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The Search for Paleoindian Contexts in Florida and the Adjacent Southeast

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By

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I dedicate this work to my wife, Patricia, for supporting me in the pursuit of this degree. I also dedicate this work to my family and many mentors for their overall enthusiasm and encouragement to follow my passion for this subject of study.
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Forgive me I know there are others!
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ABSTRACT

The origin and time of appearance of human groups, the Paleoindians, in the Americas has been a significant question in Americanist archaeology. Beginning in the latter half of the nineteenth century and extending through the twentieth century, two paradigms have dominated thinking. The first denied the possibility that human groups were present in the Western Hemisphere during the late Pleistocene. When archaeological evidence confirmed the association of extinct Pleistocene megafauna and human tools, the second paradigm, Clovis First, provided a model of origins, migration, subsistence practices, and technology. Both paradigms were based in whole or in part on speculation at worst, and limited data at best. In their times, both were defended staunchly. Yet there were sites, throughout the Americas, that suggested even earlier Paleoindian presence. During the second half of the twentieth century, a variety of new techniques were applied to these questions: radiocarbon dating, geological stratigraphy, and genetic testing. The data produced confirmed that humans were in the Americas before Clovis, but the Clovis First paradigm continued to be defended by many.

In this dissertation, the question is not how, or even when, the Paleoindians arrived in the Americas. This study focuses on Florida and the adjacent southeastern states and closely examines the available data. A contextual approach is used in which chronology, site integrity, climate, habitat, resource availability, technology, and subsistence patterns provide the clearest picture of what is known, how it is known, and what is not known about Paleoindian lifeways in the state and region. It is an approach solidly rooted in prior research and aimed toward current and future research goals. The Paleoindian occupation of Florida and the adjoining Tertiary karst region of the southeastern Coastal Plain is considered as a distinct region outside the confines of the Clovis First trajectory.
CHAPTER ONE

INTRODUCTION

In a sense, archaeological research is similar to a three-dimensional jigsaw puzzle without all of its pieces. Only partial reconstruction is possible, and there might be discontiguous pieces that may or may not be related. The older the site the more difficult it is to establish contexts due to a number of factors including preservation and, it should be no surprise, that the oldest sites, Paleoindian sites, present the foremost challenge. Paleoindian sites are highly variable in depth of burial, stratigraphic integrity, the potential for dating, and other contextual qualities.

A Paleoindian site might have acceptable stratigraphic contexts with older occupation levels below progressively younger ones. Another Paleoindian site might have a component capable of being radiometrically dated thereby setting its temporal context. A third site might yield preserved faunal specimens along with stone artifacts and provide a means of interpreting both technology and dietary patterns. Yet another site might have preserved pollen or macrobotanical remains thus providing information about past environments. For too many decades identifying Paleoindian sites east of the Mississippi River with multi-source contexts has been problematic; a problem that is now beginning to be resolved.

To study the late Pleistocene peopling of the Americas entails understanding the traditions inherited from nineteenth century researchers who first considered the question substantively. Their approach was not archaeological; rather it was a peculiar philosophical and theoretical framework dedicated to the notion that the first Americans arrived relatively recently, in the Holocene. For its protagonists it was a set of theories, laws, and generalizations with sufficient power to support itself. For its antagonists it was an obstacle to overcome something that was already known. What it did demonstrate is that some had no idea what they were looking for while others rested in the comfort of their own absolutism. In this and chapters to follow there are several quotes for various authors. Where the quotes include this type of bracket with text [comment], they represent annotations by this author.
A Matter of Tradition, History and Legacy

Six decades passed between the first report of a “Pleistocene man” site to the confirmation that Folsom and Clovis sites demonstrated that there were humans -- Paleoindians -- in late Pleistocene America. Another seven decades were required to determine that pre-Clovis sites also exist in the Americas. In Chapter 2, *Paradigm stasis and punctuated equilibrium*, a review of this legacy is presented in a way that attempts to capture the essence of these once-strong belief systems. The efforts of the researchers who were responsible for actually uncovering the archaeological remains are contrasted with their adversaries who challenged their findings. It is a big picture view of Paleoindian archaeology on a national scale but it is not intended to be inclusive of every investigation. It is an attempt to demonstrate that there were two long-lived paradigms; paradigms that eventually collapsed abruptly.

In Chapter 3, *The Paleoindian sites of Florida*, I adopt a more parochial view and provide a history of Paleoindian site investigations in the absence of paradigm assumptions. However, a review of the literature reveals that Paleoindian artifacts were being found shortly after the Civil War in Florida. These artifacts were being compared to the rude implements from the Trenton gravels in New Jersey and to the European Acheulean (Anonymous 1876; Wyman 1875)(Figure 1.1). Nevertheless, it was not until later in twentieth century when Clovis and Folsomoid points were recognized as belonging to the Southeastern Paleoindian tradition. The first major discovery came in 1930 when the remains of *Mammut americanum* (mastodon) were recovered from Wakulla Springs (Gunter 1931). The artifacts found with the mastodon skeleton were later identified as Paleoindian (Simpson 1941a), once the Folsom and Clovis finds had gained acceptance and lanceolate points were “known” to be that old (Antevs 1935a; Cotter 1937; Roberts, Jr. 1936).

Past research assumptions and site investigations are important and provide the context and background upon which new avenues of research follow. There are however, five other areas of contextual data that are important to archaeological site interpretation. These are the contexts of: 1) stratigraphy; 2) chronology; 3) paleoclimate; 4) the combined consideration of habitat, resource availability, and subsistence; and 5) artifacts and technology. These are the subjects of the remaining chapters followed by a concluding chapter discussing the use of contexts in
Paleoindian archaeology as a holistic research approach. Because this dissertation includes terms from a number of disciplines that are seldom used in archaeology Appendix A provides a glossary of terms.

**Site Integrity and Stratigraphic Context**

Understanding the stratigraphic history of when and how artifact-bearing levels accumulated and whether they were post-depositionally altered is of vital importance to archaeologists. The attempt to understand site integrity is made principally through analytical means such as geoarchaeology and taphonomy. These concepts have been championed by Schiffer and others:

The first order of business for the archaeologist is to identify the nature of the cultural and noncultural formation processes that created a given deposit or set of deposits. To accomplish this, we may consider artifacts as merely peculiar particles in a sedimentary matrix (Schiffer and McGuire 1982:252) that potentially have been subjected by cultural and natural formation processes to a variety of mechanical and chemical alterations. By recording the systematic effects, such as size reduction and sorting, damage patterns, and disorganization, investigators can come to appreciate the past agencies that were responsible for the complex arrangements of cultural and environmental materials (deposits) observed today. Knowledge gained from ethnoarchaeology, experimental archaeology, taphonomy, and geoarchaeology contributes importantly to the effort to understand the distinctive sediments encountered by the archaeologist (Schiffer 1983: 696-697).

There are examples of archaeological sites that have been badly misrepresented due to mistaken or purposeful assumptions. The findings at Sandia Cave (Hibben 1941), for example, were later determined to be completely in error based on jumbled stratigraphy and ambiguous artifact assemblages (Haynes and Agogino 1986). On the other hand, there are instances of competent work on archaeological sites, such as the Meadowcroft Rockshelter (Adovasio et al. 1978; 1980; 1999; Anonymous 1975a; 1975b), which was effectively criticized for decades (Fiedel 1999b; Haynes 1980; Mead 1980), then vindicated by new data (Goldberg and Arpin 1999).

The results of research on Paleoindian sites in Florida and the question of site integrity share somewhat similar circumstances. Recognition that Florida might have sites inundated by Holocene water table rise has been a subject of discussion since the early twentieth century (Gunter 1931; 1933; Sellards 1916b). Just prior to World War II, the discovery of mastodon
remains with lanceolate stone points at Wakulla Springs and mastodon remains with stone and ivory artifacts in the Ichetucknee River hinted that inundated site remains might have unusual significance (Simpson 1941c; 1948a); however, Stanley Olsen (Olsen 1949a; 1958; 1961; 1962) quashed that idea believing instead that no intact stratigraphy was present in spring and river deposits. On the other hand, at Warm Mineral Springs, W. A. Cockrell (Cockrell and Murphy 1978) excavated a human burial from well-preserved, wood-rich peat on a water-eroded ledge 13 m below the present water table. The peat and other sediment below recent subaqueous muck were characterized as dominantly derived from dry deposits and the burial was said to be about 12.0 ka cal BP. These assertions, however, must be treated with caution. Peat can only survive under totally saturated conditions, even a semidry environment would degrade peat rapidly (Neuendorf et al. 2005: 476). The age of the Warm Mineral Springs burial also has come into question (Tesar 1997). Of the thirty-three radiocarbon dates from the burial area, only the oldest was said to represent the burial’s age (Cockrell and Murphy 1978: 1). Yet the average of several radiocarbon dates associated with, or directly adjacent to, the burial date to the Early Archaic, not to the Late Paleoindian; a finding consistent with other Early Archaic artifact types and chronologies (Carter and Dunbar 2006).

It is not the intent of Chapter 4, *Stratigraphic context*, to discuss problems like those discussed above however. This study explores the types of sedimentary environments in Florida where Paleoindian evidence has been found and discusses what can be said about different depositional processes and mechanisms including post depositional taphonomy and specimen and site preservation.

**Chronological Context**

The Paleoindian Period is generally broken into three temporal phases, Early (> 11,500$^{14}$C BP - 11,000$^{14}$C BP or >13.5 - 13.0 ka cal BP), Middle (11,000$^{14}$C BP - 10,500$^{14}$C BP or 13.0 - 12.5 ka cal BP), and Late (10,500 - 10,000$^{14}$C BP or 12.5 - 11.6 ka cal BP)(Anderson et al. 1996). However, with the acceptance of pre-Clovis sites, David Anderson (2005: 33, Table 1) has suggested that Clovis be relegated to Middle Paleoindian, which greatly reorganizes the time chart. For the purposes of this dissertation, the timeline in David Andersen et al. (1996) is used. Also in this discussion of chronological context, the placement of artifact assemblages such as Clovis and Suwannee are considered as members of the above mentioned timeline of Early,
Middle, and Late Paleoindian. It should be pointed out however, that we do not know where on this timeline some of the artifact assemblages should be placed.

The relative chronology of distinct Paleoindian artifact assemblages based on stratigraphic position and context can be surprisingly good but more often is problematic in one way or another. At the Paradise Park site (8MR92), in Florida for example, Clovis points were recovered from the lowest level of the site (Neill 1958) yet other Paleoindian components such as Suwannee and Simpson were not present thus providing no clue regarding their relative temporal position compared to Clovis. The Paradise Park site became the first widely recognized Paleoindian site for a number of years (Willey 1966). Similarly, at Helen Blazes site (8BR27), a heterogeneous assemblage of lanceolate and notched points (Late Paleoindian to Early Archaic) were found buried below Archaic artifacts (Edwards 1952). At the Wakulla Springs Lodge site (8WA329), a suspected Simpson preform and Page-Ladson point were found below younger components (Jones and Tesar 2000). With one possible exception, no Paleoindian sites in Florida have been discovered in which Simpson, Clovis, and Suwannee artifacts were recovered stratigraphically separate from one another. The possible exception occurred during site investigations by William Edwards and Clarence Simpson in north central Florida (Dolan and Allen 1961: 2-5). The effort led Edwards to conclude that “components at one site have a very limited number of highly specific point types, each of which appears thus to have spatial and temporal significance” (Edwards 1952: 90). Unfortunately, the highly specific point types were not described and that opportunity lost. At the Harney Flats site (8HI507), Paleoindian Suwannee and Early Archaic Bolen points were found virtually on the same stratigraphic level; however, that proximity may have more to do with the apparent lack of sedimentation during Suwannee and Bolen times (Daniel and Wisenbaker 1987: 37-38). Other sites, such as Page-Ladson (8JE5911) and Sloth Hole (8JE121) have yielded non-diagnostic artifacts in highly stratified deposits below younger Paleoindian levels.

The radiometric dating of sites has begun to place older Paleoindian components in pre-Clovis (Dunbar 2006b; Rink et al. 2012) and Clovis (Hemmings 1999; 2004) temporal context but no site has been found where it has been possible to place post-Clovis Middle Paleoindian components in temporal context. This is an important observation because most archaeologists believe that Suwannee point makers were post-Clovis, Middle Paleoindian descendants of Clovis. Because the temporal context has yet to be demonstrated, it has led some researchers to
speculate that Suwannee point makers might be pre-Clovis (Stanford et al. 2005). There are at least two undated Suwannee point camp sites in Florida with megafaunal remains, species that supposedly died out by 11,000 $^{14}$C BP (Haynes 2008). However, since most researchers place Suwannee points as a Middle Paleoindian manifestation (Anderson et al. 1996; Ellis et al. 1998; Milanich and Fairbanks 1980), the implication is that Pleistocene megafauna survived after 11,000 $^{14}$C BP. So there is a dilemma. Where does the Suwannee point-making tradition fit in time? There is technological evidence that Suwannee is post-Clovis, Middle Paleoindian (Dunbar et al. 2005; Dunbar and Hemmings 2004; Dunbar and Vojnovski 2007), but that is not the subject here. Chronological context is the subject and no chronological context has been established for the Suwannee tool-making tradition.

The first Paleoindian site to be radiocarbon dated was Hornsby Springs on the Santa Fe River near High Springs (Dolan and Allen 1961), but that date is suspect because the shell sample submitted for radiocarbon dating was taken from a level above the Paleoindian level that yielded a Middle Archaic stemmed point. For example, radiocarbon dates much older than expected were derived from shell samples collected from a shell midden site in the St. Johns River (Bullen and Bryant 1965: 23). At the Hornsby Springs site, a radiocarbon age of 9,880 ± 270 (Dolan and Allen 1961: 20) on the shell sample is also older than expected given the Middle Archaic point recovered from the level. The source of contamination is derived when gastropods in karst rivers assimilate ancient calcium carbonate derived from the Tertiary limestone. The calcium carbonate once dissolved in spring and river water is assimilated by algae mats and periphyton communities that symbiotically growing on freshwater vegetation and exposed river snags. In turn the algae mats and periphyton communities are a major food source for the gastropods. The older than expected radiocarbon dates are produced by this type of ancient calcium carbonate contamination that becomes a component of the gastropods shell. The radiocarbon date from Hornsby Springs was taken on a sample of freshwater snail shells that had lived under these conditions (Dunbar 1981c).

More secure dating has been accomplished on other stratified sites. At the Page-Ladson site in the Aucilla River, five Paleoindian artifact-bearing levels were sampled and determined to span a range time from pre-Clovis to late Paleoindian (Dunbar 2006b). At Sloth Hole at least two Paleoindian levels were identified, one Clovis and the other pre-Clovis in age (Hemmings 1999;
2004). Recent optically stimulated luminescence (OSL) dates from the Wakulla Springs Lodge site are in agreement with pre-Clovis dates (Rink et al. 2012).

While pre-Clovis contenders have been identified in Florida, other site are scattered along the eastern Atlantic Coast from Virginia to Florida. Important pre-Clovis sites outside Florida include Cactus Hill (44SX202)(Feathers et al. 2006; McAvoy and McAvoy 1997; Wagner and McAvoy 2004), Miles Point site (18TA365) on the western Delmarva Peninsula (Lowery et al. 2010), and the Topper site (38AL23) in South Carolina (Goodyear 1999). The Atlantic seaboard sites are yielding dates assignable to the Last Glacial Maximum (LGM as occurring from 26.5 to 19.0 ka cal BP see Clark et al. 2009) yet they do not represent the oldest sites with artifacts and faunal remains.

Perhaps the oldest pre-Clovis site contender in North America is the Burnham site (34WO73) in northwestern Oklahoma. The site yielded the fossil remains of *Bison chaneyi* in association with 52 debitage flakes, a biface fragment, a flake tool and large chert cobble (Buehler 2003). According to the most recent interpretation of the site the bison remains and related stone artifacts date from about 43.0 ka cal to 34.5 ka cal BP with a median age of 39 ka cal BP (Wyckoff et al. 2003). Biostratigraphically *Bison chaneyi* is the correct form of bison for this temporal placement. *Bison chaneyi* is the descendant of *Bison latifrons* and progenitor of the late Pleistocene, Clovis-age *Bison antiquus*. Although an attempt to conduct uranium series radiometric dating failed, the site’s excellent organic preservation allowed age determination to be made by radiocarbon and ESR methods. These assays place the age of the site prior to the LGM during Marine Isotope Stage 3 (MIS-3) around 39 ka cal BP (Wyckoff 1999; Wyckoff and Carter 1994).

The Burnham site is controversial because of its age, but the depth of the site’s burial, the cluster of artifacts surrounding the bison remains (but nowhere else above, below, or laterally adjacent to the remains), as well as the species of bison that matches the expected bio- and chronometric stratigraphy is difficult to reject. The Burnham site, similar to Monte Verde I in Chile, dates prior to the LGM (Dillehay and Collins 1988), and should not be dismissed, though additional sites and context studies will be needed before such an early age for Paleoindian in the Americas will be considered for acceptance (Meltzer 2009). In Florida the Latvis-Simpson site (8JE1617) in the Little River Section of the Aucilla River has the remains of a mastodon with three statistically related radiocarbon dates (Mihlbachler et al. 2002) that average 35,872 ±606
cal BP. Sediment samples collected from the profile wall of the excavation has yielded a single debitage flake from the MIS-3 mastodon level (Hemmings 2010). Given these data, just how far back in time the Paleoindian occupation of Florida extends is, and should be, an open question.

In Chapter 5, *Chronological context*, a number of radiometric dating techniques will be discussed that have been used, or might be used, to establish temporal context on Florida sites. Relatively new developments with the calibration of radiocarbon years to calendar years now allow radiocarbon years to be calibrated to calendar years extending through the first half of MIS-3 (~24 – ~59 ka cal BP) (Reimer et al. 2009). This development also helps to place other contextual data, such as climate phases, in temporal context.

**Climate as a Context**

Climate change occurred frequently and sometimes rapidly during the late Pleistocene (Broecker 2000; Broecker and Hemming 2001). Many climate shifts occurred globally or nearly so while at other times, they occurred in response to regional phenomena such as glacial meltwater discharge and chilling of a region’s coastal sea water. When a climate mode was interrupted by an event shift, the short term event eventually led to another, longer term climate mode that differed from the previous mode (Alley and Clark 1999). Understanding the nature of climate shifts from cold to warm, wet to dry or other combinations is important because different climate modes impacted habitat, resources, and animal responses (including human) in different ways.

Determination of climatic mode, its onset, duration, and ending is accomplished through the collection of proxy data from numerous sources. For example, climate proxies are collected from ice cores in Greenland and Antarctic, from varves in glacial lakes and deep ocean cores, from pollen cores, and from tree rings. Recent global, regional, and local climatic data along with the data published in Dunbar (2006c), will be discussed in Chapter 6, *Climate change as a context*. Local, regional, and global climatic modes and events will be compared to a geoclimatic model for the Big Bend area of the Florida.
Habitat, Resource Availability, and Subsistence Contexts

In Chapter 7, *Habitat, resource, and subsistence contexts*, these contexts will be considered as an interrelated set of evidence aimed at providing a better means of site interpretation.

**Habitat**

S. David Webb (Webb et al. 2003; Webb 2006a) proposed one of the most notable theories about the uniqueness of habitats in the coastal southeastern US with his hypothesis that there was a unique mix and abundance of tropical Central and South American and temperate North American species during the late Pleistocene -- but not in the Holocene. The evidence indicates that a species-rich thermal refugium existed in the Southeast bounded by the Southern Appalachians to the west, the Atlantic coast to the east, Cape Canaveral to the south and Cape Hatteras to the north (Russell et al. 2009).

[Here] spectacular megafauna-dominated biota of the Southeast during the LGM [last glacial maximum] and early postglacial interval rivaled that of modern Africa. The gradient separating warm and cool temperatures north of Cape Hatteras was probably steep. A much shallower gradient extended from the Cape south to Florida (Russell et al. 2009: 192 and 195).

It was a refugium that closed by the Holocene onset even though climatic changes were comparatively minor in contrast to the northern latitudes. For example, the extinction of species in Florida (amphibians, reptiles and mammals) approached 50 percent of a Pleistocene diversity of 170 species (Russell et al. 2009: 193-194).

Other important environmental studies include those at Lake Tulane (Grimm et al. 2003; 2006) and Tampa Bay (Willard et al. 2007). Both either refine or add to our knowledge of late Pleistocene climate of the South Florida peninsula below 27.7° North Latitude. The study at Sheelar Lake covers Central Florida (Watts and Hansen 1994; Watts and Stuiver 1980) and Camel Lake, North Florida (Watts et al. 1992). Along the Southeastern Coastal Plain outside Florida, other studies cover Georgia and South Carolina (Booth et al. 2003; LaMoreaux et al. 2009; Watts 1970; 1973; 1980; Watts et al. 1996). Collectively these studies show the late Pleistocene was one of ever changing environmental settings (see Figure 1.2 as an example) with
South Florida, due to latitudinal differences, hosting distinctly different botanical assemblages compared to the more northerly latitudes.

**Resource Availability**

Resource availability and the extent to which collected resources can be tracked from their point of acquisition to the location where they were lost or discarded has been a means of reconstructing mobility and procurement patterns (Ellis and Lothrop 1989; Goodyear 1983; Tankersley et al. 1990; 1995). It is also a means to make inferences about technology and lifeways when direct evidence is lacking in the archaeological record. For example, the widely held assumption that late Paleoindian and Early Archaic biface adzes were used for woodworking (Bullen and Benson 1964; Goodyear et al. 1980; Morse and Goodyear 1973) was based on inference, not direct evidence. Recent work at the Page-Ladson site confirmed that inference when a chop-marked tree, carved wooden stakes, wooden slats and several adzes were found on the Early Archaic, Bolen level (Carter and Dunbar 2006). The occurrence of small animal faunal remains at two Paleoindian campsites now suggests the use of Paleoindian set traps or snares, a premise based on inference (Dunbar and Vojnovski 2007), not direct evidence.

**Subsistence**

There have been two dominant hypotheses regarding Paleoindian subsistence patterns in North American archaeology over the past several decades. First is the big game hunting hypothesis that purports that Paleoindians actively preyed on migratory Pleistocene megafauna to the exclusion of smaller game (Haynes 1974; Martin 1967; 1987; 1990). A driving assumption of this hypothesis is that it explained why so many species of megafauna became extinct: it was overkill. Opposing this idea is the general foraging hypothesis, which contends that Paleoindians were similar to Archaic peoples because they seldom hunted megafauna, preferring instead to hunt smaller animals to decrease hunting risks (Meltzer 1988; Meltzer and Smith 1986). Discussions about the pros and cons of both premises are still argued (Grayson and Meltzer 2003; G. Haynes in press; 2007; Hemmings 2004) with insufficient evidence to settle matters either way.
As might be expected, the evidence for Paleoindian subsistence patterns is meager in eastern North America, but in Florida, the dietary pattern of waisted Suwannee point-making peoples is yielding returns. The evidence comes primarily from the Ryan-Harley (8JE1004) and Norden (8GI40) sites in North Florida. Both are campsites and both have yielded a variety of faunal remains reflecting the exploitation of megafauna and smaller animals. These findings are very significant because they support aspects of both the general foraging and big game hunting hypotheses (Dunbar et al. 2005; Dunbar and Vojnovski 2007) and represent a good fit for the subsistence parameter proposed by Bryan (1969). It also appears to represent a more realistic human pattern.

The Technological Contexts

Bifacially flaked stone tools

Within the repertoire of tool and craft technology employed by the Paleoindians are certain items that serve as index or key items diagnostic of the tradition. In Florida, the bifacially flaked Clovis, Suwannee, and Simpson points were recognized by Ripley Bullen as Paleoindian diagnostic types (Bullen 1968; 1975) although it was John Goggin (Goggin 1950) who first named Suwannee as a type. Subsequent studies have shown the Florida assemblage of biface projectile points and knives to be much more complex than this initial three-part classificatory scheme (Dunbar and Hemmings 2004; Farr 2006) and the latest distribution study, documenting over a thousand specimens, illustrates a bewildering diversity of fluted and unfluted point and knife forms (Thulman 2006; 2007).

There is no doubt that Clovis people occupied Florida (Bradley et al. 2010; Hemmings 2004; Neill 1958). They also occupied most other parts of un-glaciated North America and, to a lesser extent, parts of Central and South America (Bradley et al. 2010). Both forms of Clovis points, recurvate and waisted, display distinct flaking patterns including short to medium basal flutes and overshot (outré passé) flaking of the blade margins. They are easily separated from other Paleoindian point types based on these attributes. Suwannee points in Bullen’s type collection not only display an assemblage of heterogeneous morphologies, they also display different manufacturing techniques. To make matters more complicated, the type Bullen
identified as the Simpson, is indistinguishable from the waisted Suwannee points he included in the type collection (Dunbar and Hemmings 2004).

The attempt to clarify the Florida typology, including the heterogeneous Suwannee and nebulous Simpson types, is based on unique manufacturing criteria for Simpson and the separation of Suwannee into recurvate, waisted, and parallel-sided forms. Yet there are other lanceolate point forms that were not identified by Bullen. Most notable is the Page-Ladson type, a bifacially manufactured point made on a thin flake. Page-Ladson points often, but not always, display flute-like features in the basal area that are nothing more than the original flake scar of the preform flake. These flute-like features run laterally from one side of the point to the other as opposed to true fluting that is extracted by percussion during bifacial reduction from the base toward the tip. There are also more bifacially flaked Page-Ladson point forms made on thicker preforms and reduced in a more typical fashion by percussion. They are not fluted, tend to have flat to slightly concave bases, are basally ground, and they are not fluted. Some, but not all, display overshot flaking. It is possible that the two subtypes of Page-Ladson points are not temporally related because unequivocal archaeological evidence is needed for the bifacially flaked variant. Besides these types are other waisted and non-waisted point forms that, at least at this time, do not fit in the typological classification (Dunbar and Hemmings 2004).

Basic research questions yet to be answered about many of these diagnostic point forms remain. For example, with the exception of Clovis, we still do not know where many of the diagnostic tools belong in time. Therefore, a legitimate question becomes: which point types are temporally related and which are not, and which belong to different tool making traditions? Of the tools that are culturally distinct, were any manufactured by two different coexisting cultures or were they the tools of progenitors, offspring, or new immigrants? These are questions that can only be partially addressed and will require additional site discoveries and investigations before the point seriation and typology are fully realized.

**Other Tools**

Besides bifacial points and knives that are Paleoindian diagnostics, there are certain classes of other stone, bone, and ivory tools. For example the manufacture of large blade tools is common in Clovis (Collins and Kay 1999). Tools identified at the pre-Clovis components of Cactus Hill and the Delmarva Peninsula were determined to be small points manufactured on
thin flakes. The toolkit also included a small, uniface blade making technology. Both the points and blades are not Clovis, (Lowery et al. 2010; McAvoy and McAvoy 1997), but they do resemble the Meadowcroft Rockshelter tool assemblage (Adovasio et al. 1999). As for the points manufactured from thin flakes, they also exist in Florida (Dunbar 2006b; 2008; Dunbar and Hemmings 2004), suggesting this pre-Clovis manifestation is regionally widespread.

Our understanding of the North American Paleoindian tool-making tradition has also changed in terms of what the toolkit does and does not include. Clovis, once thought not to include adzes or other tools for wood working or heavy chopping (Goodyear 1999: 441), has now been shown to include them (Bradley et al. 2010). Also, small diameter bone pins made from the long bones of medium-sized animals, such as the extant white-tailed deer, were thought to be post-Paleoindian manifestations made necessary by megafaunal extinction, yet there is evidence from Florida suggesting otherwise (Dunbar and Vojnovski 2007).

It may be stating the obvious, but it is important to understand that tools fashioned from late Pleistocene megafaunal bone and ivory represent tools manufactured and utilized by Paleoindians (Dunbar et al. 1989; Hemmings et al. 2004; Webb and Hemmings 2001). There is no evidence that Pleistocene megafauna survived in the Southeast during the early Holocene (Carter and Dunbar 2006; Jones and Tesar 2004; Peres and Simons 2006; Walker 1998); therefore, sources of fresh, thick-walled long bones for tool making were unavailable in the Holocene. Bone weathering in the Southeast is a rapid decay process and its suitability for manufacturing trustworthy bone tools is only suitable when the bone is fresh or in its so-called green-bone state (Bradley et al. 2010; Dunbar et al. 1989).

In Chapter 8, Artifacts and technology as a context, a variety of artifact types will be discussed with an emphasis on an attempt to differentiate the Paleoindian toolkits from one another and from Early Archaic, Bolen toolkits to the extent possible.

Compilation of Contextual Data for New Hypothesis

Chapter 9, The context approach and conclusions, will consider a holistic view of all the contexts. Standing alone, any one of these contexts (site integrity, chronology, climate, habitat, resource availability, subsistence, and technology) provides only a narrow means of reconstructing Paleoindian lifeways but together, they form a powerful interpretive tool. Like
any field of research, however, it is important to categorize the evidence within each context as known, conditional or unknown. Only then will the needs of future research be most efficiently met. The noise of human assumption is best overcome in this way.
Stone implements from the St. Johns River said to be like those from the Trenton Gravels site in New Jersey. They are “rude” implements and therefore like “St. Acheul,” the French bone cave sites of ice age antiquity (Anonymous 1876).

Ironically Jeffries Wyman (1875) included a Clovis point (top right) among the crude stone implements from Florida.

Figure 1.1. Clovis point and crude stone artifacts from the St. Johns River basin (Wyman 1875, Plate II, 6.) thought to represent Pleistocene relics because they were rudimentary. To Charles Abbott crude construction represented evidence that specimens were older than those of more refined manufacture (Abbott 1872; 1876). They were also said to resembled, however vaguely, the “St. Acheul pattern” of the European Paleolithic (modified from Anonymous 1876: 169).
Figure 1.2. Sheelar Lake, located near Keystone Heights in northeast Florida has been cored twice. The result of the first, composite, core was reported by Watts and Stuiver (1980: 325-327) and the result of the second core was reported by Watts and Hansen (1994: 163-176). A second core was “taken to cover a hiatus caused by a coring error in the first study” (Watts and Hansen 1994: 172). Please note that the Pinus pollen oscillations in both cores did not yield records with the same rates of accumulation and the hiatus in the first core reflects some uncertainty. There is a vertical scale difference between the two. Nevertheless, the radiocarbon timescale of both cores is chronologically similar and consistent as are the Pinus oscillations to global mode shifts.
CHAPTER TWO

PARADIGMS STASIS AND PUNCTUATED EQUILIBRIUM

Coming to the Americas in the Pleistocene?

During the last decades of the nineteenth century larger-than-life antiquarians, earth scientists, and fledgling anthropologists dominated a race to disclose their next big discovery or, conversely, to dispute the claims of its protagonists. Many were ego-driven individuals with assertive theories that segregated their position from that of their competitors. Negotiation, concession, or incorporation of ideas was not an option. Add to this mix the absence of context and their debates were often based on assumptive speculation. These were men who often demanded respect in long-winded, loquacious fashion. For example, in paleontology, the so-called dinosaur “Bone Wars” between O. Charles Marsh and Edward D. Cope came to epitomized this type of bitter rivalry (Goldish 2007; Holmes 1998).

In archaeology and topics related to prehistoric America, late nineteenth to early twentieth century scholars aligned themselves on two sides of a debate regarding the peopling of the Americas: the view that humans occupied the Americas during the late Pleistocene (Abbott 1892a; 1892b; Gidley 1926; 1931; Sellards 1916a; Wright 1912) versus the view that they did not (Chamberlin 1892; Holmes 1893; Hrdlicka 1917). Often associated with northeastern museums, these scholars published their works in prestigious journals with descriptions of places explored and artifacts found, journals copiously illustrated by lithographs and photographs. Though it is not my intent to compile a comprehensive account of the initial peopling of the America’s debate, it is my intent to suggest that this beginning lay the foundations for Paleoindian archaeology’s corporate culture, a corporate culture rooted in nineteenth century values.

Charles C. Abbott (Figure 2.1) was a naturalist, archaeologist, and assistant curator of the Peabody Museum in Cambridge, Massachusetts. William Henry Holmes (Figure 2.2) was an anthropologist, archaeologist, geologist and artist associated with the U.S. Geological Survey and the Smithsonian Institution's Bureau of American Ethnology. Both men authored publications depicting sometimes amazing artifacts of elaborately carved shell and stone along
with other artifacts of far more rudimentary manufacture. To Abbott a chipped stone tool’s antiquity could be determined by its level of sophistication, which was evident in the craftsmanship of its manufacture:

Take a series of, whatever class of relics you may, there is always a gradation from poor (primitive) to good (elaborate), which is an indication, we believe, of a lapse of years from very ancient to more modern times, from a paleolithic to a neolithic age . . (Abbott 1872: 146; also see Abbott 1876: 65-66).

The site of Abbott’s crudely fashioned, ancient artifacts became known as the Trenton Gravels, a site located in New Jersey. Eventually, human skeletal remains were unearthed in the gravel and similarly offered as proof of late Pleistocene man (see for example Putnam 1884). On the other side of the argument, William H. Holmes saw the unsophisticated artifacts as nothing more than unfinished tools; the half-formed discards of unfinished chipped stone implements (Figure 2.3). To Holmes these were not ancient artifacts as Abbott claimed (Holmes 1893).

Ales Hrdlicka (Figure 2.4), the first curator of physical anthropology at the Smithsonian Institution found no evidence of ice-age man, including the human remains recovered from the Trenton Gravel (Hrdlicka 1902). He also dismissed other claims (for information regarding the Florida controversy; see for example Gidley 1926; 1929; 1931; Gidley and Loomis 1926; Hrdlicka 1917; Hrdlicka 1937; Sellards 1916a). His position as a physical anthropologist at the Smithsonian Institution provided an unparalleled opportunity to evaluate and validate or invalidate finds. He not only evaluated sites based on their human remains and configuration of such things as skull morphology, he also judged them on their geological context and evidence of Holocene prehistoric occupation (see for example Hrdlicka 1902).

Another critic of the evidence was Thomas C. Chamberlin (Figure 2.5), a prominent geologist who worked extensively on glacial deposits in the Great Lakes region. Chamberlin brought an interesting approach to the problem, proposing the use of multiple working hypotheses over that of a ruling theory or a narrow-ranged hypothesis (Chamberlin 1890; Chamberlin 1897; Railsback 2003). Using this approach, he required that certain prerequisites be met for the identification of glacial age relics and cautioned against the misinterpretation of geological and archaeological data (Chamberlin 1892; 1903). His was a warning to either side of
the argument not to become entrenched in the ideology of one’s own paradigm over accurate interpretation of the evidence no matter the outcome.

But some of the evidence for Pleistocene man in America seemed to have slipped passed scrutiny and critical review or, worse, was ignored. A case in point is the 12 Mile Creek site in Kansas, excavated in 1895 and 1896 by Samuel Williston, Handel Martin, and Thomas Overton (Williston 1902). Williston (Figure 2.6) was a professor at Kansas State University and a graduate of Yale where he had been a student of Charles Marsh of dinosaur “Bone Wars” fame. Martin and Overton also had worked for Marsh at the US Geological Survey. They knew how to excavate and both were seasoned veterans accustomed to meticulous work on fragile bone sites. Their excavation of the 12 Mile Creek site uncovered the remains of an extinct Pleistocene bison, and with it, a lanceolate projectile point with an unusual feature, basal fluting (Hawley 2009; Rogers and Martin 1984; Williston 1902). The 1902 site report identified the bison remains as an extinct *Bison occidentalis* (Williston 1902), an intermediary between *Bison antiquus* and *Bison bison*. Recent paleontological studies of bison communities in the Americas suggest this identification is questionable and that late Pleistocene bison species south of the Cordilleran and Laurentide ice barrier are more likely *Bison antiquus* (Burns 2010; Wilson et al. 2008). But the main point here is that a Paleoindian fluted point site was discovered and went largely unrecognized until the aftermath of the identification of the first legitimate Paleoindian sites.

Even after most scholars recognized that Paleoindians coexisted with late Pleistocene megafauna, Ales Hrdlicka did not. A year before his death Hrdlicka spelled out his doubts:

The Paleolithic cultures of northern Asia are characterized by well-defined stone tools and by the presences of peculiar little ivory figurines, the so-called “Venus.” Nothing of this sort is found in America. Instead there is already highly differentiated Neolithic “Folsom” point, which moreover in isolated specimens and more or less superficially is found widely scattered over the United States, has in places [been] associated with it commonplace objects of American stonework, does not apparently extend into Mexico and the rest of America, and whose main character, is vertical groove (for firmer hefting doubtless) along the middle of each surface, has many parallels in the bifluted ivory and slate points of Alaska.

The mainstay of all the claims for man’s antiquity in America is the association of the Folsom points and a few other objects with the bones of extinct mammals. But this is an Achille’s heel of American archaeology, for many conditions indicate that such animals have not been extinct very long; besides which the associations occur almost wholly in the southwest States, where great washes and sand storms [the dust bowl had taken place in the decade of the 1930s] often play havoc with the poorly protected surface and loose deposits; and the associated animal parts are generally but fragments, the original location of which is entirely uncertain. Secondary deposition and secondary stratification are the rule in that region rather than that exception. Geology is a living and very active something in such parts, which is often forgotten. . . .
It may be well, however, to conclude this abstract with a brief marshaling of the conditions that have to be fulfilled if the presence of early man in America is to be accepted. They are:

1. It must be shown where the man could have come from, and how, in the then climatic conditions, he could have reached here.
2. It must be shown that at that time in the region from which supposedly the migrants came, there were already people from whom they could be derived.
3. It must be shown how, while the paleolithic times existed everywhere yet in the Old World, a man could have reached America without any of the essentials of the paleolithic industry, but with the neolithic in its stead.
4. It will be imperative to show sites of the early man and their accumulations, such as exist wherever early man lived in the Old World.
5. It will be necessary to show skeletal remains that differ, in the directions of primitiveness and racial differences, from those of the Indian or Eskimo.
6. It will be incumbent to show and explain the geographic extension and limitation of the old timers on the American continent.
7. It will be necessary to show in general at least how long the early comers existed here and why they disappeared.
8. There must be shown other distinctive items of their material culture than just one or two forms of highly differentiated stone points.
9. The void between the disappearance of the supposed early people and the coming of the Indian and Eskimo must be filled in with sufficient geological accumulations to cover that period.

No serious attempts have yet been made on the part of the claimants of ancient man in America to comply with these necessities. But until these demands be duly satisfied it is legitimate, it seems, to hold the question of the presence of early man in America in abeyance. (Hrdlicka 1942: 54-55)

He had used the same logic as Charles Abbott, the only difference being that Hrdlicka felt Folsom points were too well made to be that old (Paleolithic); therefore, Folsom point-making people were younger and “Neolithic First” was the rule. Allied with Hrdlicka, Herbert Spinden developed a time scale for the peopling of the New World based on the Mayan astronomical calendar. Spinden, though acknowledging the development of tree ring and varve clay chronometric techniques, choose to ignore them and placed New World human entry at 752 BC or about 2,700 years ago, at the beginnings of Mayan time (Spinden 1942). Although the belief in Neolithic First was already passé by the beginning of World War II when Hrdlicka and Spinden published their work, to them, it was established fact. Theirs was the ruling theory of which Chamberlin had warned.
Neolithic First was disproved by the discovery of Folsom and Clovis sites in New Mexico. The discovery of *Bison antiquus* remains associated with Folsom points at Lindenmeier near Folsom, New Mexico (Cook 1927; Figgins 1927) and Clovis points with *Mammut columbi* remains at Blackwater Draw near Clovis, New Mexico (Cotter 1937; Howard 1936) represent the most important breakthrough sites. At both sites the skeletal remains of extinct Pleistocene mammals were found in unquestioned association with artifacts. Early humans not only coexisted with now extinct Pleistocene animals, there was evidence that they also hunted them! Recognition that there were Paleoindians in the Americas was accepted, incredibly, without first having to establishing their Old World origins, a topic that remains unanswered today. It is significant in this case that archaeological field evidence trumped intransigent nineteenth century logic.

Research soon escalated into multidisciplinary investigations during the WPA era, the kinds of research one would anticipate during and in the aftermath of such a paradigm-breaking discovery. Prior to the advent of radiometric dating, sites west of the Mississippi River offered bone and other organic specimens with good archaeological and geologic contexts. The first climatic and temporal contexts were developed from these archaeological and geologic data (Antevs 1935a; 1935b; 1936a; 1936b; Bryan 1928; 1937a; 1937b; 1941) and with them, Ernst Antevs (Figure 2.7) developed a temporal placement for Folsom and Clovis point-making Paleoindians using varved sediments and comparative stratigraphic position.

The artifacts, including Folsom points, which occur in association with "cold" mollusks and bones of mammoth and extinct bison in lake clays at Clovis, New Mexico, are perhaps 12,000 to 13,000 years old (Antevs 1936a: 336).

It should be mentioned that at that time, both Clovis and Folsom types were singly referred to as Folsom. His age evaluation was not a random estimate, but a carefully calculated assessment based on geologic correlation of sediments. Antevs pre-radiometric age evaluations are incredibly accurate considering that they are almost identical to the modern, radiometrically established chronology with Clovis beginning around 12.9 cal yrs BP and Folsom ending around
12.0 cal yrs BP (radiocarbon ages from Taylor et al. 1996; Waters and Stafford 2007, calibrated to calendar years using Calib ver 6).

**Paradigm Making**

After World War II, the investigation of western Paleoindian sites pushed forward making progress unmatched elsewhere in the Americas. For better or worse, Paleoindian research began to assume a decidedly Southwestern regional posture. At first, many of the researchers were the same (Antevs 1954; 1962; Bryan 1950; Bryan and Albritton 1943; Sellards 1952), but they were joined by a new generation who brought with them new technologies, radiocarbon dating among them (Green 1963; Haynes 1964; Leonhardy and Anderson 1966; Martin 1967; Warnica 1966). By the 1960s the Paleoindian occupation of the West and Southwest was established and artifacts such as Clovis and other fluted points were recognized as manifestations of a tradition found elsewhere in North America. Extinction of all megafauna in the southwest US was linked to the appearance of Clovis around 11,500 $^{14}$C BP and the total demise of megafauna except bison by 11,000 $^{14}$C BP (Haynes 1967; Martin 1967). Researchers added to this evidence questions about the time and place of human New World entry (Haynes 1964; 1967; 1969b; 1971) and tied it to the Clovis toolkits, hunting, and overkill as an explanation for late Pleistocene megafauna extinction (Martin 1966; 1967; 1987; 1990). With these ideas, they built a new paradigm. Clovis was becoming seen as a brief, 500 year spread of early hunters and gatherers across North and parts of Central America.

Hard-won archaeological and paleontological data from the Southwest was entwined with seemingly logical possibilities in the development of this new paradigm, a paradigm that was destined to become known as Clovis First. Like its predecessor, that posited Pleistocene fauna and humans had not coexisted in the New World, Clovis was now believed to be the earliest human manifestation and the theory was destined to be dominant for a long run. How Clovis First became ruling theory lies in its protagonists. After all, Frank Hibben’s work at Sandia Cave became a grand justification for the theory after his results (Hibben 1941) were found to be largely contrived (Haynes and Agogino 1986).

The measure for Paleoindian sites in the Americas became the comparative judgment of Clovis versus similar or new and unfamiliar early site assemblages. Although Clovis points were
found to be geographically widespread, there were other regions yielding Paleoindian artifacts that were not, or only remotely, Clovis-like. Reported Pleistocene sites that yielded unrecognized tool assemblages were often criticized without onsite inspection to evaluate the validity of their stratigraphic record or hands-on familiarity with the artifacts and faunal remains recovered from them.

Perhaps the policing of other researchers’ work was important. After all, the enticement of national recognition was real for those claiming to have the oldest sites in the Americas. But Clovis First also encompassed broad assumptions. Clovis First included notions about the timing of New World origins based on ice-sheet melting and corridor opening, human terrestrial entry via the Bering Land Bridge, established artifact types and geographic occurrence as benchmarks, big game hunting to the exclusion of smaller game, and blitzkrieg stalking that resulted in overkill extinction. These and other aspects of the Clovis First paradigm were assumptions, not facts (Haynes 1966; 1969b; 1971; 1982; Martin 1967; 1990). Based on the Clovis First criteria, pre-Clovis-age sites were not accepted until the Monte Verde site inspection and its unanimous acceptance (Meltzer et al. 1997). Prior to that, pre-Clovis sites were only sometimes visited, evaluated, found to be problematic, and dismissed as contenders using Southwestern-based reasoning.

