B. All three samples yielded a few fragments of *Picea* charcoal, indicating use of spruce wood as fuel. Sample CAKR 13315 from Hearth 2 and sample CAKR 13316 from Hearth 4 also contained small fragments of *Picea* charcoal.

A single piece of Salicaceae charcoal was present in sample CAKR 13260 from Hearth 3, again noting use of a woody member of the willow family. Sample CAKR 13261 from Hearth 6 contained an incompletely charred piece of unidentified hardwood charcoal with a diffuse porous distribution of vessels noted in the cross section view. Trees such as willow (*Salix*), aspen/cottonwood (*Populus*), birch (*Betula*), and alder (*Alnus*) all exhibit a diffuse porous vessel distribution. The charcoal fragment was very friable and appeared to be saturated with salt. Smaller fragments of unidentifiable charcoal also were noted.

Sample CAKR 13308 was recovered from Housepit 2. This sample contained three small fragments of *Picea* charcoal, reflecting use of spruce wood as fuel. Three fragments of Salicaceae charcoal in sample CAKR 13323 from Housepit 3 suggest burning a woody member of the willow family.

Small fragments of *Picea* charcoal were noted in sample CAKR 13571 from House 1A, samples CAKR 13343 and CAKR 13346 from House 1B, sample CAKR 13459 from House 3A, and sample CAKR 13490 from House 5A. The pieces of *Picea* charcoal in sample CAKR 13545 from House 7A, sample CAKR 13522 from House 8A, and sample CAKR 13567 from House 10A were partially charred. Local spruce wood appears to have been burned as fuel in these various houses.

Sample CAKR 13529 from House 4A and sample CAKR 13514 from House 13A each yielded fragments of Salicaceae charcoal. A woody member of the willow family also appears to have been burned as fuel.

Sample CAKR 13339 was taken from Feature 1B. This sample contained an incompletely charred piece of *Picea* charcoal from local spruce wood that was burned.

Samples CAKR 13404, CAKR 13340, CAKR 13367, and CAKR 13714 were collected from various depths in Unidentified Feature 1B. Samples CAKR 13404 from a depth of 5-10 cmbs and sample CAKR 13367 from a depth of about 80 cmbs each contained a fragment of Salicaceae charcoal, while sample CAKR 13340 from a depth of 14 cmbs yielded *Picea* charcoal. Sample CAKR 13714 from a depth of 94 cmbd represents an uncharred twig from a possible floor layer. This sample consists of an unidentified hardwood twig with a diffuse porous distribution of vessels. The wood was compressed and distorted, possibly suggesting that it had been water-logged and under pressure from being buried. Because of the compression and distortion of the wood’s vessel elements, no further identification could be made.

Samples CAKR 13526 and CAKR 13626 were recovered from Unidentified Feature 2B. Sample CAKR 13526 consists of a piece of *Picea* charcoal, while sample CAKR 13626 contains Salicaceae charcoal.

A single piece of conifer charcoal was present in sample CAKR 13409 from Unidentified Feature 3B. Salicaceae charcoal fragments were noted in samples CAKR 13601 and CAKR 13381 from Unidentified Feature 4B, although the Salicaceae charcoal fragment in CAKR 13381 was partially charred. Sample CAKR 13384 from Unidentified Feature 5B yielded a piece of *Picea* charcoal.

Sample CAKR 13517 from a depth of 7-9 cmbs in Unidentified Feature 7B yielded two fragments of *Betula* charcoal and one piece of Salicaceae charcoal, indicating that birch and a woody member of the willow family were burned. *Picea* charcoal and conifer charcoal too small for further identification were noted in sample CAKR 13585 from a depth of 10-14 cmbs in Unidentified Feature 7B.

Sample CAKR 13569 from Unidentified Feature 9B and sample CAKR 13586 from Unidentified Feature 10B each contained fragments of Salicaceae charcoal. Fragments of unidentified hardwood charcoal with a diffuse porous distribution of vessels in sample CAKR 13586 were too small for further identification, but it is likely that they also represent Salicaceae charcoal.

Fragments of *Picea* charcoal were present in sample CAKR 13736 from Unidentified Feature 11B, in sample CAKR 13523 from Unidentified Feature 12B, in sample CAKR 13301 from Unidentified Feature 3, and in sample CAKR 13307 from Unidentified Feature 16. Sample CAKR 13301 also yielded incompletely charred fragments of Salicaceae charcoal.

Sample CAKR 13254 consists of charcoal fragments from a hearth. This sample contained several pieces of *Picea* charcoal, suggesting that spruce wood was burned as fuel. One incompletely charred fragment of conifer root charcoal also was noted.

Sample CAKR 13295 from an unspecified context yielded several fragments of Salicaceae charcoal. Samples CAKR 13255, CAKR 13394, CAKR 13296, CAKR 13297, CAKR 13305, CAKR 13620, and CAKR 13624, also from unspecified contexts, each contained fragments of *Picea* charcoal, suggesting use of local spruce as a fuelwood. Sample CAKR 13624 also yielded two fragments of unidentified hardwood charcoal with a diffuse porous distribution of vessels.

SUMMARY AND CONCLUSIONS

Charcoal samples were submitted for identification from the Cape Krusenstern beach ridge site complex in Northwest Alaska. Of the 54 samples examined, a total of 34 samples contained *Picea* charcoal, indicating that spruce wood commonly was burned as fuel. Conifer charcoal was noted in 4 samples and also is likely to represent spruce wood that was burned. Salicaceae charcoal was present in 17 of the samples, representing a woody member of the willow family. Sample CAKR 13517 from Unidentified Feature 7B contained *Betula* charcoal from birch wood that was burned. Three samples yielded unidentified hardwood charcoal with a diffuse porous distribution of vessels, a characteristic of both *Betula* and Salicaceae charcoal. The single wood fragment (sample CAKR 13714) also represents a hardwood with a diffuse porous distribution of vessels.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM
THE CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

Sample No.	Feature No.	Level	Depth	Provenience/ Description	Analysis
CAKR 13475	Cache Pit 1A of 2XH071608A	3	51 cmbd	Charcoal	Charcoal ID
CAKR 13477	Cache Pit 1A of 2XH071608A	8	100 cmbd	Wood; slightly burnt	Charcoal ID
CAKR 13486	Cache Pit 1A of 2XH071608A	2	54 cmbd	Charcoal	Charcoal ID
CAKR 13427	Surface Scatter 1B		5-10 cmbs	Charcoal	Charcoal ID
CAKR 13416	Surface Scatter 2B		Surface	Charcoal found in association with hearth	Charcoal ID
CAKR 13401	Surface Scatter 2B		≈5 cmbs	Charcoal found with surface hearth	Charcoal ID
CAKR 13414	Surface Scatter 2B		≈10 cmbs	Ceramic and charcoal found together in situ - large lump of charcoal with dirt, rocks, and rootlets	Charcoal ID
CAKR 13389	Hearth 1B		Surface	Charcoal	Charcoal ID
CAKR 13495	Hearth 1B			Charcoal	Charcoal ID
CAKR 13580	Hearth 1B			Charcoal	Charcoal ID
CAKR 13315	Hearth 2		4 cmbs	Charcoal	Charcoal ID
CAKR 13260	Hearth 3		5 cmbs	Charcoal	Charcoal ID
CAKR 13316	Hearth 4		3 cmbs	Charcoal	Charcoal ID
CAKR 13261	Hearth 6		5 cmbs	Charcoal	Charcoal ID

TABLE 1 (Continued)

Sample No.	Feature No.	Level	Depth	Provenience/ Description	Analysis
CAKR 13308	Housepit 2		4 cmbs	Charcoal	Charcoal ID
CAKR 13323	Housepit 3		25 cmbs	Charcoal	Charcoal ID
CAKR 13571	House 1A of 2XH071608A		8 cmbs	Charcoal	Charcoal ID
CAKR 13343	House 1B	2	17-25 cmbd	Charcoal; large fragments removed from large charcoal log	Charcoal ID
CAKR 13346	House 1B	5	39 cmbd	Charcoal	Charcoal ID
CAKR 13459	House 3A of 2XH071608A	3	51 cmbd	Charcoal	Charcoal ID
CAKR 13529	House 4A of 2XH071608A	6	70 cmbd	Charcoal	Charcoal ID
CAKR 13490	House 5A of 2XH071608A		≈10-33 cmbd	Charcoal	Charcoal ID
CAKR 13545	House 7A of 2XH071608A		10-20 cmbs	Wood, slightly charred	Charcoal ID
CAKR 13522	House 8A of 2XH071608A		44 cmbs	Charcoal	Charcoal ID
CAKR 13567	House 10A of 2XH071608A		25 cmbs	Charcoal	Charcoal ID
CAKR 13514	House 13A of 2XH071608A		38 cmbs	Charcoal	Charcoal ID
CAKR 13339	1B		12 cmbs	Charcoal	Charcoal ID
CAKR 13404	Unidentified 1B		5-10 cmbs	Charcoal	Charcoal ID
CAKR 13340	Unidentified 1B		14 cmbs	Charcoal	Charcoal ID