The Selby and Dutton sites in Colorado, excavated in the late 1970s, for example, were said to have flaked megafaunal bone tools displaying use-wear and were found lying below Clovis levels. Age estimates from the Selby and Dutton sites ranged from 15.0 ka cal years old or older (Graham 1981; Stanford 1979). There were no stone artifacts from the pre-Clovis levels, which led other researchers to suspect that the flaked bone debitage was of natural not cultural origin (Binford 1981; Haynes 1982). However, similar flaked bone tools were later found with Clovis artifacts at the Lange/Ferguson mammoth kill site in South Dakota in the 1980s (Hannus 1989; 1990)(Figure 2.8) causing some researchers to revisit the possibility that sites such as Selby and Dutton were culturally derived. Additional flaked bone tool sites were investigated including the Clovis-age Wasden site in Owl Cave, Idaho (Miller 1989) as well as other pre-Clovis sites similar to Selby-Dutton (Holen 1995; 1999).

To strengthen the notion that flaked bone tools can be differentiated from geofacts, the Ginsberg experiment was carried out by modern knappers on fresh elephant bone (Stanford et al. 1981). Nevertheless, Lewis Binford (1981) and Gary Haynes (2002) saw reason to question both
the Ginsberg experiment and the sites mentioned above, believing instead that the ability to discriminate between cultural and natural bone flakes was unreliable. In one case, it was proposed that some type of earthmoving equipment had caused the damage to old bone just prior to site investigations (G. Haynes 2002: 135-149). Since then Steven Holen (2006; 2007) has produced additional evidence that the flaked and polished mammoth long bones from his Nebraska sites represent artifacts dating to the LGM some 21.0 to 18.0 ka cal years ago. The arguments continue.

So how does one move away from Clovis First judgment? One approach involved the development of a radically different hypothesis. “It’s Iberian, not Siberian” was a statement offered by Dennis Stanford to colleagues at the Clovis and Beyond Conference in Santa Fe, New Mexico in 1999. This alternative was presented by Stanford and Bruce Bradley many times before it was published (Bradley and Stanford 2004). This hypothesis involved boats and Solutrean people going to sea during the LGM along a North Atlantic ice-edge corridor. For the Solutrean seafarers who went farthest, they encountered the American coast somewhere south of the ice front.

The Iberian hypothesis also has its adversaries. The first salvo of opposition, particularly that by Lawrence C. Straus (2000) was published prior to the time that Stanford and Bradley published their hypothesis. Once the Solutrean hypothesis was published, many arguments against it were already in print permitting Bradley and Stanford to directly address critical issues on first printing. Stanford and Bradley perhaps have a more plausible argument for the Iberian route, than had previously been published for the overland route embedded in Clovis First (Haynes 1982).

The idea that people could navigate along ice-edge corridors is no frivolous concept to Dennis Stanford, who investigated the prehistoric Thule (Eskimo) Walakpa site located about 40 km southwest of Point Barrow, Alaska. The site is located on a spit of land bordered to the south by Walakpa Bay and north by the Arctic Ocean (Stanford 1976). The archaeological site yielded rich evidence of marine fishing and mammal hunting as well as seafaring and boat building abilities. Stanford once hunted with the local Eskimos of the Point Barrow area and learned that their spending a night on the pack ice due to storms was a commonsense, safe option (Stanford 2011). But would such a journey from the Iberian coast to the Delmarva Peninsula be possible? Stanford and Bradley (2012) propose it as a possibility because the polar front was much farther
south as was the sea ice in the North Atlantic Ocean at the time. Ice-edge corridors are places rich in fauna and hunting potential and the ice a source of potable water.

Bradley has dedicated his career to decoding the minute details of prehistoric technology and manufacturing techniques, most notably stone knapping. In doing so, he has become intimately familiar with the unique knapping techniques shared by Solutrean and Clovis knappers. Both tool-making cultures share the characteristics of bifacial projectile manufacture primarily thinning the preform with percussion flaking rather than pressure flaking. But it is the specialized type of percussion flaking that makes these stone tool traditions unique. In North America, archaeologists call the technique overshot flaking while European call it *outré passé*. In other cultures practicing bifacial projectile point manufacture, occasional overshot flakes occurred but represent clear mistakes that often ruined the preform (Callahan 1979: 111; Whittaker 1994: 163). Solutrean and Clovis knappers used overshot flaking not only purposefully, but also with great skill (Figure 2.9). Solutreans used pressure flaking and basal grinding during finishing processes, as did Clovis knappers. An unusual aspect of the debitage left from striking an overshot flake is that the flakes are as diagnostic of the two cultures as the finished Solutrean laurel leaf and Clovis points.

Another stone tool common to both cultures is a large uniface blade struck from a prepared blade core and modified into a variety of specialized tools such as an endscraper on a uniface blade. The Solutrean bone tool assemblage is strikingly similar with a number of items made from megafauna: thick-walled long bone or proboscidean ivory tusks. Osseous Solutrean *sagaie* and osseous Clovis spears, foreshafts and harpoons are very similar in manufacture and, in some cases, share similar decorative design. The toolkit similarities do not end there.

Stanford and Bradley have inspected Page-Ladson points from the Page-Ladson and the Wakulla Springs Lodge sites in Florida (Dunbar and Hemmings 2004) and found them to be similar to other pre-Clovis specimens from the Atlantic Seaboard. The specimens from the Wakulla Springs Lodge site was recovered from a Paleoindian level of the site (Jones and Tesar 2000; 2004). Bradley and Stanford pointed to the Cactus Hill site in Virginia, Meadowcroft Rockshelter in Pennsylvania and the Page-Ladson site in Florida as having similar artifact assemblages, specifically point types (Bradley and Stanford 2004; Stanford et al. 2005). In support of their hypothesis Bradley and Stanford (2004), cited several published findings about LGM Solutrean site investigations that were published by Straus, the same Straus who published
the first paper critical of the Solutrean hypothesis (Straus 2000). It did not take long for Straus to provide rebuttal.

With Straus, Dave Meltzer, the mediator of the Monte Verde expedition, and Ted Goebel, a respected Beringian archaeologist also joined the argument (Straus et al. 2005). Meltzer’s entry into this fray might be related to Stanford’s toast to the Meadowcroft Rockshelter on the last day of the Monte Verde expedition. As mediator, Meltzer had seen things go smoothly, with a great deal of decorum until that toast on the last day of the expedition (Meltzer 2009: 126-127). Point by point, Straus, Meltzer, and Goebel identify areas of disagreement with the Solutrean hypothesis, while at the same time, asserting that one need look no further than northeast Asia for the human entry route. The similarities between Clovis and Solutrean then are due to the psychic unity of mankind and coincident parallelism where different technologies end up sharing convergent traits. They concluded that the ice-edge corridor between Europe and America was too long to permit passage. The artifacts are not that similar, much less those in the pre-Clovis site assemblages. They (Straus et al. 2005: 511) also state that Clovis peoples did not practice non-perishable art (Figure 2.10) and that “the ubiquity of overshot flaking is hardly demonstrated. Indeed, this technological feature occurs only rarely in fluted points in eastern North America . . .” (Strause et al. 2005: 511). However, they have ignored documented occurrences of engraved stone, bone, and ivory as well as beads manufactured from the same material unless these items are not considered art forms as they are in the Old World (Bradley et al. 2010; Dunbar and Webb 1996; Gingerich 2009; Glowacki 2012.; Green et al. 1998; Hemmings 2004; Hemmings et al. 2004; Purdy et al. 2011; Stafford et al. 2003; Tratebas 2010; Walker et al. 2010; Webb and Hemmings 2001; Wernecke and Collins 2010; Wilmsen and Roberts 1978: 132-134). And, their contention that overshot flaking is not ubiquitous in the Southeast is misleading. While it is true that many Paleoindian period lanceolate points do not display overshot-flaking, the points in question are not Clovis types which by definition are overshot flaked (Bradley et al. 2010). There are many Clovis points in the Southeast and they are overshot flaked.

Let the reader beware. There are others who have weighed in against the Solutrean hypothesis (see for example, Westley and Dix 2008). One of the most recent contends that the sea-ice conditions were more difficult than hypothesized. Westley and Dix (2008) point to evidence that wind and current patterns were directed toward Europe (and would be against
west-traveling people) and that the American side had difficult landscapes very different from Europe (Westley and Dix 2008). Both hypotheses then, Clovis First and Solutrean, are steeped in origin speculations, not in hard data, and that is one of the subliminal messages embedded in the Solutrean hypothesis.

The coastal entry route by boat has always seemed to be a logical possibility to me. It is certainly quicker transport and, depending on the ability of watercraft, its operator, and the water body involved, it is the most efficient way to transport people, equipment and supplies. A coastal Pacific entry route involving island-hopping is another alternative to the overland Bering Land Bridge route (Fladmark 1979). In terms of its feasibility, all one needs to do is look further back in time in the Old World for evidence of ancient seafaring. The existence of early modern human sites on the coast of South Africa with evidence of marine adaptation during the Middle Stone Age around 80 ka cal BP (Brown et al. 2009; Henshilwood et al. 2002; Henshilwood and Sealy 1998; Wadley 2007) and the occurrence of early modern humans sites in Australia by 50 to 45 ka cal BP as well as and the Solomon Islands shortly thereafter after (Bowler et al. 2003; O'Connell and Allen 2004) speaks of ancient seafaring ability thousands of years before New World colonization. A New World migrant would have been able to transport an eighty pound block of chert in his/her boat, for example, with much less effort compared to backpack manuporting.

Apparently, the genetic evidence now indicates that there may have been one (Fagundes et al. 2008; Goebel et al. 2008) or two (Perego et al. 2009) migrations to the New World with entry dates possibly before the LGM >30.0 ka cal BP or, alternatively, around the time of the first post glacial warming around 16.0 to 15.0 ka cal BP (O'Rourke and Raff 2010). As important as the genetic evidence is and as promising as its eventual findings will likely be, there are cautions:

1. mtDNA and the NRY are but two of potentially millions of independent realizations of evolutionary history that constitute our genome. . . . Indeed, the genome seems to be made up of loci with widely varied evolutionary histories” (Garrigan and Hammer 2006: 678). Most recently it has become important to study rare haplogroups with discrete geographical distributions (O'Rourke 2009: R205).

2. As the last continents colonized by members of our species, the Americas represent the end of the modern human dispersal to major continental land-masses. . . . If we are unable to reconstruct the colonization of the Americas from genetic data, we must be concerned about our ability to infer much more ancient and complex population histories and origins elsewhere, e.g., in Africa, Europe, or Asia. Despite the 80 year history of genetic studies in the Americas, the real work is now beginning to fully elucidate the genetic history of two continents. It is an exciting time to be studying genetic variation and prehistory in the Americas (O'Rourke 2009: R204).
3. Complete agreement between mtDNA, Y-chromosomal DNA and autosomal genetic systems has not yet been realized with respect to colonization models, although all three are consistent in failing to support the “blitzkrieg” or “threewave” migration models. Nevertheless, these models and their underlying assumptions continue to be used as the framework for hypothesis testing in American colonization scenarios. Dillehay (2009) recently suggested that the nature of different data sets relating to continental origins — e.g., archaeology, genetics, and paleoecology — are sufficiently diverse that it is not realistic to expect concordance across them with respect to origin models. At the analytical level this is certainly true. We suggest, however, that there is one area where some degree of concordance should be helpful and measurable. It has become clear that appropriate calibration of coalescent estimates of lineage divergence is critical to our understanding of colonization events (Ho 2008) and that some methods are more robust and yield more reliable dates than others (Cox 2008). Given the well-known time-depency of mutation rates for calibrating molecular evolution, using reliable internal calibration points is essential. The use of well-dated ancient DNA samples from archaeological contexts provides perhaps the best opportunity to refine calibrations of lineage divergence in the temporal window relevant for the peopling of the Americas (Henn et al. 2009; Kemp et al. 2007) - (O’Rourke and Raff 2010: R206).

Returning to New World entry by sea, coastal and possibly even ice front navigation by ancient mariners is just as likely as the land route. It is clear that a land route is required to account for the various Miocene to Pleistocene faunas that ranged back and forth between the New and Old World. People, like nature, are never as simple as we think. People do unpredictable things like inventing boats, paddles and sails.

The advancement of Paleoindian archaeology in eastern North America was slow in developing. Armed with the knowledge gained from western Paleoindian sites, archaeologists working east of the Mississippi River began identifying Clovis and Clovis-like points in much larger concentrations (Mason 1962). Most sites lacked bone preservation or a means to place them in chronological context. And, other than Clovis and Dalton points, the eastern assemblage of lanceolate projectile points is different and cannot be used for direct comparison with western counterparts.

The long fought battle in eastern North America was about finding Paleoindian sites with decent preservation. Organic specimen preservation can provide the evidence to determine chronological, environmental, and cultural evolution during this transformative period. With the notable exception of stone tools, Paleoindian sites are the least likely to provide surviving specimens for interpretation due to age and specimen attrition. The survival of bone specimens and the establishment of contexts were first used to verify the Paleoindian occupation in the Southwest (Cook 1927; Cotter 1937; Figgins 1927; Howard 1936), and the survival of bone,
wood and other botanical material to verify the pre-Clovis occupation in South America (Meltzer et al. 1997).

The major challenge for Paleoindian researchers outside the Southwest has been identifying where sites with good preservation might be found and establishing their contexts. Nowhere has the contrast been as sharp as during the late twentieth century when the mantra, “Clovis First,” reigned supreme (Dincauze 1984; Fiedel 1999a; Haynes 1971; 1984; 1993). To researchers in the eastern United States, it had not gone unnoticed that many of the Clovis First premises, applied continent-wide, had little applicability to geographic regions outside the southwestern US. It seemed unreasonable to equate Southwestern climate, habitat, faunal richness, Paleoindian toolkits, and stratigraphy on a one-to-one basis to regions outside the Southwest, yet that was common practice. Although the Clovis First paradigm was multifaceted, because of its regional basis it was one-dimensional. Clovis First became a de facto standard, yet elements of the hypothesis can also be questioned.

1. The belief that it is important to determine the origins of Pleistocene immigrants, the route they took to get here, and the timing of their entry is a concept initiated by Ales Hrdlicka (1942) and plugged into Clovis First. What is the likelihood that any Paleoindian site, outside perhaps Alaska and the Northwest Pacific coast, will ever yield evidence of Old World origins?

2. Forgetting Old World origins, does the Clovis evidence support a reflection of its in-place development in the Americas? What were the intra-continental migration routes of Clovis people in the Americas? In what directions did they move across the landscape and is this unanswered question enough to deny alternative hypotheses?

3. If the striking similarities between Clovis and Solutrean artifact assemblages cannot be accepted as evidence of genetic relatedness, can the comparison of any Old and New World artifact assemblages be used as evidentiary proxies? In fact, outside of genetic studies, how likely is it that the First American origin questions will be answered by conventional archaeological evidence during this century?

4. Was the timing of the geoclimatic condition known as the ice-free corridor used as a foundation of hypotheses or a means of temporal exclusion to deflect evidence away from potential pre-Clovis sites in the New World? What about ice
free coastal margins, circumnavigation, iceberg camping, and/or island-hopping by boats?

5. Is it wise to maintain one ruling theory versus multiple hypotheses as a means of advancement and adjustment of our understanding? Is there a more time efficient way to make determinations? Should the distinctly Southwestern Clovis data be the guide by which all Paleoindian evidence is judged elsewhere in the Americas? Is Clovis First intransigent?

**Paleoamerican Origins – Paradigm Breaking Part II**

It is worth discussing the means by which the first pre-Clovis site came to be accepted, the Monte Verde site in South America. By the late twentieth century, there were two proposed pre-Clovis sites in South America: Taima-Taima in Venezuela and Monte Verde in Chile. The sites were similar in many respects: both were around 14.6 years old, had El Jobo and El Jobo-like artifact assemblages associated extinct fauna remains, and had excellent botanical preservation.

Taima-Taima was investigated by a multidisciplinary research team in the 1970s (Bryan et al. 1978; Ochsenius and Gruhn 1979), but the research was criticized (Dincauze 1984; 1991; Haynes 1974; Lynch 1974) and the results largely ignored even though its critics never visited the site. One critic argued that the site had disturbed stratigraphic contexts due to presumed artesian spring flow that fluidized sand and clay sediment and sorted its original matrix by particle-size into a lower sand unit and two upper units of clay (Haynes 1974) even though Alan Bryan (1979: 41-51) had described the stratigraphy differently. Vance Haynes argued that:

Under these conditions it is easy for bones and artifacts to penetrate the fluidized sediments and settle out on the bottom (Haynes and Agogino 1966). If the black clay [above the red clay which was actually sand and lower grey sand] is due to a vegetation mat over all or part of the spring, then the possibility must be considered that the Taima-Taima deposits represent a spring bog to which man was attracted by trapped animals [but what about the paleo-spring at Black Water Draw in the US?]. . . .

Considering these possibilities all that can be said regarding the age of the artifacts is that they are older than the oldest date at the base of the black clay and no older than the youngest date in the grey sand. This would place the occupation between 10,300 and 12,500 y.a. $^{14}$C . . .
There is overwhelming evidence which shows that if there is one dominant trait that characterizes Paleo-Indians it is big game hunting. Rather than accepting this as the best interpretation of the available evidence Bryan prefers to argue for early man having arrived as a generalized hunter and gatherer. This may have indeed been part of the picture but all that is lacking is the compelling evidence to support it, especially if the questionable aspects of the sites under discussion are kept in mind [hydraulic deflation and particle size sorting]. In other words, this could be true, and there is some evidence that it could be so interpreted, but it is not an established fact to be used as a foundation for other hypotheses. (Haynes 1974: 381)

This was not the first time Vance Haynes disagreed with Alan Bryan, a main proponent for the pre-Clovis age of the Taima-Taima site. Bryan previously offered a hypothesis for the peopling of the Americas that envisioned multiple human migrations over a greater time depth than consigned to Clovis and a subsequent, in-place, cultural development for Clovis rather than an Old World imported one. His reasoning was as much anthropological as it was archaeological (Bryan 1969).

But Haynes offered the greatest detail about known Paleoindian life ways. In the Desert Southwest, the archaeological record not only had established that Paleoindians occupied the Americas; it also provided the contexts of climate, chronology, and, to a degree, the fauna being exploited. Nowhere in the Americas had archaeologists developed such a tight Paleoindian dataset and the effectiveness of his argument resonated brilliantly with the goals and ideology embraced by the “New Archaeology” (Watson 1972). Haynes brought geoarchaeology and radiocarbon dating to the table and knowledge of several Clovis sites located around artesian fed waterholes. These waterhole sites incidentally all had passed muster as recognized sites with meaningful contexts. His judgment was distinctly regional and his counter to Bryan based on the Southwest dataset. It was an argument that was distinctively Clovis-centric (Haynes 1969a); it was the dominant paradigm.

Getting back to the Taima-Taima controversy, Thomas Lynch (1974) joined Haynes in doubting the site’s integrity. Lynch (1974) took Haynes’ suggestion that groundwater may have contaminated the bone and sediments concluding that, “To my mind, the safest date for the Taima-Taima cultural association is 9910 ±130 B.C. . . .” However, the 9910 ±130 B.C. (11,910 $^{14}$C BP) must have been a typo because the tenor of his evaluation was critical of the pre-Clovis assessment of Bryan and others, and, in a later critique, Lynch (1990) placed the site’s age at 10,000 BP similar to Haynes. Using Clovis First criteria, sites like Taima-Taima were relegated to the status of archaeological possibilism (Haynes 1992).
Discarding the Taima-Taima evidence required several assumptions. First is the idea that artesian spring action occurred everywhere in the valley where the site was located became a base assumption. Jose Cruxent (1967) originally identified Taima-Taima as an undisturbed site in a spring fed valley. Apparently, his findings and the findings of others on the multidisciplinary crew that worked the site (Bryan 1979; Cruxent 1979; and Ochsenius 1979) was insufficient even though their adversaries never set foot on the site. A second assumption was that spring action fluidized the sediment. This led to a third assumption that the sediment column became so fluidized as to size-sort the entire stratigraphic sequence displacing artifacts and fossils to the bottom and the smallest and lightest particles to the top of the sequence. That led to a fourth assumption that the uppermost black clay (which is actually sand) may represent the remains of a vegetation mat of degraded organics. The fifth assumption was that the faunal remains not only included proboscidean bones but also smaller-sized animal remains that Haynes (1974) found to conflict with the big game hunting assumption in Clovis First. Finally, assuming that all else was true, then the site was ~10,300 $^{14}$C years old, maybe younger because of the suspected site disturbance (Dincauze 1984; Haynes 1974; Lynch 1974).

Because I have never visited the Taima-Taima site, I find making arguments one way or another ill-advised. But, I do have experience with artesian features. Had artesian spring action deflated bones and artifacts, and size-sorted a meter or more of the sediment column, it also would have destroyed the site’s fragile organic contents, the same organic content supposedly sorted upward then degraded to form the uppermost black sand, assuming that the sand in that unit is spodic; but it was not the only botanical component. Proboscidean digesta, recovered from the gut area of the animal’s skeleton was preserved on the level containing the bones and artifacts (Ochsenius 1979: 95-97). This evidence suggests that Haynes’ (1974) argument against the site’s validity is actually quite weak. Because of Haynes’ influence, the Taima-Taima site did not qualify as a pre-Clovis site.

At Taima-Taima the proboscidean remains were concentrated at the bottom of the lower sand unit intermingled with artifacts and digesta. Among the materials associated with Proboscidean remains were “small sheared twigs (gastrointestinal content)(Ochsenius 1979: 97, Figure 1)” and two El Jobo point fragments in the pelvic cavity area. Some bones had cut-marks and the artifacts, though considered by Haynes (1974) to be too few in number, were found with the proboscidean remains, not scattered elsewhere. By the time the site investigation was
complete, 21 lithic and 6 bone artifacts had been recovered (Cruxent 1979). “If we applied the same standard of context and association that we apply to Clovis sites in North America [such as Blackwater Draw No. 1, Naco, and others], Taima-Taima would pass muster” (Dillehay 2000: 131).

In Florida, locations where sediment liquefaction naturally occurs are artesian upwellings called sand boils. They are springs with insufficient flow to clear the spring vent of sand and it recirculates, creating the appearance of sand boiling (Scott et al. 2004). All particles in sand boils are abraders and are being abraded by others in this rock tumbler-like environment. However, groundwater movement to the surface can take place at different energy levels, some very minimal. For example, seepage is the low energy infiltration upward or conversely, percolation downward of water through porous rock or soil to or from the surface. Both are usually restricted to very slow ground water movement (Field 2002). Seepage wetlands and bogs represent one class of low energy, discharge environments where preexisting sediment is often augmented by the dissolved mineral content arriving via groundwater (Bryan et al. 2008; Richardson 1996). In these types of environments, there is little to no displacement in the existing sediment column. Rather, they are environments of deposition.

After two decades of criticism, Alan Bryan, along with Tom Dillehay, welcomed the idea of outside site inspections as a means of gaining sound judgments of their South American sites. They hoped to sway opinions and gain the acceptance of Taima-Taima and Monte Verde as legitimate pre-Clovis sites. Learning of this, Vance Haynes began seeking sponsors. In an article in *Natural History*, Haynes noted that Bryan had openly invited such inquiry (Haynes 1988). In another attempt at funding, Haynes published brief note in *Science* magazine urging granting agencies such as the National Science Foundation to sponsor an investigative trip because “controversial yet important sites for understanding the peopling of the New World, such as Monte Verde, need independent verification” (Haynes 1989).

The first volume on the findings at the Monte Verde site was published by the Smithsonian Institution Press in 1989. Dena Dincauze’s (1991) review of this volume (Dillehay 1989) pointed out that Dillehay’s effort did not present the archaeological findings, rather he detailed the site’s paleoenvironment, temporal, and site contexts. "The atypical kinds of data considered all contribute to the site a pervasive strangeness that only the data in the second volume can help allay. Dillehay is clearly aware of this problem; he notes that any ‘attempt to
link Monte Verde to North American cultures or to derive a set of generalizations about early cultures from it strikes me as quixotic’” (Dincauze 1991). But that did not prevent Thomas Lynch (1990) from criticizing Monte Verde’s site integrity, age, and the potential for younger, Archaic artifacts to have settled in Paleoindian-age level. But Lynch’s criticism fell far short, a mistake often made by people who have not undertaken a critical field review. As David Meltzer noted, "[and] to Dillehay’s lament that only two archaeologists had responded to his invitation to visit Monte Verde during the excavation and see for themselves, Lynch growled: ‘If so many of us stayed away, it was in good part because we did not feel free to go and make our own observations’" (Meltzer 2009: 122). The need for funding a firsthand site inspection and evaluation was growing.

The persistence of Vance Haynes and the willingness of Tom Dillehay led to a renewed funding search. Ultimately, the National Geographic Society and Dallas Museum of Natural Science co-sponsored a trip for nine outside Paleoindian specialists, the site investigators, and representatives from the funding agencies. They inspected the collections from Monte Verde housed at the University of Kentucky and Universidad Austral de Chile and traveled to the Monte Verde site for a site inspection during a weeklong expedition. Instrumental in this effort, Dave Meltzer observed that there were some who wondered if Monte Verde I, at ~33.0 ka $^{14}$C BP (~37.7 ka cal BP), represented a site, but "no one wanted to go there just yet" (Meltzer 2009: 125). By week’s end, the funding sponsors asked for a panel decision, which was unanimous. Monte Verde II was an archaeological site dating 14.6 ka cal BP.

The preservation at the Monte Verde II site was superb. Visitors were able to see structural elements lashed with fiber cordage, bone, stone, and organic artifacts including imported and local food and medicinal resources (Dillehay 1997; Dillehay et al. 2008). As for the lithic projectile points, Michael Collins said, “Given the substantial ambiguity resident in existing typologies of lanceolate points and the lack of bases on the three Monte Verde specimens in question, it is not possible to make an absolute typological determination; however, it is with the El Jobo points (Bryan et al. 1978; Cruxent and Rouse 1956) that these three have morphological similarities as well as relative proximity in time and space, so an educated guess would be that they are likely of that type” (Collins 1997: 426).

Nothing, however, has been decided regarding Monte Verde I, the 37,000 year old component with artifacts. It seems that archaeologists still don’t want to go there; Monte Verde I
cannot be summarily dismissed, however. The group inspecting Monte Verde I agreed, as did Dillehay, that it is an extremely intriguing site with artifacts in what appear to be well-dated contexts. Nevertheless, Dillehay and the panel were in agreement that further excavation of the artifact-bearing level was needed (Meltzer et al. 1997). At the time, it seemed that it was far better to avoid having the age of the older component get in the way of the younger site’s pre-Clovis acceptance.

The controversy about pre-Clovis sites such as Meadowcroft Rockshelter and, to a lesser degree, Monte Verde, did not go away. The argument over Meadowcroft Rockshelter in Pennsylvania need not be revisited here except to say that among the Paleoindian specialists who went to Monte Verde were Vance Haynes, a founder of Clovis First, and James Adovasio, principal investigator at Meadowcroft Rockshelter and by default a member of the pre-Clovis movement. On the last day, in a Chilean bar somewhere in Puerto Montt, a toast was proposed for the unanimous consensus that had just been reached, and to the christening of Monte Verde II as the first accepted pre-Clovis site in the Americas. While toasting, there was a toast mentioning Meadowcroft, not Monte Verde. Things went south after that including a falling out between Adovasio and Haynes (Meltzer 2009), but Monte Verde II was recognized as a legitimate pre-Clovis site in American Antiquity by its critics (Meltzer et al. 1997).

Two years later, however, Clovis First versus pre-Clovis enmity reappeared in the press (Adovasio 1999; Anderson 1999; Bonnichsen 1999; Collins 1999; Dillehay et al. 1999; Fiedel 1999a; Haynes 1999; Meltzer 1999; Tankersley 1999; West 1999), just in time for the “Clovis and Beyond” Conference in Santa Fe, New Mexico. Like a phoenix rising from the ashes, Stuart Fidel debuted as heir apparent spokesman for the Clovis First paradigm with the tacit backing of Haynes (1999). As a group of students and their friends spelled out on t-shirts at the 1999 Society for American Archaeology meeting in Chicago, IL, one side of the shirts had “Clovis Police: Kickin ass and enforcing paradigms” and the other “Monte Verde Mafia: It used to be mammoth now it’s just personal.” Remembering this message, Gary Haynes stated in an article published just after the meeting:

Advocates of a very early, pre-Clovis human presence in the Americas possibly would argue that the skeptical standards that once were applied by the so-called “Clovis police” (also known as the “Clovis mafia”)—self-appointed enforcers of the rules of interpretation who maintained the status quo by keeping Clovis the first people in the New World—are irrelevant, because Monte Verde has been universally accepted in all its interpretations. However, it should be argued in response
that even if the Clovis-first enforcers have disbanded, the standards of archeological interpretation must not be relaxed. Unsound interpretations are bad, no matter how many archeologists they may please; sound ones are good, no matter how few they satisfy (Haynes 2000: 265-266).

Monte Verde has not fallen from grace and continued research has only served to strengthen its pre-Clovis placement (George et al. 2005).

For years the Meadowcroft Rockshelter was debated and defended on many fronts and the fight for its acceptance as a pre-Clovis site included issues such as questions about contamination by coal dust and site repeatability, i.e., are their more Meadowcroft Rockshelter-like sites out there? Carbon contamination from coal dust was suspected of yielding anomalously old radiocarbon dates in levels that were much younger (Haynes 1980). Micro-morphological analysis of the proposed contaminated cave sediments showed there was no problem (Goldberg and Arpin 1999). Site repeatability, the other issue, asked if similar artifact assemblages existed, where were they? Adovasio began addressing this issue by pointing to a number of other nearby locations in the Cross Creek drainage that yielded surface-collected Miller complex artifacts. He felt the Miller complex represented an older-than-Clovis population in the upper Ohio Valley, and, possibly the Northeast (Adovasio et al. 1999; Adovasio and Pedler 2005: 26).

Indications that Adovasio might be correct came with the discovery and investigation at the Cactus Hill site in Virginia. Like the Meadowcroft Rockshelter, Cactus Hill had Miller or Miller-like points and yielded both radiocarbon and optically stimulated luminescence (OSL) dates of comparable age below the Clovis level (Feathers et al. 2006; McAvoy and McAvoy 1997). Geoarchaeological investigations also showed that Cactus Hill had good site integrity (Wagner and McAvoy 2004). The most recent discovery of a pre-Clovis site comes from the Delmarva Peninsula at the Miles Point site in eastern Maryland where a Miller-like point and a microcore and blades similar to Cactus Hill have been found in 24.4 ka cal BP context (Lowery et al. 2010).

Finally, the somewhat similar Page-Ladson points from Florida have been found at three sites: Page-Ladson, Wakulla Springs Lodge, and Half Mile Rise Sink. At Page-Ladson the early Paleoindian level is ~14.4 ka cal BP (Dunbar 2006b) and at the Wakulla Springs Lodge site, below the Clovis-like blade, the youngest possible age of that component is ~13.5 ka cal BP (Rink et al. 2011) with a median age similar to the Page-Ladson site.
That eastern seaboard pre-Clovis sites have similar biface projectile points appears to be more than random chance (Stanford et al. 2005) and, as a writer for the journal Science distinguished them, “Clovis-lite” (Marshall 2001). Thus it appears that early sites along the eastern/eastern Seaboard (including the northeastern Gulf Coast) are candidates to be the first recognized pre-Clovis ancestor in North America.

**Holocene Megafauna or Extinction by Extra Terrestrial Impact: the ET Hypothesis**

The defense of a paradigm can be revealing, perhaps disappointing if outcomes are not supportive, yet respectable researchers publish their results. In 2005 at the “Clovis in the Southeast” conference held in Columbia, South Carolina, Richard Firestone gave a presentation on behalf of his research group entitled *Evidence of a Catastrophic Impact Event at the End of the Clovis Era* (http://www.clovisinthesoutheast.net/spksched.htm). It was a hypothesis that an extraterrestrial (ET) impact had occurred at the Allerød-Younger Dryas boundary. Similar to the concepts of the KT Boundary impact and dinosaur extinction theory (Alvarez et al. 1980), Firestone proposed that the Younger Dryas climatic downturn was caused by an ET impact, which resulted in megafaunal extinction ~13.0 cal years BP (11.0 ¹⁴C BP) (Firestone et al. 2007). The ideas of the ET impact hypothesis were in agreement with several elements of the Clovis First paradigm. First, the timing was in agreement with Southwest Clovis-age stratigraphy with Allerød sediments occurring under Younger Dryas age black mats. Second, the Southwestern Clovis components had mammoth remains but the Younger Dryas (YD) black mats of Folsom age did not.

Both Martin (1967) and Haynes (1967) had recognized that the Southwestern megafaunal extinction had taken place at the end of the Allerød. The ET impact theory was a good match for Clovis First. Had there been a sudden extinction event resulting from an ET impact and, if so, was it the cause of ubiquitous black mats (Haynes 2008)? “I remain skeptical of the ET impact hypothesis as a cause of the YD onset and megafauna extinction. However, I reiterate, something major happened at 10,900 B.P. that we have yet to understand” (Haynes 2008: 6525). It was Vance Haynes who called for the testing the ET hypothesis in a proposal to the National Academy of Sciences. There were researchers with supporting evidence (Anderson et al. 2008; Bunch et al. 2010; Kennett et al. 2008; Kennett et al. 2009; Mahaney et al. 2010) but many
others brought evidence forward that no ET impact had taken place (Buchanan et al. 2008; Collard et al. 2008; Daulton et al. 2010; Gill et al. 2009; Hammen and Geel 2008; Paquay et al. 2009; Paquay et al. 2010; Surovell et al. 2009). Perhaps the most interesting exchange has been between Firestone (2010) claiming to have found evidence of ET impact at the Murray Springs site and Vance Haynes and others, including a cosmochemist and specialist in planet formation and asteroids, who found no evidence for ET impact residues at Murray Springs (Haynes, et al. 2010; Haynes, Boerner et al. 2010). More recently the ET impact hypothesis appears to have been refuted again (Pinter, Scott et al. 2011). Yet another study of the Murray Springs site has found evidence that appears to support an extraterrestrial event of some sort at the Allerød-Younger Dryas boundary (Fayek et al. 2012). So the question becomes, if there was an ET event, an air burst or impact, was it the cause of a sudden late Pleistocene extinction at the Allerød-Younger Dryas boundary (Firestone et al. 2007)?

A few questions come to mind at this point. First, are the Younger Dryas black mats ubiquitous markers of the Allerød-Younger Dryas boundary throughout the Americas? Second, did all Pleistocene megafauna become extinct by the end of the Allerød? The short answer to both questions is no. Vance Haynes found the stratigraphic sequence at Monte Verde to be remarkably similar to Clovis sites “with black mats or soils covering erosional surfaces” (Haynes 1999: 18) yet the Monte Verde sequence dated 14.7 ka cal years BP (n=4 \(^{14}C \) related dates). They represented similar looking sequences with different temporal contexts. As for Pleistocene megafaunal extinction by the end of the Allerød, instances of Younger Dryas and Holocene megafauna are now known in both the Old and New World (Boeskorov 2006; Coltorti et al. 1998; Ficcarelli et al. 2003a; Gonzalez, et al. 2000b; Gutiérrez and Martinez 2008; Haile et al. 2009; Hubberten 2003; Kuzmin and Orlova 2004; Politis and Messineo 2008; Steadman et al. 2007; Stuart et al. 2004; Veltre et al. 2008). The data now indicate that the so-called late Pleistocene extinction “was spread over more than 50,000 years globally; was the accumulation of diachronous, shorter-term pulses that took place on a regional basis; and was amplified by the interaction of both biotic (humans as invasive species) and abiotic (climate) drivers” (Barnosky et al. 2004: 74). The cultural and natural aspects of post glacial recession differed regionally from one place on the globe to another. Therefore the Allerød extinction of proboscideans and other fauna that apparently took place in the desert Southwest should not be expected to precisely correspond to the timing of extinction events elsewhere in the Americas.
As research has progressed, and as new methods of investigation have been deployed, the Clovis First paradigm has lost its former authoritarian status. Simply put, there are too many non-Clovis sites that represent a predecessor or a contemporary of Clovis and the series of geoclimatic and chronostratigraphic events once proposed for Pleistocene America are in fact regionally variable phenomena. One is now left with the notion that the peopling of the New World may have taken place thousands of years before Clovis and possibly as early as the latter part of Marine Isotope Stage 3 or prior to 24.0 ka cal BP, though the more conservative view places it about 16.0 ka cal years BP range.

Archaeologists had been working under a one-size fits all paradigm for the peopling of the Americas based on one region’s initial Paleoindian discoveries and its researchers’ ability to establish contexts. All evidence based on archaeology -- regarding how, when, and where the first people came to the New World -- are conjectural. There is little uncertainty that our present understanding of the Paleoindian occupation in the Americas is in flux and has been begrudgingly reinvigorated in the aftermath of this once dominant paradigm; a paradigm that was exclusive and dismissive of all contenders. It was the type of paradigm that Chamberlin warned us about (Chamberlin 1897).

Make no mistake, Clovis First is still a viable paradigm for some (Dickinson 2011), but the tenor of the debate has become inclusive, optimistic, and clearly less dogmatic (Goebel et al. 2008). For the first time since the first Folsom and Clovis sites were discovered, we are again provided an opportunity to reboot and recompile the evidence. This time we should judge each region’s evidence on its own merits. The elusive question of first American origins may be one of the most enduring and exciting questions in American archaeology, but it need not interfere with discoveries of merit.
Figure 2.1. Charles C. Abbott (source - http://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_30/February_1887/Sketch_of_Charles_C._Abbott)
Figure 2.2. William Henry Holmes (source - http://en.wikipedia.org/wiki/File:William_H_Holmes_c1918.gif)
Figure 2.3. Trenton Gravel preform (Abbott 1872: 154, Figure 21)
Figure 2.4. Ales Hrdlicka (Source - http://en.wikipedia.org/wiki/File:Ales_hrdlicka.jpg)
Figure 2.5. T. C. Chamberlin (source - http://en.wikipedia.org/wiki/File:T.C.Chamberlin.gif)
Figure 2.6. Samuel Williston (source - http://en.wikipedia.org/wiki/File:Williston1890s.jpg)
Figure 2.7. Ernst Valdemar Antevs (source - http://www.greatarchaeology.com/archaeologist_list.php?archaeologist=59)
Figure 2.8. Flaked mammoth bone recovered with Clovis artifacts at the Lange-Ferguson site, Pine Ridge, South Dakota (Bostrum 1997: slide 17)
Figure 2.9. Clovis point and biface with overshot flaking (http://www.texasbeyonddhistory.net/gault/clovis.html)
Figure 2.10. Gault site Texas portable Paleoindian art represents some of numerous examples from various sites (http://www.texasbeyondhistory.net/gault/clovis.html).
CHAPTER THREE

THE PALEOINDIAN SITES OF FLORIDA

Paleoindian Site Investigations

Florida has long been recognized for its rich yield of Pleistocene vertebrate fossils and its prolific assemblage of Paleoindian stone tools primarily concentrated in karst river basins. The most productive areas have been the lower Santa Fe River from River Rise at O’Leno State Park downriver to its confluence with the Suwannee River (Dunbar 1991b; Dunbar and Waller 1983; Thulman 2006; Waller and Dunbar 1977). Although these areas have produced significant remains, the first investigations purported to have evidence Pleistocene megafaunal and human interactions were not located in north-central Florida.

In the early twentieth century, finds of Pleistocene fauna and human remains at Vero and Melbourne set off a firestorm of controversy (Gidley and Loomis 1926; Hrdlicka 1917; Sellards 1916a). Geologists considered the human remains to be contemporary with the Pleistocene faunal remains, but Ales Hrdlicka, Smithsonian Institution physical anthropologist and acknowledged expert on “Early Man” finds in the Americas, declared that they were recent burials intruding into Pleistocene strata. Although the antiquity of these finds was discredited, recent radiometric dating at Vero suggests that the bone bed containing Pleistocene fauna dates to about 80,000 years BP (Rink 2010) supporting Hrdlicka’s assessment. Artifacts recovered at Vero are stylistically associated with the more recent, Archaic period assemblages. Even though these early finds were discredited, the possibility persisted that Pleistocene animal remains might be associated with early artifacts in Florida.

Other evidence of Paleoindian occupation eventually came from tools found elsewhere in Florida. In 1935 Mrs. H. H. Simpson, Clarence J. Simpson’s mother, published an article in Hobbies magazine (Simpson 1935) reporting the discovery of ivory artifacts and mastodon bones in a spring run in the Santa Fe River basin (now believed to be the Simpson Flats Site, 8CO174). Five years earlier, hard-hat divers recovered the remains of a mastodon from the Wakulla River just below the headspring (Gunter 1931). It was not the first nor the last time that late Pleistocene
fossils would be recovered from Wakulla Springs (Sellards 1916b). In the main, these finds have been individual carcasses. The Wakulla mastodon recovery was headed by the State Geologist, Herman Gunter, and included Clarence J. Simpson as one of the divers. In handwritten notes, Simpson documented that they recovered “a number of them [lanceolate Yuma points, a point type then in usage] while taking the Wakulla mastodon out of Wakulla Springs” (Simpson 1941a). Simpson discovered many archaeological sites during his employment with the Florida Geological Survey and among them, numerous Paleoindian sites and artifacts. His ability for detecting archaeological sites was nothing short of incredible.

It is important to digress briefly to discuss the history of point typology and the terms of usage. After the Lindenmeier site yielded Folsom points and the Black Water Draw site yielded Folsom and Clovis points, other lanceolate point sites were discovered nationwide but there was no consistent terminology to describe them. At that time one thing was clear. Most Paleoindian points were lanceolate and of those, many, but not all, displayed basal fluting. According to Marie Wormington (1949:33), “at first all grooved [fluted] points were simply called Folsom and, unfortunately, a few writers still continue this practice” (Wormington 1949: 33). Terms such as Folsom, Folsomoid, Folsom-like, and un-fluted Folsom were used as was Yuma, as catchalls for Paleoindian lanceolate points (see for example Howard 1943).

In September, 1941 a symposium held in Santa Fe, New Mexico brought scholars together with the goal of refining the confusing and haphazardly applied terminology. The use of Yuma as a type name was scrapped although some of its Southwestern variants were placed into a new type called Plainview. In the late 1930s, developments at Black Water Draw had split Clovis from Folsom and, at the Santa Fe symposium, the term Fluted Points was adopted as the generic term to encompass all lanceolate points with fluting but restricting the Folsom type name to the classic form we know today (Wormington 1949). The clarification of terms, though important, also reflected the Southwestern venue. Moreover, the term Fluted Point led to an assumption that became implicit in the academic literature, namely that Fluted Points, including Clovis and Folsom, were older and unfluted points such as Plainview were younger. It now appears that this long-maintained assumption is not correct and unfluted forms such as El Jobo points (Bryan et al. 1978; Collins 1997; Cruxent 1979; Dillehay 1997; Meltzer et al. 1997), Miller points (Adovasio et al. 1999; Bradley and Stanford 2004; Lowery et al. 2010; McAvoy and McAvoy 1997; Stanford et al. 2005), Page-Ladson points (Bradley and Stanford 2004;
Dunbar 2006b; 2008; Dunbar and Hemmings 2004; Rink et al. 2012; Stanford et al. 2005), and the early end of the stemmed point tradition of the American Pacific coast (Erlandson and Braje 2011) predate Clovis and fluting. The temporal assignment implicit in the term Fluted Point is yet another assumption that led researchers astray.

Returning to Florida where, in the summer of 1940, a mastodon was recovered from an unknown location in the Ichetucknee River somewhere below the head springs. The recovery included “an exceptionally fine head and set of tusks along with the other bones except for “one hind leg” (Gunter 1941). Around the same time, Simpson (1941) reported the second discovery of Yuma points as well as carved ivory rods at the Simpson’s Flats site (8CO174), another underwater site in the Ichetucknee River. An article published in American Antiquity was dedicated to the beveled ivory rods due to their striking similarities to specimens from the Black Water Draw site in Clovis, New Mexico (Jenks and Simpson 1941). In a letter to E. H. Sellards, Alex Krieger characterized two of the Simpson’s Flats site stone points as Plainview types and the third as Clovis “if fluted on both sides” otherwise it would also be a Plainview (Krieger 1946). The Simpson’s Flats site also yielded a lithic scraper lying below the partially articulated vertebral column of a mastodon (Jenks and Simpson 1941; Simpson 1941). A third article about this and other Paleoindian sites was published in the inaugural issue of The Florida Anthropologist. In it, Simpson characterized the stone points as Folsom-like and the beveled rods as “fossilized ivory points, similar to those found at Clovis, New Mexico” (Simpson 1948a: 13).

Simpson went on to say:

While the occurrence of these points in the river bed in association with fossil vertebrates is not indisputable evidence of contemporaneity, the consistency with which they are found together and the degree of fossilization of the ivory artifacts which also occur under the same conditions, clearly indicate that there is a need for further research on the problem (Simpson 1948a: 13-14).

This was the first appeal for the investigation of sites located in a karst riverine environment. It was also a general call for the investigation of Paleoindian sites in Florida.

Stanley J. Olsen, a paleontologist then at the Harvard Peabody Museum, inspected sites in the Ichetucknee River during the spring of 1949. In a letter and report to Alfred S. Romer, director of the Harvard Museum of Comparative Zoology, Olsen does not mention who accompanied him to these sites yet there is no doubt he visited the Simpson’s Flats site and
found it to be the most productive of all the sites he inspected (Olsen 1949). In the letter, Olsen indicated that published material about the Ichetucknee sites consisted of only a few sentences in Florida Geological Survey publications, that maps of the area were almost nonexistent, and that his informants were not even aware of the true length of the Ichetucknee River. In the report he added, “As to recent reptiles, five-foot cotton-mouth moccasins and one three-foot alligator were encountered without incident” (Olsen 1949: 3).

The site Olsen referred to as Mill Pond (Simpson’s Flats) was characterized as having many fossils strewn over the channel bottom as well as eroding from dark grey clay. He found the dark grey clay stratum (actually calcareous silt) at other sites in the Ichetucknee that also yielded fossils. That Simpson was part of the survey team during the site inspections is probable because Olsen did not know the location of the sites. Olsen also reported that he used two methods commonly used by Simpson: the use of a glass-bottomed bucket from a boat to locate specimens in water deeper than ~4m ± 1.5 and by diving to the bottom using hard-hat diving equipment. Simpson had been using a glass-bottomed bucket to located specimens for years and the Florida Geological Survey, where Simpson was employed as a diver when needed, used hard-hat diving equipment to recover the Wakulla mastodon. Though Olsen seemed impressed with the Ichetucknee’s fossil remains, he did not seem impressed by its potential for yielding in situ remains even though he documented that potential. Perhaps his training as a paleontologist narrowed his focus and limited it to fossil remains. For whatever reasons, Olsen mentions nothing about artifacts or archaeological potentials.

Later that year, John M. Goggin wrote Simpson proposing that Folsom-like points from Florida be reassigned to the type name Suwannee. Goggin first considered the term Santa Fe but thought it too confusing because it had meaning “in the West” (Goggin 1948). Simpson agreed, saying, “I am glad that you are going to call them Suwannee Points.” He also provided Goggin with instructions on how to find a site at the mouth of the Santa Fe River (Simpson 1948b).

In 1949 Goggin excavated the unnamed site (8SU2) at the mouth of the Santa Fe River and in an article about his findings, formally proposed Suwannee as a type name for Paleoindian lanceolate points in Florida (Goggin 1950 and Florida Master Site File data for SU2).

Goggin’s investigations were not the only work that took place at the Suwannee river mouth. Simpson and William E. Edwards conducted work at the Butler site (8GI1) on the Gilchrist County side of the river mouth as well as at other sites (Dolan and Allen 1961; Edwards
1952; Simpson 1950a). The Butler site previously had been collected by Simpson and discussed in his article and in correspondence (Simpson 1948a; 1950a; 1950b; 1950c). Simpson described the Butler site and artifacts in this way:

The largest majority of the Folsom-like points, which I have from the mouth of the Santa Fe River, were obtained by digging where a series of high waters had eroded the bank [in 1948 the Suwannee River experienced its all-time record flood]. Some had eroded from the original deposit but some seemed to have been in firm sand that I am confident had not been eroded yet. It would take some detailed trenching at the site to make sure. There are no artifacts on the surface over the area where we have been finding them. The river is eroding the point away and concentrating material at the places where it is eroding (Simpson 1950d).

The results of Edwards’ and Simpson’s efforts are briefly documented in a site report on the Darby and Hornsby springs sites. Only the results on two of the seven sites they excavated are represented, however. The sites that were not reported included the Butler site, Ichetucknee site (at an unknown location), Meander site (8AL302), Marchant site (8AL14), and Archer site (never recorded but near 8AL14). Odd though it may seem, a few artifacts from the Butler and Meander site are depicted in plates of the Darby and Hornsby Springs report with minimal explanation though stratigraphic levels are noted (Dolan and Allen 1961).

Of the sites Edwards and Simpson investigated, it is unclear which sites Edwards later discussed in his dissertation. Nevertheless, it is important to note what he had to say about them.

Further stratigraphic data from central Florida resulted from excavations by the writer in 1951 and 1952, with the assistance of J. C. Simpson and with funds supplied by the Florida Geological Survey. At one site, two smoothed-base lanceolate points . . . [with] fairly concave bases, were recovered with several hundred Paleo-Indian implements. These Paleo-Indian artifacts extended to a depth of from 2 to 5 feet and resembled for the most part artifacts reported from various Paleo-Indian sites in the West. These preceramic deposits were capped by a fiber-tempered potsherd-bearing horizon, on which was superimposed a stratum containing material assignable to later ceramic period cultures. Mineralized horse teeth at this site appear to indicate contemporaneity with Pleistocene fauna now extinct. At another site in the vicinity, a large “fish-tail” point occurred with a variety of other artifacts (some previously undescribed at any locality) stratigraphically below Deptford pottery. Finally, representing perhaps the earliest occupation in this area, parallel-sided, straight-based points (but not belonging to any of the lanceolate types previously mentioned) were found in virtually certain association with mastodon remains. . . [the Page-Ladson type from North Florida sites as well as the lozenge-shaped type recovered from Harney Flats are parallel-sided, flat to slightly concave based points – author’s addition]

. . . Despite the vast variety of Paleo-Indian points in surface collections, it was found that single components at one site have very limited number of highly specific point types, each of which appears thus to have spatial and temporal significance (Edwards 1952: 89-90).
At Hornsby Springs, a chert scraper was found in association with a mastodon tooth, debitage and other fossil remains in the sealed interior of a sediment-filled solution tube. The Butler site, located on the south bank of the Santa Fe River at its confluence with the Suwannee River, yielded a major concentration of lanceolate points (Simpson collection 102432, Florida Museum of Natural History).

At the Helen Blazes site (8BR27) in Brevard County, waisted or fishtail as well as excursive lanceolate points and Early Archaic notched points were found below younger Archaic stemmed points (Edwards 1952: 63-66, 76). Though Edwards acknowledged Goggin’s Suwannee type, he, like Simpson, preferred using the term Folsom-like points. Edwards also understood that a diversity of Paleoindian and Early Archaic projectile point forms had been recovered from the Helen Blazes site (Edwards 1952: 87-90). Helen Blazes seemed problematic. Was the site a multicomponent site with many point types in a sediment column with little to no stratigraphic separation or was it a single component site like the ones Simpson and Edwards excavated in north Florida? This question is significant and will be discussed later.

In the late 1950s, investigations were undertaken at Bolen Bluff (8AL439) overlooking Payne’s Prairie in Alachua County and at the Paradise Park site (8MR92) near Silver Springs in Marion County. The results of investigations at the Bolen Bluff site were equivocal (Bullen 1958) as they had been when Goggin worked there (1950). Only surface finds of Suwannee points were revealed. Investigations at the Paradise Park site, however, yielded Clovis points from contexts below younger artifact levels (Neill 1958). Even though Wilfred Neill identified the projectile points as Suwannee to be consistent with Goggin’s new typology, the points are excursive and waisted fluted Clovis types. The discoveries at Silver Springs were significant enough to put Florida in the academic literature (Willey 1966: Figure 2.2, page 61).

Around the same time, SCUBA diving was being introduced in Florida and the discovery of abundant underwater fossil and artifact concentrations became apparent with the new technology. The ability to freely swim underwater with a contained air supply for a prolonged period and safely return to the surface meant that access to formerly unreachable places was possible. At places like Silver and Wakulla Springs, mammoth, mastodon, bison, and other late Pleistocene animal remains were being recovered at the same places that were yielding Paleoindian artifacts (Neill 1964; Olsen 1958). People using SCUBA equipment were the first to
have access to these deposits since water tables rose and inundated former low-lying land surfaces around 10.8 ka cal years BP.

Olsen returned to Florida to accept a position with the Florida Geological Survey and continued to collect fossils and artifacts. His collecting focus took place in Florida’s karst rivers on sites of archaeological and paleontological interest. In an article published in *Natural History*, Olsen stated:

In the Ichetucknee River, one of Florida’s most productive fossil localities, for example, it is possible to find the remains of mastodon and tapir in juxtaposition with pop bottles and beer cans. Until extinct animal bones are found with a spear point actually embedded in the bone – and preferably with the bone growing around the point – positive, contemporary association of the two cannot be claimed in the case of a stream deposit (Olsen 1958: 402).

A few years later in an article entitled “Underwater Treasure,” Olsen stated:

Several months ago a few isolated bones of a large Pleistocene bison, that had washed downstream from the main deposit, led to the discovery of much of the animal’s skeleton which was found lodged in a limestone solution hole in the bottom of the Wakulla River. Single fossil bones will often indicate a richer deposit farther upstream which may yield material still in place in the clay beds that form the sides of many of the stream bottoms (Olsen 1962: 26).

Today, the *Bison antiquus* collected from Wakulla Springs is not in a public museum in Florida and its whereabouts is unknown. Shortly afterward Olsen authored yet another publication through the Florida Geological Survey stating:

Good material has been obtained . . . from the clay flats of Mill Pond area [Ichetucknee River, Simpson’s Flats site] which begins a mile downstream from the main boil. The best method of collecting in the mill pond area is by the use of a steel rod or probe which is shoved into the clay, just beneath the water. If a bone is struck, it is felt through the metal rod and can then be gently excavated, the swift running water carrying away the excavated mud. Many of the fragile muskrat skulls and antlered deer skulls were obtained by Mr. Clarence Simpson in this way (Olsen 1963: 72).

These articles, as well as those in other publications (see for example Olsen 1961) served to discourage all interest in the scientific investigation of karst river sites but they also generated interest in fossil and artifact collecting. His publications served as guides for how and where to
collect specimens in a karst river environment. It is the reason that archaeological resources in Florida rivers were opened to collecting.

In the early 1960s, two submerged sites in southwest Florida gained notoriety. Warm Mineral Spring and Little Salt Spring revealed artifact, faunal, and botanical deposits accumulated on submerged edges and ledges of their cenote walls (Clausen et al. 1979; Cockrell and Murphy 1978). The sites were located in quiet, relatively still water environments, which should have eliminated any concerns about swift currents and erosion affecting site integrity. Nevertheless, controversy about the validity, methodology, and handling of the site investigations and the people involved began almost immediately and continued for decades. Within the past decade or so, research crews led by John Gifford and Steven H. Koski of the Rosenstiel School of Marine and Atmospheric Science, University of Miami, have established a sound approach to the investigations at Little Salt Spring and the controversy at that site has subsided (Alvarez Zarikian et al. 2005; Gifford 1993). Work at Warm Mineral Springs ended some time ago. Both of these sites are important but they are best known for their Early and Middle Archaic components. The nature and significance of the Paleoindian component(s) at Little Salt Springs are presently under investigation.

But what about the archaeological potential of sites in flowing water karstic river environments? The very definition of fluvial environments is often related to geologic terms such as reduction environment, erosion, transport and selective particle size sorting by washing. For example see terms such as fluvial, lag, washing in the *Glossary of Geology* (Neuendorf et al. 2005). Most riverine systems are at least seasonally erosive due to steep gradients from their headwaters often thousands of meters above sea level and their ultimate confluence with their base level, the sea. But one size rarely fits all in nature and Florida karst river systems represent that rare exception to the rule. The highest point of elevation in Florida is only 105 m above sea level (Britton Hill in Walton County) and only one river, the Apalachicola, has its headwaters in the Appalachian, Great Smokey Mountain chain. All other drainages are confined to the coastal plain. The karst nature of Florida’s river systems also plays an important role that serves to attenuate the potential for destructive water currents. In-bank storage is a phenomenon that diverts floodwater to a labyrinth of subterranean karst conduits, a natural holding tank in Florida’s highly karstified Tertiary limestone. The result is the reduction of surface flow (Clarke
1965) and with it, the potential for erosion. But early researchers, like Olsen for example, did not appreciate these rather exceptional river dynamics.

By the 1960s SCUBA diving and the collection of artifacts and fossils from Florida rivers became a hobby for some and a source of income for others. Archaeologists were skeptical of river sites because most were not divers and had accepted the published observations of those who were. A notable example of this perspective is Clauser (1973) who discounted the integrity of the terrestrial sites surrounding the Ichetucknee River because he believed flooring and erosion had likely compromised the integrity of the sites in reach of the river’s flood stage levels. The problem really stemmed from a lack of geological knowledge on the part of archaeologists.

A few river divers/collectors observed that there were intact underwater artifact and fossil concentrations. Their experiences led directly to the first hypotheses attempting to explain why and how archaeological sites located in now-flowing rivers were formed (Neill 1964; Waller 1969; 1970). It should be noted that the most significant concentrations of diagnostic Paleoindian artifacts are from river basins, mostly from karst river channel locations (Allen 1967b; Bullen 1962; Dunbar 1991b; Dunbar and Hemmings 2004; Dunbar and Waller 1983; Dunbar and Webb 1996; Faught 1996; Goodyear 1999; Hemmings et al. 2004; Milanich 1994; Neill 1964; 1978; Purdy 1981; Simpson 1948a; Thulman 2006; Waller 1969; 1970; 1983), though there is no doubt that many have gone unrecognized in the surrounding wetland basins.

Reports of partially articulated late Pleistocene megafauna embedded in underwater sediment columns became more and more common (Allen 1967b). Sometime in the late 1960s, Ben Waller and his diving partners found a partially articulated Pleistocene horse skeleton eroding from a submerged part of the riverbank at the mouth of the Santa Fe River. The discovery was reported to archaeologist Ripley Bullen of the Florida State Museum (now the Florida Museum of Natural History) but Bullen was not a diver and it was unfortunate that another prominent Florida archaeologist and diver of the period, John Goggin had recently passed away. Waller subsequently collected the site while it was actively eroding. In addition to the horse remains, he also recovered four Suwannee points, three of which were near the thoracic vertebrae in the animal’s neck region (Waller 1983).

From 1968 to 1969 paleontologist S. David Webb surveyed several rivers in Florida for vertebrate fossil localities. As a result of these surveys, Webb’s crew discovered several partially articulated skeletons in the Half Mile Rise section of the Aucilla River.

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An important section of the [Aucilla] river in this confusing terrain is Half Mile Rise into which the Wacissa River drains. . . Half Mile Rise reveals a succession of marl and peat deposits, only feebly eroded, along the river bottom. Spectacularly complete skeletons of mammoths (*Mammuthus floridanus*) and mastodons (*Mammut americanum*), excellent material of *Bison antiquus* and the ground sloths, *Megalonyx jeffersoni* and *Paramylodon harlani*, and a considerable diversity of smaller vertebrates were collected in the marls, and other material, though less abundant, was recovered from the peat. . . Potentially these [Aucilla River] sites constitute the most interesting Late Pleistocene sequence in Florida (Webb 1974b: 480).

In 1972 a river diver named George Guest found mammoth remains in the Silver River not too far from the Paradise Park terrestrial site mentioned above. He reported the find to Ben Waller, who in turn, reported it to archaeologist Charles Hoffman, then a faculty member at the University of Florida. The site was named the Guest mammoth after its discoverer or the Silver Run Mammoth site (8MR130) as it was recorded. The Guest site became the first river channel site to be archaeologically investigated since Olsen’s pronouncements. The results, other than a student master’s thesis (Rayl 1974), were only minimally published in a short journal article (Hoffman 1983). Hoffman was inhibited by the critical scrutiny regarding what a Paleoindian site should include or, in this case, not include. The Guest site yielded a non-diagnostic, small lozenge-shaped point as well as small, Holocene-sized, deer metapodial bone pins. In addition, a sample of the mammoth bone yielded a radiometric date of about 11.3 ka cal BP, a Holocene age much too young to represent an extinct Pleistocene species. After all it had already been documented that the extinction of mammoth took place around 13.0 ka cal BP and that Clovis hunters were involved (Haynes 1967; Haynes 1971; Martin 1967). Although Hoffman presented his findings at regional and national meetings, other archaeologists were critical of his findings. It is unfortunate that Hoffman’s findings and the opinions of his critics were never published. The bone date from the site is very likely too young due to the problems inherent with the $^{14}$C dating of bone and absence of procedures at that time to correct it. There is also good evidence that small lozenge-shaped points (Adovasio et al. 1999; Bradley and Stanford 2004; Dunbar 2008; Jones and Tesar 2000; Lowery et al. 2010; McAvoy 1992; Stanford 1991) and small bone pins (Dunbar and Vojnovski 2007) are part of the Paleoindian toolkit.

A second attempt to test a karst river channel site was undertaken by underwater archaeologists with the Florida Bureau of Archaeological Research (Clayton 1981; Dunbar 1981c; Palmer et al. 1981) at the Fowler Bridge Mastodon site (8HI393Cuw) near Tampa. But it
was not until the investigation of the Page-Ladson site (8JE591) beginning in 1983 that the true potential of inundated sites in docile fluvial environments was realized (Dunbar et al. 1988; Serbousek 1983; Webb 2006b). As a result, general interest in the archaeology of river channel sites increased. The Aucilla River Research Project was promoted by a handful of river divers who at one time or another had found something extraordinary in the river; a discovery or two that spurred their quest for knowledge over the excitement of discovery or a particular specimen’s monetary value.

*Bison antiquus* remains, discovered in the Wacissa River by Roger Alexon and his diving companions, were reported to Jerald T. Milanich and Webb of the Florida Museum of Natural History. Because of the site’s importance, the site location was reported and the specimens collected were donated for museum curation. The frontal bone of the bison’s skull contained a fragment of an embedded projectile point. A bone sample collected from the site and excavated by hand from a buried context yielded an age of ~12.8 ka cal BP; it was Clovis age. Beside the horn cores and skull fragments, there were several other skeletal elements of *Bison antiquus* which appeared to come from a single individual (Webb et al. 1984: 389).

On land, a pre-construction survey in the Interstate 75 (I-75) corridor in Hillsborough County near Tampa presented an extraordinary opportunity to advance Paleoindian research. The proposed right-of-way near Harney Flats had Early Archaic (Bolen points) and Paleoindian (Suwannee points) components (Jones 1978). Interviews with Son Anderson and Bruce Guimares, both land owners on and adjacent to the I-75 right-of-way, indicated that 15 Suwannee, 2 Clovis and 1 Simpson (possibly a waisted Suwannee or Clovis point) and numerous lanceolate preforms had been recovered by them and a friend, Mike Harold, from a new cut-bank of the Tampa Bypass canal directly adjacent to Guimares’ property (Dunbar 1981a). The cut-bank area of the canal lies 250 m east of the centerline of the I-75 right-of-way and Harney Flats site. Son Anderson’s property was in the right-of-way of I-75 and was purchased under eminent domain. I. Randolph Daniel and Michael Wisenbaker directed excavations on the Anderson property, one of the largest Paleoindian basecamps to be investigated in the Southeast US (Daniel and Wisenbaker 1987). Similar to the Paradise Park site at Silver Springs, the Paleoindian/Early Archaic components were deeply buried from 1m to 1.6m below the surface.

Investigations on underwater sites such as the Fowler Bridge Mastodon site (8HI393) in the Hillsborough River (Palmer et al. 1981) and the Alexon Bison site in the Wacissa River

Don Serbousek and his diving partner John Cotrill reported Paleoindian artifacts and Pleistocene fauna from the Half Mile Rise Sink site (8TA98)(Serbousek 1983). They felt archaeologists should investigate the site but subsequent investigation found the site remains lay in sediments that had avalanched down slope. As a result, investigation shifted to the Page-Ladson site (8JE591) and by 1987 work at Page-Ladson yielded surprising results and the first grant was secured from the National Geographic Society to continue the research. Eventually, the research was also funded by special category grants from the Division of Historical Resources. One of the test units at the Page-Ladson site had revealed a level with Pleistocene megafauna and artifacts sealed beneath several meters of sediment. It yielded radiocarbon dates averaging about 14.4 ka cal BP. Investigations were also carried out on a number of other underwater sites in the Aucilla-Wacissa basin including Sloth Hole (8JE121), Cypress Hole (8JE1146), and Latvis-Simpson (8JE1617) (Hemmings 1999; 2004; Mihlbachler et al. 2002), Little River Rise and Little River Rapids (Muniz 1998a; 1998b; 1998c) in the Aucilla River, and the Ryan-Harley site (8JE1004)(Dunbar et al. 2005; Dunbar and Vojnovski 2007) in the Wacissa River.

Back on the terrestrial surface, in 1995 plans were approved to replace septic lines to the Wakulla Springs Lodge. The area affected included the location of an archaeological site known by the same name. B. Calvin Jones of the Bureau of Archaeological Research headed an archaeological salvage effort, and his crew literally dug most of the pipeline trench by hand on the north side of the Lodge. Their work resulted in the discovery of a Paleoindian component buried more than a meter below the ground surface as well as below a number of Early Archaic (Bolen at 10.4 ka cal BP) and younger site levels (Jones and Tesar 2000). The Paleoindian level(s) of the Wakulla Lodge site (8WA329) were not dated because no surviving materials suitable for radiocarbon dating were recovered, an all too common problem associated with deep
sand terrestrial sites in the Southeast. In 2008 funding was secured from the National Geographic Society to reopen the investigations at Wakulla Springs Lodge site with the objectives of identifying the Paleoindian level(s) and collecting sand samples for an emerging dating technique, optically stimulated luminescence (OSL). Using the most conservative interpretation of the dating results the early Paleoindian level at the Wakulla Lodge site appears to be a little younger; however, using the median age it is about the same age as the Page-Ladson site (i.e., ~13.5 ka cal BP young end of the error bar and ~14.7 ka cal BP median age of the error)(Rink et al. 2012).

Shortly before the Wakulla Springs Lodge site investigation began, another mastodon fossil site, the Vickery Mastodon, was located in a submerged context in the Wakulla River a few hundred meters below the springhead. Vibracores, ground penetrating radar, and cursory testing suggest that there may be a substantial amount of the animal’s remains buried in a stratigraphic section about one to one and a half meters deep. Bone preservation appears to be excellent. The only attempt to date a bone specimen from this skeleton was unsuccessful after Tom Stafford determined there was insufficient collagen content. It is a site worthy of investigation.

Most recently an effort was undertaken through McMaster University, Canada in cooperation with the Department of Anthropology at Florida State University to OSL date a number of Paleoindian sites (for a discussion of the sites proposed for dating see Dunbar 2007). The results for the Helen Blazes indicated that it has at least two components based on the successful results on two out of three OSL samples taken (Rink et al. 2012) The uppermost level dates to the Middle Archaic and is consistent with the heat treated and stemmed points recovered by Edwards (Edwards 1952) as well as the recent testing. The level below it dated from the Late Paleoindian to Early Archaic which is also consistent with most of the artifacts recovered by Edwards as well as the artifacts recovered during recent testing. A third OSL sample, taken near the base of the unit, was determined to be questionable because the bottom of the pit was water saturated and the sand unit in the test pit wall above a dense clay base was actively sloughing into the pit.
Paleoindian site distribution in Florida

Another aspect of Paleoindian research in Florida bears mentioning: the geographic distribution of diagnostic Paleoindian artifacts. It is important in understanding the occurrence of early artifacts and site distribution across the landscape. The pattern in Florida is distinctive. The majority of sites are located in areas where chert-bearing Tertiary limestone occurs near or at the surface. In areas where the Tertiary limestone is deeply buried by younger, non-chert bearing sediment, Paleoindian artifacts are least common. In addition, the Tertiary limestone formations of Florida, Georgia, South Carolina, and parts of Alabama hold one of the nation’s largest freshwater aquifers. It was, and is, an excellent and persistent source of potable water (Dunbar 1991b; Thulman 2006; Thulman 2009).

Prior to World War II, investigation of Paleoindian sites west of the Mississippi River had shown that lanceolate, basally ground, projectile points of different types were associated with now extinct Pleistocene animals in late Pleistocene contexts (Cook 1927; Cotter 1937; Figgins 1927). By the 1940s, archaeologists recognized that lanceolate projectile points were also diagnostic of Paleoindian activity in Florida and first began documenting their distribution (Simpson 1941a; Simpson 1948a). Since that time there have been several efforts to document Paleoindian site distributions in Florida (Allen 1967b; Anderson 1996; Bullen 1962; Coastal Environments 1977a; 1977b; Dunbar 1991b; Dunbar and Waller 1983; Faught 1996; Goggin 1950; Goodyear 1999; Hemmings 2004; Neill 1964; 1978; Thulman 2006; Waller and Dunbar 1977). All of these efforts have consistently shown that the largest single concentration of diagnostic artifacts lies in the lower Santa Fe River basin, with other concentrations occurring in and around major Tertiary karst features in west central, north, and Panhandle sections of Florida. One of the most recent efforts to map Paleoindian site distributions revealed a surprising discovery of an inundated site concentration, Lake George Point site (8PU1470), in the St. Johns river (Thulman 2006). The documentation of Lake George finds only serves to underscore the largely untapped potential of inundated and submerged Paleoindian sites in Florida rivers and lakes.
CHAPTER FOUR

STRATIGRAPHIC CONTEXT

Introduction: Southeastern Karst

The Floridan Aquifer and Karst

Florida and parts southern Georgia, Alabama, and, a small area of southeast South Carolina have long been recognized for having a sequence of chert-bearing Tertiary Limestone formations. Where the Tertiary limestone is most extensive it has a distinctive limestone topography having numerous karst features such as springs, swallowts, sinkholes, peneplain lakes, as well as karst affected and controlled river basins. The river basins in particular have abundant karst features connected to a groundwater labyrinth known as the Floridan Aquifer (Figure 4.1). In the Southeastern Coastal Plain, Paleoindian sites are most concentrated where the Floridan Aquifer and the chert-bearing, Tertiary limestone occur near or at the ground surface (Dunbar 1991b; Thulman 2009).

The nature of Florida’s near surface limestone and its developed karst terrain is best visualized though inspection of false color Digital Elevation Models (DEM) of its topography (Figures 4.2, 4.3, 4.4). The lower Santa Fe River basin is that section of the river with fully developed karst features. Most of the upper Santa Fe River flows through an upland area known as the Northern Highlands (White 1970; Williams et al. 1977) where stream drainage systems have typical dendritic drainage patterns (see eastern end of Figure 4.2, Northern Highlands). In the Northern Highlands, the Tertiary limestone is blanketed by a thick sequence of confining and semi-confining sediments belonging to the Hawthorne Group, Coosawhatchie Formation which itself is blanketed by undifferentiated Pleistocene and Holocene sediments (Meyer 1962; Scott et al. 2001). In the High Springs Gap, Western Valley, and Bell Ridge physiographic areas, the land surface is highly karstified even though the Bell Ridge has a considerable thickness of undifferentiated sediments above the limestone. The drainage patterns west of the Northern Highlands differ greatly and, at least in part, appear to be controlled by an extensive fracture zone near High Springs, but mostly it reflects the area’s high degree of karstification (Williams
et al. 1977). The irregular pocked appearance of the land surface west of the Northern Highlands is a result of the dissolution of limestone, its karstification.

The Big Bend area of the Florida Panhandle reflects similar topographic differences between the upland of the Tallahassee Hills that is little affected by karstification and the lowlands below the Cody Scarp that are highly karstified (Figure 4.3). But there are east to west differences in the abundance of surface karstification in the lowlands caused by differing geology. In the Aucilla-Wacissa river area, the Suwannee Limestone formation represents the near surface carbonate rock, the rock that holds the Floridan Aquifer. However, further to the west, in the Wakulla-St. Marks river area, the younger St. Marks Formation limestone lies above the more porous Suwannee Limestone. Suwannee limestone approaches 97 percent pure calcium carbonate where it is not dolomitized (Yon 1966: 40) whereas the St. Marks limestone is highly impure and is characterized as a mixed quartz-rich carbonate (Bryan et al. 2008) with a quartz content greater than fifty percent (Cooke 1945).

The Aucilla-Wacissa area is typified as having numerous springs and sinkholes as well as having numerous non-contiguous surface channel sections. In the Wakulla-St. Marks area karst features, although present, are less numerous. The obvious reason for this difference is the degree of solubility of the limestone. In the Aucilla River there are numerous sediment-filled, as well as open, cavernous sinkholes. When the flow potential of a sinkhole (swallet or spring) becomes plugged with sediment, other fissures in the limestone dissolve to form other subterranean passages. At locations such as Wakulla Springs, the potential for a natural alteration in the subterranean passage system is less likely because the overlying St. Marks limestone is solution resistant due to its quartz content. As a result, huge underground passageways have formed over extended periods of time owing to the extensive solution of the lower Suwannee Limestone formation versus the restricted solution of the St. Marks limestone, which lies above it. The size of the entrance at Wakulla Springs literally rivals that of the Chunnel between England and France and could similarly accommodate two trains running side by side.

**Karst Rivers, Flowing Water, and the Concept of Sedimentation**

With a maximum elevation of just over 105 m above sea level, Florida is part of the Southeastern Coastal Plain and offers little potential for topographic fluvial erosion. The
Apalachicola River is the exception with its headwaters in the southern Appalachian Mountains. The Apalachicola drains high mountain-streams with considerable down-gradient slopes, albeit only in its northern reaches. In stark contrast, rivers such as the Aucilla represent small surface drainages located completely within coastal lowland topography (Figure 4.5).

It is not only stream gradient but also the Floridan Aquifer’s capacity to retain in-bank storage, which helps to diffuse surface flow velocity during times of high river stage and flooding. For example, the volume of flood water entering the swallet at River Sink on the upper Santa Fe River is often much greater compared to the discharge at its counterpart spring, River Rise, in the lower Santa Fe River. Subterranean storage capacity in the vicinity of the Natural Bridge ingress (River Sink) and egress (River Rise) hold floodwaters underground thereby diminishing flow velocities and erosion in the Lower Santa Fe River (Williams et al. 1977). In addition, a study of the $^{234}U/^{238}U$ disequilibrium in the waters of the Santa Fe River basin also reflects similar complexity of mixing, storage, and discharge (Briel 1976). One of the beneficial aspects of diminished fluvial erosion capacity is the preservation of ancient sediment columns in these karst river systems.

Before discussing river basin sedimentation, it is important to distinguish between two basic types of sedimentary accumulations: 1) channel-cut and 2) channel-fill sequences. The concept of channel-cuts versus fills is used in geology, archaeology, paleoanthropology and paleontology. In Anna Behrensmeyer’s (1988) discussion of taphonomic bone preservation in fluvial regimes, she distinguished between channel-lag (cut) and channel-fill deposits:

Two taphonomic modes for attritional vertebrate assemblages in channels are proposed, based on sedimentary context of vertebrate remains and taphonomic features of the bones themselves. The channel-lag [channel-cut] mode includes bones that are buried with coarse lithologies near the base of active channels. The channel-fill mode occurs in fine-grained to mixed fills of abandoned channels. The extreme for a channel-lag assemblage would be a cluster of allochthonous [transported from elsewhere], abraded, unidentifiable fragments, and the extreme for a channel-fill assemblage would be a cluster of autochthonous [produced where found, in place], unabraded, complete skeletons. Between these extremes there is a broad spectrum of possible taphonomic histories for bones in channels, but distinct channel-lag vs. channel-fill modes can be recognized in fluvial deposits in different tectonic and climate settings throughout the Phanerozoic [540 ma to present]. Physical and biological processes that affect the different modes produce different samples of vertebrate paleocommunities, with bones in channel-lag mode representing transported remains from a variety of habitats, whereas channel-fill assemblages are more autochthonous and habitat- specific.

Taphonomic modes provide a basis for comparing faunas with similar preservational histories throughout the geologic record, and they can help to minimize biases in important paleobiological
parameters such as diversity estimates and the timing of appearance and extinction events (Behrensmeyer 1988: 183).

No doubt, the most common type of sedimentary sequence in river channels (non-karst and karst) are channel-cut sequences that include channel lags, levee, overbank, and bank-of-deposition point bar sedimentation. According to the Glossary of Geology (Neuendorf et al. 2005: 385), channel lag is the concentration of the coarse-grained fraction of a sediment deposit after the dispersal downstream of the finer-grained fraction of sediment caused by flowing water. In the most erosive areas of a river channel there may be no lag at all because the current velocity is such that no sediment is being deposited; rather it is being transported elsewhere and exposed bedrock or other erosion resistant substrate is laid bare and exposed. The very definition of a fluvial channel is indicative of erosional displacement of sediment down gradient in a “channel” formed (cut) by flowing water.

Non-karst Rivers in the southeastern US, such as the Savannah River, have two types of channel-cut basins formed during the Pleistocene to the present day. These are the braided and meandered channel types. They will not be discussed here other than to say that braided channels are unable to support their sediment load and thus commonly form multiple, braided channels in a high energy fluvial environment. Rivers with their headwaters in the Southern Appalachian commonly had braided channels during the late Pleistocene, but were replaced by meandered channels, which is the type of non-karst, channel-cut system that dominates today (Leigh 2008).

In Florida, channel-fill deposits in karst river basins often have assemblages of faunal and botanical material in stratified sequence. During the Holocene, with a water table rise to near modern levels by 8.5 ka (Carter and Dunbar 2006; Watts 1969b; 1983; Watts and Hansen 1994) and the reestablishment of flowing water since then, erosion has impacted some late Pleistocene sites, exposed parts of others and left some totally undisturbed. It is in the erstwhile channel-fill deposits that a great deal of archaeological, paleontological, and climatic information is preserved. The investigations of the Page-Ladson and other sites in the Aucilla River help to demonstrate the research potential (Webb 2006b) that remains largely untapped.
Wetland Sediment Types in Karst River Basins

Channel-cut Deposits

The upper Suwannee River and its potentials for erosion are unique compared to most karst rivers in Florida. The Suwannee River’s potential for channel-cut lag deposits is due to its entrenched channel and its channel bottom’s elevation above sea level; ~14.5 m at White Springs, Florida. The river channel has cut through a considerable sediment column and has become entrenched in the limestone bedrock. As a result the channel does not meander laterally and floodwaters are forced to follow the same path through time as down cutting continues. However, open limestone conduits (cavernous sinkholes and springheads) attenuate the erosive potential by diverting some of the surface water underground during high river stage. From the state line downriver below Branford, many of the springs reverse or halt flow during flood stage and those that reverse flow become siphons that divert floodwater underground as in-bank storage (Clarke 1965). Nevertheless, at flood stage, the surface flow in the upper Suwannee River is sufficient to reconfigure lag deposits along the channel bottom.

With elevations greater than 18 m above sea level near Marianna, Florida, the Chipola River channel also mobilizes and shifts lag deposits during flood stage. Yet some of the Chipola’s tributaries do not experience channel-cutting and, at least one nearly complete mastodon skeleton has been found in a tributary (Dunbar 1991b). Beside tributaries in these upland river areas, another situation where good stratigraphic integrity and bone preservation has been found is sediment-filled sinkholes (Thulman and Webb 2001). Otherwise, Pleistocene bone in the upper Suwannee and Chipola channels, if present, is generally fragmented, water-polished and rounded. Lithic artifacts are typically polished and have a medium to dark brown patina.

There are at least three types of channel-cut, lag deposits in upper the Suwannee River. They include:

1. Unconsolidated channel lag
2. Cemented non-humate channel lag
3. Cemented humate or spodic lag deposits (hardpan)
Unconsolidated Channel Lag

These highly mobile, coarse-grained, sandy lag deposits are sorted and moved by current mostly during flood stage. The typical lag deposit consists of medium to large-grain quartz sand and small pebbles that range in color from dark to light tan-brown. Their color is the same type of river-stain found on lithic artifacts. Even steamboat wreck sites are partly covered by lag accumulations (Dunbar 1991c). It is important to understand that lag mobilization during flooding events is destructive and fossil bones and bone artifacts, once incorporated in it, are pounded by its flood-period oscillations. A well-preserved fossil bone or bone artifact found in this type of heavy lag deposit most likely indicates that it recently eroded from a riverbank or sinkhole context.

Cemented Non-humate Channel Lag

Cemented non-humate, channel lag deposits occur in places along the channel bottom of the upper Suwannee River including its tributary, the Withlacoochee River (there are two Withlacoochee Rivers in Florida this is the one that flows from Valdosta, Georgia to its confluence with the Suwannee at Ellaville, Florida). The cemented lag deposits are light tan to dark brown in color and the cementing agent is non-reactive to a 30 percent solution of hydrogen peroxide meaning that the cement is not humate. The cemented lag is erosion resistant yet friable and encapsulates artifacts at some localities. In 1980, when the Madison Blue Springs site (8MD33) was recorded, cemented non-humate lag deposits off the mouth of Madison Blue Spring run in the Withlacoochee River channel were found to contain numerous lithic artifacts. The artifacts included significant amounts of debitage, a Paleoindian preform base, and a unifacial scraper (Dunbar 1991b). The artifact-rich lag deposit was determined to no longer exist during an August 2007 site inspection, no doubt because of the significant amount of collecting activity that was evident when the site was first inspected in 1980 and continued subsequently. The site’s stone fishweir, spanning the Withlacoochee River just below the spring run, remains largely intact (Dunbar 1981b; Porter and Dunbar 2007). Cemented lag of this type was also found on top of the structure of the “River” Tom’s wreck (8LF30) in the Suwannee River above Troy Springs (Dunbar 1991c). Tom’s wreck is the site of a large side-wheel steamer, possibly the Orpheus, which is believed to have hit a snag and sank in 1845. But the important point here is that unconsolidated non-humate lag can become cemented in a relatively short period of time.
Cemented Humate or Spodic Channel Lag

Cemented deposits of humate or spodic soils, more commonly known as hardpan, also occur in the Suwannee River and its tributaries. Geologists have attributed the formation of humate to one of two sedimentary environments: 1) forming in the sediment column of terrestrial locations at and just above the zone of saturation (i.e., the water table) and 2) forming owing to precipitation when humic acid in freshwater is mixed with brackish or some other agent that varies the pH to allow its formation (Swanson and Palacas 1965). But the humate cemented deposits in question are located well inland and up-gradient from the coast where no known source of brackish or saltwater catalyst exists. Therefore, it appears that one of the possible ways humate formations developed in river channel locations is when they become exposed subaerially during past episodes of dry climate. If this assessment is true, the humate deposits are archaeologically significant because they had to have formed during one of the Early Holocene or late Pleistocene (>~9,500 $^{14}$C BP) intervals when inland water tables were much lower (Dunbar 2006c).

Humate or spodic horizons are common in Florida’s sandy sediments and form when carbon-based humic solutions from decomposed organic materials in freshwater (often with aluminum and iron components) solidify and cement the sediment they surrounds (Swanson and Palacas 1965). Inland humate horizons are known to form near the zone-of-saturation in the sediment and in underwater environments if the pH changes and results in its precipitation.

The organic material will be transported in solution until a physical-chemical change takes place in the water, whereupon this material is precipitated or flocculated to form a humate deposit. . .

. . . Humate can be observed in the process of being deposited or of being redissolved at many places in the field. . . It is the ease and completeness of removal of the organic matter from sediment by weakly alkaline to near neutral waters, only to be transported and deposited elsewhere, that suggests specific explanations for the ubiquitous distribution of organic matter as carbonaceous films, roll structures, and the like in some sedimentary rocks.

The dissolution or remobilization of the humate in the Florida sands apparently takes place during ordinary physical-chemical changes in its hydrologic environment . . . . The conditions under which humate eventually becomes immobilized or insoluble in subsurface water have not been investigated, but very probably dehydration [subaerial exposure], time, increasing depth of burial, compaction, and other diagenetic processes make humate immune to further attack and redistribution (Swanson and Palacas 1965: B11-B13).
Humate-cemented channel lag may represent a process formed under subaerial conditions as a result of illuvial processes (material displaced in soil profiles by the action of rainwater and percolation) when inland water tables were substantially below present, during the early Holocene or Pleistocene. For instance, the inundated part of the Butler site (GI1-SU2) in the Suwannee River (Figure 4.6) has humate deposits 7 m to 9 m below present river stage. This humate cemented lag is black and by soaking it in under a chemical hood in a 30 percent solution of hydrogen peroxide the carbonaceous cement dissolved effervescently within a minute leaving behind clean silica sand and chert debitage (Figure 4.7). Similar results were obtained by soaking a sample in a 3 percent solution of hydrogen peroxide for 48 hours. A sample placed in water originating from the Floridan Aquifer had no effect and after soaking it for forty days, the humate remained unaffected.

If the illuvial deposition of now-inundated humate deposits proves to be correct, it may represent an important paleo-environmental indicator because humate can be dated by the radiocarbon technique. Thus understanding the origins of humate horizons in karst river channels may lead to yet another means of determining when ancient water table stands and extreme drought conditions occurred in the Southeast.

Channel-fill Deposits

Numerous karst rivers with late Pleistocene to early Holocene channel-fill deposits are found in Florida. The deposits include four important sediment types, though some parts of a sequence may be interrupted by hiatuses or thinner, less common sediment types. The most common channel fill deposits are: 1) shell marls, 2) calcitic to neutral pH silts and clays with few or no freshwater shells, 3) organic-rich peat, and 4) colluvium, which may include quartz and calcium carbonate silt, sand, and rock detritus of various sizes.

It is important to remember that karst river channel-fill deposits are most often inundated below the modern potentiometric surface of the Floridan Aquifer as well as the low flow stages of extant modern channels. However, this is not always true and in river basins like the Santa Fe, numerous exposures of stratified channel-fill deposits are stranded well above the modern water table (Williams et al. 1977: 73). Where river basin channel-fill deposits have been abandoned above the modern water table, former organic-rich peat deposits of Pleistocene origin have been oxidized and are absent (hiatus resulting from desiccation) or have been greatly reduced. Even in
shallow water of three meters or less, former organic deposits are found to be substantially reduced and often appear as oxidized dark gray or rusty-looking horizons. For example, shallow inundated areas yielding evidence of past subaerial exposure include sites such as Norden and Simpson’s Landing in the Santa Fe basin and Latvis-Simpson and the Ryan-Harley in the Aucilla basin. In contrast, the more deeply inundated channel-fill sequences, such as the sequence at the Page-Ladson site (4 m to 12 m below present low river stage), have very good preservation.

Shell Marl

The occurrence of shell marl as well as calcitic silt (mud; see next section) is ubiquitous in most karst rivers (Dolan and Allen 1961; Means 2005; Neill 1964; Olsen 1949a; Simpson 1948a; Stone 1986; Vernon 1951; Waller 1983; Yon 1966) and is also known in lakes (Brooks 1974; Vernon 1951) and seasonally flooded areas of the Florida Everglades (Gleason et al. 1974; Gleason and Stone 1994). Through geologic time there have been periods when shell marl actively formed versus periods when it did not. The formation of shell marl appears to differ in the south Florida Everglades compared to the deposits in central and north Florida karst rivers. Both are derived from biogenic origins.

In the Everglades, the “River of Grass” is inundated during the wet season. In the wet season, the water in the shallow sawgrass marshes and sloughs carries a dissolved calcium carbonate load derived from the local limestone formations near the ground’s surface. Decaying organic material in the marshes and sloughs contributes acidity to the water, which in turn becomes neutralized as the underlying limestone is dissolved and goes into solution. This calcium carbonate load is then assimilated by periphyton algal mats.

Periphyton is a complex assemblage of algae, cyanobacteria, microinvertebrates, their secretions, and detritus attached to submerged surfaces. . . Most periphyton in the Everglades is considered calcareous due to abundance of the limestone (calcium carbonate) bedrock underlying the Everglades and from surface water inputs containing high cation [+] ion concentrations. Periphyton is crucial and a fundamental part of the food web as the primary food source for small consumers, including fish and invertebrates (Brown and Wright 2009: also on line at - http://edis.ifas.ufl.edu/ss522).

During the dry season, calcium carbonate previously assimilated in the periphyton during the wet season, is deposited as marl consisting of calcitic muds and freshwater gastropod shells after the organic material dies and decomposes; a process that often includes subaerial exposure.
Marl prairies in the Everglades represent vast open areas of seasonally wet-dry prairies. During the wet season the periphyton community of organism thrives and represents the base of the food chain in a shallow, slow moving to static water environment (Brown and Wright 2009)(Figure 4.8).