TABLE 1 (Continued)

Sample No.	Feature No.	Level	Depth	Provenience/ Description	Analysis
CAKR 13367	Unidentified 1B		≈80 cmbs	Charcoal	Charcoal ID
CAKR 13714	Unidentified 1B of PROXH070908A	8	94 cmbd	Wood; twig from possible floor layer	Charcoal ID
CAKR 13562	Unidentified 2B		10-20 cmbs	Charcoal	Charcoal ID
CAKR 13626	Unidentified 2B		12 cmbs	Charcoal	Charcoal ID
CAKR 13409	Unidentified 3B		11 cmbs	Charcoal	Charcoal ID
CAKR 13601	Unidentified 4B		12 cmbs	Charcoal	Charcoal ID
CAKR 13381	Unidentified 4B		68 cmbs	Wood fragment; partially burnt	Charcoal ID
CAKR 13384	Unidentified 5B		14 cmbs	Charcoal	Charcoal ID
CAKR 13517	Unidentified 7B		7-9 cmbs	Charcoal	Charcoal ID
CAKR 13585	Unidentified 7B		10-14 cmbs	Charcoal	Charcoal ID
CAKR 13569	Unidentified 9B		15 cmbs	Charcoal	Charcoal ID
CAKR 13586	Unidentified 10B		≈28 cmbs	Charcoal	Charcoal ID
CAKR 13562	Unidentified 2B		10-20 cmbs	Charcoal	Charcoal ID
CAKR 13736	Unidentified 11B of PROXH072808A	5	54 cmbd	Charcoal	Charcoal ID

TABLE 1 (Continued)

Sample No.	Feature No.	Level	Depth	Provenience/ Description	Analysis
CAKR 13523	Unidentified 12B		25 cmbs	Charcoal	Charcoal ID
CAKR 13301	Unidentified 3		8 cmbs	Charcoal	Charcoal ID
CAKR 13307	Unidentified 16		10 cmbs	Charcoal	Charcoal ID
CAKR 13254			5 cmbs	Charcoal fragments from hearth	Charcoal ID
CAKR 13255			5 cmbs	Charcoal fragments from hearth	Charcoal ID
CAKR 13294			11 cmbs	Charcoal	Charcoal ID
CAKR 13295			15 cmbs	Charcoal	Charcoal ID
CAKR 13296			15 cmbs	Charcoal	Charcoal ID
CAKR 13297			25 cmbs	Charcoal	Charcoal ID
CAKR 13305			20 cmbs	Charcoal	Charcoal ID
CAKR 13620			20 cmbs	Charcoal	Charcoal ID
CAKR 13624			10 cmbs	Charcoal	Charcoal ID

TABLE 2
IDENTIFICATION OF CHARCOAL FROM
THE CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13475	Total sample weight						0.14 g
Cache Pit 1A	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.14 g
13477	Total sample weight						0.06 g
Cache Pit 1A	CHARCOAL/WOOD:						
	Bark					1 pc	0.06 g
13486	Total sample weight						0.24 g
Cache Pit 1A	CHARCOAL/WOOD:						
	Picea	Charcoal		2			0.24 g
13427	Total sample weight						0.20 g
Surface Scatter 1B	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		6			0.20 g
13401	Total sample weight						0.02 g
Surface Scatter 2B	CHARCOAL/WOOD:						
	Conifer	Charcoal		2			0.008 g
	Salicaceae	Charcoal		3			0.012 g
13416	Total sample weight						0.05 g
Surface Scatter 2B/ Hearth 2B	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		3			0.02 g
	OTHER:						
	Sediment					X	0.03 g
13414	Total sample weight						5.08 g
Surface Scatter 2B/ Hearth 2B	CHARCOAL/WOOD:						
	Picea $\geq$ 2 mm	Charcoal		72			0.59 g
	OTHER:						
	Charcoal < 2 mm, sediment, rootlets, gravel			X			4.49 g
13389	Total sample weight						0.19 g
Hearth 1B	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.19 g
13495	Total sample weight						0.04 g
Hearth 1B	CHARCOAL/WOOD:						
	Picea			2			0.04 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13580	Total sample weight						0.205 g
Hearth 1B	CHARCOAL/WOOD:						
	Picea	Charcoal		5			0.205 g
13315	Total sample weight						0.09 g
Hearth 2	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.09 g
13260	Total sample weight						0.03 g
Hearth 3	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		1			0.03 g
13316	Total sample weight						0.20 g
Hearth 4	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.20 g
13261	Total sample weight						0.06 g
Hearth 6	CHARCOAL/WOOD:						
	Unidentified hardwood - diffuse porous, friable	Charcoal		1 ic			0.03 g
	OTHER:						
	Sand, Unidentified charcoal			X		X	0.03 g
13308	Total sample weight						0.54 g
Housepit 2	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.16 g
	OTHER:						
	Humic sediment					X	0.19 g
	Gravel					X	0.19 g
13323	Total sample weight						0.19 g
Housepit 3	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		3			0.19 g
13571	Total sample weight						0.015 g
House	CHARCOAL/WOOD:						
Feature 1A	*Picea*	Charcoal		1			0.015 g
13343	Total sample weight						0.22 g
House	CHARCOAL/WOOD:						
Feature 1B	*Picea*	Charcoal		1			0.22 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13346	Total sample weight						0.05 g
House	CHARCOAL/WOOD:						
Feature 1B	*Picea*	Charcoal		2			0.05 g
13459	Total sample weight						0.03 g
House	CHARCOAL/WOOD:						
Feature 3A	Total sample weight						0.03 g
	Picea	Charcoal		1			0.03 g
13529	Total sample weight						0.19 g
House	CHARCOAL/WOOD:						
Feature 4A	Salicaceae	Charcoal		2			0.19 g
13490	Total sample weight						0.80 g
House	CHARCOAL/WOOD:						
Feature 5A	*Picea*	Charcoal		1			0.80 g
13545	Total sample weight						0.24 g
House	CHARCOAL/WOOD:						
Feature 7A	*Picea*	Charcoal		1pc			0.24 g
13522	Total sample weight						0.40 g
House	CHARCOAL/WOOD:						
Feature 8A	*Picea*	Charcoal		1pc			0.40 g
13567	Total sample weight						2.216 g
House	CHARCOAL/WOOD:						
Feature 10A	*Picea*	Charcoal		1 pc			2.216 g
13514	Total sample weight						0.33 g
House	CHARCOAL/WOOD:						
Feature 13A	Salicaceae	Charcoal		1			0.33 g
13339	Total sample weight						0.09 g
Feature 1B	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic			0.09 g
13404	Total sample weight						1.20 g
Unidentified	CHARCOAL/WOOD:						
Feature 1B	Salicaceae	Charcoal		1			0.40 g
	OTHER:						
	Humic sediment					X	0.80 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13340	Total sample weight						0.05 g
Unidentified	CHARCOAL/WOOD:						
Feature 1B	*Picea*	Charcoal		2			0.5 g
13367	Total sample weight						0.06 g
Unidentified	CHARCOAL/WOOD:						
Feature 1B	Salicaceae	Charcoal		1			0.06 g
13714	Total sample weight						0.306 g
Unidentified	CHARCOAL/WOOD:						
Feature 1B	Unidentified hardwood - diffuse porous; compressed and distorted	Wood				1	0.306 g
13562	Total sample weight						0.092 g
Unidentified	CHARCOAL/WOOD:						
Feature 2B	*Picea*	Charcoal		1			0.092 g
13626	Total sample weight						0.13 g
Unidentified	CHARCOAL/WOOD:						
Feature 2B	Salicaceae	Charcoal		2			0.13 g
13409	Total sample weight						0.25 g
Unidentified	CHARCOAL/WOOD:						
Feature 3B	Conifer	Charcoal		1			0.10 g
	OTHER:						
	Humic sediment					X	0.15 g
13601	Total sample weight						0.028 g
Unidentified	CHARCOAL/WOOD:						
Feature 4B	Salicaceae	Charcoal		1			0.028 g
13381	Total sample weight						0.08 g
Unidentified	CHARCOAL/WOOD:						
Feature 4B	Salicaceae	Charcoal		1 pc			0.08 g
13384	Total sample weight						0.39 g
Unidentified	CHARCOAL/WOOD:						
Feature 5B	*Picea*	Charcoal		1			0.07 g
	OTHER:						
	Humic sediment					X	0.31 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred		Uncharred		Weights/ Comments
			W	F	W	F	
13517	Total sample weight						0.061 g
Unidentified Feature 7B	CHARCOAL/WOOD:						
	Betula	Charcoal		2			0.049 g
	Salicaceae	Charcoal		1			0.012 g
13585	Total sample weight						0.306 g
Unidentified Feature 7B	CHARCOAL/WOOD:						
	Conifer	Charcoal		X			0.024 g
	Picea	Charcoal		5			0.232 g
	OTHER:						
	Humic sediment					X	0.052 g
13569	Total sample weight						0.183 g
Unidentified Feature 9B	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		1			0.083 g
	OTHER:						
	Humic sediment					X	0.1 g
13586	Total sample weight						0.268 g
Unidentified Feature 10B	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		2			0.034 g
	Unidentified hardwood - diffuse porous	Charcoal		X			0.011 g
	OTHER:						
	Humic sediment					X	0.223 g
13736	Total sample weight						0.074 g
Unidentified Feature 11B	CHARCOAL/WOOD:						
	Picea	Charcoal		2			0.074 g
13523	Total sample weight						0.180 g
Unidentified Feature 12B	CHARCOAL/WOOD:						
	Picea	Charcoal		8			0.180 g
13301	Total sample weight						0.54 g
Unidentified Feature 3	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		3 ic			0.50 g
	Picea	Charcoal		1			0.04 g
13307	Total sample weight						0.27 g
Unidentified Feature 16	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.16 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13254	Total sample weight						0.07 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		12			0.05 g
	Conifer root	Charcoal		1 ic			0.01 g
13255	Total sample weight						0.25 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		19			0.19 g
13294	Total sample weight						0.97 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		3 pc			0.33 g
	OTHER:						
	Humic sediment					X	0.64 g
13295	Total sample weight						0.44 g
	CHARCOAL/WOOD:						
	Total sample weight						0.44 g
	Salicaceae	Charcoal		17			0.31 g
	OTHER:						
	Humic sediment					X	
13296	Total sample weight						0.06 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.06 g
13297	Total sample weight						0.31 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		2 ic			0.29 g
13305	Total sample weight						0.19 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		11			0.14 g
	Unidentified	Charcoal		X			
13620	Total sample weight						0.526 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		3 pc			0.526 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred		Uncharred		Weights/ Comments
			W	F	W	F	
13624	Total sample weight						0.175 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.035 g
	Unidentified hardwood - diffuse porous	Charcoal		2			0.140 g