Karst rivers, on the other hand, deposit shell marl under perennially inundated conditions in flowing water. Karst river basins have abundant spring vents which act as the delivery system for highly charged, dissolved concentrations of calcium carbonate from water originating from the Floridan Aquifer. Spring water not only supports the aquatic community that assimilates the calcium carbonate, it also supports the gastropod community that feeds on the calcium carbonate assimilators (Riding 2000). “Of Florida’s 100-odd species of freshwater snails, most occur in spring runs” (Whitney et al. 2004: 241). And because karst rivers have numerous springs discharging into them, they too can be considered spring runs, only differing in their much greater length. The shell marl deposits in karst rivers are often basin-wide forming marl floodplains (Figure 4.9 Santa Fe Springs).

There is a great deal of geologic literature regarding the formation of carbonate deposits in freshwater (Alonso-Zarza 2003; Pomar and Hallock 2008), however, only a few discuss carbonate sediments formed in karst riverine environments. The Sarine River in Switzerland, for example, is located in a karst region where calcium carbonate in the river water is assimilated in microbial laminates on extracellular polymeric substances (EPS), promoting the formation of travertine and calcitic crust on rocks and other objects in the river’s channel. “Freshwater microbial deposits often show carbonate precipitation on or impregnation of cyanobacterial sheaths or cells” (Dupraz et al. 2009: 153-154). EPS provides structural integrity to mats, allowing diverse microbial groups to coexist in a biofilm. In other words, the stability of the microbial aggregates is provided by microorganisms that secrete high molecular weight EPS, which, in turn, is the binding agent for these diverse microbial colonies. The matrix of EPS is very heterogeneous and varies with the organisms it has incorporated. Biofilms and microbial aggregates such as flocs are hydrophilic and therefore act as filtering mechanisms. In unpolluted natural systems, biofilms can assimilate dissolved and particulate matter of biotic and abiotic origin (Flemming et al. 1999).

In Florida karst areas, biochemical processes take place in periphyton biofilms that result in some of the calcium carbonate in the water to be assimilated by microbial colonies. The report
entitled, *Summary and Synthesis of the Available Literature on the Effects of Nutrients on Spring Organisms and Systems*, outlines the need to understand this type of depositional environment (Brown et al. 2008). Apparently, similar to the Everglades marl formation, perennially inundated algal mats in Florida’s karst rivers generate bacteria that actively exude substantial EPS (Figure 4.10). But they also form on exposed obstructions in the water column such as fallen trees and on the underwater components of aquatic vegetation. Thus the formation of calcitic sediment appears similar to the processes identified in the Sarine River. Biofilm, epiphyte, and benthic algal mats are identified as the agents of carbonate assimilation and deposition. According to Patrick Inglett (et al. 2008), “To our knowledge, only one study has attempted to characterize sediments/subaqueous soils from a spring system” in karst spring runs and river channels and that is by Thomas J. Saunders (2007). However, a review of Saunders (2007) reveals that his research is focused on recent soil development and the results of unbalanced nutrient charging caused by modern pollutants. His work does not investigate the mechanisms of unpolluted, natural systems that are held in the Pleistocene and Holocene channel-fill deposits of the karst river basins in the Tertiary Karst regions of the southeastern Coastal Plain.

Therefore, a mechanism for calcitic sediment formation in karst rivers is derived from biogenic processes that capture dissolved calcium carbonate from the water only to release it as shell marl and carbonate mud deposits upon the organisms’ death and decay. One major difference, however, is that unlike the Everglades, major karst rivers do not have wet-dry seasons and, with few exceptions, do not go dry, thus sediment formation does not result from subaerial exposure. It should be noted that sections of channel in the upper Suwannee River above Ellaville, and smaller karst rivers such as the Econfina River in Taylor County, do go dry during extreme drought conditions but that is not the case elsewhere. This is a topic in geology and environmental research that has gone almost completely unstudied. The deposition of shell marl in karst rivers holds a geologic history spanning the late Pleistocene into the Holocene. It promises to be an excellent source of paleo-environmental information and appears to have the potential to be U-series radiometrically dated (see Chapter 5).

**Calcitic and Neutral pH Silts and Clays**

Besides shell marl, another sediment type common in karst river basins are silt and clay deposits that do not have gastropod shells or in which the shell content is no longer evident.
These clays and silts are alkaline to neutral offering good environments for bone preservation. Testing at the Page-Ladson and Norden (8GI40) sites indicate good pollen preservation is also present. These types of silt and clay deposits may also have peat and wood preservation where they are inundated in deeper water or display root tracks where they occur in shallower water.

The mechanisms causing the deposition of river basin silt and clay sediments are not well understood. Silt and clay deposits appears to have at least four possible origins: 1) the biogenic accumulation of calcitic sediments caused by biofilms on flotsam, snags, vegetation, and/or mats, a silt without the shell, 2) the reduction of calcitic shell marl to residuum, 3) as overbank alluvium deposited during flood stage, or 4) some type of abiotic mechanism resulting in the precipitation (re-solidification) of the large dissolved sediment load found in karst rivers.

Alkaline to neutral pH silt and clay deposits have formed in karst rivers during the Pleistocene and Holocene. The calcitic silt deposits of Unit 4 and Unit 6 at the Page-Ladson site ranged in age from ~12.3 ka $^{14}$C BP to ~9.4 ka $^{14}$C BP and may have formed by biogenic means when wood flotsam accumulated at this former river siphon, developed biofilm on its water exposed side before becoming totally waterlogged and sank to the channel bottom. Silts also may have formed on objects extending above the bottom and on the exposed limestone banks. Thirdly, silts may have formed on vegetation that supported gastropods but their shells decomposed and are not prominent as they are in shell marls.

Some of the clay and silt deposits now stranded above the modern water table in rivers such as the Santa Fe may have formed from the reduction of former shell marl to residuum or by overbank deposition of fine-grain sediments over thousands of years of accumulated flood cycles. Neither of these scenarios seems satisfactory, however. In addition, karst rivers in Florida carry “almost no sediment load other than fine muds” (Puri et al. 1967: 15; Vernon 1951: 29; also see Yon 1966: 37) and many, including the lower Santa Fe River from the Ichetucknee mouth to River Rise, the Ichetucknee, lower Aucilla, Wacissa, and Wakulla rivers do not have river levees. So it appears, in the absence of any coherent studies on the subject, that neither reduction to residuum or overbank deposition provides a satisfactory explanation because neither appears to have a sufficient source input. The one source input that is available is the high charge of calcium carbonate dissolved in the water but the mechanism for its coming out of solution, other than by biogenic means, is unknown at this time.
At a site opposite the confluence of the Ichetucknee River, 8GI38, twenty-four sherds of Deptford linear check-stamped pottery were recovered in gray silty clay 10 cm below its surface. The clay’s overall column thickness is 2 m and it is capped by a 10 cm thick humus layer. Several sherds fit together indicating that all were probably from a single bowl. The 24 sherds recovered were partly or totally embedded in the clay. Other elements of the pot may have eroded from their primary context and been displaced in the adjacent river channel (Allen 1967a; Dunbar 1974). Prehistoric Deptford ceramic sherds also have been observed embedded in gray silt near the Sandy Point site (SU110) on the banks of the Santa Fe River. In most sections of the Santa Fe River basin, neither shell marl nor calcitic silts appear to be actively forming today and the dominant river channel is confined by an entrenched limestone channel. Sequences of marl and silt are now abandoned in many places above the river’s modern non-flood stage level. Some sequences are as much as 3 m above present stage level but more typically range from 0.5 m to 1.0 m above low river stage. For the shell marl sequences, this represents direct evidence that the river once occupied the breadth of the river basin during a time of prolonged higher-than-present water stages.

The possibility of an abiotic means of deposition should be considered. The water in karst rivers, water that originates in the Floridan Aquifer, holds a very large load of dissolved solids (Dysart and Goolsby 1977). But the mechanism for an abiotic means for the re-solidification and deposition of this potential source needs to be identified, if it exists. A final possibility is simply that the silt and clay deposits formed during times of substantially different depositional environments compared to today. Perhaps there were times of substantially larger-than-present particulate sediment loads. But that scenario also would require rather gentle to non-flowing water conditions for silt and fragile organic material deposition which seems as paradoxical as it does impossible.

**Organic-rich Peat Deposits**

The definition of peat varies depending on a discipline’s emphasis of study (Bond et al. 1986). The geologic definition of peat is, “An unconsolidated deposit of semi-carbonized plant remains in a water saturated environment, such as a bog [acidic] or fen [alkaline], and of persistently high moisture content (at least 75 percent)” (Neuendorf et al 2005: 476). The Society for Testing and Materials defines peat “as a naturally occurring unconsolidated substance derived
primarily from plant materials. Peat is distinguished from other organic soil materials by its lower ash content (less than 25 percent ash by dry weight [ASTM Standards D2974]) and from other phytogenic material of higher rank (i.e., lignite coal) by its lower BTU value on a water saturated basis” (Bond et al. 1986: 5). The United States Department of Energy defines peat “as an organic soil consisting of greater than 75 percent organic matter in a dry state.” (Bond 1986: 5). The most useful definition, as it pertains to this study, is that peat requires a saturated environment to endure.

In the southeastern US, peat chemistry can be acidic or alkaline but the terms bog and fen are not applied. In Europe and in more northerly latitudes, fen peat primarily consists of reeds, whereas in Florida, alkaline-based peat is generally associated with limestone terrain and karst features that help lower organic acidity while karstification (solution of the limestone) is enhanced. Alkaline to neutral peat can consist of woody peat, fibrous peat, sapropel peat and other organics that are generally associated with bog peats in Europe.

Because there is bog-like peat in Florida that has undergone transformation from acidic to basic, the character of the peat bed can include a number of interesting features as a result of the pH shift. For example, at De Leon Springs in Volusia County and at a number of sites in the lower Aucilla River, peat consisting of small sticks, branches, and leaves has been observed in cemented deposits.

The chemistry of some of the cementing agents is uncertain but appears related to some type of carbonate bonding cement. In some instances the cementing agent has a metallic sheen from silver to light copper, while in other instances it is light gray. The cementing agent encases the organic matter and binds to itself making the deposit friable. Bone artifacts in some peat levels can have varying degrees of acid pitting -- from no apparent alteration to rather substantial pitting of the outer bone wall. Bone specimens may also be coated with a cementing agent but occur in peat that is not cemented (Dunbar et al. 1989). Conversely, some bog-like deposits appear to have been formed with basic pH syngenetically and have pristine bone and botanical preservation. An example of these conditions is Unit 3 at the Page-Ladson site (Dunbar 2006b; Webb and Simons 2006).
Colluvium

At the Page-Ladson site, the peat component in Unit 3 is mixed with colluvium that includes abundant *Fallotella cookei*, a species of foraminifera common in the Suwannee Limestone formation. It has a fine-to-medium grain size on the Wentworth scale. *Fallotella cookei* as well as other elements of the Suwannee Limestone formation, and silica sand makes up a significant part of the colluvium in Unit 3. The colluvium in Unit 3 has a strong alkaline component, which offsets the acidic nature of the woody peat. At Page-Ladson Unit 3, colluvium is believed to have resulted from natural processes including animal trampling caused by Pleistocene animals entering the sinkhole when water tables were lower. Animal trampling as a factor contributing to this type of deposition has been documented elsewhere (Govers and Poesen 1998).

The occurrence of Pleistocene and early Holocene colluvial deposits in karst channel-fill sequences is important. Several stratigraphic sections have levels that may represent colluvial deposits that have heretofore gone unnoticed. It is easy to assume that all sediment sequences in river channels are of fluvial origin but that assumption can be in error. Unit 3 at the Page-Ladson site is an important example of a Pleistocene colluvial input into the river channel due to lower than present water tables (Dunbar 2006b; 2006c). Similarly the sediment unit at the Latvis-Simpson site (8JE1617) with mastodon remains appears to contain colluvium. River diver and site informant Mike Stallings has reported several colluvial deposits primarily consisting of slope-wash from upland hills surrounding the Ocklawaha River that extend to the river and contain Paleoindian and Early Archaic artifacts. The cultural level at the Piney Island site (8MR848) is 0.65m to 1.10m below the ground surface and is buried in alternating levels of shell marl and colluvium (Denson and Dunbar 1992; Jones 1992).

Paleoclimatological Inferences

River systems in the southeastern US, with their headwaters originating in the Appalachians Mountains, have yielded evidence of strikingly different late Pleistocene channel environments compared to their Holocene record. Their channels were dominated by braided channel systems from ∼30 cal ka BP to ∼16 ka cal BP. Subsequently, they developed large scrolled meandered channels until ∼11 Cal BP. During the early Holocene they changed once
again and developed large un-scrolled meander channels until ~5.5 ka Cal BP. After the mid-Holocene they reconfigured again to their modern form of small meandered channels (Leigh 2008). Thus Southeastern rivers systems, with their headwaters in the Appalachians Mountains, represent major erosive, channel-cut systems. Karst river systems in the coastal plain of Florida and parts of southern Georgia and Alabama differ from those with their headwaters in the Appalachian Mountain and have their own, distinct Pleistocene and Holocene sedimentary histories.

During the late Pleistocene, from ~30.0 ka cal BP until the beginning of the Holocene at ~11,500 cal BP, karst rivers were predominantly either being sediment filled or experiencing much lower than present water table conditions. In the deepest of these channel systems, they seldom or ever went dry and in the shallower rivers such as the Wacissa, alternating sequences of wet or dry channel conditions occurred. For deeper channel sections that remained inundated, channel-fill sequences accumulated. For shallower channel sections that alternated between inundated and subaerially exposed conditions, channel-fill sequences accumulated or, in some cases, experienced episodes of little to no sedimentation (Dunbar 2002; 2006c). By ~8.5 ka cal BP, during the Holocene, inland water tables rose and permanently inundated shallow lake and river basins (Watts 1971; 1975; 1983; Watts et al. 1996). It is after ~8.5 ka cal BP that channel-cuts began to form the coarse-grained lag deposits that today have yielded so many fossil bones and artifacts eroded from earlier Pleistocene channel-fill deposits.

A paleontological analysis, conducted by Ryan Means (2005), was undertaken on a shell marl level below the Suwannee point level at the Ryan-Harley site (8JE1004) in the Wacissa River. His study focused on fossils as a proxy for understanding the paleoenvironment in which they were originally deposited. In his study entitled “Ecology, Deposition, And Modern Environmental Analogs,” Means states:

Most of the mollusk species in this layer are generalists that prefer oligotrophic habitats, but can stand some siltation and acid-water turbidity. Spilochlamys, Amnicola, and Campeloma strictly require pristine habitats and would be characteristic of spring runs, in which the others would also thrive (Fred G. Thompson, FLMNH personal communication). It seems very likely that the environment in which these mollusks lived was a spring run, very much like the Wacissa River is today. The presence of Terrapene carolina and the small bony fish in this layer is also consistent with this idea. Goose Pasture on the Wacissa River is a good modern environmental analog. Clear spring water usually flows here with many sections of slow-moving water. Particularly in these slower backwater areas, there are abundant grass beds in which many gastropod species thrive. The snails cling to grass blades and plant stems throughout the course of their lives, and bivalves
occupy the river bottom. When they die, their calcareous shells sink to the bottom, and gradually, a species rich layer of shells is accumulated.

This layer is composed of differentially sized particles ranging from clay to adult gastropod size. No exact particle size percentages have yet been determined. The majority of shell material is composed of broken fragments of varying size. For most mollusk species, there seems to be an ontogenetic size representation. All vertebrate fossil material is black and well mineralized. Vertebrate material is relatively uncommon, yet easy to pick out due to its black color contrasted with the whitish shell marl.

There are at least four reasons why the shells have become fragmented. The first is that acidic water dissolves and leaches out the calcium carbonate from the shells through time, weakening certain areas until breakage occurs. Most of the shells exhibit eroded apices because this is the oldest part of the shell, and it has had more exposure time. Next, the mollusk-crushing Loggerhead Musk Turtle (*Sternotherus minor*) must be considered. Populations potentially crush a great number of mollusks and could be one of the main reasons why there is so much shell fragmentation in this layer and also in other marls within the range of this turtle. The next possible contributor to fragmentation is the weight of the overlying sediments. This layer was nearly two meters below the river bottom. Analysis under magnification revealed a percentage of sharp breakages and a percentage of smooth-edged breakages, but the shell bodies in general did not appear river-polished and rounded. It may, however, be difficult to distinguish the difference between an acid-etched surface and a river-polished surface. And for that matter, it could be equally as difficult to distinguish between the breakage due to turtle jaws versus overlying sediment weight. Stream washing, then, may be the fourth reason why these shells have become fragmented, but this seems the least likely reason of all. We can't say much about the paleoclimate in which this shell layer was deposited unless an oxygen isotope analysis was conducted. It may be safe to say that the climate of then was somewhat similar to that of now just based on the similarity of the fauna and paleoenvironment between then and now (Means 2005: 3-4).

The invertebrate and vertebrate fossils in shell marl at the Ryan-Harley site is only part of the sediment matrix which also is comprised of a clay and silt matrix that likely originated from the biogenic processes of biofilms and algal mats mentioned earlier. As will be discussed later in the chapter on radiometric dating, calcium carbonate derived from biogenic sediments might be datable using the $^{230}\text{Th}/^{234}\text{U}$ method combined with the $^{226}\text{Ra}_{\text{ex}}/^{226}\text{Ra}(0)$ method for comparison of age calculations (see for example Eikenberg et al. 2001).

Clearly the paleofaunal-environmental data and dating potentials for karst river basin shell marls demonstrates great promise. The Wacissa River is recognized as one of the most pristine karst rivers in Florida that remains largely unaffected by excess nutrient pollution. As a result water grass is abundant in its wide, shallow channel sections as are abundant shallow-water floras and faunas. It provides an excellent analog for what the Santa Fe River basin once looked like because the Wacissa River today maintains basin-wide inundation providing environmental conditions conducive to the active formation of shell marl and calcitic silts.
Modern species accessing the river channel of the Wacissa River once included wild, free roaming, long-horned cattle (prior to their removal in the 1980s) that literally grazed on the river’s lush aquatic vegetation; cattle that walked freely across the river or stopped in its channel for an extended feast. It is no stretch of the imagination to envision similar activity by large Pleistocene grazers and browsers. In fact, megafaunal remains have been found in shell marl deposits in the Wacissa, Aucilla, Santa Fe, and other karst river basins. In the Wacissa River, for example, the Consolidated Mastodon site, 8JE613 represents the remains of a mastodon cemented in shell marl (Dunbar 1983). At another site in the Wacissa River, the skeletal remains of a *Bison antiquus* cow was determined to represent a Paleoindian kill site (Alexon Kill, 8JE570) based on a projectile point tip embedded in the animal’s frontal bone (Webb et al. 1983; Webb et al. 1984).

**Documented Stratigraphic Sequences in Karst River Basins**

**Aucilla and Wacissa Rivers**

The Sloth Hole, Cypress Hole (Hemmings 1999; Muniz 1998c), and Wayne’s Sink sites (Halligan 2011), located in the Aucilla River below Nutall Rise, have their earliest channel-fill sequences dating prior to the LGM. In the Little River section of the Aucilla the Crag Hole, Little River Rapids, Mathen-Childers and Latvis-Simpson sites (Figure 4.11) have similar channel-fill deposits with the oldest sediment dating prior to the LGM. They also have younger channel-fill sediment units but these appear less extensive compared to the sequences identified in the Half Mile Rise section of the river where the channel-fill deposits identified to date are extensive and date from the LGM to the early Holocene. All of the channel-fill deposits appear to consist primarily of organic-rich silts, peats, or freshwater shell marls. Occasionally, colluvial sediments occur as do tree stumps, which have been found inundated in the Aucilla River channel at a number of locations and depths.

The water level in the lower Aucilla River represents an exposure of the Floridan Aquifer’s unconfined surface (Yon 1966)(Figure 4.12 and 4.13). Compared to the Wacissa, the Aucilla is incised and generally much deeper with mid-river sinkhole depths reaching well below present sea level (Figure 4.14). At the paleontological site, Aucilla 3B, samples from shell marl (not shell) dated ~16 ka $^{14}$C BP to ~15.1 ka $^{14}$C BP. About 0.6 kilometers downstream from
Aucilla 3B at the Page-Ladson site, the upper part of the shell marl yielded dates ranging from ~15.4 ka $^{14}$C BP to 15.1 ka $^{14}$C BP. The upper part of the shell marl units, both at Page-Ladson and Aucilla 3B, are contemporaneous and related. Aucilla 3B and Page-Ladson are located in the same land-locked surface channel and it appears that there was a period of spring-fed, shallow water in this channel that supported a Wacissa-like aquatic plant and faunal assemblage some 19,200 to 18,140 calendar years ago. During that time, proboscideans entered the river channel, some never leaving. At Page-Ladson, proboscidean digesta has been identified in the shell marl. The mammoth skeleton now on display at the Florida Museum of Natural History, was recovered from the shell marl at Aucilla 3B. Subsequent to this interval of shell marl deposition in the Half Mile Rise channel, no sedimentary environment of this type occurred again.

In contrast, the Wacissa River is shallow with most if not all of its channel segments elevated above present sea level. There shell marl deposits, though not radiometrically dated, formed during the Pleistocene and Holocene. The deposits appear to be discontinuous in places but are wide ranging in horizontal extent. In some places the shell marl gives way to shell-rich sandy deposits. For example, sandy shell-rich sediment was found at the Alexon Bison site (8JE570). A bone specimen buried in this sediment dated to about 11 ka $^{14}$C BP (Webb et al. 1984). As previously mentioned, the Consolidated Mastodon site in the Wacissa is in shell marl and shell marl is forming today in the wide, clear water, aquatic vegetation-rich channel sections. Where the Wacissa River channel system breaks up into anastomosing multiple channels hidden under tree canopies, the abundant aquatic vegetation is largely absent or patchy and shell marl is not being formed although shellfish remains may be included in the sediment.

**Ocklawaha and Silver Rivers**

The Florida Geological Survey (Davis 1946) was the first to document deeply buried sections containing freshwater shell marl near Eureka and the Moss Bluff locks in the Ocklawaha Basin. In the Silver River, work in the early 1960s by divers with the Ross Allen Reptile Institute, in the company of geologist H. Kelly Brooks, recovered radiocarbon samples from a mammoth site that dated ~18.0 ka $^{14}$C BP (Allen 1967b)(Figure 4.15). Shell marl in both the Ocklawaha and Silver river channels grades into peaty members in some instances, an indication of environmental shifts the exact nature and timing of which remains to be determined.
The radiocarbon dates shown in Figure 4.15 (after Allen 1967b) are approximations based on a personal communication from geologist Brooks (Department of Geology, University of Florida) to Robert Allen on December 13, 1967. Brook’s felt that there were unconformities between some levels at Silver Springs that represented episodes of lower than present water tables when the spring stopped flowing and the river channel was dry (Allen 1967b; Brooks 1973a; 1973b). The horizontal sediment units on the left side of Figure 4.16 represent Pleistocene channel-fills and the diagonal units to the right represent the Holocene channel-cut sequence. The suspected hiatus between the sand unit and white marl above are suggestive that the sand is of colluvial origin.

**Santa Fe and Ichetucknee Rivers**

The Santa Fe River also contains numerous sites in its basin. Over the decades archaeologists involved with compiling Paleoindian site distributions based on the occurrence of diagnostic point types, have repeatedly found that the single largest concentration of sites and Paleoindian points is in the Santa Fe River basin, which includes the Ichetucknee.

The Santa Fe and its spring-fed tributary, the Ichetucknee, have extensive sequences of shell marl deposits. The Ichetucknee deposits are located mostly in its upper section above Mill Pond Springs where they are found below the modern water table. In contrast, extensive shell marl deposits are primarily exposed above the water table in the Santa Fe River.

Clarence Simpson recovered several carved ivory shafts/foreshafts and a Simpson-like point from the Simpson’s Flats (8CO174). This is also the site where “a chert scraper was found in place below a partly articulated mastodon skeleton” (Simpson 1948a). Stanley Olsen subsequently inspected this site in the company of an unidentified informant, yet there is little doubt that it was Clarence Simpson. Here Olsen profiled a series of channel-fill sediments exposed by a much narrower Holocene channel cut (Figure 4.17)(Olsen 1949a). However, Olsen went on to make the assumption that this, and other karst river channel sites, were of no value because “sites in which stratigraphic interpretations can be applied are nearly non-existent” (Olsen 1961). Within the site boundary of the Simpson Flats site, yet slightly upstream from Simpson’s mastodon find, two other occurrences of mastodon remains were identified in two separate locations.
Larry Roberts and the author discovered the remains of a partially articulated mastodon vertebral column (Dunbar field notes 1974) that was subsequently said to have no cultural association by E. Thomas Hemmings (then at the FLMNH) even though the level on which the bones rested was not exposed and there was no attempt to expose it. This mastodon site had just become exposed when a large block of shell marl bank caved into the deeper Holocene channel cut. The mastodon remains were exposed at the base of the new exposure. About a month after the site inspection with Hemmings, the bones disappeared, most likely due to collecting by unknown individuals. A second discovery took place from a boat when the late Rob Bonnichsen and the author accompanied some dignitaries upriver. An isolated mastodon tusk was discovered. Again a section of the shell marl bank had collapsed and exposed the distal end of a tusk. The park manager was alerted to the find and the site was revisited about two weeks later. By then more of the tusk had become exposed. Several weeks later the tusk was recovered by staff from the Florida Bureau of Archaeological Research in cooperation with the FSU Academic Diving Program (Figure 4.18).

Further upstream, at the Simpson’s Camp site (CO173)(Dunbar 1986), four carved ivory shaft fragments were recovered eroding from a stratified sequence of channel-fill sediments being exposed by Holocene channel cutting (Figure 4.19). The fragments, which include an obliquely truncated, roughenedhaft section, are assumed to represent one artifact. In cross-section, the stratigraphic sequence (Figure 4.20) identifies the suspected level where the artifact may have originated: 1) an oxidized, organic-rich unit, 2) the top of a shell marl unit or 3) on the contact between these units (Figure 4.20). Unfortunately, none was found in place. The ivory artifact was recovered about 45 m downstream from the phosphate tram, a historic component of the site.

Sites in the upper Ichetucknee River, from the Simpson’s Camp site downstream to Mill Pond Springs, have been adversely impacted by ever-increasing erosion potentials caused by park visitors who, not only tube down the spring run, they also walk around on the shallow flats destroying the shallow-water aquatic vegetation. Once the vegetation is gone, the channel-fill deposits are exposed to erosion. Although I have not visited the park in several years, my last visit revealed a new channel being cut through the Simpson’s Flats site; a direct result of the wild rice and other aquatic vegetation being denuded from the flats.
The Butler site (8GI1 – SU2, see Figure 4.6), at the mouth of the Santa Fe River, is where the late Ben Waller (1983: 36) reported finding a partially articulated Pleistocene horse (Equus sp.) skeleton with three Suwannee points in the neck region and one in the pelvic region. It was discovered eroding from an underwater sediment bank. It is not known in what type of sediment matrix the skeletal remains lay but, sand seems the least likely because it is very unstable on the side of a sloping riverbank and prone to sloughing downslope too easily. In the area, both shell marl and silts and clays are known to exist.

At the Norden site, discovered in 1974, the primary location of interest is a Suwannee-point maker’s campsite that has yielded hundreds of artifacts and fossils from displaced context in a channel and a buried component in the adjacent flood plain. The floodplain component included Pleistocene faunal remains and unifacial stone tools consistent with the Paleoindian tools recovered from displaced contexts (Dunbar and Vojnovski 2007)(Figure 4.21).

Since the initial findings for the Norden site were published, there have been several important discoveries. First, the depth of the cultural level(s) is much thicker than originally suspected, having an overall depth of at least 45 cm as determined from a test conducted in 2009 (ST-1). Second, the upper level of the site is clay resting on shell marl and the Suwannee artifacts occur in both units. Third, a Paleoindian preform base recovered from the river channel in 1974 was re-fit to a preform tip recovered in 2009 from the 25 cm level of the test unit (Figure 4.22). In addition, dosimetry of the clay for OSL dating showed very little radioactive signal whereas the shell marl below the clay showed an active radioactive signature (Rink pedrsonal communication). Preliminary results of the OSL dating indicate that the clay unit is only ~2 ka cal BP but the shell marl level has not been dated (Figure 4.23). The deposition origins and post-depositional disturbance of the clay unit are problematic at this point but not totally unexpected in a site with relatively shallow burial. In the floodplain today, beavers burrow into the sediment leaving gopher tortoise-sized excavations. Though there was no evidence of this type of bioturbation in this sediment, it remains a possibility. A vibracore sediment sample taken directly adjacent to ST-1 for a continuous sediment sample may eventually provide an OSL date (Figure 4.24). Perhaps it should be no surprise that the gray clay unit at the Norden site is only a few thousand years old. The grey clay and silt resting above the shell marl at the Ichetucknee River Mouth and Sandy Point sites, with imbedded Deptford ceramics, suggests that about 10 cm depth is reasonable. These are the types of challenges one faces with shallowly buried Paleoindian
sites. Even though the Norden site leaves many questions unresolved, its stratigraphy and archaeological potential are still very promising.

The occurrence of the aforementioned refit paleo-preform is not an isolated example. Several other specimens have been found to refit (Figure 4.25). This is not a site that has been subjected to a great deal of disturbance. It also is a rare example of a Suwannee camp site with a full range of tools both bone and stone. It is imperative to develop a more refined geological understanding of the sediments at the Norden site and, if possible, the age of its Suwannee component.

The Dunnigan’s Old Mill site, located just up river from the Norden site, is an enigma as far as Florida Paleoindian sites are concerned. It is located on a three-meter high bluff overlooking the Santa Fe River (Figure 4.26) and is buried by a 65 cm thick column of sand. Below the sand, the artifacts are embedded in a sandy silt about 20 cm thick which in turn rests on Eocene, Ocala limestone. This level produced only a few stone artifacts but abundant bone specimens including tools. The most diagnostic artifact, a bone point manufactured from a white-tailed deer-sized animal, was found in four pieces. Three pieces of the proximal end were articulated along old bone breaks. The distal end of the three adjoining pieces displayed a green bone fracture. The fourth piece, the proximal hafting area was found in another test unit, and refit the green fracture of the other segment. Together they form a complete bone point, albeit small compared to the bone points made from ivory or other megafaunal bone. The bone assemblage includes both extant and extinct Pleistocene species but all of the bone specimens were too mineralized for $^{14}$C dating (Dunbar and Vojnovski 2007).

Wilder’s Point (8CO42) is an upland site extending to the edge of the river’s north bank (Figure 4.27). The site was recorded based on one site inspection on July 1, 1975 (Dunbar 1981d) where a bulldozer cut was placed along a property boundary to establish a fence line to the river’s edge. The bulldozer cut exposed abundant artifacts including faunal remains in the river’s floodplain. Early and Middle Archaic points, a Suwannee preform and unifacial stone tools consistent with a Paleoindian occupation were identified. Bone specimens were either calcined or well mineralized. The more elevated areas of the site lay in sandy sediment and generally did not have bone preservation whereas the lower elevated areas, in the floodplain, had shell marl, silt and clay with bone preservation. Similar to Dunnigan’s Old Mill, this site is on private property.
The Blue Springs site (8GI21) includes the remains of a mammoth located in the swamp forest near Naked Spring, a small spring and tributary of Blue Springs run. The mammoth site is located just below a high sandy hill overlooking the Santa Fe floodplain. Although partially collected by the landowner, the remaining bone elements were left in place and are buried in organic-rich sandy sediment. The ivory tusks are degraded to the consistency of crumbly mud, although the bone is in fair to very well preserved condition.

The Waller Bridge site (8GI64) has an intriguing channel fill sequence that may or may not include archaeological remains in an abandoned paleo-channel now elevated above the channel of the Santa Fe River (Figure 4.28). It is possible that the Paleo-channel or the adjacent high ground acted as a human activity area. It is the site that the late Ben Waller used as a type locality for his hypothesized Paleoindian river ford-game trail crossing, an ambush hunting locality (Waller 1969; 1970; 1983). Notably, this is a site that many river divers, Ben Waller included, have said yielded the largest single concentration of Paleoindian projectile points in the Santa Fe River basin. River channel deposits are uncommon, particularly in the river shallows. Mid-channel sinkholes in the site (Figure 4.28) are partially filled with lag deposits of unknown depth and it remains unclear if channel fill deposits occur below the lag. If they exist, it is channel-fill deposits that are of the greatest archaeological potential.

Hornsby Springs (8AL124) is notable because, like the Norden site, it is one of the few Paleoindian sites that have been archaeologically tested in the flood plain where shell marl and other channel-fill sediments exist. C. J. Simpson of the Florida Geological Survey and William E. Edwards, then a doctoral student at Columbia University carried out the archaeological investigation in 1951 and 1952. Unfortunately, Simpson died in 1952 and the relationship between Edwards and the Florida Geological Survey (FGS) came to an unproductive stalemate (Vernon 1959: 24-25). Years afterward, the FGS hired two FSU Anthropology Department graduate students to develop the report on Darby and Hornsby Spring (Dolan and Allen 1961).

Artifacts and faunal remains including extinct Pleistocene species were found in 15 of the 17 solution features excavated including units HO 512, 521, 542, 550, 551 and 560(Figure 4.29). Two different shell marl units covered the limestone outside the solution holes, but only the younger, upper unit covered the solution holes (Dolan and Allen 1961: 10-11). The older shell marl unit descended into and was found adhering to the sides of the solution holes. Apparently, the lower shell marl unit slumped into the solution features after the solution features were
subaerially exposed during a time of low water table stand. This left the central sector of the solution holes exposed as open depressions. These depressions then acted as sediment traps and filled with colluvium of late Pleistocene-age that also included faunal remains and artifacts. Subsequently, at some time during the Holocene, the Santa Fe basin was re-flooded sufficiently for another shell marl unit to form and cover the entire sequence of older sediment. Today, this area of the site is no longer perennially inundated, though it can be during flood stage.

The solution hole features contained artifacts and fossils, notably the remains of *opossum*, turtle, *Equus spp.*, and *Mammut americanum* and artifacts included a scraper and other lithic artifacts (Dolan and Allen 1961: 9). A radiocarbon date on the upper, Holocene shell marl yielded an age of 9,880 ±270 (Shell Development Company lab) but this date is likely too old. Freshwater shells have been found to date significantly older than they actually are because of the animal’s uptake of ancient calcium carbonate ingested while feasting on periphyton/biofilms during life. The cycle of Tertiary limestone dissolution in aquifer water, followed by its uptake by periphyton/biofilms, provides a source of ancient, radioactively dead carbon that yields anonymously older than expected ages without reservoir correction (Bullen and Bryant 1965: 23). A Kirk serrated projectile point (Dolan and Allen 1961: plate VIId)(Figure 4.29) was found in the upper shell marl in unit HO 551, which suggests a reservoir correction factor of about 1.5 ka to 2.0 ka years younger than the carbon date results.

**Wakulla and St. Marks Rivers**

Other than the Wakulla Springs Lodge (8WA329) and Wakulla Springs (8WA24), sites, only a few other early sites are known in the Wakulla and St. Marks River basins. The Wakulla Springs Lodge site is located on a hill overlooking the headspring. Here the late Calvin Jones identified a deeply buried Paleoindian level (Jones and Tesar 2000; 2004) with one Early Archaic pit feature with bone preservation. Otherwise, there was virtually no bone preservation. This is a situation common to many other upland, deep-sand sites with acidic soils. They have little to no organic preservation including bone. By contrast, the Wakulla Springs site is submerged and has very good bone preservation including late Pleistocene specimens of *Mammut americanum* and *Bison antiquus*.

It is assumed that the mastodon remains recovered by the Florida Geological Survey in the 1930’s originated from channel-fill deposits, yet the records of the recovery are sketchy.
Given that it was recovered in 6 to 8 m of water depth, the recovery location was most likely the small plateau area north of the descending slope to the mouth of Wakulla Spring cave (Figure 4.30). It is the area where a stack of a dozen or so mastodon bones can be observed by tourists on the glass-bottomed tour boat. It is also in an area of considerable channel-fill deposits. Recently, another mastodon site was identified at Wakulla Springs, the Vickery mastodon site. Vibracores taken east, west, and north of the site, shows a rich sequence of meter-plus channel-fill sediments in the area and preliminary investigation showed that much of a skull is buried in the channel-fill sequence (Figure 4.31 and 4.32)(Dunbar et al. 2007). Subsequent ground penetrating radar imagery of the site shows a sedimentary anomaly at the site but nowhere else nearby (Porter 2012; Rink and Burdette 2008)(Figure 4.33).

There have been a number of Pleistocene fossil discoveries near the headspring at Wakulla. Only five can be assigned to their general area of recovery (Gerrell 2011; Rupert 2011)(Figure 4.30). The skeletal remains of a number of other now-extinct forms of Pleistocene megafauna have been found in what is now Wakulla Springs State Park. It is unclear, however, where they were found and to what extent they were collected. Much of the 1950s to 1960s work was orchestrated by the late Stanley Olsen and it is known that he recovered an almost complete example of a *Bison antiquus* the whereabouts of which is unknown today.

Further downstream in the Wakulla River, megafaunal remains have been reported at the Powell Mastodon site (8WA175) and a mastodon location downstream of the Olin site that also yielded a waisted Clovis point (Dunbar 1991b). In the Wakulla River, largely unexplored, deep sequences of channel-fill sediments can be found in many locations, though most are underwater. In the St. Marks River, there are few places that have yielded evidence of channel-fills. Several locations at the lower end of the Natural Bridge area have shown some evidence of channel-filling.

**Withlacoochee and Rainbow Rivers**

The Withlacoochee River, and its tributary Rainbow River, are similarly not well documented except for a geologic investigation of Citrus and Levy counties (Vernon 1951). Shell marl, as well as other channel fills, are found in this basin including in the surrounding shallow lakes, Tsala Apopka and Panasoffkee, and are believed to exist in Gum Slough Spring and run. The Vertebrate Paleontology program at the Florida Museum of Natural History
recognizes this area as a major late Pleistocene fossil area. River, spring, and lake basin features in this area also have been the locations of Paleoindian diagnostic artifact recoveries (Dunbar 1991b).

**Wetland Stratigraphic Sequences**

It is worthwhile to compare the diagrammatic profiles of site stratigraphy for some of the sites discussed above (Figure 4.34). With the exception of the Butler site, which represents a channel-cut sequence, all others represent channel-fill sequences. Of the known channel-fill sequences, shell marl is common to all of the sites. Yet shell marl occurs at different elevations above and below the modern water table (at average river stage) and is indicative of a formational environment of different times and elevations of the local water table. Shell marl appears to form during times of relatively shallow, flowing water conditions where ample sunlight helps to support lush aquatic vegetation in wide, non-canopied channel sections. The lush aquatic vegetation, rocks, and snags that project from the river bottom also support microbial mats that enjoy a symbiotic relationship with the plant life, which, in turn, also supports a distinctive aquatic fauna that includes copious colonies of gastropods.

Calcitic and neutral pH silts and clays, sand, and organic-rich levels, which include peat and oxidized peat, occur at many sites but are not as ubiquitous compared to shell marl. Only one site, Page-Ladson, has a colluvial (Unit 3) and a smectite (Unit 5) level. Both are distinctive. The colluvium unit represents both colluvial sediment input mixed with still-water pond deposits. The smectite represents a shallow, low or no flowing water environment with aquatic fauna, including articulated bivalves. The artifacts recovered from the smectite unit may have been introduced as discards or lost by people conducting activities on the adjacent riverbank. The smectite level needs to be better understood. Sylvia Scudder mistakenly referred to the smectite level, Unit 5 as the “Bolen layer” (Scudder 2006: 440). The so-called Bolen level is actually the bottom of Unit 6 and on the top of Unit 5, the Bolen surface (Carter and Dunbar 2006).

**Some Sediment Types in the Karst Uplands**

It is not my intent to comprehensively cover every sedimentary environment one might find on the coastal plain of the Southeast; rather it is to discuss two types of sedimentary deposits
where archaeological remains have been found. One is quite common and other not so common. They are: 1) sites buried in deep sand uplands and 2) sites located in terrestrial cave deposits. In the former many Paleoindian sites have been identified, in the latter there is promising potential.

**Deep Sand**

Paleoindian components buried in deep sand deposits occur at sites such as Paradise Park (Neill 1958) near Silver Springs, Harney Flats (Daniel and Wisenbaker 1987) near Tampa, and the Wakulla Springs Lodge (Dunbar 2008; Jones and Tesar 2000; 2004; Rink et al. 2012) south of Tallahassee. Archaeologists have recognized for some time that artifacts typically do not occur in discrete levels in deep sand environments; rather they occur in generalized zones within these loose, unconsolidated deposits. The origin of sedimentation is often fluvial or aeolian, but deep sand deposits can be structureless or seemingly so. Researchers are often faced with determining the origins of site burial and the degree to which the zone of occupation, its “level,” has become distributed vertically in the sediment column. Under many circumstances they must explain the degree to which artifact zones are diffuse yet remained identifiable as a coherent component. This means understanding sediment accumulation and burial versus the degree of component post-depositional disturbance and displacement. The investigation at the Pen Point site in South Carolina represents an excellent example of such a study effort (Brooks and Sassaman 1990).

**Sediment Deposition and Artifact Burial in Deep Sand Deposits**

This section is limited to a discussion of aeolian sand deposition and inland wind-blown sand deposits, mostly dunes. A discussion of fluvial deposits has already been discussed above. Aeolian (also eolian) sand deposits are common in the geologic literature of the Southeast (for example see White 1970: 149-153). In Florida aeolian deposits are actively forming and being reworked along the coastal strand that lies outside the near-surface Tertiary karst areas of the Central and Northeastern Gulf Coast of Florida (Ball 1967; Pye 1993). The karst coastal areas tend to be sediment starved and present odd coastlines such as the islands and estuaries that form the coastline between the Crystal and the Chassahowitzka rivers. From the Ochlockonee Bay to Anclote Key the Tertiary limestone outcrops or is very near the surface and forms the so-called
drowned karst coastline (Bryan et al. 2008: 51). The drowned karst coastline is not without aeolian sand dunes, which is an important part of the discussion that follows. It is also important to point out that this section of coastline does not have sandy beaches and large beach-line dune sets. This area has virtually no sand beaches; it is an area where saltmarshes meet the Gulf Coast without them.

Interpretations about the origins and age of aeolian deposits, particularly those inland from the coast, first were hypothesized to have been generated during times of higher sea level stands when the coastal strand was farther inland and provided a means for wind-blown distribution. However, inland aeolian sand deposits without their diagnostic cross bedding structure were also said to have formed atypically due to the large, predevelopment Southeastern forests which disrupted normal accretion and cross bedding development (White 1970). William F. Tanner (1980) identified deposits of non-dune, aeolian sand lacking cross-bedding in mound sites located in the Florida Panhandle and hypothesized:

The . . . writer sees at least some of such field examples [of non-dune aeolian accumulations] as representing river sands which were carried by the wind up the valley wall, to be trapped in vegetation of one kind or another near the rim of the valley (Tanner 1980: 227).

In the coastal plain of the southeastern US, a number of more recent studies of inland and coastal parabolic and lunate dunes and dune fields have shown that they formed as inland phenomena during the late Pleistocene to early Holocene from ~59 ka cal BP until ~10 ka cal BP (Ivester et al. 2001; Ivester and Leigh 2003; Leigh 2006; Leigh et al. 2004; Otvos 2004; Otvos and Price 2001; Wright et al. 2005). In other words, they were not formed as a result of once being adjacent to a coastal location. Interpretations of dune development have been facilitated by radiometric dating and by the identification of cross bedding in them. But not all suspected aeolian dunes and other, less sculpted wind-blown deposits have cross bedding. While White’s (1970) proposal that aeolian deposition was obscured without cross bedding by the obstacle of the Southeastern forests, Tanner’s (1980) assessment agreed with White’s but went further envisioning that the windblown sand originated from fluvial sources. Other researchers have proposed post-depositional disturbances as reasons for the absence of cross bedding or, more importantly, that suspected deposits of non-cross bedded sand deposits are, in fact, not aeolian.
It is interesting that lunate dunes of aeolian origin formed in many places in the Southeastern Coastal Plain during the Pleistocene but ceased to form just after the beginning of the early Holocene. During much of the Pleistocene climate oscillated from wet to dry and from cool to warm in various combinations and with it, but lagging to catch up, were changes in vegetation sequences (Dunbar 2006c; Grimm et al. 1993; Grimm et al. 2003; Grimm et al. 2006 - this topic will be discussed in more detail in Chapter 5). Parabolic dunes accumulated in this vastly more open landscape. It was a landscape that did not exist in prehistoric times in the Holocene Southeast.

Site Bioturbation in Deep Sand Deposits

There are many things that can disturb deep sand deposits and they generally fall under the headings of bioturbation and biomantling. Bioturbation covers anything in the way of a biological agent that can disturb the sediment column such as tornado swath tree falls (Phillips et al. 2008) whereas biomantling is concerned with the upper-most bio-rind of the earth where living organisms inhabit and rearrange it (Johnson 1989). The concepts are more or less the same with nuanced differences. Rather than sort those out, they will be considered collectively.

Biological disturbances to the soil can be accomplished by the actions of small or large organisms including turbations by animal, plant, or fungi. Important factors to determine include the degree to which the soil is bioturbated, how deep the disturbance penetrates, and the degree to which original stratigraphic context has survived. For example, there have been some studies that have shown significant site disturbances (Johnson 1989) and others that have found coherent archaeological datasets in slightly disturbed sequences (Brooks et al. 1996). Bioturbation then is a matter of scale and degree of displacement (Figure 4.35 and 4.36). It is like so many things in the earth sciences, the data are fuzzy around the edges, the less fuzzy the better.

Site interpretations are often cast in terms of the accumulation of aeolian sediment burying site components (Austin et al. 2004), or of bioturbation forming a biomantle ever more deeply over them (Peacock and Fant 2002). What then is the evidence for either kind of disturbance?
Discussion of Deep Sand Sites

The Harney Flats site near Tampa is located on a sand bluff overlooking a lowland depression. The Paleoindian, and Early Archaic components at Harney Flats lie beneath a well-developed B horizon (spodic or alternatively also known as humate) that, according to soil scientist John Floss, often develop slowly and take thousands of years to form (Austin et al. 2004: 473). At Harney Flats, a B horizon had formed about a meter below the land surface and partly encased a middle Archaic Newnan point component with a Kirk component below it and the Early Archaic-Paleoindian level below the Kirk component. The Early Archaic-Paleoindian level was sealed below the hard pan of the B horizon and had two younger components above it. The West Williams site (8HI509) is located on the other side of the Tampa Bypass Canal from Harney Flats about 1 km to the southeast. West Williams has a similar B horizon, but it does not have a Paleoindian component. Both sites are believed to be buried in aeolian sand deposits that accumulated during the Holocene (Austin et al. 2004; Daniel and Wisenbaker 1987).

At Harney Flats wind-blown sand deposits began accumulating substantially after Bolen times and built up sufficiently to separate the younger Early Archaic Kirk occupation from the Early Archaic-Paleoindian component. This is interesting because research on sites further north from the Florida panhandle to the Carolinas shows that parabolic dune formation concluded by the end of Bolen times (see for example Ivester et al. 2001). Other Holocene aeolian activity in these more northerly latitudes was much less substantial and caused by the reworking of Pleistocene dune crests to lower elevations (Brooks et al. 1996; Ivester and Leigh 2003) or, as in the case in the Florida Panhandle, were non-dune accumulations (Tanner 1980).

Using Johnson et al.’s (2005) criteria of dynamic soils denudation, the possibility that Harney Flats or West Williams experienced significant biomantling by upward bio-transfers (ants) of older sediments to the surface is minimal because there are no stone lines of mixed artifacts assemblages. The degree of site modification due to bio-mixers (pocket gophers and land tortoise) also is minimal. This is not to say that these types of processes did not occur, certainly they did, just not on a broad geographic scale that, in most cases, significantly impacted site integrity and not all sites were necessarily affected. Consequently is it possible that small organism in the soil column effected the detectability of cross bedding in aeolian deposits?

The concept of the deep sand deposits with cultural components is worth considering at the Wakulla Springs Lodge site. The Paleoindian component at the Wakulla Springs Lodge site
is elevated about 5 m above the modern water table. The last time the water table and sea level were high enough to have formed an ancient estuarine river mouth is about half a million years ago. Evidence now suggests that the deep sand column at the Wakulla Springs Lodge site was derived from fluvial sources and because it is not eolian, must have experienced some type of post-depositional bioturbation while also retaining site integrity.

Granulometric analysis of several sand samples from the Wakulla Springs Lodge site showed that all of the samples had bi-modal plots indicating sand of fluvial origin (Means 2012). However, bare ground LiDAR imagery of the site shows a remnant Pleistocene dune field (Figure 4.37) indicative of aeolian origins. The formation of Pleistocene dunes in the southeastern US has been determined to have originated from fluvial sand derived by wind-blown processes being transported from exposed Pleistocene river channels (Ivester et al. 2001; Ivester and Leigh 2003; Leigh 2006; Leigh et al. 2004; Otvos and Price 2001). In Georgia and the Carolinas,

Eolian dunes on river valleys of the southeastern Coastal Plain were ‘‘source bordering’’ dunes that had a genetic linkage to river channels that exposed abundant sources of sand for eolian transport (Leigh 2006: 157).

In the Mississippi River valley, in Louisiana,

[Most Pleistocene] dune hills appear to be structureless and homogenous in filed exposures . . . [and have] . . . illuval lamella. Reflecting muddy floodplain sources, Miscar Hill, an exceptional parabola-shape clay dune, displays unusually large amounts of silt (49.9%) and clay (33.0%) [bi-modal] (Otvos and Price 2001: 153).

At the Wakulla Springs Lodge site, dunes are structureless with illuval lamella and are located near the Wakulla River. Other nearby Pleistocene dune fields are located near the St. Marks, Steinhatchee, and Suwannee Rivers in Florida (Wright et al. 2005) and the Flint River in Georgia (Ivester et al. 2001). Even though it appears likely that the sandy sediments at the Wakulla Springs Lodge site were derived from wind-blown sand originating from fluvial sources, it has not been demonstrated at this site and additional soil and geologic testing is required. But that also brings us back to the topic of bioturbation.

The original attempt to OSL date samples for the Wakulla Springs Lodge site (see discussion in Chapter 5) proved to be problematic. Without a discussion of the dating method,
suffice it to say that an original aliquot size of about 300 grains each was determined to be too large and a smaller aliquot size of about 20 grains proved to be most suitable. Some type of disturbance was evident. It was thought that some type of bioturbation might be responsible, even though all dating samples lined up in chronostratigraphic order. By using a smaller 20 grain aliquot, a mixed grain assemblage was detected and for that reason the minimum age model was applied to the dates. More important to our purposes here is that the OSL procedures applied by Rink showed that post-depositional disturbance had occurred yet the site was still datable with overall good site integrity. What caused this type of site disturbance?

The original, larger aliquot size dated the lower artifact levels of the site older than anticipated. It used both a large aliquot as well as the middle age model for dating. Shifting to a smaller aliquot size not only revealed that there was a degree of post depositional disturbance; it also provided a means of checking site integrity. Using the minimum age model provided the most conservative means and dates that the site components can be no younger than Rink et al. 2012). Perhaps the most unexpected result is that the OSL data indicated older sand grains had moved up the sand column but not to the ground surface where their radiometric clocks would have been reset to zero time. It is the type of bioturbation caused by upward bio-transfers such as ants moving older sediments upwards (Johnson et al. 2005) but not to the surface. A study of harvester ant bio-transfer being headed by Walter Tschinkel of Florida State University and Jack Rink of McMaster University, Hamilton, Canada, now promises to provide the first quantifiable data for deep sand environments in the Southeast.

Cave Deposits

Paleoindian sites in the Southeast are sometimes located in caves that were used as shelters (see for example Driskell 1994; 1996). In Florida there are 31 terrestrial caves sites (including the Cutler Ridge Fossil site -8DA2001- which is in a karst sinkhole). Five have Paleoindian or suspected Paleoindian components. Most terrestrial cave sites are located in Jackson County west of the Apalachicola River in karst uplands. Another, cluster of sites is located in Citrus County and occurs in upland karst along the spine of the Ocala Uplift. Besides Jackson, Citrus, and Dade counties, Alachua and Marion counties also have documented terrestrial cave sites. Early cave sites in Florida, while not common, are known to exist. For
example, the Dixie Lime Cave 1 and Dixie Lime Cave 2 in Marion County yielded Early and Middle Archaic site components (Bullen and Benson 1964).

The configurations of cave sites have different potentials for rates of sedimentation and infilling. Cavernous sinkholes have sheer and steep-sided walls prior to branching in rock overhangs. Lateral walk-in caves have entrances that are approached at level to declining elevations versus those that are approached with increasing elevations. Caves having level or declining elevations to their entrances obviously have the potential to be more rapidly in-filled. The potential for a cave to become filled with sediment can also change as circumstances, both natural and cultural, change around them. The Dames Cave site (8CI154) in Citrus County is an excellent case in point.

The Dames Cave site, is one of the most visited caves in Central Florida and has been impacted over the past several decades by human traffic and the absence of proper stabilization measures. Yet its archaeological potential remains undisturbed because the downward sloping cave entrances have been filling with colluvium. Dames Cave has four walk-in entrances and one skylight pit fall-like opening. Because the eastern and northern entrances are blocked by sediment fill, an effort to test the cave floor was undertaken using the western entrance to access the skylight area of the cave. A 2x2-m unit was excavated to an overall depth of 1.20 to 1.40 m where a limestone rock-rubble floor was contacted that may represent the rock-fall roof collapse that created the skylight opening. A few prehistoric artifacts were recovered from the deepest levels of the site (1.20 m to 1.40 m), with highly stratified levels of cave-fill above it dating from the early 1970s. Rough calculation of the rate of infilling is about 3 cm a year over the last thirty-six years. The upper part of the stratigraphy, while striking, is very young (Figures 4.38 and 4.39).

At the eastern cave entrance of Dames Cave, the proximal end of an Aucilla Adze was recovered. At the Page-Ladson site an Aucilla Adze was recovered from a level dated to 10,650 cal BP (Carter and Dunbar 2006). The adze from the eastern entrance of Dames Cave was moderately patinated while other, less diagnostic artifacts (cores and flakes) were extremely patinated indicative that an earlier component is possible. Testing in the skylight room in the very deepest levels of the site, below the modern fill, a few debitage flakes and well preserved faunal remains were found, their age unknown. Testing on the terrestrial surface outside the cave revealed the typical upland scenario, that of no bone preservation. At the very least there appears
to be an Early Archaic and very possibly a Paleoindian component buried in Dames Cave. In the mid-to-late 1960s, when I first visited Dames Cave, it was more interconnected and the west and north entrances could be accessed. Both openings led to the skylight floor and another large room extending in the direction of the eastern entrances. During the late Pleistocene the now-filled eastern room as well as the skylight room (that may have then had an intact roof) offered shelter.

There are isolated chert outcrops around Dames Cave but it is the Lizzie Hart Sink site (8CI153), a very large prehistoric chert quarry that was the major source of prehistoric chert in the area. It is less than a kilometer to the south and, if the modern tree cover were cleared, Dames Cave at 30 m above sea level would visually overlook the Lizzie Hart chert quarry at 3 meters above sea level. Within a kilometer southwest of Dames Cave is the Simpson site (8CI83), yet another Paleoindian site identified by Clarence Simpson. Upland Paleoindian sites, though not as common as the river basin sites, do occur and they may be uniquely informative in ways the lowland river basin sites are not. These types of sites may be our only opportunity to investigate upland Paleoindian and Early Archaic sites that have decent organic preservation. One additional matter to consider is that highly stratified modern infilling found in Dames Cave may also occur in earlier occupation levels, but that would mean that heavy rains, unless deflected away from the cave entrance or diverted away from a living floor, would have perhaps have caused its inhabitants to leave. The cave systems in Jackson County tend to have elevated entrances that likely did not have that problem.

Discussion and Conclusions

Karst river basins in Florida vary in configuration from deeply entrenched channels like the Half Mile Rise section of the Aucilla River to the lowland, swamp-forest flood plain of the Wacissa or Ocklawaha rivers. Many are very old and have yielded evidence of early and middle Pleistocene deposits and some, like the Ocklawaha, have evidence of former estuarine and coastal environments indicative of possible Pliocene origins. Florida karst rivers share one thing in common. These rivers occur where the Tertiary limestone is at or near the surface and they are all connected by subterranean conduits to the Floridan Aquifer (Figure 4.40). The Tertiary
limestone formations are chert-bearing and access to the Floridan Aquifer offered a clear, clean source of potable to the Paleoindians who occupied its geographic extent.

These conduits discharge aquifer water highly charged with calcium carbonate dissolved from the Tertiary limestone. The aquifer water provides the necessary calcium carbonate and, through biogenic means, is responsible for the alkaline rich shell marls that formed during much of the Pleistocene and Holocene. Specific environmental conditions must be present in these spring-fed features to form shell marl deposits. Relatively shallow water depth, water clarity, the presence of abundant aquatic vegetation not only basking in the sunlight but also hosting EPS biofilms, snags and bottom channel segments hosting periphyton (algal) mats, and the presence of abundant gastropod communities are all requirements. These are the conditions under which shell marls form in Southeastern karst rivers. Where they survive as channel-fill deposits they are important environmental markers, some of which contain or cover archaeological remains.

Calcitic to neutral pH silts and clays with little or no freshwater shells are not as well understood. Those that may have been formed under biogenic circumstances similar to shell marls hold similar significance. What is not clear is if there may be some mechanism for their production by abiotic means. The abiotic deposition of Everglades lime mud was first suspected to have resulted from the precipitation of calcium carbonate from super-saturated, carbonate-charged waters during the dry season (Gleason et al. 1974). However, it has since been determined to have originated via biogenic means from periphyton mats. Clearly more research is needed along these lines.

Peat, colluvial sediments, and the reduction products of wetland sediment transformed by age and subaerial exposure also occupy these basins. Within the last 8,500 or so years, Holocene channel-cut sequences have dominated and erosion of earlier channel-fill sequences has, and is, taking place. Many of the stratigraphic sequences profiled in this dissertation, both inundated and stranded above the modern river stages, were exposed by Holocene channel cutting, though some in the Santa Fe basin may have developed during the previous interglacial. With that said, it is clear that the erosive potential of these karst rivers has been low and that many key channel-fill sequences remain intact.

Karst river basin channel-fill sequences in Florida have the potential to provide vital multi-proxy data for the late Pleistocene and early Holocene. With the exception of the Page-Ladson site in the Aucilla River, they seldom have been studied and remain virtually untapped.
In order to properly study karst river basin sites, two types of field approaches are recommended for recovering proxy data. The first is to identify and carefully sample the levels in deep channel-filled features (sinkholes, etc.), particularly in water of 6 m or greater depth. These more deeply inundated sequences promise to provide the most datable and uninterrupted records. Sediments from deep karst features are likely to provide evidence of low-level paleo-aquifer stands. The second is to test, sample, and geologically map shallow water and river flood plain sediment sequences, which, among other things, will establish the elevations of ancient high-level river stands. It should also be kept in mind that these sequences have archaeological sites in them as well. Thus under ideal circumstances, both will co-occur at the same site to provide cultural as well as environmental reconstruction.

Another unusual proxy not yet discussed is that of the trees that once grew on earlier land surfaces in the karst river channels when they were dry or only minimally inundated. They grew there during times of subaerial exposure and provide rather obvious environmental insights. In the Aucilla, Ochlocknee, Santa Fe, and Apalachicola Rivers among others, in situ, tree stumps have been identified. At least three archaeological sites have preserved tree stumps from components that, to date, have no evidence of human activity and date to the LGM ~18.0 to ~18.5 ka \(^{14}\)C BP (Dunbar 2002; Dunbar 2006c; Smith et al. 1997). Tree stumps in now inundated settings are clear evidence that the inland water table (the Floridan Aquifer’s surface in the Tertiary Karst Region) was substantially lower during some or all of the LGM.

Research carried out at the Page-Ladson site and, more recently, the first formal test unit conducted at the Norden site, have shown that bone and pollen is preserved in their channel-fill sequences regardless of their elevation above or below present average river stage.

In closing, it is only fitting to mention the archaeological potential of Florida Paleoindian sites by summing it up succinctly. Paleoindian sites are preserved in karst river basins or in upland karst features, primarily caves. Karst river basins have the greatest concentration of these early sites, yet they have been infrequently investigated. The lack of professional research in these contexts is related to the incorrect perception that stratigraphic integrity has been compromised by fluvial activity. This perception began with interpretations of river channel sites by the late Stanley Olsen, (1949a; 1961; 1962). It is unfortunate that archaeological research was inhibited at the same time uncontrolled collecting was promoted by Olsen’s proclamations. Paradoxically, it was relic divers like Ben Waller (1983) and Don Serbousek (Serbousek 1983)
who urged archaeologists to rethink this false position and challenged them to investigate karst river sites. Today, even in these difficult economic times, it is the antiquity market that is the problem (Figures 4.41 and 4.42).

Archaeologists and researchers of the late Quaternary have one of the most important, if not the most important archaeological and paleontological resources in the Americas and they are located in Florida’s karst river basins. It is to be hoped that there will be a new awakening of research and respect for the archaeological potential of these geological features. Further, measures must be taken to preserve these sites before they are seriously damaged. This research absolutely meets the high-level standards set forth by the International Quaternary Union (INQUA) and the Paleoclimate Commission for the integration of ice core, marine and terrestrial records (INTIMATE group)(Lowe et al. 2001; Lowe, Rasmussen et al. 2008; Walker et al. 2001; Yu et al. 2008). History tells us not to repeat the mistakes of the past when it comes to the management and preservation of this non-renewable resource.
Figure 4.1. The Floridan Aquifer in the southeastern Coastal Plain of North America.
Figure 4.2. Digital Elevation Model of the lower Santa Fe River Basin with river and physiographic place name identifications (GIS from USGS data compiled by the author).
Figure 4.3. Digital Elevation Model of the Big Bend area Showing Physiographic Provinces (GIS from USGS data compiled by the author).
Figure 4.4. Digital Elevation Model of the Aucilla River drainage basin shows that karstification has generally reduced the Tallahassee Hills (see Figure 4.3) south of the Georgia state line. Note that the Tallahassee Hills are more intact to the west and north of the middle Aucilla River basin between the state line and Gulf Coastal Lowlands. Where the Tallahassee Hills are more intact dendritic drainage systems are still cutting through non-karst sediments. In the middle Aucilla basin the karstified terrain reflects an overall reduction of the Tallahassee Hills (GIS from USGS data and compiled by the author).
Figure 4.5. Drainage of the Apalachicola Basin (includes the Flint and Chattahoochee Rivers) compared to the smaller Coastal Plain restricted, Aucilla River Basin (GIS from USGS data compiled by the author).
Figure 4.6 Santa Fe River mouth at confluence with the Suwannee River showing river depth. The Gilchrist-Suwannee county line runs down the Santa Fe River, therefore, the Butler site is in Gilchrist County and the unnamed SU2 site is in Suwannee County (data from bathymetric survey by staff of the Florida Bureau of Archaeological Research and compiled by the author).
Figure 4.7. Humate sediment from the Butler site (8GI1 – 8SU2) collected from the Suwannee River component just above the Santa Fe River mouth. This image shows the humate coating the sediment before (left) and its absence after cleansing it (right) in a 30 percent solution of hydrogen peroxide.
Figure 4.8. Florida Everglades showing marl prairie in the foreground with periphyton suspended and floating in the water column among the marsh grass. In the background is a willow tree island (source - http://teacher-nomad.blogspot.com/2010/07/day-in-everglades.html).
Figure 4.9. Lower Santa Fe River basin showing the locations of springs that discharge water from the Floridan Aquifer to its surface channel. The lower Santa Fe River is in essence an elongated spring run within its wide flood plain are thick deposits of channel fill deposits, among them shell marl. Spring location information was plotted using GIS shape files compiled by the Florida Geological Survey (compiled by the author).
Figure 4.10. Idealized models of biofilm and algal mats (actually periphyton communities or mats) in Florida karst rivers (from Inglett et al. 2008: 140, Figure 2).
Figure 4.11. LiDAR Digital Elevation Model of the lower Aucilla River from the lower end of Half Mile Rise to Ward Island showing selected site locations (from LiDAR data from the Florida Division of Emergency Management – FDEM and compiled by the author).
Figure 4.12. A dry channel section of the Econfina River located 10.3 kilometers east of the Aucilla River on US 98 is depicted during the drought of 2007. Looking north, upstream, this river rarely goes dry and reflects a drop in the Floridan Aquifer’s surface to a level below this section of the river’s channel.
Figure 4.13. A dry channel section of the Econfina River located 10.3 kilometers east of the Aucilla River on US 98 is depicted during the drought of 2007. Looking southeast, upstream to the right and downstream to the left (in the distance is the US 98 bridge), this section of the river channel is a clear-water, non-flowing surface pond expression of the Floridan Aquifer’s surface.
Figure 4.14. Bathymetric map of the lower Half Mile Rise section of the Aucilla River showing depth contours and the locations of inundated sites located in the river’s channel (from a bathymetric survey conducted by the Aucilla River Research Project team and compiled by the author).
Figure 4.15. SCUBA divers, including Robert Allen, inspect mammoth bones in possible colluvial sands located between shell marl levels in Silver River (photograph courtesy of the late Ben Waller).
Figure 4.16. The idealized stratigraphic profile developed by Robert Allen in 1967. Allen was a diver on the Silver River mammoth site project and student in the University of Florida, Anthropology Department. He is one of the sons of the late Ross Allen of the Ross Allen Reptile Institute, then centered on the grounds of Silver Springs.
Figure 4.17. Simpson’s Flats site idealized stratigraphic profile scanned and traced digitally from Stanley Olsen’s hand-drawn field map (Olsen 1949). This location is where Clarence Simpson recovered carved ivory shafts, lanceolate points, and the *in situ* mastodon bones with a lithic scraper beneath the bones.
Figure 4.18. Divers from the Bureau of Archaeological Research and FSU Academic Dive Program are shown mapping a mastodon tusk when the tusk was uncovered (left) and mapping its position in relation to an arbitrary control point (right). There is a shell marl level above the tusk in the background behind the exposed tusk and diver. The tusk was recovered from a sand level below the marl.
Figure 4.19. Plan-view map depicting the location of four carved ivory shaft fragments discovered by the author in 1974 (see Figure 3.17).
Figure 4.20. The idealized stratigraphic units at Simpson’s Camp (see Figure 13.16).
Idealized geologic cross-section of the Santa Fe River at the Norden Site (8GI40).

Figure 4.21. Cross section of the Santa Fe River basin at the Norden Site (adapted from Dunbar and Vojnovski 1997).
Figure 4.22. Norden site re-fit preform. The river-stained base was recovered by the author in 1974 and the tip from the 25 cm level in Test Unit 1 in 2009. The tip is not water stained (image compiled by Louis Tesar).
Figure 4.23. Stratigraphic profiles taken by Charles Fredrick at the Norden site and provided to the author.
Figure 4.24. Vibracore sampling at the Norden Site using a three-inch diameter aluminum core tube. Top right Glen Doran (left) measures tube length to ground contact and Charles Frederick (right) is taking measurement from the core tube location to the SE corner of Test Unit 1. Jack Rink is crouched in middle as shown in the top right photograph while taking notes. Bottom photograph is the field book with notes as Jack Rinks records the information.
Figure 4.25. Of the other preforms recovered from the Norden site, three have been refit for a total of four refit preforms as well as other uniface tool refits including an ovoid scraper and a blade-flake to a conical core.
Figure 4.26. The location of the Dunnigan’s Old Mill site overlooks a large set of rapids (during low water stage) on the Santa Fe River and is also near and the old mill run (Image source, the Marston Map & Imagery Library, University of Florida).
Figure 4.27. The location of the Wilder’s Point site on the Columbia County side of the Santa Fe River (Image source, the Marston Map & Imagery Library, University of Florida).
Figure 4.28. Waller Bridge site (8G164) is the site that Ben Waller characterized as typical of Paleoindian game trail crossing location where hunting ambushes took place. The shallows represent the crossing area and the deep drop off downstream the area where prey animals were theoretically driven to more easily dispatch them (from Labins.org aerial imagery and USGS DEM data compiled by author).
Figure 4.29. Hornsby Springs site solution tube stratigraphic profile showing the location of the radiocarbon sample at the red X, and the Archaic projectile point recovered from the same level. There are two shell marl levels, one Holocene in age (upper) and the other Pleistocene in age (lower). In the center of the solution hole Pleistocene and extant vertebrate animal remains were recovered with numerous debitage flakes, a scraper and other stone tools (adopted from Dolan and Allen 1961, Figure 4, Florida Geological Survey).
Figure 4.30. 2010 aerial photograph of the headspring area of Wakulla Springs State Park showing the locations of Paleoindian artifact recoveries and mastodon skeletal remains that have been identified near the headspring. Bone preservation on the terrestrial Paleoindian components is absent, however, underwater it abounds (from Labins.org aerial imagery and compiled by author).
Figure 4.31. Posterior view of a *Mammut americanum* (Kerr) skull showing the area of the Vickrey mastodon skull that was exposed during the inspection dive.
Figure 4.32. The exposed mastodon tusk alveolus, upper maxilla and fractured zygomatic arch area. The other side of the maxilla is buried and the skull is lying at a 20° or so angle dipping towards the left side of this photograph (Florida Bureau of Archaeological Research).
Figure 4.33. This is a Ground Penetrating Radar (GPR) image of the Vickery mastodon site showing the GPR subsurface profile (top) as well as a cross section of the channel bottom (bottom) (provided by Rink and Burdett 2008).
Figure 4.34. Stratigraphic profiles of karst river basin Paleoindian sites.
Figure 4.35. Example of a termite mound in Australia like the ones documented by (Johnson 1989) to have caused major biomantling and artifact displacement. Ryan (left) and Harley Means (right) pose as scales in this photograph (photo courtesy of Harley Means).
Figure 4.36. Example of a harvester ant mound in the ant research area of the Apalachicola National Forest with Dr. Walter Tschinkel posing for scale.
Figure 4.37: Wakulla Springs area LiDAR Digital Elevation Model (DEM) showing locations and frequency of parabolic dunes (from LiDAR data from the Florida Division of Emergency Management – FDEM and compiled by the author).
Figure 4.38. Kevin Porter of the Florida Bureau of Archaeological Research, Public Lands Archaeology program points to a modern fire hearth feature in the north wall profile of the skylight test unit in Dames Cave (8CI154), Withlacoochee State Forest (Florida Bureau of Archaeological Research).
Figure 4.39. North wall profile of the skylight test unit in Dames Cave showing the highly stratified modern deposition that has taken place since the 1970s. The lenticulate feature in the approximate center of the profile is a fire pit complete with broken beer bottle glass and sardine cans. The very dark gray sediment above the limestone rubble is the pre-modern cavern fill with heat-treated chert and faunal remains. The large roots from a nearby oak tree were found to spread across the top of the dark grey sediment unit and penetrated into it but not into the modern units above (Florida Bureau of Archaeological Research).
Figure 4.40. Idealized geologic cross section in the Tertiary Karst region of the Floridan Aquifer showing a cavernous subterranean to river channel karst conduit. Where the Floridan Aquifer’s surface is above the ground the land is inundated because the elevation of the land lies below the aquifer’s surface. Under this circumstance subterranean caverns open to the surface discharge as springs even though the aquifer is unconfined and therefore lacks artesian head pressure it has where it is confined. Should the aquifer’s surface drop far enough, the water level in the river channel and springs will fall and, if depressed sufficiently, dry up (adapted from Dunbar 1991).
Figure 4.41. Paleoindian carved ivory shafts for sale by the fossil collector who hosts the Tallahassee Arrowhead and Fossil Show (see Figure 3.42). The ivory shafts look specifically like the ones that have been recovered from sinkhole sites such as Sloth Hole in the Aucilla River. Here the river bottom and the sinkholes in them are state-owned property, but some adjoining lots nearby that are private property.
Figure 4.42. Advertisement for the 11th annual Tallahassee Artifact and Fossil Show held February 25th, 2011 where, specimen by specimen, Florida’s prehistory is for sale to the highest bidder. Come one come all everybody plays, everybody wins?
CHAPTER FIVE

CHRONOLOGICAL CONTEXT

Introduction

In this chapter, I explore four methods of time placement techniques to understand the temporal placement of Paleoindian sites. Two methods of radiometric decay dating are considered: radiocarbon dating, the most widely used method in archaeology, and the Uranium-series method (also referred to as Uranium-thorium dating, thorium-230 dating, and uranium-series disequilibrium dating) a method with potential for dating biogenic carbonate deposits in the karst rivers of Florida. Optically stimulated luminescence dating (OSL dating) is another radiometric method based on radioactive accumulation with age determinations dating the last time quartz sand grains were exposed to sunlight. The last method of dating to be considered here is the potential of dendrochronology (tree ring dating).

Radiocarbon Dating

Radiocarbon dating is the most commonly used late Quaternary dating technique in archaeology and there are several databases attesting to its use (see for example Dasovich 1996; Dasovich and Doran 2011; Morlan 2004). It is also true that since its inception (Libby et al. 1949), the age results from radiocarbon dating do not correlate to calendar years particularly for assays taken on late Pleistocene samples. For example, the Allerød-Younger Dryas boundary has been radiocarbon dated to about 11,000 radiocarbon years old (see for example Haynes 1967). However, that is not the true age of this boundary in calendar years before present. Once adjusted to calendar years, the Allerød-Younger Dryas boundary is 12,885 ±192 cal years BP (Stuiver and Reimer 2010), which, incidentally, is in strong agreement with the chronology that Antevs (1936a) developed for western Paleoindian sites. The most recent radiocarbon-to-calendar year correction datasets are based on biogenic and inorganic materials that have accumulated in annually deposited layers such as tree rings, varved sediments including the Greenland and Antarctic ice-cores, lacustrine, and deep sea sediments in addition to the use of uranium-series
dating of fossil corals in tandem with radiocarbon to derive correction factors. The correction
dataset is manipulated using Bayesian methods to determine calendar years from radiocarbon
year assays. It is also used to average statistically related dates (Reimer et al. 2009)(Figure 5.1).

There are a number of problems inherent in the radiocarbon time scale including: 1) non-
constant levels of radioactive carbon in marine and atmospheric environments since the time of
Marine Isotope Stage 3 (MIS 3)(see for example Reimer 2001; Reimer et al. 2009; Stuiver et al.
1998); 2) the possible under-estimated half-life of radioactive carbon at a $^{14}$C half-life of 5730 ±
40 years BP (the Cambridge convention established in the 1960s and in use today) versus a
recommended revision to 6030 years BP (Chiu et al. 2007), a proposal that has not been
demonstrated but is a possibility; and, 3) the variability of marine reservoir correction factors not
only through time (Austin et al. 2011; Cao et al. 2007), but also at present, at differing set-point
constants in marine and brackish water sites in Southeastern US and adjacent Caribbean (Table
5.1). Radiocarbon dating is similar to a number of other radiometric decay methods in that it was
originally based on the assumptions that: 1) radioactive carbon 14 has occurred in the
atmosphere and oceans at a constant level through time and, 2) radioactive decay for the half-life
of carbon 14 is known. As it turns out, the first assumption is not true and the second might need
to be revised.

Fluctuations in the levels of radioactive $^{14}$C in the earth’s atmosphere and oceans have
occurred. Depending on the origin of the sample from terrestrial (atmospheric), marine, or mixed
marine environments and if the sample is from the northern or southern hemisphere, there are
different calibration datasets for processing radiometric age to calendar age using Calib (Stuiver
and Reimer 2010). There are also other datasets and calibration programs available to determine
calendar years (see for example Weninger et al. 2010 ; and the Greenland-Hulu U/Th dataset,
Weninger and Joris 2008). An example of the somewhat variable results these different programs
yield is shown in Table 5.2.

The half-life of radiocarbon was originally estimated to be 5720 years (Libby et al. 1949),
then changed to 5586 years (Libby 1955) and changed again to 5730 ±40 (Godwin 1962). Since
1962 the half-life of radiocarbon has remained at 5730 years but recently that value has been
challenged by a proposed revision to a half-life of 6030 years (Chiu et al. 2007). Still some
researchers choose to retain the use of the Libby half-life of 5568 ±30 years as a lab standard to
calculate calendric results (see for example Nakagawa et al. 2012).
Another aspect of radiocarbon dating is the equipment and technique used to acquire a sample’s radiocarbon age. For many years, age determinations were acquired by standard radiometric means that provided an age result based on the proportional counting of a representative sample of the $^{14}$C atoms. The longer the counting time the greater the accuracy. Subsequent to the standard radiometric method, Accelerator Mass Spectrometry (AMS) was developed. In this method, a mass spectrometer is used to count all the $^{14}$C atoms. The AMS method requires a much smaller sample and yields a more precise result.

Yet the AMS method can lead to questionable results if samples are not handled properly. For example, AMS samples of waterlogged botanical material (wood, seeds, peat, etc.) can become contaminated with fungi or micro-organisms during preparation, identification, and storage in a cool, wet, dark location for several weeks or months before dating. Samples should be desiccated or kept damp but sent to the radiocarbon lab promptly with minimal opportunity for contamination. The results of failing to desiccate or process the samples promptly can lead to results that are hundreds to several thousands of years too young. “Samples with low sample dry weight and low carbon content seem to be more susceptible to contamination than larger samples. If small macrofossil samples (\(< 1.4 \text{ mg carbon content}) cannot be prepared with extreme care and in a sterile environment to avoid any impurities, larger samples may have to be submitted if significant errors in the subsequent age determination are to be avoided” (Wohlfarth et al. 1998: 144).

The type of material being dated also can be problematic. Bone samples, without proper pretreatment, for example, are error prone because samples may become contaminated by humates (Stafford et al. 1991). Bone is composed of organic collagen fibers and inorganic apatite. Organic collagen is used for radiocarbon dating but is often contaminated by postmortem, intrusive organic residue. The use of standard pretreatment procedures for bone samples is insufficient and has been shown to result in age determinations that are most often too young. For instance, two fragments of the same mastodon radius recovered from different contexts at Monte Verde II in Chile yielded different ages about 5,000 radiocarbon years apart ($6550 \pm 160$ $^{14}$C BP [BETA-7824] versus $11,990 \pm 200$ $^{14}$C BP [TX-3769]) (George et al. 2005: 767) and were considered problematic (Fiedel 1999a). Both specimens were known to be from the same bone because they refit along a fracture line. One specimen was recovered from stratigraphic context and the other from displaced context in an adjacent stream. Because both
samples were dated on the collagen fraction without further pretreatment the results were in error. A second effort to re-date additional samples from both bone fragments employed two groups (A and B) for processing by two different pre-treatment and preparation methods. Group A samples isolated the amino acids using highly purified chemical fraction, XAD-gelatin hydrolyzate, while Group B processed collagen to ultrafiltered gelatin. The resulting four dates (two samples from each bone specimen, one processed in Group A and one in Group B) yielded ages that were statistically identical (12,510 ± 60 14C BP to 12,450 ± 60 14C BP) (George et al. 2005:770).

The calibration of radiocarbon years to calendar years for Pleistocene and early Holocene samples is critical not only to place archaeological remains in chronological order to understand patterns of cultural development but also to correlate global and regional climatic and habitat shifts through time. The most divergent age discrepancies between radiocarbon and actual calendar years originate from Pleistocene and early Holocene samples. Although radiocarbon dating may be the primary dating method used in archaeology, it is not the only one. Earth scientists routinely use multiple methods of making age determination but archaeologists do not. Alternative methods of radiometric dating often yield results in calendric years BP not radiocarbon years. Hence there is a real need to understand the calendric calibration a given radiocarbon assay or a set of averaged assays represent. The calibration program Calib v6 is one such program. It can convert radiocarbon years to calendar years and graph individual dates, test sets of dates from the same stratigraphic level to determine if they are statistically related and if they are, it can average sets of related dates. Yet its graphing capability is limited and it is not set up to manipulate the data by Bayesian or non-Bayesian means beyond the calibration datasets built into the program and made available to other calibration programs (e. g., Intcal09)(Figure 5.2).

Yet another aspect of radiocarbon dating relates to Bayesian versus non-Bayesian methods of post-processing multiple radiocarbon assays from different stratigraphic levels of the same site. The online program BCal is an Bayesian radiocarbon calibration tool hosted by the Department of Probability and Statistics at the University of Sheffield, UK (http://bcal.shef.ac.uk/)(Buck et al. 1999). Aspects of temporal manipulation such as simple age calibration, age span of a level, and continuous deposition versus hiatus between stratigraphic unit contacts can be calculated utilizing BCal. The program uses Bayesian probability by
incorporating inference of “known” factors to assess the probability of events with the radiocarbon data. Bayesian inference is sometimes termed subjective because it allows a degree of subjectivity in the selection of prior distributions. The use of prior distributions can strongly affect the results. Thus it is an exploratory method of analysis and a way to compare different sets of assumptions. Its use, however, requires accountability on the researcher’s part to assure unintentional biases are not introduced with the use of the so-called “known” factors. It is important, therefore, to test the conclusions with other distributions or to use a method that does not employ Bayesian inference and is capable of yielding the sought-after results.

For example, using BCal to explore the possibility that there is or is not a hiatus between stratigraphic levels of the Page-Ladson site, it is possible to force the results with a “known” partition placed in the radiocarbon data saying there is or is not hiatus present (Table 5.3). BCal forces that result. If the researcher is a competent geologist or geoarchaeologist, he or she is able to impose their “known” into the data for the desired result. The only problem, at least as I see it, is that in matters of American Paleoindian archaeology, it opens the door to arguments about the so-called “knowns.” It has been the type of thing too easily challenged by antagonists, particularly the type who never visit the sites in question yet generate arguments against its researcher’s findings. In other words, one person’s conformable contact is another person’s hiatus! So is there another way to test age determinations from different levels of the same site to identify evidence of depositional history? The answer is yes.

The program CalPal is a calibration program with the ability to run multiple sets of dates in various comparative modes:

1. CalPal is a radiocarbon calibration program package designed to support research on hominid behavioral response to Pleistocene climate change.
2. CalPal allows calendric age-conversion (“calibration”) of 14C-data by a variety of methods (2D-Dispersion, Wiggle Matching, Monte Carlo).
3. CalPal allows the dating results to be presented in high-quality graphs in context with climate data (e.g. ice-cores) (http://download.calpal.de/about/) (Weninger et al. 2010).

By conducting two different runs on CalPal from the same Page-Ladson dataset, one run with all radiocarbon assays displayed individually for each level and the other run using
averaged results for each level, an alternative method for identifying features of the stratigraphy is revealed. It is possible to make determinations without the use of “known” forcing by utilizing sets of averaged dates that are statistically related from the same level (Figure 5.3). Averaging of two or more related dates to determine an averaged date in radiocarbon years was accomplished using Calib. The averaged Calib results from nine different units were then run in CalPal for plotting. The results confirmed that the same “knowns” as the geological analysis had deciphered from field work (Kendrick 2006) were also evident in the averaged radiometric dates plotted by CalPal. In this instance, the use of BCal and CalPal together has served to strengthen the research results from the Page-Ladson site. Appendix B (plates A.1 to A.4) contains additional radiocarbon-to-calendar year adjustments of archaeological and paleontological sites in the Aucilla River.

**Long-lived Radioactive Isotopes, Uranium-Series Dating**

Recent investigations in Florida indicate that the origin of karst river basin calcitic sediments are of biogenic origin (see Chapter 4)(Inglett et al. 2008). A paleontological study of a karst river basin calcitic sediment, a shell marl unit in the Wacissa River, showed that the unit formed as a channel-fill sequence in a wide, vegetation choked, clear-water spring run (Means 2005). This type of calcium carbonate formation is an ideal candidate for U-series radiometric dating (Dunbar 2007). The Uranium-series dating method is used to date abiotic calcium carbonate-derived flowstone formations in limestone caves as well as calcium carbonate derived from biogenic processes. U-series decay may occur as daughter deficient (DD) or as daughter excess (DE) in the decay chain which allows disequilibrium dating to be accomplished once one or the other, DD or DE, has been deposited with the calcium carbonate during formation (Walker 2005).

The DD method measures 230Th/234U ratios to determine age. The time clock is set because uranium is soluble in water but thorium, the daughter, is not, resulting in the disequilibrium state. Organisms such as shellfish and, most importantly biofilms (Beveridge et al. 1997; Flemming et al. 1999; Riding 2000) in Florida karst rivers, take up uranium along with the calcium carbonate in solution in the water; a solution that is derived from the Tertiary limestone formations surrounding the Floridan Aquifer groundwater system and emitted to the
surface via springs. The near ambient spring water discharge from the Floridan Aquifer supplies the uranium, which in turn becomes incorporated in the biofilms (biogenic formation). The post-mortem result of this process are deposits of meteogenic travertine (Pentecost 2005). It is the DD method of U-series dating that holds great promise, though unproven, as a dating tool to determine the age of calcium carbonate shell marl and calcitic silt deposits in the southeastern Coastal Palin.

U-series dating assumes that the material being dated has maintained closed-system behavior although it may be affected by the post-mortem migration of radionuclides in or out of mollusk shells (Schwarcz and Gascoyne 1984). Correction for open-system behavior in shellfish requires a detailed knowledge of the processes that caused the post-mortem disequilibrium (Walker 2005).

The inclusion of detrital materials, such as quartz sand from air-borne or water-transported sources also contain radionuclides that can cause problems for dating meteogenic travertine deposits. If the detrital sediment carries daughter isotopes, older ages are generated or, alternatively, if it has 234U and 238U, younger than actual dates are generated. The isochron technique is used to correct for this type of contamination through the measurement of the 232Th found in the detrital sediment but not in the carbonates. Correction is achieved by determining the ratio of 232Th/Th230 and eliminating the detrital additions of 232Th from the age calculation (Walker 2005).

The dating of shell can be problematic if the post-mortem, open-system behavior cannot be determined whereas the dating of calcitic sediments (meteogenic travertine deposits) appears to have greater promise, although post-depositional leaching or recrystallization may also pose concerns. In Florida, many karst rivers have very little detrital sediment load but have highly charged loads of dissolved calcium carbonate and tannins (Puri et al. 1967; Yon 1966). It seems most likely that calcitic sediments in the karst river basins will have contamination from aeolian or river margin colluvial sources.

The potential importance of this dating method to archaeology is the large number of archaeological sites found in (e.g., Simpsons Flats site) or in contact with these types of deposits (e.g., Norden site) in river basins such as the Ichetucknee, Wakulla, Santa Fe, and Aucilla rivers to name a few (see for example Allen 1967b; Carter and Dunbar 2006; Dunbar et al. 2005; Dunbar et al. 2007; Dunbar and Vojnovski 2007; Jenks and Simpson 1941; Olsen 1949b;
Simpson 1948a). It also has great potential to place the heretofore undated record of riverine environmental episodes in the Santa Fe, Ichetucknee, Wacissa, and Wakulla rivers in temporal context and thereby plug additional data into the chronostratigraphic geoclimatic model for the Southeast (Dunbar 2006c).

**Radiation Exposure, Optically Stimulated Luminescence (OSL) Dating**

Upland Paleoindian sites in Florida have not been dated because the absence of organic preservation has made radiocarbon dating impossible. The Wakulla Springs Lodge site represents one such site that has several archaeological components including Early Archaic and Plaeoindian levels that lie below Middle Archaic and younger levels. The early Paleoindian component at the Wakulla Springs Lodge was not dated when first investigated in 1994 by Calvin Jones (2000; 2004). The site yielded artifacts, but the sand in which they were recovered was not datable at that time. There are literally thousands of upland sites in acidic sediment environments, the type of environment that has eluded radiocarbon dating during the latter half of the twentieth century. The inability to date these types of sites changed with the introduction of the Optically Stimulated Luminescence radiometric dating technique. Using the Science Direct library database (http://www.sciencedirect.com.proxy.lib.fsu.edu/) as an indication, the subject of Optically Stimulated Luminescence’s use in the earth sciences and archaeology had only one peer reviewed article published during the decade from 1970 to 1979. From 1980 to 1989, nineteen articles were published followed by two hundred and ninety-five articles in the decade 1990-1999. From the year 2000 to 2011, a somewhat staggering twenty-thee hundred and twenty-seven articles, or about 88.1 percent, of the total number of articles were published about Optically Stimulated Luminescence dating. Counting its own facility, the US Geological Survey now lists twenty-one active OSL dating laboratories in North America (http://crustal.usgs.gov/laboratories/luminescence_dating/other_labs.html). From these data it appears that the Optically Stimulated Luminescence (OSL) dating is a technique that has found great utility in the Twenty-first Century.