W = Whole
F = Fragment
X = Presence noted in sample
g = grams
ic = incompletely charred
pc= Partially charred

TABLE 3
INDEX OF MACROFLORAL REMAINS RECOVERED FROM
THE CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

Scientific Name	Common Name
CHARCOAL/WOOD:	
Betula	Birch
Conifer	Cone-bearing, gymnospermous trees and shrubs, mostly evergreens, including the pine, spruce, fir, juniper, cedar, yew, hemlock, redwood, and cypress
Picea	Spruce
Salicaceae	Willow family
Unidentified hardwood - diffuse porous	Wood from a broad-leaved flowering tree or shrub, with a diffuse porous distribution of vessels

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IDENTIFICATION OF CHARCOAL FROM THE CAPE KRUSENSTERN COMPLEX, ALASKA

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PaleoResearch Institute Technical Report 10-29

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February 2010

INTRODUCTION

A total of 89 additional charcoal and wood samples from the Cape Krusenstern beach ridge archaeological site complex were submitted for identification. This site complex is located within Cape Krusenstern National Monument in Northwest Alaska. Charcoal and wood fragments were examined in order to identify the types of wood available to and used by the prehistoric occupants of this site complex, as well as to provide identifications for charcoal samples submitted for radiocarbon dating.

METHODS

Charcoal and Wood Identification

Charcoal and wood fragments were broken to expose fresh cross, tangential, and radial sections, then examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at a magnification of 400-800x. The weights of each charcoal and wood type were recorded. Wood and charcoal fragments were identified using manuals (Carlquist 2001; Core, et al. 1976; Hoadley 1990; Panshin and de Zeeuw 1980) and by comparison with modern and archaeological references.

DISCUSSION AND CONCLUSIONS

Additional wood and charcoal samples were submitted for identification from the Cape Krusenstern beach ridge site complex in Northwest Alaska (Table 1). Of the 89 samples examined, a total of 51 samples contained *Picea* charcoal and three samples yielded partially charred or incompletely charred *Picea* wood, indicating that spruce wood commonly was burned as fuel (Table 2, Table 3). Three of the *Picea* charcoal fragments exhibited areas of iridescent blue coloring, possibly from absorbing some type of petroleum product. A single sample yielded *Larix* charcoal, identified by the presence of numerous paired bordered pits on the tracheid walls. *Picea* exhibits paired bordered pits only rarely. Salicaceae charcoal was present in 23 samples, and one sample contained an uncharred Salicaceae twig fragment. Of these 24 samples, 14 charcoal fragments yielded more of the heterocellular rays common in *Salix*, while six samples exhibited only homocellular rays, which is typical of *Populus*. Three samples contained *Betula* charcoal as identified by the presence of sclariform perforation plates and minute, alternate intervessel pitting. Charcoal in two of the samples was too small and friable for identification. In addition, these unidentified charcoal samples exhibited compressed wood, as if the wood had been water-logged for a period of time, then dried out and burned. When water-logged wood is dried out, the cellular structure of the wood often collapses and appears compressed. Four of the samples yielded charred bone fragments, while a single sample contained a piece of what appears to be asphaltum-type material.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM THE CAPE KRUSENSTERN COMPLEX, ALASKA

Catalog No.	Field No.	Provenience/ Description	Analysis
CAKR 13245	CAKR-06-0012	Charcoal	Charcoal ID
CAKR 13246	CAKR-06-0013	Charcoal	Charcoal ID
CAKR 13253	CAKR-06-0021	Charcoal	Charcoal ID
CAKR 13259	CAKR-06-0028	Charcoal	Charcoal ID
CAKR 13269	CAKR-06-0040	Charcoal	Charcoal ID
CAKR 13290	CAKR-06-0066	Charcoal	Charcoal ID
CAKR 13293	CAKR-06-0069	Charcoal	Charcoal ID
CAKR 13309	CAKR-06-0086	Charcoal	Charcoal ID
CAKR 13312	CAKR-06-0089	Charcoal	Charcoal ID
CAKR 13313	CAKR-06-0090	Charcoal	Charcoal ID
CAKR 13317	CAKR-06-0094	Charcoal	Charcoal ID
CAKR 13321	CAKR-06-0099	Charcoal	Charcoal ID
CAKR 13355	CAKR-08-0019	Charcoal	Charcoal ID
CAKR 13356	CAKR-08-0020	Charcoal	Charcoal ID
CAKR 13362	CAKR-08-0026	Charcoal	Charcoal ID
CAKR 13385	CAKR-08-0049	Charcoal	Charcoal ID
CAKR 13386	CAKR-08-0050	Charcoal	Charcoal ID
CAKR 13583	CAKR-08-0248	Charcoal	Charcoal ID
13810	CAKR09-002	Charcoal	Charcoal ID
13814	CAKR09-006	Charcoal	Charcoal ID
13828	CAKR09-019	Charcoal	Charcoal ID
13831	CAKR09-022	Charcoal	Charcoal ID
13835	CAKR09-026	Charcoal	Charcoal ID
13860	CAKR09-051	Charcoal	Charcoal ID
13879	CAKR09-070	Charcoal	Charcoal ID
13891	CAKR09-082	Charcoal	Charcoal ID
13919	CAKR09-110	Charcoal	Charcoal ID
13941	CAKR09-132	Charcoal	Charcoal ID
13953	CAKR09-144	Charcoal	Charcoal ID

TABLE 1 (Continued)