For the first time, OSL provides a means to radiometrically date the last time a grain or, more likely, aliquots of quartz sand were exposed to sunlight. The technique dates the age of burial and radioactive accumulation in quartz sand. The time clock in quartz sand is essentially
erased upon exposure to sunlight. The clock is reset, and radiation re-accumulates, a chronometer of lapsed time upon reburial and sunlight deprivation. OSL dating has become a major Quaternary dating tool despite its ~5 to ~10 percent standard deviation in ± years cal BP (Walker 2005). Age determinations derived from the OSL method are in real calendar time, years BP, which is not tied to a standard like radiocarbon’s 1950 benchmark unless stated by the researcher in a published context (Rink 2011). OSL also does not require calibration although it does require a comprehensive understanding of site deposition and potential post-burial disturbances.

Southeastern archaeologists have known for some time that unconsolidated quartz sand is prone to disturbance from such things as bioturbation, karst slumping, colluvial, alluvial, and illuvial action, and pedoturbation (Brooks and Sassaman 1990; Leigh 2001). Pedoturbation is used in a few articles but is not in the Glossary of Geology (Neuendorf et al. 2005) and, therefore, it is not a mainstream term. Pedoturbation includes bioturbation and non-biological disturbances such as intrusions in clays due to wet-dry cycles and frost action on rocks. Biomantling is another type of site disturbance (Peacock and Fant 2002). For a discussion of upland sandy sediment environments see Chapter 4.

If the OSL dates from deep sand archaeological sites are to be successful, an understanding of the site’s depositional histories must be understood. For example, the first attempt to OSL dating the Wakulla Springs Lodge site yielded surprisingly older than expected results. Jack Rink and Kevin Burdette of the School of Geography and Earth Sciences at McMaster University, Hamilton, Canada, conducted the on-site sampling and subsequent dating procedure. It was determined that aliquot size (the number of grains being dated) made a difference.

Initial studies utilized large, several thousand-grain aliquots (8 mm diameter) and initial ages were calculated using the central age model. Those results were presented at the 2009 Society for American Archaeology Annual Meeting. However, we continued the age evaluation by reducing the aliquots size on all samples to approximately 20 grains (1 mm diameter aliquot size) and utilizing the minimum age model (Galbraith et al., 1999) to establish the burial age (Rink et. al 2012: 17.).

The several thousand-grain aliquot size (8 mm diameter) tended to yield an apparent yet deceiving age result because the luminescent brightness of the older grains in the sample concealed the signal of younger, less luminous grains. The reduction in aliquot size to about 300
grains (3mm diameter) began to show evidence of a “mixed-grain” assemblage and the further reduction to about a 20 grain size (1mm diameter) confirmed this.

While the 8 mm mask (diameter) distribution shows no doses lower than about 6.5 Gray (Gy), we see that the 1 mm mask aliquots show 5 of 7 aliquots with doses lower than 6.5 Gy. We see a similar trend for sample C2 (Figure 14), where all aliquots at 8 mm mask have doses larger than 7 Gy, while a large proportion is less than 7 Gy in the 1 mm mask size. We also observe one aliquot at around 14 Gy, which is a dose that was not observed in either of the other two mask sizes. Since the trend is to lower doses with decreasing mask size, we do not see any evidence for incomplete zeroing at burial, which generally would be evidenced by a strong spreading to higher doses with decreasing mask size. From these observations we believe that the mean of the equivalent dose distributions are not a good indicator of burial age, and that there appears to be a mixing of older (higher equivalent) dose grains mixed in with younger grains. From this analysis, we have chosen to calculate the burial age based on a statistical analysis of the 1 mm distribution that seeks to find the minimum possible burial age of the sample, called the minimum age model... (Rink et al. 2012: 21).

Mixing of sand grains from different stratigraphic elevations caused by bioturbation has been shown to occur in other sites in Florida. For example, the mixing of younger sand grains with older ones has been revealed at the Sandy Point Hammock site (8HG941) with the younger grains moving downward in the stratigraphic column (Bateman et al. 2003; 2007). At the Wakulla Springs Lodge site the situation appeared to be exactly the opposite with older grains moving up the stratigraphic column. David Thulman, who worked on the 2008 Wakulla Springs Lodge project, came across the fascinating research of Walter Tschinkel an entomologist in the Department of Biological Sciences at Florida State University who is conducting research on the Florida harvester ant, *Pogonomyrmex badius* (Tschinkel 2004). In a number of discussions Thulman, Rink and I hypothesized that it might be ant bioturbation that acted to bring sand grains from older levels (deeper) upward to younger levels (shallower).

To test this idea Rink, in partnership with Walter Tschinkel, is conducting an experiment at Tschinkel’s harvester ant research area in the Apalachicola National Forest. The experiment involved excavating two 1-m square units to a depth of 2 m and then backfilling both of them with levels of different colored sand. Both units were bounded by plywood, open-ended boxes extending a full 2 m deep in the ground. Tschinkel and his doctoral student, Christina Kwapich, have somehow managed to persuade colonies of harvester ants to occupy the test units, one colony in each unit. After about a year, one of the test units was exhumed and yielded evidence that more than 80 percent of the displaced sand grains moved by the ants had moved up the sediment column (Rink 2011), which is exactly opposite from the bioturbation disturbance.
caused by larger animals such as gopher tortoises. One more test unit remains to be excavated and the results compiled before this study is published.

The results from dating two sandy sediment Paleoindian sites are now available and both employ the minimum age model with good results. The sites are the Wakulla Springs Lodge site in North Florida (Table 5.4) and the Helen Blazes site in south Central Florida (Table 5.5). At the Wakulla Springs Lodge site the level of the shallowest Paleoindian artifact (a Clovis-like blade tool) yielded a youngest possible age of 12,600 cal BP (youngest end of error range) while all other artifacts in the Paleoindian levels yielded ages of 13,500 to 13,700 cal years BP. At the Helen Blazes site the age range for a suspected Middle Archaic level ranged from 5,400 to 7,000 cal BP and for the upper part of an Early Archaic/Late Paleoindian level 9,000 to 12,000 cal BP.

**Dendrochronology**

Another, potentially important dating method yet to be utilized for age determinations in Florida is dendrochronology of late Pleistocene and early Holocene trees. It holds great promise simply because it is one of the proven, non-radiometric ways to determine annual cycles based on tree rings and is an absolute dating method. Dendrochronology or tree-ring dating was developed prior to the radiocarbon method and is prominently used to calibrate it. The atmospheric radiocarbon calibration dataset IntCal09 is based on tree-ring dating and spans the period from 0 to 12,410 years ago (Reimer et al. 2009; Stuiver et al. 1998).

In Florida a number of tree-ring studies have been conducted (Anderson et al. 2005; Miller et al. 2006; Stahle et al. 1985) but the potential for the development and use for this method has never been seriously pursued. That it has great potential, there can be no doubt. For example, archaeological and paleontological sites in the sinkholes of the lower Aucilla River hold in them the well-preserved remains of trees dating prior to the LGM. Oak, pine, and cypress have been documented at the Page-Ladson site. This certainly does not mean that full trees are preserved everywhere, but bark-bearing sections of trees are not uncommon and as investigations on submerged sites continue, there should be an effort to take samples when they are encountered. It is important to begin preserving and storing these specimens to build a dendrochronological dataset not only for dating purposes but also for the important paleoenvironmental record they hold.
Based on documented findings, there is little doubt that sites in the Aucilla River hold a
tree ring record that extends from MIS-3 to the early Holocene and it is likely that there were
other inundated areas with similar potentials. The potential for building an even older chronology
is also possible given the sinkhole near Peace Creek, Florida that contains 50 m section of mid-
to-late Pliocene fill with preserved plant remains (Hansen et al. 2001). This type of preservation
is very rare world-wide and surpasses the preservation found in arid-land dry caves. Preservation
of this quality is particularly uncommon at latitudes so far removed from Polar Regions. Florida
appears to have one of the best preserved records of Pleistocene environmental data in the world,
yet the potential it holds has barely been tapped (see for example Grimm et al. 1993; 2003; 2006
and their significant contribution to regional and global late Pleistocene climate shifts derived
from one sinkhole site in Florida). It is a resource important to archaeology as well as to the
Quaternary earth sciences. It is an unambiguous, fully datable record of the past located in our
own backyard.

Conclusions

Not all dating methods are considered here, only those that have, or appear to have, the
means to establish chronological time depth as well as to place within that temporal context the
progression of Paleoindian cultures that once inhabited the Southeastern Coastal Plain.
Radiocarbon, OSL, U-series, and dendrochronology are the suggested methods for inundated,
wet land and upland sites. It is the temporal context that for too long has eluded archaeologists
investigating Paleoindian sites in the Southeastern United States; a context that is vital to
understand. Inundated sites located in sinkholes have shown the efficacy of radiocarbon dating
and have significant potential to establish dendrochronology as a dating tool. U-series dating
may also be possible. Archaeological sites located in shallower water, or in river basin or other
wetland settings, have not been radiocarbon dated because botanical preservation has been
absent and because bone preservation, while present, lacks the collagen needed for $^{14}$C dating.
OSL and U-series dating hold the most promise to date these sites. Finally, we now have the
means to determine the age of deep sand sites using OSL dating. The application of these
radiometric dating methods will revolutionize our understanding of Paleoindian cultural activity
and more completely refine the geoclimatic and chronostratigraphic reconstruction developed at the Page-Ladson site (Dunbar 2006c).
Figure 5.1. Example of the results of averaging seven radiocarbon dates from Unit 3 at the Page-Ladson site and calibrating them to calendar years (Calib v5).
Figure 5.2. Latvis-Simpson site (JE1617) calibrated age ranges (Calib v6).
Figure 5.3. Results of twin CalPal runs superimposed on one another. The averaged dates from each unit, in blue, demonstrate hiatus breaks at points A, D, and E and that conformable contact occurs at points B and C. The set of dates that are not averaged and, therefore, show the individual dates plotted for each unit, are in red and do not reveal conformable versus hiatus breaks. Note the dates from the Unit 2-3 hiatus represent the older outliers recovered in Unit 3, all other dates from Unit 3 were related and averaged for Unit 3.
Table 5.1. Marine reservoir correction sites and data for the Southeast US from the \(^{14}\)Chrono Centre, Queens University Belfast (http://calib.qub.ac.uk/marine/)

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<td>The Rocks, FL Keys, FL</td>
<td>16</td>
</tr>
<tr>
<td>294</td>
<td>-78.0000</td>
<td>26.0000</td>
<td>56</td>
<td>59</td>
<td>Bahamas Islands</td>
<td>59</td>
</tr>
<tr>
<td>293</td>
<td>-78.0000</td>
<td>26.0000</td>
<td>-40</td>
<td>42</td>
<td>Bahamas Islands</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 5.2 Radiocarbon to Calendar Year Age Calibrations Using Different Programs and Datasets

<table>
<thead>
<tr>
<th>Radiocarbon Age</th>
<th>Calendar Age</th>
<th>Calibration version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± (^{14})C years BP</td>
<td>Mean age ± Cal BP</td>
<td></td>
</tr>
<tr>
<td>12,425</td>
<td>32 (n=7)</td>
<td></td>
</tr>
</tbody>
</table>

- 14,315: 102 LDEO/Fairbanks0107 (1 sigma)
- 14,421: 167 Calib/Intcal04 (1 sigma) 68%
- 14,488: 310 Calib/Intcal04 (2 sigma) 95%
- 14,690: 130 CalPal/05-SFCP (1 sigma) 68%
- 14,690: 260 CalPal/05-SFCP (2 sigma) 95%
- 14,420: 170 OxCal/Intcal04 (1 sigma) 68%
- 14,500: 350 OxCal/Intcal04 (2 sigma) 95%
Table 5.3. BCal Bayesian results of stratigraphic units test.

<table>
<thead>
<tr>
<th>Query 1: Unit 2 is earlier than Unit 2-3 Lower*</th>
<th>Probability = 0.9993563</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 5: Unit 3 (younger end) is earlier than Unit 3-4 (older end)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.0</td>
</tr>
<tr>
<td>Negative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 2: Unit 2-3 Lower is earlier than Unit 2-3 Upper*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.9994851</td>
</tr>
<tr>
<td>Positive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 6: Unit 3-4 (older end) is earlier Unit 4 Lower (older end)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.99798316</td>
</tr>
<tr>
<td>Positive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 3: Unit 2-3 Upper is earlier than Unit 3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.9996996</td>
</tr>
<tr>
<td>Positive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 7: Unit 3-4 (younger end) is earlier than Unit 4 (older end)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.0</td>
</tr>
<tr>
<td>Negative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 4: Unit 3 (older end) is earlier than Unit 3-4 (older end)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.9988414</td>
</tr>
<tr>
<td>Positive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query 8: Unit 4 Lower (older end) is earlier than Unit 4 Lower (younger end)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability = 0.99772567</td>
</tr>
<tr>
<td>Positive</td>
</tr>
</tbody>
</table>

* Chronology set to indicate a hiatus at the contact of the Units
** Chronology set to indicate there is a conformable contact between Units

Table 5.4. Wakulla Springs Lodge OSL Dating Results (1mm Diameter Aliquots)(n=7).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth (cm)</th>
<th>Elevation NAVD 88 (m)</th>
<th>$D_e$ (Gy) Central Age Model ± Standard Error</th>
<th>$D_e$ (Gy) Minimum Age Model ± Two Sigma</th>
<th>OSL Age (ka) Minimum Age Model</th>
<th>OSL Age (ka) Central Age Model</th>
<th>OSL Age Range (ka) Minimum Age Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>B4</td>
<td>84.9</td>
<td>4.838</td>
<td>5.7 +/- 0.3</td>
<td>4.0 +/- 0.3</td>
<td>15.0 +/- 1.1</td>
<td>10.6 +/- 1.0</td>
<td>9.6 to 11.6</td>
</tr>
<tr>
<td>B3</td>
<td>97.3</td>
<td>4.714</td>
<td>6.0 +/- 0.6</td>
<td>5.5 +/- 0.4</td>
<td>14.9 +/- 1.6</td>
<td>13.7 +/- 1.1</td>
<td>12.6 to 14.8</td>
</tr>
<tr>
<td>B2</td>
<td>104.1</td>
<td>4.646</td>
<td>8.5 +/- 0.6</td>
<td>5.1 +/- 0.4</td>
<td>24.7 +/- 2.1</td>
<td>14.9 +/- 1.4</td>
<td>13.5 to 16.3</td>
</tr>
<tr>
<td>B1</td>
<td>134.7</td>
<td>4.340</td>
<td>14.8 +/- 0.7</td>
<td>9.9 +/- 0.6</td>
<td>40.3 +/- 2.8</td>
<td>27.0 +/- 2.1</td>
<td>24.9 to 29.1</td>
</tr>
</tbody>
</table>

**UNIT B**

| C3     | 83.5       | 4.852                  | 7.3 +/- 1.2                                 | 5.4 +/- 0.5                              | 20.5 +/- 3.4                  | 15.1 +/- 1.6                    | 13.5 to 16.7                       |
| C2     | 105.3      | 4.634                  | 7.7 +/- 0.5                                 | 5.4 +/- 0.6                              | 22.2 +/- 1.8                  | 15.6 +/- 1.9                    | 13.7 to 17.5                       |
| C1     | 119.9      | 4.488                  | 11.8 +/- 0.7                                | 6.8 +/- 1.7                              | 31.3 +/- 2.4                  | 18.0 +/- 4.5                    | 13.5 to 22.5                       |

| C2     | 83.5       | 4.852                  | 7.3 +/- 1.2                                 | 5.4 +/- 0.5                              | 20.5 +/- 3.4                  | 15.1 +/- 1.6                    | 13.5 to 16.7                       |
| C2     | 105.3      | 4.634                  | 7.7 +/- 0.5                                 | 5.4 +/- 0.6                              | 22.2 +/- 1.8                  | 15.6 +/- 1.9                    | 13.7 to 17.5                       |
| C1     | 119.9      | 4.488                  | 11.8 +/- 0.7                                | 6.8 +/- 1.7                              | 31.3 +/- 2.4                  | 18.0 +/- 4.5                    | 13.5 to 22.5                       |

**UNIT C**

Table 5.5. Helen Blazes OSL Dating Results for (1mm Diameter Aliquots) (n=2).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth (cm)</th>
<th>Moisture (%)</th>
<th>Minimum Age Model $D_e$ (Gray) +/- 1 sigma max value</th>
<th>Cosmic Dose Rate (1 x 10^6 Gray per year)</th>
<th>Beta Dose Rate (1 x 10^6 Gray per year)</th>
<th>Gamma Dose Rate (1 x 10^6 Gray per year)</th>
<th>Total Dose Rate (1 x 10^6 Gray per year)</th>
<th>OSL Age Minimum Age Model (ka)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB1-3</td>
<td>17.5-22.5</td>
<td>7</td>
<td>3.5 +/- 0.2</td>
<td>258 +/- 10</td>
<td>163 +/- 12</td>
<td>167 +/- 12</td>
<td>599 +/- 18</td>
<td>5.8 +/- 0.4</td>
</tr>
<tr>
<td>HB1-3</td>
<td>30</td>
<td></td>
<td>258 +/- 10</td>
<td>134 +/- 10</td>
<td>140 +/- 10</td>
<td>532 +/- 14</td>
<td>6.5 +/- 0.3</td>
<td>5.4 to 7.0 ka</td>
</tr>
<tr>
<td>HB1-3  Total Age Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HB1-3</td>
<td>34.5-39.5</td>
<td>7</td>
<td>5.6 +/- 0.8</td>
<td>238 +/- 10</td>
<td>145 +/- 12</td>
<td>205 +/- 21</td>
<td>598 +/- 24</td>
<td>9.4 +/- 1.4</td>
</tr>
<tr>
<td>HB1-3</td>
<td>30</td>
<td></td>
<td>238 +/- 10</td>
<td>119 +/- 10</td>
<td>171 +/- 18</td>
<td>539 +/- 20</td>
<td>10.4 +/- 1.6</td>
<td>9.0 to 12.0 ka</td>
</tr>
<tr>
<td>HB1-3  Total Age Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER SIX

CLIMATE CHANGE AS A CONTEXT

Introduction

In the edited volume by S. David Webb, *The First Floridians and Last Mastodons* (2006b), I contributed a chapter entitled, “Pleistocene–Early Holocene Climate Change: Chronostratigraphy and Geoclimate of the Southeast US” (Dunbar 2006c). The chapter was an updated version of my master’s thesis at the Florida State University (Dunbar 2002). There have been a number of developments since then including the ability to calibrate radiocarbon dates of pre-LGM age along with newly refined understandings of global, regional, and local climate and geologic proxies. One of the most significant developments since the 2006 publication is related to the effort to synchronize terrestrial, marine, and ice-core climate proxies through time (Hoek et al. 2008; Lowe, Rasmussen et al. 2008; Yu et al. 2008).

The INTegration of Ice-core, Marine and Terrestrial records (INTIMATE) group of the International Quaternary Union (INQUA) Palaeoclimate Commission is dedicated to determining and testing means of temporal synchronization of climate proxies and developing protocols to facilitate that effort (Björck et al. 1998; Davies et al. 2012; Hoek et al. 2008; Lowe, Shane et al. 2008; Lowe 2002; Lowe et al. 2001; Lowe, Rasmussen et al. 2008; Nakagawa et al. 2012; Newnham et al. in press; Newnham et al. 2012; Walker et al. 2001; Yu et al. 2008). For example, it is important to understand the timing of increased ice accumulation during the Younger Dryas in Greenland ice-cores versus the timing of vegetation shifts in Northern Europe. A goal in this instance is to refine our understanding of snow and ice buildup at the Younger Dryas onset versus the timing and character of the ensuing vegetation change. Some proxy swings occurred in near synchrony globally while others were more regional.

Before dealing with the period of buildup, optimum, and decline of the last glacial interval (59 to 10 ka cal BP), during which many climatic shifts took place, the longer timescale of the Pleistocene or glacial epoch (2.6 to 0.01 million BP)(Ogg 2010; Walker and Geissman 2009) should be considered because it provides the perspective for large-scale climatic change.
Milankovitch cycles, theorized by mathematician Milutin Milanković in the early twentieth century, proposed that variations in the earth’s orbital eccentricity, axial tilt, and precession are features that determined some of the earth’s climatic patterns. His hypothesis gained acceptance after geologic research conducted on emergent coral terraces (Broecker et al. 1968; Mesolella et al. 1969) and marine sediment cores (Hays et al. 1976) showed that the timing of climate shifts from stadial to interstadial had taken place in near synchrony with the planet’s orbital rhythms over 500 ka calendar years. The corals of Barbados demonstrated that high sea level episodes of the interglacial stages were synchronous with Milankovitch’s predictions; however, the study was unable to determine if the timing of low sea level episodes during glacial stages were correctly predicted by him. Deep-sea marine cores were analyzed to determine paleo sea surface temperatures through time using δ18O evaluations on foraminifera that likewise might be used to test the Milankovitch predictions. Shifts in δ18O from higher (colder) to lower (warmer) isotopic values represent different marine isotope stages. Isotope stages were temporally placed by assuming a constant sedimentation rate for the relatively stable deep-ocean core locations and by using known biostratigraphic horizons in them and the Brunhes–Matuyama magnetic pole reversal at 780 ka cal BP (lower) and modern, Holocene sediments (upper) as temporal control points for calculating age determinations. The marine isotope chronostratigraphy has been supported in other studies (Cheng, et al. 2009b) and an example of the last eight marine isotope stages is presented in (Figure 6.1 after Martinson et al. 1987, http://fi.wikipedia.org/wiki/Tiedosto:Isotopic_stages_hg.png). There also is evidence that geomagnetic excursions, such as the Laschamp at 40.4 ±2.0 ka cal BP (Guillou et al. 2004) and the Mono Lake at 33.3 to 31.5 ka cal BP (Benson et al. 2003) and, less frequently, magnetic pole reversals, take place at 40 ka and 125 ka periodicities when the planet’s obliquity is low or decreasing (Rampino 1979; Thouveny et al. 2008). This evidence shows that the “pacemaker” of the ice ages has been the earth’s orbital eccentricity.

Besides the advance and retreat of glacial and interglacial intervals there were cyclic and non-cyclic episodes theorized to have shaped environmental landscapes, including those of Florida. Some are debated as possible subroutines of orbital variation, while others clearly deal with aspects of topographic chance, the ever-changing set of geologic configurations of the earth’s crust due to weathering and plate tectonics.
In North America the last glaciation, also referred to as the Wisconsinan glaciation, is recognized as having three advances, the Tahoe (~50 to 42 ka cal BP early in Marine Isotope Stage [MIS] 3), Tenaya (~31 to 32 ka cal BP also in MIS 3), and Tioga (onset ~21 to 20 ka cal BP and retreat ~15 to 14 ka cal BP in MIS 2)(Kaufman et al. 2003: 90, Table 2). The Tioga represented the last and coldest of the three-stepped advance. However, reference to the Tahoe, Tenaya, and Tioga intervals are seldom used outside the glaciological literature documenting the glacial fronts of the northern US and Canada. What is noteworthy is that the middle Wisconsinan from about 59 to 24 ka cal BP was largely one of moderation in the latitudes of the Southeast US. Apparently related to moderate conditions, animal populations such as the muskrat, *Ondatra zibethicus*, thrived in Florida and were substantially larger during the middle and late Wisconsinan until ~19.2 ka cal BP. A slight reduction in body size began after that until ~14.3 ka cal BP. The species then abandoned Florida (extirpated) and now has a significantly smaller body size outside of this part of its late Pleistocene range (Mihlbachler et al. 2002). The contention that Pleistocene mammals were experiencing significant change after the glacial maximum is also demonstrated in the notable study by Kathryn Hoppe and Paul Koch (2007b). It shows that mastodons were not migratory in Florida during MIS 3, but became highly migratory afterward, in MIS 2 about 14.4 ka cal BP. The evidence that mammals were experiencing conditions that required adaptive changes is applicable to the late Pleistocene Southeast and, taken collectively, can be viewed as evidence of the variety of impacts climate change had on fauna.

But what about the climate shifts, their timing and duration outside the Southeast? Unless climate change was globally forced, as it sometimes was, these episodes may or may not have had a counterpart in the Southeast and, if there was a climatic expression, it was regionally distinct. It is important to consider the shorter-term climate cycles of the last glacial period. They include the millennial-scale Dansgaard-Oeschger cycles and, the more episodic, Heinrich events. Both are sometimes referred to as sub-Milankovitch climate variability (Bond et al. 1997; Wolff et al. 2010), but that is still debated (Ditlevsen and Ditlevsen 2009). A Dansgaard-Oeschger cycle is characterized as a coupled, quick onset warm, “interstadial” phase, followed by longer-term cooling (Spötl and Mangini 2002), and terminated by a rapid onset stadial (Wolff et al. 2010) prior to the next Dansgaard-Oeschger cycle. But the term “interstadial” is applied rather loosely because it represents periods detected in the Greenland ice cores and there is
disagreement about what effects the warming may have had on the ice sheet. One view contends it was a time of substantial freshwater discharge (meltwater) which served to chill the oceans and return things to “ stadial” conditions (Bond et al. 1999). Another view contends that the term “warming” is relative in the high northern latitudes and it was during “ interstadial” phases (at least the lesser ones) when precipitation (snow) increased and glaciers concurrently grew and advanced (Marshall and Koutnik 2006). For the purposes of this discussion, the cold stadial phase of Dansgaard-Oeschger cycles will be considered irrespective of its interstadial phase.

There are also shorter-term, inter-decadal climatic cycles known as El Niño Southern Oscillations (ENSO), which have an El Niño and La Niña phase between periods of neutrality when neither exists. ENSO couplets have a periodicity of three to seven years with some being more intense than others (Giannini et al. 2001) and, according to most authors, they have taken place throughout the Pleistocene and Holocene (Tudhope et al. 2001). An even shorter oceans-atmospheric event of 30 to 60 day duration is the Madden-Julian Oscillation (MJO) restricted to the tropics. Other than to say the MJO can facilitate but not cause ENSO cycles, it need not be considered further (Gottschalck and Higgins 2008).

The ENSO is an excellent case in point to illustrate how climate change resulting from the same ocean-driven circumstance often differs regionally. During an El Niño phase in the Southeast US and in Florida in particular, the region becomes wetter and cooler during the winter; but the Pacific Northwest and Canada are infused with air of tropical origin from the south. Conversely, during the La Niña phase, Florida becomes warmer and drier as colder air intensifies in the Pacific Northwest (Giannini et al. 2001; Holmgren et al. 2001).

Dansgaard-Oeschger cycles take place at intervals that average ~1.4 ka years apart or more generally somewhere between once every 1 ka to 2 ka years (Bond et al. 1999). The last Dansgaard-Oeschger cycle of the Holocene, known as the Little Ice Age, began during the Middle Mississippian Period around AD 1300 and ended around AD 1850. The Little Ice Age, like other Dansgaard-Oeschger cycles before it, are distinctive for their noticeable cooling phase that, during the Little Ice Age at least, resulted in noticeable human strife (Fagan 2000). During the late glacial recession, this cooling also existed, but was minor in comparison to the impacts of Heinrich events (Vidal L. et al. 1997; Weaver et al. 1999). Archaeologists who study the Paleoindian occupation of the Americas often wax poetic about the last major Heinrich event, Heinrich 0 (H0), also known as the Younger Dryas. It was a return to near glacial maximum-like
conditions in the northern latitudes of North America and its onset, at ~12.9 ka cal BP, has been incorrectly touted as the date by which Pleistocene megafauna became extinct in the Americas (Haynes 2008). Yet the Younger Dryas was muted compared to the Heinrich events that preceded it. Heinrich 1 (H1) was far more devastating and believed to have been a colder interval in the northern latitudes than the LGM. How did these climatic events affect the late Pleistocene environment of Florida?

The Oceanic Side of Climatic Change: The North Atlantic Thermohaline Circulation and Southern Pacific El Niño Southern Oscillations

In 1798, Thompson Count Rumford proposed a dynamic ocean model which emphasized large scale, interacting current mechanisms now recognized as the north–south thermohaline circulation (Weaver et al. 1999). The three-dimensional configuration of the North Atlantic and, to a lesser extent, the adjoining Arctic Ocean, forms a perfect topography for facilitating a natural pump. It is an oceanic pump generated by convection and thermohaline circulation and reaches far beyond the Atlantic Ocean (Figure 6.2). Today, the warm surface current known as the Gulf Stream flows to the northeastern European coastline, then circulates further north until it is substantially cooled. Once cold, the water becomes dense and begins to sink to the ocean floor. Then it begins to recirculate forming the North Atlantic Deep Water (NADW) conveyor off the coast of Greenland. The NADW current flows southward to the tropics where it up-wells, is again warmed, and rejoins the Gulf Stream. During the Pleistocene, Atlantic conveyor currents impacted climate depending on their volume of flow, the degree of latitudinal repositioning during Dansgaard-Oeschger cycles, or the cessation of flow during Heinrich events (Boyle 2000). The Pacific Ocean does not have a counterpart to this type of thermohaline circulation yet is assisted by Atlantic conveyor influences.

Another type of oceanic circulation phenomenon resulting in climate change is the west to east ENSO of the southern Pacific. A 130,000-year record of El Niño oscillations is recorded in the Pleistocene corals of Papua, New Guinea (Tudhope et al. 2001). ENSO couplets have a warm ocean phase, El Niño, and a cold ocean phase, La Niña that occur about once every three to seven years. Oceanic proxy data suggest that the end result of some ENSOs has resulted in noticeable climatic downturns about once every 2,000 years (Weaver et al., 1999:267–276). This
is about the same periodicity as the Dansgaard-Oeschger cycles (Peterson et al. 2000: 1947-1951).

Thus any consideration of terrestrial climate change during the late Pleistocene is incomplete without recognition that there are corresponding changes in the oceanic components. From a much broader view, the paleoclimatic evidence of increased atmospheric CO$_2$ is the suspected “Achilles heel” triggering past climate change. “The changes in climate associated with these jumps have now been shown to be large, abrupt, and global” (Broecker 1997; 2000).

The Terrestrial–Atmospheric Side of Climate Change

Dansgaard-Oeschger cycles

Dansgaard-Oeschger oscillations are ocean circulation processes that are believed to have included cold meltwater (freshwater) as the suspected trigger and that may have followed in response to an ENSO-type mechanism. The Dansgaard-Oeschger cycle phase considered here is the cool phase minima which promotes glacial advance and is centered in the northern North Atlantic. These cycles affect climate change in regions with strong atmospheric responses to changes in the North Atlantic. In contrast, Heinrich events, which are also centered in the North Atlantic, transfer their climatic effects more globally (Clark et al. 1999). Because Heinrich events are restricted to glacial expressions of Milankovitch cycles, they do not appear to be true cyclic events. Rather, Heinrich events co-occur with, and appear to represent, particularly severe Dansgaard-Oeschger cycles.

Both proxy data and computer modeling of cool phase Dansgaard-Oeschger cycles indicate their occurrence did not result in the shutdown of the NADW conveyor current. During the Pleistocene, Dansgaard-Oeschger cycles resulted in Atlantic conveyor currents shifting southward to the middle North Atlantic, but the rate of oceanic current overturn remained only slightly less than modern conditions. The Dansgaard-Oeschger cycles represent less intense cool phase minima when sea-ice, while present, was essentially non-existent compared to the volumes of icebergs that filled the North Atlantic during Heinrich events (Chappell 2002). The sea-ice that existed during Dansgaard-Oeschger cycles originated from the eastern coast of Greenland (Bond et al. 1997), whereas Heinrich event sea-ice originated primarily from the Laurentide ice-sheet of the northeastern Canadian coastline (Hemming, Biscaye et al. 1998; Hemming,
Broecker et al. 1998). Pleistocene glacial-like conveyor circulation during Dansgaard-Oeschger cycles is believed to have resulted in cool oceanic conditions in the tropical western North Atlantic. Dansgaard-Oeschger cycles differed from cool phase Heinrich events in that Heinrich events disrupted the North Atlantic conveyor currents. This is an important distinction because Heinrich events, such as the Younger Dryas, are believed to have resulted in warmer oceanic conditions in the tropical western North Atlantic (Rühlemann et al. 1999; Seidov and Maslin 2001), a factor that directly affected the southeastern US.

**El Niño Southern Oscillation**

Inter-annual ENSOs are of short duration, ~3–7 year events (Tudhope et al. 2001: 1511) that fall below the resolution of the radiocarbon method. The global impact of ENSO cycles, that include both an El Niño and a La Niña phase, has been experienced in Florida in sometimes adverse ways. For example, during La Niña phase droughts, forest fires and inland water table declines due to drought (Figure 6.3) have taken place. The El Niño phase, however, brings wet conditions and excessive rains, flooding, and mosquito infestations (Myers and Ewel 1991). The shifts in water table are especially pronounced in the Tertiary karst regions of Florida. More important to this discussion is evidence suggesting that long-term environmental change might be triggered by an ENSO event. Here I emphasize the terrestrial–atmospheric aspects of ENSOs, not the oceanic impacts.

ENSOs occurred throughout the last glacial period even though the intensity of the cycles appears to have been less than during Holocene cycles (Tudhope et al. 2001:1514-1516). The remains of the coastal Quebrada Tacahuay site in Peru have yielded dates of $10,770 \pm 150 \, ^{14}C \, BP$ (Beta-958669 charcoal/hearth), $10,750 \pm 80 \, ^{14}C \, BP$ (Beta-108692 charcoal/hearth), and $10,530 \pm 140 \, ^{14}C \, BP$ (Beta-108860 charcoal interspersed with lithic flakes) sandwiched between probable El Niño phase flood deposits. The Paleoindian component of the Quebrada Tacahuay site shows that the occupants exploited shellfish, fish, and sea birds. Quebrada Tacahuay is located along a hyper-arid coastline that is only affected by rains during El Niño phase events. Fishing is disrupted during the El Niño phase and, no doubt, played an important role in subsistence decisions (Keefer et al. 1998: 1833-1835). On the other side of the Pacific the ENSO cycles are believed to have been linked to monsoonal activity during the Younger Dryas.
Stratigraphic proxies from three locations along the arid–semiarid transition zone of northern China evidence an initial cold, dry onset followed by a middle Younger Dryas interval of more humid conditions and increased organic preservation. This shift to moderate conditions is attributed to the spatial displacement of the ENSO position far enough north to have established a tropical-polar interconnection (Zhou et al. 2001). This shift coincides with a decline in sea surface temperature of about 4–6°C in the tropical southwest Pacific where the ENSO cycles are spawned (Gagan et al. 2000).

The effects of modern ENSO events have been mapped with most affected locations showing a seesaw impact of wet–dry or conversely dry–wet phases. The first phase of ENSO is El Niño followed by the second phase, La Niña. In North and Central Florida, the effects are bimodal with a wet El Niño and a dry La Niña. The effect in South Florida is sometimes one of continued dry conditions through both phases (Holmgren et al. 2001) making the impact particularly severe. However, if Zhou et al. (2001) are correct, the zone where ENSO effects occur may also have shifted to an undetermined configuration in the Gulf of Mexico-Caribbean region during one or more of the climate modes in the Pleistocene. Perhaps the most interesting effects that ENSO cycles may cause are changes from one steady-state ecosystem to another (Holmgren et al., 2001) or that a particularly strong and/or well-timed ENSO may trigger a longer term Dansgaard-Oeschger cycle (Peterson et al., 2000).

**Climatic Modes of the Last Glacial Recession**

During the last glacial recession, environments variously shifted into one of three modes: (1) glacial, (2) modern, or (3) Heinrich (Alley and Clark 1999). Glacial mode includes those intervals of the glacial recessions during which climatic conditions in the northern latitudes returned to glacial-like, cold temperatures and the continental glaciers on both sides of the Atlantic stabilized and grew. Modern mode occurred during intervals of modern-like warm conditions. Generally modern mode intervals triggered glacial recession and meltwater discharge. Here the term mode denotes the state of atmospheric–oceanic conditions whereas the term event is used to denote when the various mode shifts occurred. In North America, meltwater discharged into the Gulf of Mexico versus the North Atlantic or Arctic Ocean served to affect open ocean regimes in different ways. As cold, non-saline meltwater and icebergs built
up in the North Atlantic, they sometimes reached threshold volumes that greatly reduced or halted the flow of the North Atlantic conveyor currents. These threshold events are believed to have triggered the sudden return to cold conditions, the Heinrich events enhanced by icebergs were more severe than the relatively iceberg-free Dansgaard-Oeschger cycles. Thus, the shifts from modern to glacial or Heinrich mode represented pulsed climatic shifts that seesawed over the duration of the last glacial recession (Alley and Clark 1999).

**Modern Mode**

During the periods of modern mode, the Laurentide ice-sheet of North America, the Fenno-Scandinavian ice-sheet of northern Europe and most glaciers in other regions of the world were in recession due to global warming (Alley and Clark 1999). Meltwater from the glaciers drained into the oceans. Across the northern latitudes in Europe and North America, mega-floods sometimes occurred when pro-glacial lake margins were breached by excessive meltwater discharge, events which resulted in catastrophic floods rushing toward base-level, the sea (Brown and Kennett 1998: 599-602).

Radiocarbon evaluations of both atmospheric (terrestrial) and marine sources indicate that the late glacial recession began in North America around ~17,000 $^{14}$C BP along the southeastern front of the Laurentide ice-sheet and by ~16,500 $^{14}$C BP along the front of the southern Laurentide (Clark et al. 2001; Dyke et al. 2002; Jackson et al. 2000). The initiation of glacial recession took place under subdued modern mode conditions during the Pleniglacial. Meltwater from the Laurentide ice-sheet drained to the northeast via the Hudson and St. Lawrence Rivers to the Atlantic Ocean during the first Pleniglacial modern mode event. The onset of this meltwater event began ~17,000 $^{14}$C BP and endured until ~15,100 $^{14}$C BP in the North Atlantic (Clark et al., 2001). This meltwater episode appears to coincide with the GRIP isotope warming phase GS-2b, the onset of which is placed at 19,500 GRIP cal BP (this age is based on GRIP ice core annual layers, see Walker et al. 1999). Evidence from glacial moraines indicates that the initial phase of recession resulted in glacial ice mass thinning more than marginal retreat (Lambeck et al. 2000). During this interval, between ~16,500 $^{14}$C BP and ~16,000 $^{14}$C BP, sea level rose 15 m or more (Clark et al. 2001). It was the meltwater event that preceded the Heinrich, H1 ice-rafting cold phase (Sarnthein et al. 1995).
Heinrich H1 occurred between ~15,100 \(^{14}\)C BP and ~13,500 \(^{14}\)C BP and took place between meltwater events (Clarke et al. 2001). After ~14,000 \(^{14}\)C BP, the cooling effects of H1 began to abate in the northwestern Atlantic. After that, meltwater discharged into the Gulf of Mexico as well as the North Atlantic (Bard et al. 2000; Chapman et al. 2000; Vidal L. et al. 1997). The second meltwater event during the Pleniglacial began ~13,400 \(^{14}\)C BP and endured until the Oldest Dryas ~13,200 \(^{14}\)C BP. Renewed meltwater discharge after H1 is the first evidence of major global warming. This event took place after the Pleniglacial during the Bølling (Clark et al. 2001). Climatic warming was preceded by the initiation of the first post-glacial maximum return of conveyor currents as far north as the Norwegian Trench in the eastern North Atlantic ~13,500 \(^{14}\)C BP (Lehman and Keigwin 1992).

At the end of the Pleniglacial, an initial modern-mode warming event, the Bølling, varies in age in the radiocarbon record. Estimates for the onset range from ~13,000 \(^{14}\)C BP (Mangerud et al. 1974; Sarnthein et al. 1995) to ~12,800 \(^{14}\)C BP (Clark et al. 2001), and ~12,700 \(^{14}\)C BP (Renssen et al. 2001; Renssen and Isarin 2001). At ~13,000 \(^{14}\)C BP, sedimentation regimes in the Gulf of St. Lawrence changed abruptly from low to high diatom concentrations with some species indicative of moderation of cold temperature conditions in the upper water column (Lapointe 2000). The late Bølling coincides with major meltwater buildup in the Gulf of Mexico from ~12,700 \(^{14}\)C BP to ~12,600 \(^{14}\)C BP that was a result of the largest mega-flood down the Mississippi River (Brown and Kennett 1998). Large volumes of meltwater in the Gulf of Mexico resulted in the Bermuda high-pressure area shifting west over Florida (Leyden et al. 1994)(Figure 6.4). Much like the La Niña phase of an ENSO, Florida’s climate became arid. The effect lasted hundreds of years instead of a year or two, however. Following this meltwater event, another Dansgaard-Oeschger glacial mode episode known as the Older Dryas occurred from ~12,500 \(^{14}\)C to ~12,300 \(^{14}\)C (Lowe 2001; Lowe 2002) and ameliorated climate in North Florida (Figure 6.5)(Dunbar 2006c).

After the Younger Dryas came the Allerød, a major modern mode episode. During the beginning of the Allerød, the Laurentide ice-sheet began to retreat northward rapidly. As a result the northern meltwater routes captured ever-increasing volumes of discharge. By ~12,000 \(^{14}\)C BP, the Mississippi River was carrying substantially less meltwater to the Gulf of Mexico and by ~11,700 \(^{14}\)C BP to ~11,600 \(^{14}\)C BP the northern routes had virtually captured all of the meltwater discharge (Heine 1994; Wright 1989). The absence of meltwater in the Gulf of Mexico during
the middle to late Allerød resulted in the Bermuda High pressure area shifting easterly, away from Florida. And this shift produced a wet cycle in the southeastern US and eastern Caribbean (Leyden et al., 1994).

Another brief episode of meltwater in the Gulf of Mexico (Broecker et al. 1989) occurred at the Younger Dryas-Preboreal transition between ~10,000 \(^{14}\)C BP and ~9,900 \(^{14}\)C BP (Clark et al. 2000; Flower and Kennett 1995; Jiang and Klingberg 1996; Lehman and Keigwin 1992; Wright 1989). This episode occurred after the re-advance of the Laurentide ice-sheet that blocked meltwater from discharging through North Atlantic routes (Wright 1989)(See Figure 6.4). In Florida, the climate again became dry.

During modern mode, routing of major meltwater to either the North Atlantic or the Gulf of Mexico is believed to have had regional climatic implications. In part or in whole, the discharge of cold, freshwater to the North Atlantic is believed to have shifted the Gulf Stream and NADW conveyor currents south during the stadial phase of a Dansgaard-Oeschger oscillation, or to have helped trigger the shutdown of the conveyor currents altogether during Heinrich events (Broecker et al. 1989). With the return of modern mode after the Pleniglacial, Atlantic conveyor currents returned in the northeastern North Atlantic. The post-Pleniglacial, modern mode surface expression of the Atlantic conveyor current, the Gulf Stream, served to warm the European coastline. However, during post-Pleniglacial glacial and Heinrich modes the conveyor current shifted south or was interrupted and Europe became a much colder place (Weaver et al. 1999).

An atmospheric–oceanic computer model of late Pleistocene climate change supports the hypothesis that meltwater via the St. Lawrence–Hudson River routes to the North Atlantic had a greater disruptive effect on the conveyor currents than southerly discharge via the Mississippi River to the Gulf of Mexico (Manabe and Stouffer 1997). However, another computer model suggests that a Bølling-age mega-flood, sometimes (but incorrectly) referred to as Meltwater Pulse-1A (MWP-1A), a mega flood event which discharged to the Gulf of Mexico, served as a necessary precondition for the eventual onset of Heinrich event H0 (the Younger Dryas). It is worth restating that the Bølling mega-flood was the largest Mississippi River flood of geologic record (Flower and Kennett 1995; Marchitto and Wei 1995). Proxy evidence of the flood is dated from ~12,700 \(^{14}\)C BP (Marchitto and Wei, 1995) to around ~12,600 \(^{14}\)C BP (Brown and Kennett, 1998), just prior to the onset of the Older Dryas at ~12,500 \(^{14}\)C BP (Björck et al. 1996; Flower
and Kennett 1995; Hughen et al. 1996). Recent investigations have shown that modern mode episodes were the periods of active meltwater discharge, not the glacial mode episodes (de Vernal et al. 1996; Kaufman et al. 1993). Thus, the late glacial recession consisted of a series of warm, modern versus cold, glacial, or Heinrich mode episodes.