Catalog No.	Field No.	Provenience/ Description	Analysis
13975	CAKR09-166	Charcoal	Charcoal ID
13990	CAKR09-181	Charcoal	Charcoal ID
14007	CAKR09-198	Charcoal	Charcoal ID
14008	CAKR09-199	Charcoal	Charcoal ID
14011	CAKR09-202	Charcoal	Charcoal ID
14012	CAKR09-203	Charcoal	Charcoal ID
14035	CAKR09-226	Charcoal	Charcoal ID
14041	CAKR09-232	Charcoal	Charcoal ID
14043	CAKR09-234	Charcoal	Charcoal ID
14046	CAKR09-237	Charcoal	Charcoal ID
14047	CAKR09-238	Charcoal	Charcoal ID
14049	CAKR09-240	Charcoal	Charcoal ID
14055	CAKR09-246	Charcoal	Charcoal ID
14058	CAKR09-249	Charcoal	Charcoal ID
14059	CAKR09-250	Charcoal	Charcoal ID
14065	CAKR09-256	Charcoal	Charcoal ID
14067	CAKR09-258	Charcoal	Charcoal ID
14072	CAKR09-263	Charcoal	Charcoal ID
14075	CAKR09-266	Charcoal	Charcoal ID
14080	CAKR09-271	Charcoal	Charcoal ID
14081	CAKR09-272	Charcoal	Charcoal ID
14082	CAKR09-273	Charcoal	Charcoal ID
14085	CAKR09-276	Charcoal	Charcoal ID
14117	CAKR09-308	Charcoal	Charcoal ID
14125	CAKR09-316	Charcoal	Charcoal ID
14126	CAKR09-317	Charcoal	Charcoal ID
14138	CAKR09-329	Charcoal	Charcoal ID
14159	CAKR09-350	Charcoal	Charcoal ID
14160	CAKR09-351	Charcoal	Charcoal ID
14164	CAKR09-355	Charcoal	Charcoal ID

TABLE 1 (Continued)

Catalog No.	Field No.	Provenience/ Description	Analysis
14178	CAKR09-369	Charcoal	Charcoal ID
14191	CAKR09-382	Charcoal	Charcoal ID
14202	CAKR09-393	Charcoal	Charcoal ID
14213	CAKR09-403	Charcoal	Charcoal ID
14215	CAKR09-405	Charcoal	Charcoal ID
14255	CAKR09-415	Charcoal	Charcoal ID
14228	CAKR09-418	Charcoal	Charcoal ID
14231	CAKR09-421	Charcoal	Charcoal ID
14236	CAKR09-426	Charcoal	Charcoal ID
14238	CAKR09-428	Charcoal	Charcoal ID
14240	CAKR09-430	Charcoal	Charcoal ID
14245	CAKR09-435	Charcoal	Charcoal ID
14246	CAKR09-436	Charcoal	Charcoal ID
14258	CAKR09-448	Charcoal	Charcoal ID
14260	CAKR09-450	Charcoal	Charcoal ID
14262	CAKR09-452	Charcoal	Charcoal ID
14271	CAKR09-461	Charcoal	Charcoal ID
14281	CAKR09-471	Charcoal	Charcoal ID
14285	CAKR09-475	Charcoal	Charcoal ID
14286	CAKR09-476	Charcoal	Charcoal ID
14308	CAKR09-498	Charcoal	Charcoal ID
14329	CAKR09-519	Charcoal	Charcoal ID
14335	CAKR09-525	Charcoal	Charcoal ID
14336	CAKR09-526	Charcoal	Charcoal ID
14339	CAKR09-529	Charcoal	Charcoal ID
14346	CAKR09-536	Charcoal	Charcoal ID
14369	CAKR09-559	Charcoal	Charcoal ID
14379	CAKR09-569	Charcoal	Charcoal ID
14414	CAKR09-604	Charcoal	Charcoal ID
14485	CAKR09-675	Charcoal	Charcoal ID

TABLE 2
IDENTIFICATION OF CHARCOAL FROM THE CAPE KRUSENSTERN COMPLEX, ALASKA
PALEORESEARCH INSTITUTE TECHNICAL PROJECT 10-20

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13810	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.038 g
13814	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal		1			0.073 g
13828	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.343 g
13831	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.124 g
13835	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.160 g
13860	CHARCOAL/WOOD:						
	Picea	Wood				1 pc	1.396 g
13879	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.139 g
13891	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal		1			0.157 g
13919	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix* - twig	Charcoal		1			0.013 g
13941	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		1			0.013 g
13953	CHARCOAL/WOOD:						
	Betula	Charcoal		1			0.050 g
13975	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic			4.518 g
13990	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.025 g
14007	CHARCOAL/WOOD:						
	Betula	Charcoal		1			0.025 g
14008	CHARCOAL/WOOD:						
	Betula	Charcoal		1			0.022 g
14011	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.019 g
14012	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.058 g

TABLE 2 (Continued)

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14035	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal		1			0.057 g
14041	CHARCOAL/WOOD:						
	Picea (exhibited areas of iridescent blue coloring, possibly from absorbing some type of petroleum product)	Charcoal		1			0.062 g
14043	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.028 g
14046	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.046 g
14047	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal		1			0.022 g
14049	CHARCOAL/WOOD:						
	Larix	Charcoal		1			0.041 g
14055	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.058 g
14058	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.022 g
14059	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.035 g
14065	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.028 g
14067	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.028 g
14072	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.692 g
14075	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.024 g
14080	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.105 g
14081	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.081 g
14082	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.087 g

TABLE 2 (Continued)

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14085	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.584 g
14117	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		1			0.007 g
14125	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal					
14126	CHARCOAL/WOOD:						
	Picea	Charcoal					
14138	CHARCOAL/WOOD:						
	Picea	Charcoal					
14159	CHARCOAL/WOOD:						
	Total sample weight						0.029 g
	Unidentifiable - small, friable, compressed	Charcoal		1			0.007 g
	Dirt					X	0.022 g
14160	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.104 g
14164	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.052 g
14178	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.058 g
14191	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.168 g
14202	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.010 g
14213	CHARCOAL/WOOD:						
	Salicaceae - twig, friable	Charcoal		1 ic			0.068 g
14215	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.064 g
14225	CHARCOAL/WOOD:						
	Unidentifiable - friable, compressed	Charcoal		1 ic			0.260 g
14228	CHARCOAL/WOOD:						
	Picea (exhibited areas of iridescent blue coloring, possibly from absorbing some type of petroleum product)	Charcoal		1			0.090 g

TABLE 2 (Continued)

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14231	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.061 g
14236	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.053 g
14238	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.010 g
14240	CHARCOAL/WOOD:						
	Picea (exhibited areas of iridescent blue coloring, possibly from absorbing some type of petroleum product)	Charcoal		1			0.043 g
14245	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.056 g
14246	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix* - twig (exhibited areas of iridescent yellow coloring, possibly from absorbing some type of petroleum product)	Charcoal		1			0.430 g
14258	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.045 g
14260	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic			0.170 g
14262	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.049 g
14271	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.116 g
14281	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.056 g
14285	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.052 g
14286	CHARCOAL/WOOD:						
	cf. *Picea* - compressed (looks as if it had been water-logged, then dried out, and then burned)	Charcoal		1			0.130 g
14308	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic			0.085 g

TABLE 2 (Continued)

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14329	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix* (appears to have salt crystals in vessels)	Charcoal		1			0.010 g
14335	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.035 g
14336	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.050 g
14339	NON-FLORAL REMAINS:						
	Asphaltum-type material					1	0.120 g
14346	CHARCOAL/WOOD:						
	Picea	Wood				1 ic	0.044 g
14369	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.058 g
14379	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.061 g
14414	CHARCOAL/WOOD:						
	Picea	Charcoal		1 pc			0.255 g
14485	NON-FLORAL REMAINS:						
	Bone	Charcoal		3			0.027 g
13245	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.058 g
13246	CHARCOAL/WOOD:						
	Salicaceae, cf. *Populus*	Charcoal		1			0.028 g
13253	NON-FLORAL REMAINS:						
	Bone and dirt			X			0.733 g
13259	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.115 g
13269	CHARCOAL/WOOD:						
	Picea	Charcoal		1			1.266 g
13290	NON-FLORAL REMAINS:						
	Bone			1			0.568 g
13293	CHARCOAL/WOOD:						
	Total sample weight						0.125 g
	Picea	Charcoal		6			0.101 g
	Salicaceae, cf. *Salix*	Charcoal		2			0.024 g

TABLE 2 (Continued)

Catalog No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13309	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.038 g
13312	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.043 g
13313	CHARCOAL/WOOD:						
	Total sample weight						0.042 g
	Picea	Charcoal		1			0.011 g
	NON-FLORAL REMAINS:						
	Bone			1 ic			0.031 g
13317	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.182 g
13321	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.032 g
13355	CHARCOAL/WOOD:						
	Salicaceae - twig	Wood				1	0.125 g
13356	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		4			0.189 g
13362	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix*	Charcoal		1			0.167 g
13385	CHARCOAL/WOOD:						
	Salicaceae - twig	Charcoal		1			0.046 g
13386	CHARCOAL/WOOD:						
	Salicaceae, cf. *Salix* - twig	Charcoal		1			0.181 g
13583	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.258 g

W = Whole
F = Fragment
X = Presence noted in sample
g = grams
ic = Incompletely charred
pc= Partially charred

TABLE 3
INDEX OF MACROFLORAL REMAINS RECOVERED FROM THE
CAPE KRUSENSTERN COMPLEX, ALASKA

Scientific Name	Common Name	Ubiquity #	Ubiquity %
CHARCOAL/WOOD:			
Betula	Birch	3	3%
Larix	Larch	1	1%
Picea	Spruce	54	61%
Salicaceae	Willow family	4	4%
Salicaceae, cf. *Populus*	Aspen, Cottonwood	6	7%
Salicaceae, cf. *Salix*	Willow	14	16%
Unidentifiable		2	2%
NON-FLORAL REMAINS:			
Asphaltum-type material		1	1%
Bone		4	4%
TOTAL NUMBER OF SAMPLES		89	

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WOOD AND CHARCOAL IDENTIFICATION OF SAMPLES FROM CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

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PaleoResearch Institute Technical Report 11-027

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February 2011

INTRODUCTION

Seventeen samples from the Cape Krusenstern beach ridge archaeological site complex in northwest Alaska were submitted for identification. This archaeological site complex is situated in the Cape Krusenstern National Monument. A total of thirteen wood samples, one charcoal sample, one sedge stem fragment, and two peat-like samples were examined.

METHODS

Wood and Charcoal Identification

Wood and charcoal fragments were broken to expose fresh cross, radial, and tangential sections, then examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at magnifications of 320-800x. The weights of each type were recorded. Wood and charcoal fragments were identified using manuals (Carlquist 2001; Core, et al. 1976; Hoadley 1990; Panshin and de Zeeuw 1980) and by comparison with modern and archaeological references.

Phytolith Analysis of A Stem Fragment

A small portion of a stem fragment was examined for the presence of plant opal phytoliths to aid in identification. The stem fragment was first sonicated in reverse osmosis deionized (RODI) water to clean off any adhering sediment. Approximately 5 ml of bleach was added to the stem fragment and allowed to sit for several days. The sample was then rinsed to neutral and sieved through a 250 μm mesh, transferred to a 15 ml centrifuge tube, and dried after several alcohol rinses. A slide was made using a small portion of sample material mounted in Cargille Type-A immersion oil (refractive index 1.515), with two opposite coverslip corners affixed with nail polish to allow for controlled phytolith rotation and observation with a light microscope at a magnification of 500x.

DISCUSSION

Samples from the Cape Krusenstern beach ridge site complex in northwest Alaska were submitted for identification. All samples were recovered from non-cultural deposits. Charcoal sample 14023 was collected from Test ID 3016B (Table 1). This sample consisted of two fragments of *Picea* charcoal, reflecting spruce wood that burned (Table 2), as well as a single small stone. Wood samples 14094, 14624, and 14952 also contained identifiable fragments of *Picea* wood.

Fragments of conifer or probable conifer wood were noted in samples 13594, 14073, 14074, and 14163. Sample 14076 yielded a fragment of conifer bark. These samples exhibited varying degrees of lignitic degradation of the cellular structure and mechanical-physical features due to anaerobic organisms present in the moist/wet sediments in which these wood fragments have lain. The wood is degraded and compressed, obscuring the morphological characteristics (Schweingruber 1990:196-202). It is likely that these conifer wood fragments also represent spruce wood, but identification cannot be made with certainty. The fragments of wood in samples 13423, 14069, 14077, 14602, and 14950 were too degraded for identification.

Samples 13809 and 14951 contained fragments of peat-like organic material, while sample 14929 yielded a stem fragment. A portion of the stem fragment was dissolved in bleach and examined for phytoliths. The phytolith assemblage was comprised of silicified cone cells diagnostic of the sedge family (Cyperaceae). Although not diagnostic to the genus, these particular cone cells are consistent with those produced by the genus *Carex*.

SUMMARY AND CONCLUSIONS

Of the thirteen wood samples submitted for identification from the Cape Krusenstern beach ridge site complex in Northwest Alaska, three of them were identifiable as *Picea* (spruce). Four wood samples and one bark sample were identifiable only as conifer, while the wood in the remaining five samples was too degraded/deteriorated for identification. Two samples consisted of peat-like organic material, while phytolith analysis indicates that the single stem fragment represents a member of the sedge family.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM CAPE KRUSENSTERN, ALASKA

Sample No.	Feature	Test ID	Depth	Provenience/ Description	Analysis
13423	4B	1356B	19 cmbs	Wood from unidentified feature	Wood ID
13594		2083B	38 cmbs	Wood	Wood ID
13809	2B	2379B	14 cmbs	Peat-like material from vegetation anomaly	Identification
14023		3016B	11 cmbs	Charcoal	Charcoal ID
14069		3275B	26 cmbs	Wood	Wood ID
14073		3259B	45 cmbs	Wood	Wood ID
14074			59 cmbs	Wood	Wood ID
14076		3314B	43 cmbs	Wood	Wood ID
14077		356A	80-85 cmbs	Wood	Wood ID
14094		3307B	48-51 cmbs	Wood	Wood ID
14163		3487B	70 cmbs	Wood	Wood ID
14602		4584B	78-82 cmbs	Wood	Wood ID
14624	3B	4950B	42 cmbs	Wood from unidentified feature, possibly cultural	Wood ID
14929	1B	5664B	20 cmbd	Stem fragment from house (feature 1B from 10PROXH070608A)	Botanic ID
14950			37-40 cmbd	Wood from house (feature 1B from 10PROXH070608A)	Wood ID
14951			43-47 cmbd	Peat-like material from house (feature 1B from 10PROXH070608A)	Identification
14952			42-46 cmbd	Wood from house (feature 1B from 10PROXH070608A)	Wood ID

TABLE 2
IDENTIFICATION OF SAMPLES FROM THE CAPE KRUSTENSTERN SITE COMPLEX, ALASKA

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
13423	WOOD:						
Feature 4B	Unidentifiable - lignitic degradation	Wood				1	19.471 g
13594	WOOD:						
	Conifer - lignitic degradation	Wood				1	1.783 g
13809	FLORAL REMAINS:						
Feature 2B	Peat-like material					1	8.706 g
14023	CHARCOAL/WOOD:						0.040 g
	Picea (Spruce)	Charcoal		2			0.015 g
	NON-FLORAL REMAINS::						
	Stone					1	0.025 g
14069	WOOD:						
	Unidentifiable - lignitic degradation	Wood				1	0.805 g
14073	WOOD:						
	cf. Conifer - lignitic degradation	Wood				1	8.145 g
14074	WOOD:						
	Conifer - lignitic degradation	Wood				1	0.120 g
14076	WOOD:						
	Conifer - litnitic degradation	Bark				1	0.836 g
14077	WOOD:						
	Unidentifiable - lignitic degradation	Wood				1	0.861 g
14094	WOOD:						
	Picea (Spruce)	Wood				1	2.205 g
14163	WOOD:						
	cf. Conifer - lignitic degradation	Wood				1	8.578 g
14602	WOOD:						
	Unidentifiable - lignitic degradation	Wood				1	0.256 g
14624	WOOD:						
Feature 3B	*Picea* (Spruce)	Wood				1	0.963 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14929	FLORAL REMAINS:						
	Cyperaceae (Sedge family)	Stem				1	0.157 g
14950	WOOD:						
	Unidentifiable - lignitic degradation	Wood				1	0.856 g
14951	FLORAL REMAINS:						
	Peat-like material					1	1.824 g
14952	WOOD:						
	Picea	Wood				1	1.130 g

W = Whole
F = Fragment
X = Presence noted in sample
g = grams

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WOOD AND CHARCOAL IDENTIFICATION OF SAMPLES FROM CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

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May 2011

INTRODUCTION

A total of 124 wood/charcoal samples from the Cape Krusenstern beach ridge archaeological site complex in northwest Alaska were submitted for identification. This site complex is situated in the Cape Krusenstern National Monument.