Several researchers have pointed to the seesaw nature of late glacial climate in the Eastern versus Western Gulf Coasts (Heine 1994; Leyden et al. 1994). During episodes of modern mode, when meltwater discharge occupied the Gulf of Mexico, the southeastern Gulf Coast and eastern Caribbean experienced dry to arid climatic conditions because the Bermuda High moved west over Florida. Today, the most devastating droughts have been linked to the westerly expansion of the Bermuda High over Florida in the late spring and summer months during strong La Niña phase events. Repositioning of the Bermuda High over Florida results in the absence of summer convectional thunderstorm activity (Chen and Gerber 1991). Cold meltwater in the Gulf of Mexico is another climatic condition that directed the Bermuda High over Florida, but had a much longer duration and devastating impact (Grimm et al. 1993).

Conversely, Western and Central America experienced more humid conditions when meltwater was in the Gulf of Mexico (Maasch and Oglesby 1990) during the Bølling and early Allerød from ~13,000 $^{14}$C BP to ~11,700 $^{14}$C BP (Leyden et al. 1994). A possible reflection of wet conditions in the southwest US was the advance of Mexican mountain glaciers around the time of the Mississippi River mega-flood. The advance of glaciers in Central America was totally out of synchrony with the climate in modern mode and is believed to be a factor resulting from glacial meltwater in the Gulf of Mexico (Heine 1994).

The presence or absence of glacial meltwater in the Gulf of Mexico during modern mode intervals directed the Bermuda High pressure area toward or away from the southeastern US. In a seesaw-like manner, meltwater in the Gulf of Mexico shifted the Bermuda High over Florida and led to prolonged dry conditions in the Southeast, but moderate to wet conditions in the southwest US. Conversely, the absence of meltwater in the Gulf of Mexico led to moderate to wet conditions in the southeastern US, but dry conditions in the southwest US. Therefore, the presence or absence of meltwater in the Gulf of Mexico differentially affected climate on a regional scale independent from global, modern mode influences.
Glacial Mode

The recession of the Laurentide ice-sheet began during the Pleniglacial ~17,000 $^{14}$C BP to ~16,500 $^{14}$C BP (Clark et al. 2001; Jackson et al. 2000; Lambeck et al. 2000) and lasted until ~9,500 $^{14}$C BP (Kaufman et al., 1993). During the 7,500–7,000 radiocarbon-year duration of the meltdown, there were episodes of return to glacial mode cooling conditions. During Pleistocene glacial mode conditions, the Laurentide and Fenno-Scandinavian ice-sheets advanced or were stable (Björck et al. 1996; Clark et al. 2001; Lambeck et al. 2000; Lehman and Keigwin, 1992). The Pleistocene Oldest Dryas, Older Dryas, Killarney-Gerzensee, and the Holocene 8.2 ka event were cold phases of Dansgaard-Oeschger cycles.

It should be noted that the terminology of Mangerud et al. (1974) included the Oldest Dryas as part of the Bølling during the post-Pleniglacial. Subsequent usage, however, separates the two with the Oldest Dryas representing a non-Heinrich, glacial mode event and the Bølling a modern mode event. The Oldest Dryas is considered to be the last phase of the Pleniglacial because both H1 and the Oldest Dryas cool phases delayed the climatic amelioration experienced afterward, during the post-glacial recession of the Pleistocene (Sarnthein et al. 1995).

Radiocarbon dates for the onset of the Oldest Dryas vary from ~13,500 $^{14}$C BP (Alley and Clark, 1999) to ~13,200 $^{14}$C BP (Sarnthein et al. 1995; Björck et al. 1996). German lake varve chronology indicates the Oldest Dryas took place over an interval of 130 calendar years (Brauer et al. 1999).

Heinrich Mode

Heinrich events (H1), the Younger Dryas (H0), and the Preboreal oscillation (HGC) appear to represent two cold phases of Dansgaard-Oeschger cycles amplified by Heinrich ice rafting. Heinrich events represent ocean–land–atmospheric events that impacted climates globally (Rühlemann et al. 1999; Bard et al. 2000). Over the last 100,000 years, there have been seven major Heinrich events that represent especially cold times in the North Atlantic (Alley and Clark 1999). Heinrich events H1, H2, H4, and H5 were well-defined episodes primarily influenced by the Laurentide ice-sheet. Heinrich events H3 and H6 were less distinct episodes influenced by the European, Fenno-Scandinavian ice-sheet (Cortijo et al. 2000). Heinrich event H0, the Younger Dryas, is ignored or not recognized by many researchers because it has not been
detectable as an ice-rafting event in the middle North Atlantic (Chapman et al. 2000; Cortijo et al. 2000; Vidal L. et al. 1997). The Gold Cove advance, which occurred during the Preboreal oscillation, represents a diminutive Heinrich event, not numbered and also ignored, that coincided with the last major advance of the Laurentide ice sheet in the early Holocene (Clark et al. 2000; Kaufman et al. 1993).

Heinrich mode events are only documented during the buildup and decline of glacial episodes and occurred before or after glacial maxima. They did not occur during interglacials. Heinrich events are considered by some researchers to be part of so-called “Bond cycles.” Bond cycles include several Dansgaard-Oeschger oscillations within a 6000–7000 year period that culminate in a Heinrich event. It is unclear, however, if the term Bond cycles should be used for sequences of cycles followed by a Heinrich event because the duration between H1 and H0 was only 4250 calendar years GRIP and between H0 and an unnamed Heinrich event in the Preboreal only 1300 calendar years GRIP (Björck et al. 1998; Walker et al. 1999; Walker 2001). The short duration between the last two Heinrich events is clearly in disagreement with the proposed 6000–7000 year Bond cycle periodicity. On the other hand, H0 and the Preboreal HGC events were not as intense as those before them, thus the identification of Bond cycles may be related to the degree of Heinrich event intensity rather than evidence of their occurrence.

Heinrich cooling conditions resulted from voluminous ice rafting, ocean surface chilling, and salinity dilution due to inordinate volumes of fresh meltwater (Clark et al. 2001). A possible cause of Heinrich ice breakouts may be related to sea level transgression of ~10–15 m or more or to rapid glacial front advancing and ice calving at sea. In one model, sea level rose sufficiently to flood glaciated land and in doing so lifted large sections of continental glacier from dry-dock and set large sections of ice-sheet to sea (Chappell 2002). In the other scenario, glacial advancing like that during Preboreal HGC, went out to sea where it eventually lost stability resulting in massive glacial front ice calving. Either scenario yields the same result. The direction of iceberg drift is believed to have been determined by the position of the Polar front. When the polar front shifted southward to about ~37–40° North latitude as it did during H1 and H0, sea-ice drifted easterly toward Greenland and the European coastline. In contrast, when the polar front remained in near-modern position during the Preboreal oscillation, sea-ice drifted southerly from the Hudson Strait along the Newfoundland coast (Calvo et al. 2001; Kaufman et al. 1993). Figure 6.6 depicts some of the climatic effects imposed by Heinrich events.
Both H1 and H0 occurred as a result of, and mostly subsequent to, meltwater pulses discharged in the North Atlantic via the Hudson and St. Lawrence Rivers (de Vernal et al. 1996; Clark et al. 2001). The Preboreal HGC event occurred subsequent to and during meltwater resumption that initiated as discharge from glacial Lake Agassiz southward via the Mississippi River to the Gulf of Mexico before shifting to a northern route via the Mackenzie River to the Arctic Ocean (Broecker et al. 1989; Fisher et al. 2002).

It is of interest that there was no Heinrich event during the largest mega-flood down the Mississippi River to the Gulf of Mexico possibly because meltwater was discharged to subtropical latitudes (Brown and Kennett 1998; Clark et al. 2001). Nonetheless, the culmination of the Mississippi River mega-flood may have led to the Older Dryas cool phase from ~12,500 14C BP to ~12,300 14C BP (Lowe et al. 2001; Lowe 2002). The Mississippi River mega-flood was originally correlated with MWP-1A, however, a 19-m sea level rise is now also referred to as MWP-1A. It took place between ~12,200 14C BP and ~11,700 14C BP subsequent to the Mississippi mega-flood. Some researchers now think that the cause of sea level rise attributed to MWP-1A is related to an episode of Antarctic ice-sheet reduction during the later time frame (Clark et al. 1996). Nevertheless, there was an all-time record mega-flood often referred to as MWP-1A that drained from Mississippi River to the Gulf of Mexico prior to the Older Dryas from ~12,700 14C BP to ~12,600 14C BP. Confirmation of the timing and direction of discharge to the Gulf of Mexico of the mega flood as well as Younger Dryas and Holocene meltwater episodes, are further supported by the recent optical age chronology (OSL dating) established for the late Pleistocene braided channel belts of the Lower Mississippi River basin (Rittenour et al. 2003).

Rafted glacial ice during H1 and H0 (Younger Dryas) originated from the Hudson Strait or Cumberland Sound in the Baffin Island area of the Nunavut Province, Canada above 60° North latitude (Bond et al. 1992; Hemming, Biscaye et al. 1998; Hemming, Broecker et al. 1998; Kaufman et al. 1993). Thus, the sources of glacial ice during H1 and H0 came from a location more than 1400 km north of the point where meltwater was being discharged. During the Younger Dryas-Preboreal transition and prior to the onset of the Preboreal oscillation (at ~9900 14C BP), meltwater that was discharged from Lake Agassiz not only went south down the Mississippi River but also north to the Arctic Ocean, a location well north of the Hudson Strait-Baffin Island launch point of glacial ice-rafting from the Labrador Sea (Alley and Clark 1999;
Fisher et al. 2002; Spero and Williams 1990). The Arctic Ocean point of meltwater discharge is located above the Arctic Circle near 70° North latitude. Thus, the addition of substantial meltwater volumes in the Northern latitudes tended to affect the Atlantic conveyor currents in a more substantial way than discharge to the south (Fanning and Weaver 1997; Manabe and Stouffer 1997).

In every respect, H1 was the most severe late glacial Heinrich event. Studies of glacial sea-ice cover in the northwestern North Atlantic suggest that H1 summertime sea surface temperatures were much colder than those of the late glacial maximum (de Vernal et al. 1996). H1 sea-ice spread throughout the North Atlantic as the eastern Laurentide ice-sheet expelled massive amounts of ice into the ocean. Like other Heinrich events, H1 ice-rafting left its imprint on the ocean floor. As lobes of the Laurentide ice-sheet pushed over bedrock in the Hudson Strait and Cumberland Sound areas of northeast Canada, it incorporated some of the bedrock in the ice. As glacial-born icebergs drifted in the open ocean, they melted and eventually lost their load of lithic debris on the ocean floor. It is the ice-rafted lithic debris that provides the means of determining the port of origin of both the lithic debris and the icebergs (Andrews and Barber 2002; Bond et al. 1992; Hemming, Biscaye et al. 1998; Hemming, Broecker et al. 1998; Thouveny et al. 2000). In addition, proxy evidence indicates that H1 endured about 500 radiocarbon years longer along the European coast compared to the North American coastline. Thus the severe effects of H1 had terminated in the west by ~14,000 14C BP but endured until ~13,500 14C BP off the Portuguese coast (Chapman et al. 2000).

The 500 14C year lag in timing, as well as proxy evidence from the subtropical western Atlantic, indicates that sea surface temperatures became warm in the western low latitudes of the North Atlantic but remained cool along the European coastline as far south as the Iberian peninsula (Bard et al. 2000:1321–1324). Unlike the cold phase of Dansgaard-Oeschger cycle, Heinrich events are believed to have resulted in a bipolar climatic seesaw effect between the northern and southern hemispheres due to the disruption of the NADW conveyor current versus an uninterrupted Antarctic Bottom Water conveyor current (Seidov and Maslin 2001). The effects of the Antarctic current negated the potential for warm water buildup in the tropical eastern North Atlantic. However, in the west, the potential for warm water buildup appears to have been magnified under static pooling conditions unaffected by the southern hemisphere heat sink (Bard et al. 2000:1321–1324). Thus, after ~14,000 14C BP the attenuating effects of a warm
tropical western Atlantic ended the cooling conditions that continued in the east for another 500 years.

During the Younger Dryas, Heinrich HO, sea surface temperatures in the northwestern North Atlantic were about the same as they were during the late glacial maximum; much warmer than conditions during H1 (de Vernal et al. 1996). The evidence for a less intense H0 comes from a number of proxies and suggests important climatic implications. Although the peak of the H0 ice-rafting lasted from ~10,900 14C BP to 10,500 14C BP, it was confined to a smaller area of geographic distribution and had a shorter duration than H1 (Clark et al. 2001). Similarly, tetra-unsaturated C_{37:4} alkenone proxies (temperature-sensitive alkenone in organic sediments) from the subtropical Northeast Atlantic show up as a distinct peak around ~14,100 $^{14}$C BP during H1 but only as a weak signal during H0, perhaps a reflection of the difference in magnitude (Bard et al., 2000:1322). H1 occurred before the end of the pleniglacial when glacial mode conditions dominated whereas H0 occurred subsequent to the ~13,000 $^{14}$C BP termination of the pleniglacial after which modern mode conditions dominated.

The H0 event is also different in that lithic detritus on the ocean floor was deposited farther north and west, around 60° North latitude in the Labrador Sea area. Apparently, the direction of the ice-sheet being calved into the sea originated from a northward advance of the Laurentide ice-sheet toward Cumberland Sound. I The icebergs contained lithic detritus derived from a source about 400 km north of the H1, Hudson Strait source (Kirby 1998). The early Holocene, Preboreal oscillation, HGC, was weaker than the Pleistocene events. But evidence to be discussed in more detail below suggests that the Preboreal oscillation (Björck et al. 2002; Fisher et al. 2002) and its accompanying HGC Heinrich event (Kaufman et al. 1993) impacted the southeastern US more than the subsequent Dansgaard-Oeschger event at ~8.2 ka cal BP.

The climatic conditions of the late glacial recession frequently shifted into one of three climatic modes: (1) modern, (2) glacial, or (3) Heinrich (Alley and Clark 1999). Throughout the Pleistocene and Holocene, millennial-scale cycles culminated with cool, glacial mode episodes from one to several hundred years in duration. With the exception of HGC, Heinrich events took place over millennial-scale durations. Once established, Heinrich events resulted in warm water pooling in the western tropical North Atlantic (Caribbean) due to the cessation of Gulf Stream and deepwater conveyor circulation. Dansgaard-Oeschger events resulted in generally cool sea states throughout the North Atlantic including the western tropics. Surface water temperatures
A Local Climate Proxy from the Page-Ladson Site, Aucilla River, North Florida

Establishing the Elevations of Late Pleistocene Water Table Stands in North Florida

One of the unique characteristics of the Page-Ladson site is the opportunity it provided to establish water table positions (elevations) through time as a proxy for paleoclimate. This approach depends on the fact that the Page-Ladson site lies in a sinkhole bounded by a much shallower limestone bench that acted as an impoundment. In addition, the sinkhole was being filled with sediment deposits throughout most of the last glacial recession. The sediment being deposited in the sinkhole represented one of four possible environmental conditions: fluvial (lotic), still water (lentic), colluvial (terrestrial slope-wash), or non-depositional oxidation (reduction) of peat-rich sediment during periods of subaerial exposure. Evidence of ancient water tables is indicated by the nature of the sedimentary beds being deposited. The deposition of silt, shell-rich silt, and channel lag represents fluvial origin. The deposition of peat and small animal bone assemblages indicates a still pond origin. The deposition of iron-rich smectite (Scudder 2006) and small animal bone assemblages indicates still or slow flowing, mostly lotic water deposition. The deposition of colluvium is from terrestrial slope reduction from higher to lower grades caused by slope wash during rains and animal activity on the inclined areas of the sinkhole margins (Govers and Poesen 1998). The occurrence of hiatuses in the stratigraphic column is either from erosional fluvial conditions or from subaerial oxidizing conditions.

The reconstruction of paleo-water tables is based on the assumption that the elevation of the shallow, limestone channel upstream from the Page-Ladson sinkhole represents the vertical bench that acted as a dam. When the water table was above the bench, flowing water could pass over it. When the water table was below the bench, it became impounded and downstream flow was prevented. The shallow limestone bench lies 3.5 m below the site’s vertical datum river gauge. Thus, estimates of the paleo-water table stands are expressed as meters below the site’s river gauge datum and any water table stand 3.5 m below present therefore represents an episode of non-flowing conditions (Figures 6.7 and 6.8).
Late Pleistocene Water Table Stands as an environmental proxy

The reconstruction of the Aucilla River, Page-Ladson site paleohydrology is based on the radiometric age and type of deposition for each sediment unit identified. By further utilizing the paleo-water table information in conjunction with other local, regional and global paleoenvironmental data, it is possible to build a chronostratigraphy showing when the different water table stands occurred during the various environmental modes and events of the late Pleistocene (Figure 6.9 and Table 6.1). As I shall demonstrate in the next chapter, this reconstruction, if correct in part or in whole, is an important step toward understanding the conditions under which habitat and resource availability were affected and how they helped guide subsistence strategies.

In Sum

In summary, from the beginning of the latter half of the Pleniglacial through the Early Holocene, ever-fluctuating climatic conditions shifted between three distinctively different Heinrich, Glacial and Modern type modes. Episodes of climate mode endured for relatively short periods of geologic time, lasting from a few hundred to a thousand or so years. Climatic events represented brief shifts from one climate mode to another. Within the durations of these modes, changing climatic conditions in the Southeast sometimes resulted in unique regional adjustments. The climatic events (mode shifts) and episodes (mode states) that occurred during the late Pleistocene resulted in a variety of biotic responses to the stresses placed on natural systems.
Figure 6.2. Showing the Atlantic and associated thermohaline currents (source - http://upload.wikimedia.org/wikipedia/commons/4/4c/Thermohaline_Circulation_2.png).
Figure 6.3. The Bermuda high pressure area shifts from its Atlantic Ocean position westward over Florida resulting in dry to sometimes very arid conditions for one or more years (basemap from ArcView geo-tiff global map).
Figure 6.4. The routing of large volumes of glacial meltwater to the Gulf of Mexico resulted in long-term droughts in the extreme southeastern US. Similar to the ENSO, La Niña phase, the Bermuda high pressure was drawn westward over Florida (basemap from ArcView geo-tiff global map).
Figure 6.5. During the last glacial, the cold phase of Dansgaard-Oeschger cycles, such as the Older Dryas, represented cool downturns in the climate. The Gulf Stream and North Atlantic Deep Water conveyor currents were not disrupted rather, their north end expression receded to latitudes well south of their modern Holocene reach (basemap from ArcView geo-tiff global map).
Figure 6.6. Heinrich events which occurred during the late Pleistocene effectively shut down the Atlantic conveyor currents causing the northern latitudes in the North Atlantic to become frigid, particularly in Europe. However, the southeast US was thermally insulated by the non-circulating tropical water in the Caribbean (base map from ArcView geo-tiff global map).
Figure 6.7. Map of the Page-Ladson site showing the location of cross section A – A’.

Page-Ladson site bathymetric contour map depicting the locations of test excavations.

Cross Section of 3.5 m Limestone Bench from A to A’ (see Figure 6.8)

- Primary underwater datum and river stage gauge
- Secondary underwater datum
- 7.5 cm Vibra-core location
Figure 6.8. Cross section of the north end of the Page-Ladson site showing the 3.5 m limestone bench.
Figure 6.9. Page-Ladson site chronostratigraphy based on past water table stands.
Table 6.1. Key to Figure 6.9.

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**Greenland climate events based on the integration of NGRIP and GRIP δ¹⁸O profiles**

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Adapted from Blockley et al., 2012

- Holocene Cooling Northern Latitudes
- Glacial-like Cooling
- Modern Mode
- Heinrich Mode
- Modern-like, Cool but Warmer
- Glacial Mode
- Meltdown from Laurentide Discharging from Mississippi River to Gulf of Mexico
CHAPTER SEVEN

HABITAT, RESOURCE, AND SUBSISTENCE CONTEXTS

The Context of Habitat

S. David Webb (Webb 1979; 1981; Webb et al. 2003; Webb 2006a) was first to point out the uniqueness of late Pleistocene fauna inhabiting the Coastal Plain of the southeastern United States. The results of his research identified a unique and abundant mix of Pleistocene Neotropical species coexisting with an equally rich abundance of North American Pleistocene species. By the beginning of the Holocene, this species richness had ended with the extinction of megafauna in the Southeast and the extinction or extirpation of Neotropical and other species. The Holocene fauna in Florida was reduced to the extant vertebrates inhabiting Florida today. Webb’s research has recently been critically reviewed and expanded upon (Russell et al. 2009). The evidence indicates the existence of a species-rich, thermal refugium in the Southeast bounded by the Southern Appalachians to the west, the Atlantic coast to the east, Florida to the south and Cape Hatteras to the north (Figure 7.1).

During the late Pleistocene, lowland environments bordering the South Atlantic Bight extended 900 km from Cape Canaveral in the south-west to Cape Hatteras in the north-east. They harbored a physical environment not greatly different from that of Florida. The biogeographic importance of this region was further enhanced by a substantial increase in land area due to the drop in sea level, adding an area to the Bight exceeding that of the state of South Carolina. Remarkable changes have transpired in the physical environment during the few tens of thousands of years separating the LGM [last glacial maximum] from the beginning of the Holocene (Russell et al. 2009: 184).

The presence of Alligator mississippiensis, the large box turtle Terrapene carolina putnami, and the giant [land tortoise] Hesperotestudo crassiscutata in Pleistocene deposits of North Carolina implies the existence of mesic climates at least as warm as at present . . . The occurrence of large terrestrial turtles and alligators so close to the ice front, even if it was in the process of melting, seems anomalous . . . [In contrast] the fauna of the California site, situated at least at the same latitude as Florida but about 3,800 km to the west, resembles the Floridian assemblages less than those of the colder Great Lakes region . . . The spectacular megafauna-dominated biota of the Southeast during the LGM and early postglacial interval rivaled that of modern Africa (Russell et al. 2009: 191-192).

The existence of a late Pleistocene thermal enclave bounded by the Southern Appalachians to the west and the Atlantic coast to the east is suggested by the physical environmental evidence. . . The “Southeastern” FAUNMAP (1996) province extended from Florida to the southern border of Virginia, where it met the “Northern Province” in turn juxtaposition to the Wisconsinan glacial
front. Vertebrate abundances, exemplified by the replacement of the heat-tolerant *Mammuthus columbi* by the cold-adapted *M. primigenius*, suggest that substantially cooler climates prevailed in Virginia than in the enclave immediately south. . . The south-eastern thermal enclave supported forests as well as prairies, and the abundant fodder of both browsing and grazing megaherbivores. Mammalian diversity was perhaps greater in the enclave than in more homogenous environments. . . The more mesic Southeastern enclave may have accordingly constituted a center of late Pleistocene biodiversity in the Americas north of Mexico.

A regime of alternating climates also implies that a south-eastern thermal enclave probably appeared and disappeared repeatedly throughout the Pleistocene. . . It would seem that the megafauna survived the rigors of repeated climatic cycles only to be exterminated at the end of one otherwise “uninteresting” cycle when climates were moderating from full glacial conditions. Nearly all of the species of plants and small vertebrates that survived remain alive today. . . During the extinction interval, which may have lasted on the order of a millennium south of the warming glacial front, extirpation was more frequent in Virginia whereas extinction was more common in Florida. . . Megafauna extinctions appear to have been more severe in the southern latitudes where climates were relatively benign, and less severe [than] in northern latitudes where climates were relatively harsh (Russell et al. 2009: 195-196).

Curiously, “Suwannee” and “Simpson” points, which includes all waisted or recurvate lithic types except waisted Clovis (see Chapter 8) and represent the points primarily recognized in Florida, are distributed and confined within the same area (Anderson et al. 2010)(Figure 7.2) as the species-rich “South-Eastern”, thermal enclave (Russell et al. 2009)(Figure 7.1). It was a Pleistocene enclave that closed by the Holocene onset with the extinction or extirpation of about fifty percent of its mammalian biodiversity (Russell et al. 2009: 189; Webb and Simons 2006: 243). In Chapter 6, the evidence of Pleistocene climatic shifts in the Southeast are apparent; shifts from one climate mode to another, sometimes responding to global changes while, at other times, responding to localized influences such as of the duration, direction and volume of glacial meltwater discharge. Post glacial maximum southeastern climate shifts endured for periods as short as a few hundred years to as long as a thousand years. Within this setting, the concept of leads and lags is that climate shifts lead whatever changes occurred -- to the biota lagging in response to the change.

There are proxies by which to judge late Pleistocene habitats, three are considered here:

1. Reconstruction of the diet, migratory range and, to the extent possible, other characteristics of the herbivores that were, or potentially were, exploited by Paleoindians.
2. Consideration of landscape modifications by potential keystone species that may have affected habitat and that are no longer here or that have been reduced in numbers to the extent that they cannot alter the terrain.
3. Comparison of proxy data to determine the resolution of habitat change.

Herbivore diet, range and characteristics: stable isotopes and morphometrics

Some of the first attempts to ascertain the diets of extinct Pleistocene herbivores involved morphometric characteristics of the skull such as muzzle shape and tooth hypsodonty. However, sometimes the results were interpreted in different ways. For example, the genus *Hemiauchenia*, one of the two extinct Pleistocene llamas, was interpreted in two ways until the introduction and use of stable isotope investigation of fossil tooth enamel. In this instance the stable carbon isotope analysis provided a more direct proxy for interpreting *Hemiauchenia* paleo-diet (Feranec 2003):

This genus has been suggested to comprise only browsers, according to morphological characteristics of the snout (Dompierre and Churcher 1996), or to include intermediate feeders with a preference for grasses, according to the presences of hypsodonty teeth and abundance of cementum (Webb 1974, Webb and Stehli 1995). (Feranec 2003: 231). . .

The stable carbon isotope values displayed by *Hemiauchenia* from the Late Tertiary through the Quaternary of Florida suggest that it most commonly fed as a \([C_3]\) browser but was fully capable of having a varied diet inclusive of \([C_4]\) grasses and sedges. *Hemiauchenia* is therefore classified here as an intermediate feeder with a preference for browsing (Feranec 2003: 236).

In another important study of herbivore paleo-diet, Feranec and MacFadden (2000) determined that *Hemiauchenia* shifted from true \([C_3]\) browser to a mixed feeder at the Blancan/Irvingtonian boundary (~1.8 ma BP) when the mega-grazer *Mammuthus* first enters the landscape.

This significant change is opposite that which we might expect with the dispersal of a large \([C_4]\) grazer like *Mammuthus* into Florida because competition for grass would supposedly force other animals to consume more browse. For this reason, it is possible that this change may not be due to competition from immigrant *Mammuthus*, but could also be due to change in the flora, possibly moving toward a more open, savanna-like habitat. It is also possible that the change in flora might be due to the effects and behavior of *Mammuthus* to open habitats, as seen by *Loxodonta* in African ecosystems today. . . (Feranec and MacFadden 2000: 166).

The study of stable isotopes now places southeastern late Pleistocene species of *Mammuthus, Bison*, and *Equus* as open habitat \([C_4]\) savannah grass-land grazers (Feranec 2003; Feranec and MacFadden 2000). While there was no significant difference in diet between the
three genera, making them competitors for the same forage; there was a difference in their collective diets between North and Central Florida and South Florida (Feranec 2004). Perhaps this should not be surprising since there was a marked vegetation change more or less between Central and South Florida in the late Pleistocene. Wetter, but fire-dependent pine forests, alternated with drier oak-hickory habitats in South Florida versus that of wetter, non-fire dependent pine mixed with species-rich deciduous forests alternating with drier oak-hickory forests from Central Florida northward (Grimm et al. 2006; Newsom 2006; Watts and Hansen 1994; Watts and Stuiver 1980).

Mixed feeders during the late Pleistocene include the llamas (*Hemiauchenia* and *Paleolama*), the peccary (*Platygonus*), and the armadillos (*Glyptotherium*) that incorporated C\textsubscript{4} forage with their shared C\textsubscript{3} preference toward browsing (Feranec 2003; Feranec and MacFadden 2000; Hoppe and Koch 2006; MacFadden 2000). *Hemiauchenia, Paleolama*, and *Platygonus* also appear to have been non-obligated drinkers; being able to extract sufficient moisture from the vegetation they ate to sustain themselves through periods of drought (Hoppe and Koch 2006; Hulbert 2001; Webb 1974a). They did well in more xeric uplands presumably in hammocks and scrublands adjacent to open savannahs where they had access to C\textsubscript{3} forage as well as C\textsubscript{4} browse.

Pleistocene browsers included the mastodon (*Mammut*), the peccary (*Mylohyus*), tapir (*Tapirus*), the sloths (*Paramylodon, Eremotherium, and Megalonyx*), and the white-tailed deer (*Odocolileus*). *Mammut, Mylohyus* and the sloths preferred the closed habitat of the woodlands where they found abundant C\textsubscript{3} browse. *Tapirus, and Odocolileus*, on the other hand, appear to have occupied the most dense forest canopies where their browse had unusually low δ\textsuperscript{13} values due to the canopy effect (Koch et al. 1998: 131; MacFadden 2000: 52).

There has been a dearth of studies related to small Pleistocene mammal assemblages yet they too promise to be informative. A notable exception was a study of *Ondatra*, the marsh muskrat, present in pre-glacial maximum through post-glacial maximum-age sites in the Aucilla River. *Ondatra* was a Pleistocene inhabitant of Florida now extirpated to locations farther to the north and west. When it inhabited the Aucilla River area, it had a larger body mass compared with its Holocene counterparts. *Ondatra* body mass remained stable from 32.0 ka \textsuperscript{14}C BP to 16.0 ka \textsuperscript{14}C BP. By 12.3 ka \textsuperscript{14}C BP, however, its body mass had reduced in size (Mihlbachler et al. 2002). Today it is generally smaller.
Landscape modifiers and animal affected habitats

Two species are considered here as potentially significant modifiers of landscape. They are *Mammuthus*, the southern Columbian mammoth and *Castor*, the beaver. The late Pleistocene mammoth of Florida appears to have had similar habits as their surviving relative, the African elephant (*Loxodonta*). Most important to this consideration is the animal’s ability to open the landscape by taking down trees. The beaver has, and can, shape landscapes around the water bodies it inhabits through building water impoundment dams. The habits of the late Pleistocene bear-sized giant beaver, *Castoroides*, are not well known but it is thought to have fed on swamp vegetation rather than trees (Hulbert 2001) and, therefore, may not have been the landscape modifier that its smaller relative is. Nevertheless, fossil remains of the giant beaver are particularly common in karst river basins such as the Santa Fe, Ichetucknee, Chipola, St. Marks, and Waccasassa (Hulbert 2001). The abundance of giant beaver in karst river basins does suggest that the river basins supported abundant swamps which, incidentally, are not common today in rivers such as the Santa Fe and Ichetucknee.

The short-haired temperate *Mammuthus* that occupied Southeastern habitats during the late Pleistocene is a member of the family *Elephantidae* that includes all forms of extinct and extant mammoths and elephants. Their skeletal remains are found throughout North America below the colder climatic areas occupied by their arctic-adapted relatives, the wooly mammoths. While it is unusual to find evidence about their habits, the Waco mammoth in Texas provided a rare exception. Here a matriarchal herd of 15 mammoths met their demise in some type of catastrophic event, probably a flood. Though the cause is unclear, it was an event that caused the herd to take a defensive bunching posture like that of modern African elephants where the older adults surround the juveniles. Around 68 cal BP, they died in the bunched posture of adult females surrounding their younger offspring.

Though speculative, it is also possible that *Mammuthus* shared other behavioral traits with *Loxodonta*. Adult male *Loxodonta* are known to congregate in loose knit herds though some individuals may choose to go things alone. Among the behaviors within these patriarchal groups is tree-felling. Adult male *Loxodonta* are known to be able to uproot or break trees with circumferences as large as 1.5 m. In doing so, elephants expand the savanna grasslands and attenuate the potential for woodlands to replace savanna (Groning and Saller 1999). Could deforestation have taken place through the actions of *Mammuthus*?
Certainly something occurred at the Blancan/Irvingtonian boundary when mammoths first entered the Southeastern landscape. At the same time, grasslands expanded and certain browsers, notably the llamas, turned to mixed browsing and grazing (Feranec and MacFadden 2000). Using his knowledge of *Loxodonta*, Owen-Smith (1987) noted the following habitat impacts caused by this megaherbivore:

In higher rainfall regions with soils allowing good water infiltration, the effect of elephant damage has been to convert stands of mature woodland into shrub coppice. . . In Chizarira Game Reserve in Zimbabwe, elephants at a local density of about 1 per km² converted . . . woodland with a tree density of 1,180 per km² into an open tree-coppice grassland within ten years (Owen-Smith 1987: 355).

The Southeastern *Mammuthus*, as well as its distant cousin *Mammut* were very large animals. Both had bone-wall thickness in their long bones that were more robust than *Loxodonta*. Similarly, their body weights are estimated to have been 2 to 2.5 times greater than the extant *Loxodonta* (Shipman 1992). Either animal was capable of pushing trees to the ground, yet the best evidence suggests it was *Mammuthus*. It is the type of potential that Owen-Smith used to propose his keystone herbivore hypothesis.

The dramatic effects that megaherbivores can have on habitats is widely evident today in Africa. . . By felling or damaging trees, elephants can transform wooded savanna to open grassy savanna or shrubby regrowth, and create openings in forests. . . . The kinds of habitat change that these species induce are not necessarily detrimental to other large herbivores. On the contrary, the coppice or gap-colonizing woody plants promoted by elephant damage offer more accessible foliage and new stems and lowered chemical defenses compared with the mature trees they replace. . . . Thus the disturbing effects of megaherbivores on vegetation can promote higher rates of production of more nutritious forage than occurs in their absence, and these habitat changes may benefit other mammalian herbivores with similar but more selective feeding habits. Following the demise of megaherbivores by whatever agency, what changes in vegetation would have resulted? Reversing the changes that have been observed in Africa following megaherbivore increases, these would have involved the elimination of open glades in forests, while in grasslands a mosaic of tall and short grass zones would have grown out to a more uniform tall grassland. The latter would furthermore have sustained more frequent and fierce fires than the former grassland mosaic, further depressing any remnant tree or shrub stands. These seem to be just the kinds of changes in vegetation documented by the fossil pollen record [in North America] (Owen-Smith 1987: 359).

Similarly Gary Haynes has proposed the term “megamammal landscape” to describe what former Pleistocene habitats may have looked like in the Americas.
A megamammal landscape has networks of trails and fixed resource points used by megamammals (and other animals), vegetation patches affected by feeding and trampling, water holes enlarged and deepened by wallowing and trampling, and a variety of other effects such as an abundance of dung beetles feeding on droppings, presence of animal taxa that feed on coppiced trees or open vegetation shaped by megamammal-feeding, and so forth. Megamammals profoundly affect community ecology in their ranges, and their signature impacts turn environments into unique settings (Haynes 2002: 110).

Did certain keystone species such as mammoth affect habitat? The answer seems to be yes, but proof in the paleontological record, is not clear and may never be. Many of the taxa that flourished alongside mammoths were also destined to become extinct or to be extirpated to smaller more isolated niches. Perhaps this suggests that the absence of mammoths as a keystone species did impact other species far more dramatically than late Pleistocene climate change.

Another, much smaller landscape-modifying animal is Castor canadensis, the American beaver. Through their actions of dam building, tree felling, excavation for den building, and, in some instances canal excavation to their dam site, they can influence soils and soil formation and create “beaver meadows” after the beaver pond has drained. They are also great mixers of the soil or bioturbators. “Beavers are capable of altering landscapes at rates comparable to those for human activity” (Johnson 2001).

In many parts of the country including Florida, beavers are considered nuisance animals due to the unwelcomed wetland alteration of which they are capable (see for example http://myfwc.com/license/wildlife/nuisance-wildlife/steel-traps/). Castor canadensis has occupied the Florida wetland landscape since the late Pliocene (Hulbert 2001). From the time that Mr. Mike Norden and I discovered the Suwannee campsite component of the Norden site in 1974, I have conducted occasional inspections of that site. During that 38 year period, beaver colonies have come and gone in the Norden site area as well as in other areas of the Santa Fe and Suwannee rivers. Populations go from low ebb to a somewhat flourishing population and are then trapped out. When populations have been active in the Norden site area, they have dug burrows for dens but may not have had the populations and time to assemble dams. Beavers have affected by the Norden site, at least in some areas effectively bioturbating the soil in the areas of their burrows.

Ichetucknee Springs and its spring run, the Ichetucknee River, derive their name from the Creek word meaning water or pond caused by beavers (Simpson 1956: 66). Assuming this meaning is true, it may have greater significance than first comes to mind. In places, both the
Santa Fe and Ichetucknee rivers have wide shallow drainage basin areas that once held numerous channels spanning the flood plain. Both rivers are entrenched or becoming entrenched in narrower, unified channels that have cut through the older anastomosing channels and their channel-fill sediments. The modern channels are now mostly incised in the limestone bedrock. The entrenchment of the Santa Fe’s channel to a lower elevation has stranded numerous paleo-channels as well as basin-wide channel-fill deposits. In many ways the now stranded anastomosing channels of the Santa Fe River raises a perplexing question. During the late Pleistocene there were climate episodes during which lower than present water table stands occurred. There were also climate episodes that resulted in near present-day water table stands. Why then did the Santa Fe River not become entrenched during the Pleistocene? Granted, there is a great deal of research that is needed before there will be a definitive answer, but it is possible that beaver dams played some role. Beaver dams may have retarded down gradient flow. Given the karstified nature of the limestone, it is possible that the majority of down gradient flow was diverted underground while the impoundment structures built by beavers created large slow-flowing pooled sections in the surface channel. This scenario is speculative, but certainly a possibility. What is certain is that like sections of the Wacissa River today, the Santa Fe River also was once an anastomosing channel system that extended the full breadth of its flood plain (Figure 7.3).

Comparison of Proxy Data to Determine the Resolution of Habitat Change

A number of important palynological studies have been carried out in Florida. The first studies were pollen cores taken from shallow lake basins that yielded pollen profiles dating to the early Holocene (~8,500 14C BP to ~8,600 14C BP no older, Watts 1969a; 1971; 1975). The absence of preserved pollen in organic-rich lake bottom sediments meant that shallow lake basins were dry prior to ~8,500 14C BP and that only the deeper sinkhole lakes (then estimated to be >20 m depth) were likely to have preserved a late Pleistocene pollen record (Watts et al. 1992; Watts and Stuiver 1980).

Camel Lake, a deep water pollen site in the Florida Panhandle near the Apalachicola River, lies at about the same latitude as the Page-Ladson site. Prior to the findings at Page-Ladson, pollen data from Camel Lake were found to consist of a species-rich mesic forest prior
to the LGM that shifted to a species-poor pine forest during the LGM. After the LGM, the species-rich mesic forest returned but also included *Picea* (spruce) during the Heinrich 1 (H1) environmental episode from ~18.3 ka cal years BP (15.0 ka $^{14}$C BP) to ~17.2 ka cal BP (14.1 ka $^{14}$C BP). Following Heinrich 1, *Picea* moved to more northerly latitudes but the species-rich mesic forest remained until the end of the Pleistocene when the climate became arid once more (Watts et al. 1992).

The pollen data from the Page-Ladson site indicates an interval of dry conditions during Heinrich 1 (Hansen 2006) followed by an even drier interval that left a subaerial hiatus in the Page-Ladson site sediment column spanning 17.0 ka cal BP (13.8 $^{14}$C BP) to 15.6 ka cal BP (12.9 $^{14}$C BP). During this period pollen data do not exist (Dunbar 2006c). Next, a species-rich mesic forest existed until sometime after 12.4 ka cal BP (10.5 $^{14}$C BP). At about the early Holocene onset, oaks dominate the forests that replaced the late Pleistocene mesic forests (Hansen 2006).

The macrophytic (macro-botanical) dataset reflects different information when compared to the pollen data. This is to be expected since it represents plant remains that existed in the immediate area of the Half Mile Rise section of the Aucilla River where the inundated components of the Page-Ladson site are located. The pollen dataset represents a wind-blown source, part of which was derived from distant places. The macro-botanical plant remains represent floristic continuity from the LGM to the end of the Pleistocene. It reflects rich deciduous tree assemblages of a bottomland forest. In the oldest levels of the site “the abundance of wild gourd and cypress, along with the presence of hazelnut, Osage orange, and black haw – relative to later deposits may well have resulted from megafauna presence” (Newsom 2006).

The third proxy to be considered is that of ancient water table stands. Water table shifts at the Page-Ladson site reflect a chronology of fluctuations. For example, the average of seven statistically related radiocarbon dates for Unit 3 at Page-Ladson (the early Paleoindian level) is 12,425 ± 32 $^{14}$C BP, a seemingly tight time span. Converting that date to calendar years yields 14,549 ± 404 cal BP, a date which has a two sigma uncertainty error of 808 years. Many things can take place within such a time span. Another aspect of the water table proxy is that within the duration of stratigraphic deposition, what appear to be abrupt and brief deviations in otherwise uniform sedimentation have been identified. They are believed to represent some type of climate event (see for example, Figure 6.9 and the twin declines in Unit 4)(also in Dunbar 2006c).
Perhaps most important is that the regressions and transgressions episodes of the paleo-water table are more precise and relevant in some aspects when compared to both the pollen and macrophytic datasets. A compilation of all three proxies, however, provides the most accurate reconstruction of climatic modes and events.

The Context of Resource Availability

Resource availability, and the extent to which collected resources can be tracked from their point of acquisition to the location in which they were deposited in the archaeological record, has been seen as a means of reconstructing mobility and procurement patterns (Ellis and Lothrop 1989; Goodyear 1983; Tankersley 1995; Tankersley et al. 1990). It is also a means to make inferences about technology and lifeways when direct evidence is lacking in the archaeological record. For example, the widely held assumption that late Paleoindian and Early Archaic biface adzes were used for woodworking (Bullen and Benson 1964; Goodyear et al. 1980; Morse and Goodyear 1973) was based on inference, not direct evidence. Recent work at the Page-Ladson site confirmed that inference when a chop-marked tree, carved wooden stakes, wooden slats and several adzes were found on the Early Archaic, Bolen level (Carter and Dunbar 2006). Similarly, the occurrence of small furbearing animal remains at two Paleoindian campsites now suggests the use of Paleoindian set traps or snares (Dunbar and Vojnovski 2007) but direct evidence has yet to be identified.

Did climate shifts place constraints on human populations and affect their choice of resource acquisition during the late Pleistocene? I believe the answer is yes, particularly during contrasting dry, low water table intervals versus those of wet, near modern water table intervals. The first consideration of this topic and how it might relate to resource availability can be found in Dunbar (2006a). In that effort, I proposed that not all resources were available through time because sometimes availability became diminished. Prehistoric fishing is a good example. When potable water was limited during episodes of low water tables, the option of fishing was a poor alternative simply because the places where fish could be found, as well as, their abundance had greatly diminished. I also argued that Paleoindians needed to adapt their tool kits accordingly. Therefore, different climatic/water table episodes should also reflect modifications to the techno-environmental repertoire of Paleoindian tools. The tools necessary for the collection of critical
resources may have been diminished or eliminated in favor of others that became more useful as climate helped to alter and shape habitat. A case in point is the shift from lanceolate point-making to notched-point making at the Younger Dryas-Preboreal boundary. Until the Middle Paleoindian period (~12.9 to ~12.5 ka cal BP), lanceolate points dominate the Paleoindian toolkit (Goodyear 1999). During the Late Paleoindian period (~12.5 to ~11.5 ka cal BP), a variety of lanceolate and notched forms coexisted and by the Preboreal onset, notched Bolen points dominate the toolkit in Florida, Georgia, South Carolina and Alabama (Driskell 1994; Driskell 1996). And with the introduction of Bolen points, the concurrent arrival of specialty tools such as the Edgefield scraper, Waller knife, and small triangular hafted spokeshaves and endscrapers. A rather abrupt shift in tool-making traditions occurs during the last phases of megafaunal extinction in the southeast US by the abrupt onset of the Preboreal, Bolen prevails.

A crucial resource throughout the last glacial recession in the southeast US was potable water. Its archaeological significance is that availability expanded and contracted a number of times. With these fluctuations, so did the selection of tool-making materials such as chert, hunting and gathering ranges, and settlement options. When the water table was greatly depressed, human activity became focused around deep karst depressions and when the water tables were near present, both game animals and the humans who hunted them became more dispersed on the landscape (Dunbar 2006b; 2006c; Dunbar and Vojnovski 2007). By any measure taken, the Floridan Aquifer, where it occurred near the surface and was the main water source, was the most important in terms of attracting Paleoindian activity.