METHODS

Wood and Charcoal Identification

Wood and charcoal fragments were broken to expose fresh cross, radial, and tangential sections, then examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at magnifications of 320-800x. The weights of each type were recorded. Wood and charcoal fragments were identified using manuals (Carlquist 2001; Core, et al. 1976; Hoadley 1990; Panshin and de Zeeuw 1980) and by comparison with modern and archaeological references.

DISCUSSION

Wood and charcoal samples from the Cape Krusenstern beach ridge site complex in northwest Alaska were submitted for identification. All samples were recovered from non-cultural deposits. A total of 31 samples contained fragments of *Picea* wood and 43 samples contained *Picea* charcoal, reflecting local spruce wood (Table 1). Eleven of the *Picea* wood samples exhibited varying degrees of lignitic degradation of the cellular structure and mechanical-physical features due to anaerobic organisms present in the moist/wet sediments in which these wood fragments have lain. The wood is degraded and compressed (Schweingruber 1990:196-202).

Salicaceae charcoal was noted in 24 samples, Salicaceae root charcoal was present in two samples, and six samples yielded Salicaceae wood, reflecting a woody member of the willow family. Charcoal in 12 samples was identifiable as *Salix* (willow). Birch trees are reflected by recovery of *Betula* charcoal in five samples, *Betula* root charcoal in one sample, and *Betula* wood in one sample. Unidentified hardwood twig charcoal/wood fragments were noted in three samples, possibly also representing birch or a member of the willow family.

Fragments of conifer or probable conifer wood were noted in four samples. Sample 14679 yielded a fragment of probable conifer bark. It is likely that these conifer wood fragments represent spruce wood, but identification cannot be made with certainty.

Six of the samples yielded fragments of wood/charcoal that were too degraded for identification. Charred, unidentified bark was present in sample 14697, while uncharred, unidentified bark was noted in samples 14789 and 15028. Two incompletely charred monocot/herbaceous dicot stem fragments were present in sample 14678.

SUMMARY AND CONCLUSIONS

Of the 124 charcoal and wood samples submitted for identification from the Cape Krusenstern beach ridge site complex in Northwest Alaska, 72 of them contained identifiable fragments of *Picea* (spruce). Wood and/or charcoal from a woody member of the willow family were noted in 32 samples, with willow specifically present in 12 samples. One sample contained birch wood and five samples yielded birch charcoal. Four wood samples and one bark sample were identifiable only as conifer.

TABLE 1
IDENTIFICATION OF WOOD AND CHARCOAL SAMPLES FROM NON-CULTURAL DEPOSITS
IN CAPE KRUSENSTERN SITE COMPLEX, ALASKA

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14604	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.931 g
14611	CHARCOAL/WOOD:						
	Picea	Wood				1	5.958 g
14615	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.163 g
14618	CHARCOAL/WOOD:						0.106 g
	Picea	Charcoal		5			0.072 g
14619	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.259 g
14625	CHARCOAL/WOOD:						
	Picea	Wood				3	1.399 g
14626	CHARCOAL/WOOD:						
	Unidentifiable - compressed, deteriorated	Wood				1	10.542 g
14629	CHARCOAL/WOOD:						
	Picea	Wood				1	1.672 g
14631	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.214 g
14635	CHARCOAL/WOOD:						
	Picea - compressed, deteriorated	Wood				1	0.363 g
14639	CHARCOAL/WOOD:						
	Picea - compressed, deteriorated	Wood				1	0.500 g
14647	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic,pc			0.548 g
14648	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.209 g
14650	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic,pc			2.104 g
14654	CHARCOAL/WOOD:						
	Picea - compressed, deteriorated	Wood				1	0.640 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14656	CHARCOAL/WOOD:						
	cf. *Picea* - compressed, deteriorated	Wood				1	0.576 g
14657	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.432 g
14659	CHARCOAL/WOOD:						
	cf. *Picea* - compressed, deteriorated	Wood				1	1.548 g
14669	CHARCOAL/WOOD:						
	Picea	Wood				1	2.925 g
14671	CHARCOAL/WOOD:						0.408 g
	Salicaceae root	Charcoal		1			0.024 g
	Salicaceae root	Charcoal		2 ic,pc			0.330 g
14672	CHARCOAL/WOOD:						
	Salicaceae root	Charcoal		3 ic			0.136 g
14674	CHARCOAL/WOOD:						
	Betula root	Charcoal		2			0.127 g
14678	Sample Weight						0.163 g
	FLORAL REMAINS:						
	Monocot/Herbaceous dicot	Stem		2 ic			0.060 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic,pc			0.038 g
	Salix twig	Charcoal		3 ic,pc			0.048 g
14679	CHARCOAL/WOOD:						
	cf. Conifer	Bark				2	0.195 g
14682	CHARCOAL/WOOD:						
	Picea	Wood				1	2.030 g
14688	Sample Weight						0.529 g
	FLORAL REMAINS:						
	Rootlets					X	Moderate
	CHARCOAL/WOOD:						
	Picea	Charcoal		31			0.214 g
	Salicaceae	Charcoal		1			0.001 g
14689	CHARCOAL/WOOD:						
	Salix twig	Charcoal		2 ic			0.117 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14690	NON-FLORAL REMAINS:						
	Bone			1			1.170 g
14692	CHARCOAL/WOOD:						0.163 g
	Picea	Charcoal		3			0.050 g
	Salicaceae	Charcoal		8			0.045 g
	Salix twig	Charcoal		3			0.057 g
14694	Sample Weight						0.137 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 2 mm						0.077 g
	Picea	Charcoal		2			0.011 g
	Salicaceae	Charcoal		2			0.045 g
	Salicaceae	Charcoal		4 ic			0.011 g
	Salicaceae twig	Charcoal		1 ic			0.010 g
	NON-FLORAL REMAINS:						
	Gravel					X	Few
14697	CHARCOAL/WOOD:						
	Unidentified	Bark		1 ic			0.193 g
14705	CHARCOAL/WOOD:						
	Picea	Wood				1 ic,pc	1.374 g
14712	CHARCOAL/WOOD:						
	Salix	Charcoal		1			0.047 g
14717	CHARCOAL/WOOD:						
	Betula	Charcoal		15			0.152 g
14728	CHARCOAL/WOOD:						
	Picea	Wood				1	0.208 g
14732	Sample Weight						2.237 g
	CHARCOAL/WOOD:						
	Conifer - compressed	Wood				2	0.857 g
	NON-FLORAL REMAINS:						
	Gravel/Sand					X	Few
14740	CHARCOAL/WOOD:						0.513 g
	Picea	Charcoal		2			0.256 g
	Picea	Charcoal		8 ic,pc			0.210 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14744	CHARCOAL/WOOD:						
	Picea	Wood				1	14.006 g
14745	CHARCOAL/WOOD:						
	Salicaceae	Wood				1	0.230 g
14750	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.148 g
14762	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		X			0.069 g
14765	Sample Weight						0.086 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 1 mm						0.045 g
	Salicaceae	Charcoal		27			0.045 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
14770	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic,pc			0.194 g
14779	CHARCOAL/WOOD:						
	Picea twig	Charcoal		1			0.329 g
14780	CHARCOAL/WOOD:						
	Picea	Wood				1	0.680 g
14783	CHARCOAL/WOOD:						
	Unidentifiable - compressed	Wood				1	0.088 g
14789	FLORAL REMAINS:						
	Unidentified	Bark				1	0.717 g
14794	CHARCOAL/WOOD:						
	Salix twig	Charcoal		1 ic,pc			0.216 g
14796	CHARCOAL/WOOD:						0.547 g
	Picea	Charcoal		1			0.252 g
	Salicaceae twig	Charcoal		1			0.295 g
14800	CHARCOAL/WOOD:						
	Betula	Charcoal		1 ic,pc			1.254 g
14801	CHARCOAL/WOOD:						
	Picea	Charcoal		2			0.118 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14803	CHARCOAL/WOOD:						
	Picea	Charcoal		1			1.966 g
14814	CHARCOAL/WOOD:						0.236 g
	Total charcoal ≥ 2 mm						0.062 g
	Salicaceae	Charcoal		7			0.027 g
	Salicaceae	Charcoal		4			0.023 g
	Unidentified hardwood - compressed	Charcoal		2			0.012 g
14846	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.065 g
14848	CHARCOAL/WOOD:						
	Picea	Charcoal		1 ic,pc			0.706 g
14850	CHARCOAL/WOOD:						
	Picea - compressed	Wood				2	0.931 g
14893	CHARCOAL/WOOD:						
	Betula	Charcoal		1			0.241 g
14904	CHARCOAL/WOOD:						
	Picea - compressed	Wood				1	0.075 g
14905	CHARCOAL/WOOD:						0.232 g
#1	Total charcoal ≥ 2 mm						0.215 g
	Picea	Charcoal		1			0.009 g
	Picea	Charcoal		2 ic,pc			0.141 g
	Salicaceae	Charcoal		3			0.065 g
14905	CHARCOAL/WOOD:						
#2	*Picea*	Charcoal		1 ic			0.036 g
14906	CHARCOAL/WOOD:						
	Salicaceae twig	Charcoal		1 ic,pc			0.208 g
14911	CHARCOAL/WOOD:						
#1	*Picea*	Wood				1	0.111 g
14911	CHARCOAL/WOOD:						0.414 g
#3	Total charcoal ≥ 2 mm						0.342 g
	Salicaceae	Charcoal		3			0.014 g
	Salicaceae twig	Charcoal		5			0.328 g
14921	CHARCOAL/WOOD:						
	Picea	Wood				1	0.270 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
14922	CHARCOAL/WOOD:						
	Picea	Wood				1 pc	1.010 g
14933	NON-FLORAL REMAINS:						
	Bone			X			0.202 g
14939	CHARCOAL/WOOD:						
	Salix twig	Charcoal		1			0.075 g
14946	CHARCOAL/WOOD:						
	Salicaceae	Wood				1	0.740 g
14948	CHARCOAL/WOOD:						
	Conifer - compressed	Wood				1	1.233 g
14957	CHARCOAL/WOOD:						
	Unidentifiable - compressed	Wood				1	0.335 g
14991	Sample Weight						
	CHARCOAL/WOOD:						0.069 g
	Total charcoal $\geq$ 2 mm						0.046 g
	Picea	Charcoal		4			0.046 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
14999	CHARCOAL/WOOD:						
	Salicaceae - compressed	Wood				1	0.342 g
15012	CHARCOAL/WOOD:						
	Betula - compressed, deteriorated	Wood				4	0.132 g
15023	CHARCOAL/WOOD:						
	Salix	Charcoal		2			0.133 g
15028	FLORAL REMAINS:						
	Unidentified	Bark				1	0.202 g
15047	CHARCOAL/WOOD:						
	cf. Conifer	Wood				1	2.090 g
15048	CHARCOAL/WOOD:						
	Unidentifiable - compressed, deteriorated	Wood				2	0.124 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
15052	Sample Weight						0.134 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 2 mm						0.088 g
	Picea	Charcoal		7			0.033 g
	Salicaceae	Charcoal		13			0.055 g
15053	Sample Weight						0.091 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		11			0.055 g
	Salicaceae	Charcoal		2			0.025 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15056	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.065 g
15073	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.102 g
15087	CHARCOAL/WOOD:						
	Salicaceae	Wood				3	0.453 g
15098	CHARCOAL/WOOD:						
	Salicaceae	Wood				1	1.746 g
15099	CHARCOAL/WOOD:						
	Salix twig	Charcaol		1 ic,pc			0.107 g
15113	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.862 g
15114	CHARCOAL/WOOD:						0.125 g
	Salix	Charcoal		1			0.076 g
	Salix twig	Charcoal		1			0.049 g
15115	CHARCOAL/WOOD:						0.059 g
	Total charcoal $\geq$ 2 mm						0.050 g
	Salicaceae twig	Charcoal		9			0.023 g
	Unidentified hardwood twig	Charcoal		2 ic,pc			0.027 g
15138	CHARCOAL/WOOD:						
	Salix	Charcoal		4			0.076 g
15141	CHARCOAL/WOOD:						
	Picea	Wood				2	0.398 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
15143	Sample Weight						0.213 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 2 mm						0.010 g
	Betula	Charcoal		6			0.010 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15144	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.128 g
15147	CHARCOAL/WOOD:						0.133 g
	Salix	Charcoal		1			0.036 g
	Unidentifiable - compressed, deteriorated	Wood				1	0.097 g
15148	CHARCOAL/WOOD:						
	Picea	Wood				1	2.219 g
15149	CHARCOAL/WOOD:						
	Picea	Wood				2	0.437 g
15166	CHARCOAL/WOOD:						
	Picea - compressed, deteriorated	Wood				1	0.091 g
15182	CHARCOAL/WOOD:						
	Picea	Wood				1	1.000 g
15185	CHARCOAL/WOOD:						
	Picea - compressed	Wood				1	1.168 g
15213	Sample Weight						0.162 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 2 mm						0.089 g
	Salicaceae	Charcoal		5			0.089 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15219	CHARCOAL/WOOD:						
	Salicaceae - compressed, deteriorated	Wood				3	0.316 g
15233	CHARCOAL/WOOD:						
	Picea twig	Wood				1	0.360 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
15246	CHARCOAL/WOOD:						
	Unidentified hardwood twig	Wood				1 pc	0.059 g
15247	CHARCOAL/WOOD:						
	Unidentified hardwood twig	Charcoal		1 ic			0.035 g
15252	CHARCOAL/WOOD:						
	Salix twig	Charcoal		3			0.095 g
15257	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		2			0.080 g
15281	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.179 g
15291	CHARCOAL/WOOD:						
	Picea	Charcoal		2			0.019 g
15296	CHARCOAL/WOOD:						1.072 g
	Picea	Charcoal		1			0.483 g
	Picea	Wood				1	0.589 g
15297	CHARCOAL/WOOD:						
	Salicaceae	Charcoal		2			0.064 g
15303	CHARCOAL/WOOD:						0.249 g
	Picea	Charcoal		1 pc			0.158 g
	Salix twig	Charcoal		3 ic			0.091 g
15305	CHARCOAL/WOOD:						
	Picea - compressed	Wood				1	1.123 g
15309	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.349 g
15312	Sample Weight						0.252 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.004 g
	Salicaceae	Charcoal		1			0.002 g
	NON-FLORAL REMAINS:						
	Bone			9			0.075
	Dirt					X	Few
15321	CHARCOAL/WOOD:						
	Salicaceae twig	Charcoal		1			0.284 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
15326	Sample Weight						1.600 g
	CHARCOAL/WOOD:						0.170 g
	Betula twig	Charcoal		3			0.024 g
	Salicaceae	Charcoal		1			0.146 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15358	NON-FLORAL REMAINS:						
	Dirt					1	2.946 g
15365	CHARCOAL/WOOD:						
	Picea - compressed	Wood				2	0.060 g
15369	CHARCOAL/WOOD:						
	Picea	Charcoal		5			0.066 g
15371	Sample Weight						0.115 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 2 mm						0.081 g
	Salicaceae	Charcoal		8			0.081 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15378	CHARCOAL/WOOD:						
	Conifer - compressed, deteriorated	Wood				1	0.150 g
15382	CHARCOAL/WOOD:						
	Picea	Wood				1	5.451 g
15389	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.054 g
15404	Sample Weight						0.061 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 1 mm						0.013 g
	Picea	Charcoal		35			0.013 g
	NON-FLORAL REMAINS:						
	Dirt					X	Few
15413	CHARCOAL/WOOD:						
	Picea	Charcoal		2			0.026 g

TABLE 1 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
15414	CHARCOAL/WOOD:						
	Picea	Charcoal		1			0.050 g

W = Whole
F = Fragment
X = Presence noted in sample
g = grams
mm = millimeters
pc = partially charred
ic = incompletely charred

TABLE 2
INDEX OF MACROFLORAL REMAINS RECOVERED FROM NON-CULTURAL DEPOSITS
IN CAPE KRUSENSTERN SITE COMPLEX, ALASKA

Scientific Name	Common Name
FLORAL REMAINS:	
Monocot/Herbaceous dicot	A member of the Monocotyledonae class of Angiosperms, which include grasses, sedges, members of the agave family, lilies, and palms, or a non-woody member of the Dicotyledonae class of Angiosperms
CHARCOAL/WOOD:	
Conifer	Cone-bearing, gymnospermous trees and shrubs, mostly evergreens, including the pine, spruce, fir, juniper, cedar, yew, hemlock, redwood, and cypress
Picea	Spruce
Salicaceae	Willow family
Salix	Willow
Unidentified hardwood	Wood from a broad-leaved flowering tree or shrub

REFERENCES CITED

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2001 *Comparative Wood Anatomy: Systematic, Ecological, and Evolutionary Aspects of Dicotyledon Wood*. Springer Series in Wood Science. Springer, Berlin.

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1990 *Microscopic Wood Anatomy. Structural Variability of Stems and Twigs in Recent and Subfossil Woods from Central Europe.* Translated by K. Baudias-Lundstrom. Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf.

CHARCOAL IDENTIFICATION OF SAMPLES FROM CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, NORTHWEST ALASKA

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PaleoResearch Institute Technical Report 12-035

Prepared for

University of Washington
Seattle, Washington

April 2012

INTRODUCTION

A total of four charcoal samples from the Cape Krusenstern beach ridge archaeological site complex in northwest Alaska were submitted for identification. This site complex is situated in the Cape Krusenstern National Monument.

METHODS

Wood and Charcoal Identification

Charcoal fragments were broken to expose fresh cross, radial, and tangential sections, then examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at magnifications of 320-800x. The weights of each type were recorded. Charcoal fragments were identified using manuals (Carlquist 2001; Core, et al. 1976; Hoadley 1990; Panshin and de Zeeuw 1980) and by comparison with modern and archaeological references.

DISCUSSION AND CONCLUSIONS

Four charcoal samples from the Cape Krusenstern beach ridge site complex in northwest Alaska were submitted for identification. *Salix* twig charcoal was noted in samples CAKR 13454 and CAKR 15267, reflecting willow twigs that burned (Tables 1 and 2). Pieces of charred *Salix* periderm (bark) also were noted in CAKR 15267. A Salicaceae twig charcoal fragment in sample CAKR 15313-B also might reflect *Salix*; however this charcoal fragment was too small for further identification. Sample CAKR 15313-B also yielded three fragments of *Picea* charcoal, reflecting spruce wood that burned. Pieces of *Betula* twig charcoal from a burned birch twig were present in sample CAKR 15313-A.

TABLE 1
IDENTIFICATION OF CHARCOAL FROM THE CAPE KRUSENSTERN
BEACH RIDGE SITE COMPLEX, ALASKA

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
CAKR 13454	CHARCOAL/WOOD:						
	Salix twig	Charcoal		1			0.0428 g
CAKR 15267	Sample Weight						0.2213 g
	FLORAL REMAINS:						
	Salix	Periderm		5			0.0946 g
	CHARCOAL/WOOD:						
	Salix twig	Charcoal		13			0.1267 g
CAKR 15313-A	Sample Weight						0.0940 g
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 4 mm						0.0836 g
	Betula twig	Charcoal		3			0.0836 g
CAKR 15313-B	Sample Weight						0.0748 g
	CHARCOAL/WOOD:						
	Picea	Charcoal		3			0.0495 g
	Salicaceae twig	Charcoal		1			0.0253 g

W = Whole
F = Fragment
X = Presence noted in sample
g = grams
mm = millimeters

TABLE 2
INDEX OF CHARCOAL RECOVERED FROM DEPOSITS
IN CAPE KRUSENSTERN BEACH RIDGE SITE COMPLEX, ALASKA

Scientific Name	Common Name
FLORAL REMAINS:	
Periderm	Technical term for bark; Consists of the cork (phellum) which is produced by the cork cambium, as well as any epidermis, cortex, and primary or secondary phloem exterior to the cork cambium
CHARCOAL/WOOD:	
Picea	Spruce
Salicaceae	Willow family
Salix	Willow

REFERENCES CITED

Carlquist, Sherwin
2001 *Comparative Wood Anatomy: Systematic, Ecological, and Evolutionary Aspects of Dicotyledon Wood*. Springer Series in Wood Science. Springer, Berlin.

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Appendix X

ASMIS definitions

ASMIS definitions from: 2007 *Archaeological Sites Management Information System, Version 3.01. Data Dictionary.* Archaeology Program, Park Cultural Resources Programs. NPS, U.S. Depertment of the Interior. Washington, DC, December 2007.

Value	Description
Destroyed	The site's formal condition assessment resulted in a professional determination that the site was destroyed or so severely damaged that the data potential/scientific research value was deemed insufficient to warrant further archeological monitoring or investigation. A destroyed site is excluded from Government Performance and Results Act (GPRA) and other national level reporting requirements and is recorded in ASMIS in the Local Resource Type field.
Fair	The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site will degrade to a poor condition and the site's data potential for historical or scientific research will be lowered.
Good	The site, at the first condition assessment or during the time interval since its last condition assessment, shows no evidence of noticeable deterioration by natural forces and/or human activities. The site is considered currently stable and its present archeological values are not threatened. No adjustments to the currently prescribed site treatments are required in the near future to maintain the site's present condition.
Inundated – Uncertain	The deposits and condition of an inundated site, formerly in a terrestrial setting, are obscured and cannot be accurately assessed due to factors such as water turbidity or natural lack of clarity, wave action, growth of aquatic vegetation, and other conditions. Application of standard methods to assess the condition of an inundated site is not possible in these circumstances.
Not Relocated – Unknown	The location where the site was last documented was visited, but the site could not be relocated. Based on best professional judgment that considers standard site types in the park, geography, topography, site documentation, and other pertinent factors, the area is deemed to most likely be the location of the site. Further testing may be required to determine the site location with certainty.
Poor	The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of severe deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site is likely to undergo further degradation and the site's data potential for historical or scientific research will be lost.
Unknown	The current condition of the site is not known, or available information is not sufficient to professionally evaluate the site's condition, or the validity of the assessment is questionable. An unknown site condition is excluded from Government Performance and Results Act (GPRA) and other national level reporting requirements.

Appendix XI

Personnel

Personnel 2006

Full Name	Initials	Job Title	Year
Chris E Young	CEY	NPS Archaeologist/Project Director	2006
Sabra Gilbert-Young	SGY	NPS Archaeologist	2006
Shelby L Anderson	SLA	Field Crew	2006
Adam K Freeburg	AKF	Field Crew	2006
Scott J Shirar	SJS	Field Crew	2006
Shane K Husa	SKH	Field Crew	2006
Cindy L Williams	CLW	Field Crew	2006
Cody J Strathe	CJS	Field Crew	2006
Stacy M Hipsak	SMH	Field Crew	2006
Bob Gal	BG	NPS archaeologist	2006
Joel Cusick	JC	NPS GIS team	2006

Personnel 2008

Full Name	Initials	Job Title	Year
Shelby Lorraine Anderson	SLA	Director	2008
Adam Karl Freeburg	AKF	GIS specialist/Co-Director	2008
Jennifer Kay Gebhardt	JKG	Field Crew	2008
Patrick (Pat) William Reed	PWD	Field Crew	2008
Nicholas Cyril Radko	NCR	Field Crew	2008
Russell B Willems	RBW	Field Crew	2008
Bob Gal	BG	NPS archaeologist	2008
Eileen Devinney	ED	NPS acting WEAR cultural resources chief	2008
Jim Jordan	JJ	Antioch University New England Geologist	2008
Sarah Katherine Campbell	SKC	Volunteer	2008
Kevin David Mitchell	KDM	Volunteer	2008

Personnel 2009

Full Name	Initials	Job Title	Year
Shelby Lorraine Anderson	SLA	Director	2009
Adam Karl Freeburg	AKF	Co-Director	2009
Bob Gal	BG	NPS archaeologist	2009
Fawn Marie Carter	FMC	Field Crew	2009
Jim Jordan	JJ	Antioch University New England Geologist	2009
Katherine Mayling Ou	KMO	Field Crew	2009
Lindsey Marie Tibke	LMT	Field Crew	2009
Pat William Reed	PWR	Field Crew	2009

Personnel 2010

Full Name	Initials	Job Title	Year
Shelby Lorraine Anderson	SLA	Director	2010
Adam Karl Freeburg	AKF	Co-Director	2010
Amy E. Thompson	AET	Field Crew	2010
Anthony R. Hofkamp	ARH	Field Crew	2010
Elizabeth A. Pentilla	EAP	Field Crew	2010
Joshua D. Dinwiddie	JDD	Field Crew	2010
Joshua M. Diles	JMD	Field Crew	2010
Kelly E. French	KEF	Field Crew	2010
Sarah M. Chappell	SMC	Field Crew	2010