An important study has determined a number of influences that drought and low water availability versus wet intervals and expanded of water sources can have on large mammal communities and their dispersal patterns. For example, in East Africa, “the carrying capacity of the country as a whole is closely related to the carrying capacity of land within ‘cruising range’ of the dry season water supplies” (Lamprey 1964). Three categories of large herbivores species are recognized: 1) migratory, 2) dispersal, and 3) resident (Lamprey 1964). Migratory and dispersal species are water-dependent, obligate drinkers. Resident species are water-independent, non-obligated drinkers which can obtain sufficient moisture from the local browse they consume. The habits of dispersal species are worth considering here. During dry times, dispersal species are gradually confined to range areas adjacent to water holes. Thus the range of dispersal species is limited by potable water but the range of migratory species is greatly
expanded by moving out of one range to another with more abundant resources. Conversely, following the reestablishment of ample rain fall, dispersal species can and do abruptly scatter because of the abundance of numerous water sources (Western 1975). Unless there is a catastrophic die-off during extreme arid conditions, predators, including human hunters, are afforded the luxury of finding their prey (dispersal species) confined to small range areas around water holes. During wet intervals and abundant water, dispersal species are widespread and their range is not geographically predictable; a more formidable challenge to predators during short term events. If, however, after a prolonged arid interval, an enduring wet interval followed for several hundred years to millennia in duration, habitat, including species richness, would change. For example, the reestablishment of fish, amphibians and other wetland species -- scarce during arid times -- would expand their range and abundance. These are all factors that would favor human exploitation of the resource base.

The late Pleistocene transgressions and regressions of inland water tables not only affected the availability of potable surface water, it also affected the availability of other resources. Protein resources are vital to humans and are likely to have varied through time in the proportion of upland, wetland and underwater species exploited. Bone was another vital resource, important to Paleoindian technology, and was largely derived from the long bones and tusks of large Pleistocene mammals (Bradley et al. 2010; Dunbar and Webb 1996; Hannus 1989; Hemmings 2004; Lahren and Bonnichsen 1974; Lyman and O'Brien 1999; Pearson 1999; Webb and Hemmings 2001). The availability of lithic resources for stone tool manufacture varied inversely with that of potable water. When water tables were high, chert outcrops in lowland basins and channels were drowned and when the local water tables dropped many outcrops became exposed and were available for exploitation (Dunbar 1981c).

By the 1970s, the archaeological evidence in Florida led to the development of two seemingly contradictory hypotheses regarding Paleoindian activity. These were the “Oasis hypothesis” (Neill 1964) versus the “River-crossing hypothesis” (Waller 1970). The Oasis hypothesis was developed by Wilfred T. Neill (1964:17-32) as an answer to why so many Paleoindian artifacts and Pleistocene fossils were recovered from submerged contexts. To Neill, sites like those submerged in the Silver River represented evidence of an extremely low Pleistocene water table when potable water was restricted to oases and attracted humans and animals. These were archaeological sites that had been inundated by Holocene water table rise.
Ben Waller saw things differently based on the sites he knew in the Santa Fe River. To Waller (1970: 129-134), Paleoindian hunting activity was purposely staged at river ford crossings where shallow water allowed Pleistocene megafauna to cross the river. There, Waller hypothesized, Paleoindians staged hunting ambushes for large game disadvantaged by water impeding their crossing. Implicit in the oasis hypothesis is the concept of substantially lower than present water tables as opposed to the river crossing hypothesis that proposes water tables were near modern levels during the late Pleistocene. With evidence from the Page-Ladson site, both hypotheses reflect actual conditions depending on climatic conditions being experienced in the Coastal Plain of the Southeast. Therefore, both hypotheses are accurate reconstructions of the inland water table stands for the sites in the inundated Silver River (Neill 1964) as well as the river-ford crossing sites in the Santa Fe River (Waller 1970).

**The Context of Subsistence**

There have been two dominant hypotheses regarding Paleoindian subsistence patterns in North American archaeology over the past several decades. First is the big game hunting hypothesis that purports that Paleoindians actively preyed on migratory Pleistocene megafauna. A driving assumption of this hypothesis is that it explained that the many species of megafauna became extinct from human hunting or “overkill” (Martin 1967; 1987; 1990). Opposing this idea is the general foraging hypothesis, which contends that Paleoindians were more like Archaic peoples because they did not hunt large dangerous animals preferring instead to hunt smaller game and decrease hunting risks (Meltzer 1988; Meltzer and Smith 1986). Discussions about the pros and cons of both premises are still argued (Grayson and Meltzer 2003; G. Haynes n.d.; 2007) with little direct evidence to settle matters either way.

As might be expected, the evidence for Paleoindian subsistence patterns is meager in eastern North America. In Florida, however, efforts to reconstruct the dietary pattern of the waisted Suwannee point-making peoples are yielding returns. The evidence comes primarily from the Ryan-Harley and Norden sites in North Florida. Both are campsites and both have yielded a variety of faunal remains reflecting the exploitation of megafauna and smaller animals. These findings are very significant because they support aspects of both the general foraging and big game hunting hypotheses (Dunbar et al. 2005; Dunbar and Vojnovski 2007). At Ryan-Harley, an
Ivory rod fragment was found in a displaced context and though it does not demonstrate that they hunted or scavenged megafauna, it does suggest that this largest of megamammals was still around. Pleistocene faunal remains from displaced contexts included giant tortoise, giant armadillo, sloth (*Paramylodon harlani*), horse, tapir and the muskrat (*Ondatra zibethicus*). Pleistocene animal remains from *in situ* contexts, both extinct and extirpated, included large mammal long bone fragments of bison or horse as well as the remains of horse, tapir, and *Ondatra* muskrat. Both sites represent bone and stone tool-making middens with a variety of large, medium and small animal bones rather than the hypothesized focused exploitation of large or small animals to the exclusion of all else. Faunal exploitation included fish, amphibians, birds, reptiles, and mammals including megafauna. Clovis subsistence practices were also varied and included a mix of small, medium, and large fauna (Hemmings 2004).

Reflected in this consideration of habitat, resource availability, and subsistence is an underlying conviction that they were interrelated parts of an ever-changing natural system in which hunter-gatherer Paleoindians participated. It was a time during which Paleoindian subsistence practices changed of necessity, according to the prevalent climate modes of the late Pleistocene. It can even be proposed that together, habitat, resource availability, and human subsistence posed formidable obstacles to the extant late Pleistocene wildlife. They certainly were factors during the extinction process. Some type of sudden, catastrophic, doomsday event is not required to explain Pleistocene extinction. More likely answers are to be found in a protracted extinction event beginning around the beginning, or prior to, the LGM and identified during these climate-affected and human-involved circumstances. Illustrating this possibility and its implications for human involvement, I proposed a “habitat and resource availability matrix” (Dunbar 2006a). Since 2006, I have revisited this model and revised it with recent data (Figure 7.4).
Figure 7.1. Approximate extents of the South-eastern Pleistocene thermal enclave (NASA satellite image).
Figure 7.2. The distribution of “Suwannee/Simpson” points in the Southeast United States mirrors the South-Eastern species-rich, thermal enclave (compare this map with Figure 7.1, the similarities are remarkable).
Figure 7.3. LiDAR elevation model of the Santa Fe River Basin showing the extensive paleo-channel systems in its relatively wide flood plain that are flanked on both sides by sandy uplands. The uplands directly adjacent to the river basin are elevated 2 m to 8 m above it. Two notes: 1) Dark blue is not the water surface, rather it represents an elevation of 5.5 m above sea level; the river level is actually lower than the blue color gradient. Setting the base elevation of this digital LiDAR model at 5.5 m it helps to show the lowest extinct springheads and runs. The extinct springs are now non-flowing water-filled sinkholes. 2) The parallel ridges in the flood plain, located in the bottom central part of this image, are old wind rows that were established during silviculture land clearing in preparation for planting pine trees in the late 1970s. The green area dividing the wind rows is another extinct spring and related spring run. The features shown in this image are that of the Santa Fe River’s former anastomosing channel system (LiDAR from the Suwannee River Water Management District).
Figure 7.4. Habitat and resource availability matrix for the late Southeast species-rich, thermal refugium (adapted from Dunbar 2006a: 531).
CHAPTER EIGHT

ARTIFACTS AND TECHNOLOGY AS A CONTEXT

The Development of Typology in American Archaeology

Before addressing the postulated diagnostic artifact types, it seems appropriate to review some thoughts regarding artifact typology. The development of typology in American archaeology was greatly influenced by Alex Krieger (1944), Albert Spaulding (1953), James Ford (1954), Julian Steward (1954), and Irving Rouse (1960). There are many other researchers of course who, in one way or another, have addressed typology. Mostly they have addressed specific artifact categories such as lithics (Bradley et al. 2010; see for example Bullen 1968; Cambron et al. 1990; Collins and Kay 1999; Crabtree 1972; Gramly 1992; Movius et al. 1968; Semenov 1973; Young and Bonnichsen 1984), or bone (Bonnichsen and Sorg 1989; Bradley et al. 2010; Dunbar and Webb 1996; Gramly 1992; Hemmings 2004; Hemmings et al. 2004; Natacha 2011; Pearson 1999; Saunders et al. 1990; see for example Semenov 1973; Shipman et al. 1984; Webb and Hemmings 2001) as well as other artifacts (shell, ceramic, etc.). Yet a necessary and fundamental predecessor of typology was the introduction of enlightened archaeological approaches that included such things as stratigraphic excavation techniques that began in the early twentieth century and was appropriately named “The New Archaeology” (Wissler 1917). Without controlled stratigraphic methods of site excavation either by arbitrary or natural levels, the development of chronology and artifact time depth would not have been possible (Browman and Givens 1996).

The Typological Concept -- Alex D. Krieger -- 1944

A primary theme of Krieger’s typological concepts was that types be identified by attributes of culture. Thus he defined an archaeological type as a unit of cultural practice equivalent to a cultural trait in ethnography. In order to qualify, a type had to represent the product of traditional, patterned ideas of a culture and be differentiated from the individual
variability (skills and ability) of its practitioners. He felt the dividing line between types should be based on “demonstrable historic meaning in terms of behavior patterns.” The same or similar concepts were subsequently referred to by Rouse (1960) as the “Historical type” and by Steward (1954) as the “Historical-index.” I prefer to use the term “diagnostic” and will use the Bolen Point type (which includes Taylor points in South Carolina and early notched points in Alabama) as an example (see Figure 8.1). Bolen points represents a temporal marker for the early Holocene as well as a technological shift away from lanceolate points to the first well-established and prolific, post-Paleoindian, Early Archaic notched projectile-point-knives in the Southeast.

Krieger (1944) felt a number of typological methods being used during his time were indifferent to cultural considerations. He dismissed two methods without discussing them and pointed to a third, the classificatory method, as particularly rigid and un-adaptable to varying collections. He proposed a typological method for archaeology based on culture as a defining factor. The approach taken is flexible and can be adjusted to the material and problems at hand.

The theoretical scope of Krieger’s typological method (Krieger 1944: 278):

1. Each type should approximate and include the mechanical and aesthetic results (artifacts) recognized within the context of individual variations that may stray from the norm.
2. Each type must hold its form with essential consistency.
3. Distinguishing attributes which differentiate types in one case may prove to be variations in another.
4. No matter how small, differences of type based on their distributions in time, space or culture are of type importance.
5. Each type is established on a case by case basis and is based on a combination of identifying features which together are more important than each individual feature.
6. Differences between types must be clear so that others are able to recognize them.
7. The typological framework must be flexible enough to allow additions, subdivisions, recombination etc. where needed and, in doing so, not disturb the others which were not purposely altered.
8. Once a type is established it must be named, not ambiguously numbered or lettered.

Krieger’s methodological procedures for assembling a typology (Krieger 1944: 279, Figure 25):

1. Sort specimens into groups which appear to have been made in a similar pattern compared to other specimens which strongly contrast.
2. Further divide each working pattern by differences seen in some but not all specimens.
3. Recombine the groups in step II by their distributions in a) geographical (site to site), b) temporal and c) associational occurrence.
4. Test the tentative types established in step III by comparing them to another collection of similar geographical and temporal origins. Exact duplication of results is not necessary
because differences, such as the workmanship of available resources may vary, and affect craftsmanship and/or final appearance.

5. Name and describe the types. A type name might include the site name and some descriptive of the least variable within the type. Also, as necessary, establish sub-types.

6. Use the typological knowledge in reconstruction of cultural relationship.

Using Krieger’s approach and the example of Bolen points, a mistake made by several Southeastern archaeologists was applying the Big Sandy type name to Early Archaic notched points (for example, see Cambron et al. 1990). Big Sandy and Bolen points are very similar in appearance but they are not related temporally and they do not share all of the same features. Bolen points are Early Archaic notched points that are basely ground (Bullen 1968), a feature not found Big Sandy points. Dan F. Morse (1994) was the first to recognize this mistake and noted that, “The name Big Sandy is associated with a Middle Archaic complex well documented by Lewis and Lewis (1961) in the Eva site report. I am pleased to note a movement away from using this name to describe the Early Archaic side notched complex in Tennessee and Alabama. We need to use the name Bolen” . . . (Morse 1994: 233).

Besides the recognition of cultural attributes that can be identified using the typological method, how can artifact types be quantified in such a way as to account for variations either as time related evolution or by contemporary cultural factors?

Statistical Techniques for the Discovery of Artifact Types -- Albert C. Spaulding -- 1953

Spaulding contended that archaeology inevitably confronts the problems of ordering and comparing quantities of data and sampling error in order to determine which of the data have meaningful or meaningless attributes. He felt that the best approach to these problems involved appropriate statistical methods provided there was a sufficient sample. He acknowledged the use of empirically derived, but potentially significant cultural data sets. He also suggested that statistical techniques should be used to develop a degree of consistency from those data. To him, an artifact type was an assemblage sharing a minimum of two attributes which, together, defined that type’s characteristic pattern.

Using four variables of a ceramic assemblage (smooth or stamped surfaces and grit or shell tempering), he explored a four-cell coefficient of association previously described and used
by Alfred Kroeber and others. Spaulding found that this four-cell formula failed to consider the variances of sampling.

Example of data used in the four-cell coefficient by Spaulding:

<table>
<thead>
<tr>
<th>Grit Tempered</th>
<th>Shell Tempered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stamped Surface</td>
<td>53[a]</td>
<td>64[b]</td>
</tr>
<tr>
<td>Smooth Surfaces</td>
<td>32[c]</td>
<td>43[d]</td>
</tr>
<tr>
<td>Total</td>
<td>85[a+c]</td>
<td>107[b+d]</td>
</tr>
</tbody>
</table>

Four-cell Coefficient of Association Formula:

\[
\frac{(a + b) - (b + c)}{a + b + c + d}
\]

He next used a chi square formula to determine attributes of independence or lack of independence. In testing the data he was testing the variations in the sample not the total collection (population) from which it had been drawn. He assumed the sample was drawn from a common binomial population.

\[
X^2 = \frac{n(ab - bc)^2}{(a + b)(c + d)(a + c)(b + d)}
\]

Chi square formula testing the hypothesis of independence of attributes

Using the numbers shown in the example table above chi square value for \( X^2 \) is 0.128. By applying “one other argument, the number of degrees of freedom, it is possible to enter a table of \( X^2 \) and read the probability of occurrence . . .”(Spaulding 1953: 307). He determined the degrees of freedom to be 1, thus a \( X^2 \) of 0.128 and 1 degree of freedom is between .80 and .70. This means “that a \( X^2 \) this large would arise by chance alone between 70 and 80 times in 100 in a population having independent attributes . . .” indicating it was a fair picture of the potter’s habits.

Spaulding went on to investigate situations involving more than two pairs of attributes and concluded by discussing uncertainties. Chief among these is one that “can at least be
estimated on the basis of statistical theory” and is purely an archaeological problem the relationship of sample to culture and the empirical data Spaulding 1953: 313). For example, the beveled edges of Bolen points resulted from re-sharpening which is not quantifiable even though the angle of the beveled edge is.

Spaulding (1957) subsequently expressed serious concern about the perceived lack of consideration for quantifying variability in artifact typology thereby questioning the “culture history” approach. In effect, Spaulding proposed ideas that became part and parcel of “processual archaeology” in the 1960s. He did not care for the approach of Krieger, Ford, Steward, Rouse and others.

**Concepts of Types -- James A. Ford with discussion by Julian H. Steward -- 1954**

Ford expressed doubt about Spaulding’s statistical methods of discovering cultural traits or features of artifacts. Ford felt the concept of type was a basic tool for researchers of culture. Therefore, he felt it was important to understand: 1) what a type is, 2) how it is defined, and 3) what purpose it may serve. To illuminate his discussion of type, Ford used a fictitious culture and place -- the people of Gamma-gamma on the island of Gamma. The island of Gamma is also surrounded by other islands which have occupied villages.

Ford first examined the Gamma-gamma people through an ethnographer’s eyes. The year was 1940 and, among the Gamma-gamma, he developed a typology for their houses based on features such as height above the ground, size and number of rooms. He found that certain houses fell outside a norm such as those built in trees, on high stilts, having very large or multiple rooms, or built at ground level. Houses that fell within the norm included small-to-medium-sized, single roomed structures which were built above the ground on stilts. He also concluded that black or white roofs appeared to have no significance.

Ford next took an excursion to the surrounding islands and acquired a different view of house types. First, the norm on Gamma-gamma was not necessarily the norm on the other islands. By viewing all house styles on all islands, a geographic typology of variation was identified. A higher percentage of black roofed houses as well as small houses on high stilts were located on islands East of Gamma-gamma. To the West were white roofed houses only, many of them large. Also all large houses were built at ground level and only a few of the smallest houses
were elevated above ground on low stilts. This distribution of houses showed spatial
differentiation of types.

Ford next reminded us that “the ethnographic view of a culture resembles a snapshot
taken in the middle of a race for it is a static view of a very fluid process” (Ford 1954: 51).
Giving this concept meaning, Ford developed a temporal typology for houses on Gamma-gamma
showing decades of change from 1890 to 1940. In this hypothetical case, houses tended to come
out of the trees and were progressively being built lower to the ground. This distribution showed
temporal differentiation of types.

From his examples, Ford proposed four dimensions of cultural type (Ford 1954: 52):

1. Because inherent organization exists in culture at all times and places, a cultural type will
reflect the boundaries of its cultural bearers. This requires an analysis of the consistency
of associated features [traits] and “may, if necessary, be tested by statistical analysis.”
2. There is a level of integrated abstraction in cultural structure at which the typology is
formulated and may be determined at the level of the artifact or at the features of the
artifacts.
3. Cultural type will vary due to cultural drift across geographic space. The apparent mean
of the type is the function of the locality at which it is defined. For example, the norm of
house styles of Gamma-gamma is a case in point. However, it should also be pointed out
that the mean of a type’s overall geographic distribution may differ.
4. A cultural type will vary in time. Therefore, the mean of the type is a result of that point
in time.

Julian Steward (1954) characterized Ford’s concepts of typology as presenting two kinds
of types: morphological and historical-index. By morphological type, Steward meant the most
elemental characteristics of cultural significance (its attributes or traits) based solely on form,
physical or external properties. The Historical-index type is similar to an index-fossil in geology;
it has chronological significance as a time-marker. In the Early Archaic period, a Bolen Point
assemblage is diagnostic of a historical-index type; it is a time marker.

Steward (Steward 1954) also described a third kind of type Ford had not considered. The
functional type based on artifact utilization and role in a culture.

The Classification of Artifacts in Archaeology -- Irving Rouse -- 1960

Rouse developed a comprehensive view of artifact typology by combining what he felt
were two recognized but fundamentally different approaches to the problem. He referred to these
approaches as the Analytic and Taxonomic classification methods. The Analytic method established what Rouse called modes rather than types of artifacts. He proposed that a mode was a natural unit of cultural study. Conversely, the Taxonomic method was concerned with attributes indicative of type; therefore, a type represents an arbitrary unit of cultural study.

**Analytic Classification**

The classification of cultural material by significant attributes is determined on the basis of 1) conceptual and 2) procedural (or functional) modes. Rouse’s conceptual mode calls on the researcher to sequentially sort a collection on the basis of materials, shapes, and decoration, followed by a final sort into artifact classes. The sorting is based on the nature of the materials used (i.e., rock, shell, clay, etc.) and the morphological modifications to which artisans of that culture conformed (this is similar to Steward’s morphological type). The results are to identify and designate which attributes are diagnostic of each artifact class of the assemblage. For example, using Rouse’s approach, Bolen point attributes are lithic, bifacial, ovate, notched, left-side opposite-beveled, lateral re-sharpened with serrated edges, and basally ground. Yet he sometimes avoided the use of type names making it confusing.

Rouse’s procedural mode will hereafter be referred to as the functional mode since that was the meaning he intended. The functional mode attempts to determine what customary procedures were followed in making and utilizing the artifacts. The artifact assemblage can be sorted on the basis of technology, styles, and function. The results of such a sort should yield artifact classes based on diagnostic attributes which are “read” from, or inferred to have resulted from, the behavior of the artisans who made them. For example, bifacially formed Bolen points are basally notched and ground for hafting with pressure or indirect percussion flaking used to notch and/or re-sharpen the lateral blade margins. Impact damage and other blade characteristics also imply that it functioned both as a projectile point as well as a cutting knife (Austin and Mitchell 2010).

**Taxonomic Classification**

Rouse felt taxonomic classification should be undertaken following the establishment of the series of analytic artifact classes. He mentioned three ways of sorting the artifacts into
taxonomic order. Two of the methods required sorting the artifacts manually either systematically by modes or randomly by feel and appearance. The other method was to “work statistically” sorting by modes using key-punch cards. Today, the equivalent to key-punch cards would be a computer database, spreadsheet, and/or statistical program. The result of the taxonomic classification is a single series of types or sub-types derived from the successive series of artifact classes which, had in turn, been derived from the modes of analytic classification.

Rouse felt the personal preferences of the researcher might affect the outcome of taxonomic classifications in two ways. First he, like Steward, identified lumpers, who perhaps group too many forms under the umbrella of one type; and splitters, who perhaps split one form into many types based on insignificant attributes. Secondly, he noted that some archaeologists derived types based on space and time while others derived types based on the intrinsic nature of the artifact. He therefore made a distinction by identifying one as the Historical type and the other the Descriptive type. In a sense, the Bolen point assemblage can serve as either because of it is fully indexed temporally and also has a distinctive morphology.

Utility of Methods (Rouse 1960: 319-321):

1. Identification of artifacts -- For public dissemination of information about findings (i.e., museum displays & interpretations) should often include functional mode description of an artifact since few lay-people understand a terms such as Tick Island Incised but will comprehend “it’s a cooking pot.”
2. Determination of the culture of a component -- Use of functional and conceptual modes as well as descriptive types.
3. Classification of components to form cultures -- Varying combinations of functional and conceptual modes and historical and descriptive types.
4. Dating components and cultures -- historical types.
5. Definition of cultural period -- On a local site level, historical types: For regional, multi-areal chronologies use of functional and conceptual modes.

Please note that Rouse’s article was published in 1960; the decade in which the movement known as “processual archaeology” or, as I prefer to call it, the new-new archaeology began. I call it the new-new archaeology in admiration and respect for my major undergraduate professor, Charles H. Fairbanks, who once blurted out, “Hell, we were doing new archaeology when these upstarts were in their diapers,” or words to that effect. After all, the new archaeological approach began in the early twentieth century (Wissler 1917) only to be co-opted
as a revitalization movement (Binford 1965; 1986; 1989). As Alice Kehoe (2011) recently entitled her article about Binford’s impact on American archaeology, “Lewis Binford and his moral majority,” perhaps a catchy title can speak a thousand words. The new-new Binfordian archaeology seems to have retarded typological efforts for many years, being preoccupied with the supposed non-holistic view of its predecessor. It is not that typology was ignored altogether, it was not, but it was a minefield to discuss typology without disavowing the normative approach used by culture historians such as Rouse, Ford and Steward among others. The irony in all this is that after decades of elocution and ink, the processualists (the new-new archaeologists) were first to successfully apply normative theory, not the cultural historians. As Lyman and O'Brien (2004) note:

Efforts in the 1960s to demonstrate the value of the “new archaeology” involved showing that the competing culture-history paradigm was inferior. One allegedly weak plank in that paradigm had to do with how culture historians viewed culture — as a set of ideas transmitted in the form of ideal norms or mental templates. Lewis Binford referred to this view as “normative theory.” In archaeology that view was manifest in the equation of artifact types with prehistoric norms — an equation that, according to Binford, the culture historians had made so that they could track the flow of ideas through time and thus write culture history. Culture historians regularly subscribed to cultural transmission as the theoretical backdrop for their artifact-based chronometers such as seriation and the direct historical approach, but with few exceptions they perceived only a weak relationship between norms and artifact types. It was not until 1960, in a paper by James Gifford, that what Binford labeled as normative theory appeared in anything approaching a complete form. Ironically, the first applications of normative theory were products of the new archaeologists, not the culture historians (Lyman and O'Brien 2004: 369).

Today both the Culture History and Processual approaches stand together and have been joined by a third perspective, Post-processualism.

**Lithic Point Types**

In Florida and the coastal lowlands of southeastern Alabama, southern Georgia, and southeastern South Carolina, besides Clovis points, there are two Paleoindian types, the Simpson and Suwannee points that are Paleoindian in age. However, both Simpson and Suwannee point types are problematic as originally defined (Bullen 1968; 1975; Goggin 1950). Their distribution extends beyond today’s modern political boundaries to encompass most of the Southeastern thermal enclave proposed by Russell et al. (2009, also see the discussion in Chapter 7). This
geographic spread introduces the possibility that at least some of the Southeastern Coastal Plain Paleoindian tool kits were adapted to the enclave’s unique mix, variety, and abundance of Neotropical and Nearctical species.

The Simpson and Suwannee point typology has been called into question (Dunbar and Hemmings 2004) because of the diversity of lanceolate point forms that Ripley Bullen (1968) lumped under the type John Goggin (1950) originally called Suwannee (Figure 8.2). It is clear neither Bullen nor Goggin understood the difference between Clovis and Suwannee, but few researchers did in those days unless they had become immersed in E. H. Sellards book defining Clovis (Sellards 1952). Wilfred T. Neill (1958:47) repeatedly referred to the Paradise Park site Clovis points as Clovis-like points, but he finally conceded to Goggin and called them Suwannee points. Neill did so because Goggin had already called them fluted Suwannee points in publication (Neill 1958: 47). Subsequently Neill again addressed the issue again saying:

In Florida, some very Clovis like points have been found (Bullen 1962: fig. 2, three specimens at left, bottom row; Griffin 1952: 21, upper figure, center specimen; Neill 1958: pl. 3, A, C; 1961: 13, left figure bottom row of specimens; Simpson 1948a: fig. 3 A, C). In recent years these Florida artifacts have generally been placed by local workers in a rather broad category called “Suwannee point” (Bullen 1958: 28-29; Goggin 1949: 20; 1952: 64-65 footnote), although Mason (op.cit. 1962: 240) evidently would expect the term “Clovis” to include some Florida specimens, and restrict the term “Suwannee” to much less Clovis-like specimens such as those figured by Goggin (1950: fig. 21, M-P),(Neill 1964:17-18)

As for Bullen, he accurately identified several Clovis points in his type collection. Yet hidden in the diversity of Suwannee point variants are Clovis points that are marked Suwannee (see for example, Figure 8.2 Suwannee Excurvate far left specimen and Suwannee Waisted far left specimen). Bullen’s projectile point identification guide (1968; 1975) only provides outlines of a few Suwannee and Simpson points. It is within Bullen’s type case collection that the variations in specimen forms can be seen and, in some cases, other types can be identified. There is no mistaking that Bullen intended the identifications in his type collection because the type name is written on each point in the type collection (Figure 8.3). Regardless of one’s feelings about the weaknesses inherent in Bullen’s typology, had he not assembled the type case collection, it could not be corrected or improved.
Goggin apparently never defined the Suwannee point type; referencing instead the points that were depicted in Clarence Simpson’s article as examples (Neill 1958: 47; Simpson 1948a). The major problem with Bullen’s classification scheme is its dearth of attribute data and reliance on morphology in the absence of structure as a consideration. This difficulty becomes painfully obvious when comparing Bullen’s Suwannee Waisted forms with his Simpson type; they overlap (see Figure 8.2). It appears that there may be a number of possible types lumped under Bullen’s Suwannee point cluster.

First among these is the Suwannee type defined by Al Goodyear (1983; 1999). Between Bullen’s Suwannee Waisted form and Simpson type are at least two types: Suwannee Waisted and Simpson. This situation was first noted by Dunbar and Hemmings (2000). Both will be defined here. Discussion and serious revision of the Florida typology can also be found in Grayal Farr’s (2006) reevaluation of Bullen’s preceramic lithic point typology. In this dissertation, the focus is strictly on the Paleoindian typology.

Before discussing the revision of the Paleoindian typology, it is useful to consider the observations of researchers who have dealt with classification of bifacially flaked projectile points and knives (ppks). For example, John Whittaker (1994) identifies the most common utility of point typology as a means to determining a site’s relative age. In a sense then, Goggin and Bullen got things right, at least for their time. Suwannee points are Paleoindian and, therefore, older than other younger and more common types and could be accurately used to identify sites with Paleoindian components. But there are aspects of Americanist archaeology that need to be mentioned. In their book, *Understanding Stone Tools: A Cognitive Approach*, the authors David Young and Robson Bonnichsen (1984) make a clear departure from the normative approach, deciding instead to develop a cognitive approach to understand and classify stone tools. It is worth restating that any classificatory scheme published in the 1970s and early 1980s had best avoid connection to the normative approach of cultural historians. But that is not the main point here. What is important is that they envisioned a holistic approach to lithic studies. To them, their approach was an effort to study “material products [that] operates on the assumption that material products cannot be understood apart from the processes involved in their creation” (Young and Bonnichsen 1984: 5). Examples of using this approach include such works as *Clovis Technology* (Bradley et al. 2010). However, in applying this approach they assume that there are
an adequate number of sites with appropriate numbers of artifacts recovered in context that will allow this type of detailed reconstruction.

In Florida many of the point finds are surface finds without stratigraphic context and the sites that have been identified have too few artifacts to allow such a comprehensive reconstruction. It is within these limitations that the proposed typological revision, based on artifact traits and structural morphology, is offered with the caveat that an attempt should be made to incorporate this approach with that of morphometric discrimination in an attempt to determine both trait variation versus differentiation. With the state of our knowledge limited by the absence of robust in-place site assemblages for comparison, only final production stage and subsequent tool maintenance reduction stages can be addressed at present. Spaulding (1953; 1957) and the proponents of the processual approach (Binford 1965) lamented the inability of the culture historians to somehow include artifact trait variation in typological development.

David Thulman (2012) has employed morphometric shape variability to discriminate the point types Simpson, Suwannee, and transitional pseudo-notch Greenbrier-like Suwannee points. Using integrated morphometric software to determine how consistent geometric landmark measurements vary, Thulman has been able to identify three morphometric point types based on variability and within each type its internal variability. His work is based on the assumption that point bases are the least likely to vary since point bases are seldom re-sharpened or reworked (Thulman : n.d.). The results are very promising, yet they do not consider point manufacturing characteristics such as percussion versus pressure flaking, flake shape characteristics, and the point’s structural stability in various use modes such as stabbing, cutting, or propulsion by atlatl. To the extent possible, finished and re-sharpening stages of point production will be identified here as will structural morphological considerations. Suffice it to say that identifying the differences between types and potential types that are all lanceolate is challenging.

**Page-Ladson Point**

The Page-Ladson type is not as common as Clovis in occurrence. This is an excurvate to parallel-sided point with two subtypes. Type 1 (Figure 8.4 top row) was manufactured from preform blanks, reduced bifacially, and employs overshot flaking as a means of bifacial reduction and thinning. Type 2 (Figure 8.4 bottom row) was manufactured from thin flakes
having part of the original preform flake’s ventral surface preserved as a flat face mimicking fluting. Larger Type 2 specimens may display overshot flaking on the dorsal side of the original preform blank, otherwise the dorsal side is finished by a combination of percussion and/or marginal pressure flaking. Neither subtype is fluted; rather the basal concavity, although slight, is marginally beveled.

Though never recovered from stratigraphic context at the Page-Ladson site, the Page-Ladson point type (both varieties) was suspected to represent the most likely candidate to have been associated with Unit 3 where evidence of Paleoindian mastodon butchery was identified (Dunbar 2006b; Fisher and Fox 2006; Webb 2006c). Unit 3 dates 12,425 ± 32 ¹⁴C BP (14,549 ± 404 cal BP) based on the average of seven statistically related radiocarbon dates and is clearly pre-Clovis (see Table 6.1). To test the assumption that the Page-Ladson type is a pre-Clovis contender, the Wakulla Springs Lodge site was investigated because it was the only recorded archaeological site in Florida where the Page-Ladson type, as well as a large Simpson point preform, had been excavated in situ from the deepest Paleoindian level of the site (Jones and Tesar 2000; 2004). The purpose of the 2008, National Geographic Society-funded investigation at the Wakulla Springs Lodge site was to determine the age of the early Paleoindian level using optically stimulated luminescence (OSL). That effort succeeded and also yielded the pre-Clovis age evaluations shown in Table 5.4. Using the median age of the early Paleoindian level, the site is older than the Page-Ladson site; however, we chose to be conservative and emphasize the minimum age of the error range (Rink et al. 2012). The Wakulla Springs Lodge site is pre-Clovis by any measure (Waters and Stafford 2007), but when the minimum possible age is used, it is younger than the Unit 3 level at the Page-Ladson site. Nevertheless, these results indicate that the Page-Ladson and Simpson types are older than Clovis.

The occurrence of overshot flaking is a Clovis trait and the flute-like features on the points manufactured on thin flakes mimics Clovis fluting. The Page-Ladson type, as well as the Miller and Miller-like points in Virginia, Maryland, and Pennsylvania are pre-Clovis and likely candidates for its ancestor. Elsewhere in South America, El Jobo points are pre-Clovis and share no traits with Clovis. It now appears that the long-held assumption that fluting is a trait of the earliest Paleoindian projectile points is incorrect.
**Simpson Point**

This is an exaggeratedly recurvate point type that is more likely a knife and least likely an atlatl-propelled projectile point. Like the Page-Ladson type, it is not common but specimens have been found as far south as the Peace River. The Page-Ladson type, at present, is known to have a north Florida distribution. At the Wakulla Springs Lodge site, a Simpson preform and Page-Ladson point manufactured on a thin flake occurred in the early Paleoindian level (Jones and Tesar 2004). Prior to the state’s purchase of the Wakulla Springs property, a Simpson point was prominently displayed in the Wakulla Lodge (Figure 8.5, photo courtesy of Dan Morse).

The Simpson type (Figure 8.6), at least prior to extensive re-sharpening, has an extreme contraction in the haft area compared to the Clovis Waisted and Suwannee Waisted types. They are manufactured in varying sizes much the same as Clovis points. Simpson points have width-to-thickness ratios reaching to as much as 21:1. Such ratios were created by successfully thinning the blade by removing broadly expanding, percussion flakes that extend beyond the midline of the point. On most Simpson points, these broad percussion flakes overlap each other and create flattened cross-sections that can result in the midline area of the point being thinner than the lateral margins. Small-sized Simpson points (Figure 8.6, see for example the Williams Landing and East Run specimens) either have broad, expanding percussion flakes taken from either side of one lateral margin or, in the smallest specimen, are overshot flaked. The results of this type of percussion flaking forms a thinner, sharper edge on one or both sides (more typical) of the lateral blade margins. Careful reduction in this way is why the Simpson type has a flattened cross section, but it is the sharp lateral edge that was likely to have been the desired result; an edge suitable for cutting. This is not the only evidence that Simpson points acted as knives, however, because they are ill-suited to be atlatl-propelled spear tips. Structurally they are too weak in the haft area and tend to break from the forces exacted by spear throwing. Replica points of this configuration failed on the first or second shot (Figure 8.7). Conversely, Clovis Waisted and Suwannee Waisted points are suitable atlatl dart tips and withstand impact fracturing on all but the hardest surfaces (i.e., rock or bone).

Both Simpson and waisted Suwannee points have been compared to the fishtailed points of South and Central America. Any relation seems doubtful although the assumption is that both types were post-Clovis (Faught 2006). However, in South American, fishtailed points at Fell’s Cave are contemporary with Clovis (~13.1 to 12.9 cal ka BP, Goebel et al. 2008). Unlike the
fishtailed points of South America (Lopez and Ranere 2007; Ranere and Cooke 1991), Simpson points are manufactured on much thicker, bifacially reduced preform blanks, not thin flakes. The Page-Ladson Type 2 point is manufactured on thin flakes but similar methods used to produce different results are not an adequate indication of relatedness. It also should be mentioned that there is a fair amount of confusion in discriminating between Simpson and Suwannee; a topic that will be discussed under the section on the Suwannee type. In this study, the Simpson type is reclassified and described in a way that is distinctively different from any of Bullen’s Suwannee type variants.

**Clovis and Clovis Waisted points**

For obvious reasons both subtypes of Clovis points (Figure 8.8) have been described in the archaeological literature numerous times (Antevs 1935a; Bradley et al. 2010 just to name a few; Buchanan and Collard 2010; Cotter 1937; Frison and Bradley 1999; Gardner 1979; Gramly 1993; Hranicky et al. 1995; Tankersley 1994; Wormington 1949) and the type has become a benchmark of comparative reference for other Paleoindian types in the Americas even though the other forms may or may not be related (Haynes 1997). A few of their manufacturing traits are discussed here to highlight their potential as shared traits through time. These are: the use of overshot flaking to thin the preform; basal fluting to thin the haft area; and the sharpening of the distal end in a way that frequently yields broad-shaped, blunt-looking tips with a razor-like edge (Dunbar and Hemmings 2004).

**Suwannee**

The first substantive analysis of one of the two Suwannee point types (Figure 8.8 top row) was published by Al Goodyear (1983) and followed by Randy Daniels and Mike Wisenbaker (1987). Both studies resulted from field investigations conducted at the Harney Flats and other sites in in the Tampa Bay area. Goodyear clearly recognized the ambiguity inherent in Bullen’s typology, noting that the excurvate type of Suwannee point exhibited distinctive basal thinning by flakes taken from lateral margins of the base (Goodyear et al. 1983; Goodyear 1999)
Expanding on Goodyear’s observation, Daniels and Wisenbaker (1987) were able to define the production and finishing stages of the type.

**Suwanee Waisted**

The distinction is important because Daniels and Wisenbaker also described what I propose here as a second type of Suwannee point -- the Suwannee Waisted point. Daniels and Wisenbaker identified it as the Simpson type (Daniel and Wisenbaker 1987: 53-54). I propose that the type name be changed to Suwannee Waisted because the type appears to be related to the un-waisted Suwannee since both types were found together at Harney Flats (Daniel and Wisenbaker 1987). It also seems that Bullen’s original intention was to separate Suwannee from Simpson based on the Simpson type having extreme waists and very wide blades. The manufacture of Suwannee points is generally not Clovis-like though there is evidence that the waisted form may be a Clovis offspring (Dunbar and Hemmings 2004; Dunbar and Vojnovski 2007), yet another reason for this reassignment of type name. Suwannee Waisted points sometimes, but not often, display overshot flaking on one or both sides, while others do not. They also display an increasing use of pressure flaking as a thinning and finishing strategy (Figure 8.10). If this set of traits represents overshot flaking giving way to pressure flaking, it represents a time transgressive evolution analogous to Clovis (predominantly percussion struck for thinning) giving way to Folsom and Goshen (predominantly pressure flaked for thinning) in the western US (Tankersley 1994).

**Harney Point**

The type name Harney Point is a new introduction to add to the overall assemblage of Paleoindian lanceolate point types. The Harney type proposed here is what Goodyear identified as the Simpson type (1983: 44 Figure 3 H and K, 1999: 440 Figure 3 B), which is not to be confused with the form that Daniel and Wisenbaker (1987) called Simpson. Again, I suggest that the type name be changed to Harney Point because it is fundamentally an excurvate point type (Figure 8.11), not the extreme recurvate form Bullen originally proposed. Specimens have been found at the Harney Flats site (Daniel and Wisenbaker 1987: Figure 19G and very likely Figure
A and B) in Tampa, as well as the Ryan-Harley site in the Wacissa River basin in northwest Florida (Dunbar and Vojnovski 2007: 174 Figure 10.6 A & B). Many other specimens are documented in the dataset of Paleoindian points compiled by Thulman and used by him in his dissertation (Thulman 2006). His dataset, and its related gallery of point images, are available through the Paleoindian Databases of the Americas web site (http://pidba.utk.edu/florida.htm) hosted by the Department of Anthropology, University of Tennessee.

The Harney type is a percussion struck excravate point with contracting auriculate base. Once extensively reworked Harney points resemble the Crowfield type, an unrelated northeastern Paleoindian type (see for example Deller and Ellis 1992: 37 Figure 31 A-K). The Harney type assumes this shape from repeated re-sharpening above the haft area. After re-sharpening, the point tip becomes stubby and trianguloid. One of the specimens is made on a thin flake (C) while nine others display overshot flake scars (Figure 8.11 A, D, E, H, I, K, L, N, & O) caused by their production. None is fluted and basal thinning is accomplished by beveling followed by grinding. The blade margins after re-sharpening take on a slight bi-beveled appearance and many of the point margins begin to display stacked step fracturing, a problem that most flint knappers attempt to avoid (Figure 8.11 B, C, E, F, G, I, J, K, & L). The stacked step fracturing on three specimens may be the reason they were discarded (Figure 8.11 N, O, & P).

Long Neck Point

This is a new type name (Figure 8.12) even though it has been previously documented. Al Goodyear (1983: 45 Figure 4) originally referred to this type as lozenge-shaped, however, it is not the lozenge-shaped type excavated from the Harney Flats site and given the type name “lozenge-shaped” by Daniels and Wisenbaker (1987). The lateral blade width above the haft area is narrow compared to its length. It is a recurvate slightly waisted point that was deliberately manufactured to its long, narrow specification, a shape it maintained upon re-sharpening. Long Neck points are percussion and pressure flaked and some display overshot flaking from their production (Figure 8.12 A, D, E, G, H, K, & 0). None is fluted. Basally one to two thinning flakes is common as is basal beveling. The base is concave as are other waisted point forms.
Proximal hafting area grinding often extends about one third the length of the blade. Their primary function may have been as knives.

**Lozenge-shaped Point**

This is the Lozenge-shaped point type recovered from the lowest level of the Harney Flats site and given that name by Daniel and Wisenbaker (1987: 57-59, Figure 18). There are two subtypes, the round-based variety and the flat-based variety. Both subtypes are small points as are some forms of the Long Neck points. A number of Paleoindian types such as Simpson, Clovis, and Suwannee points are manufactured in a variety of sizes from large to small-sized points. The Lozenge-shaped are small points.

The round-based variety is notable because it is the type recovered *in situ* from the Guest site (also known as the Silver River Mammoth site 8MR130) with mammoth remains (Hoffman 1983; Rayl 1974). The specimen depicted in Figure 8.13 A, displays pot lid fracturing from being overheated in a fire. The flat-based variety is notable because they are bifacially flaked points with basal beveling or with basal thinning flakes (Figure 8.13 B-D). They are basally ground and generally somewhat asymmetrical. They are also similar in size and manufacture when compared to the Miller point from the Cactus Hill site in Virginia though any relationship between them has clearly not been established at this time.

**Florida Dalton**

In his discussion of Dalton points, Grayal Farr (2006) referred to the various subtypes included in the Dalton cluster. This is appropriate given the variety of forms the Dalton type has come to subsume. Bullen (1968: 44), for example, recognized two Dalton variants, Dalton Nuckolls and Dalton Colbert, while the *Handbook of Alabama Archaeology* identifies Dalton Colbert and Dalton Greenbrier (Cambron et al. 1990). These types, although present in Florida, are not common. A third subtype called the Chattahoochee Dalton, is said to be concentrated mostly in north Florida and southwest Georgia (Powell 1990: 12). The Chattahoochee subtype is also considered by Lloyd Schroder (2006: 26-28) and is not an opposite-beveled form.
Here I make no other distinction than to say that the Florida Dalton (Figure 8. 14 top row) is opposite-beveled along the left margin as viewed with the tip facing up. It therefore does not represent any of the three subtypes discussed above. Daltons in Alabama, Georgia, and the Carolinas are seldom re-sharpened by opposite beveling; rather they are re-sharpened on both sides of both faces (Cambron et al. 1990; Goodyear 2012). In Arkansas, Dalton points are opposite-beveled but along their right side (Morse 1997: 20-21). In Illinois there is a mix of opposite-beveled Daltons: some beveled on the left side and others on the right side as well as some that are re-sharpened without beveling (Luchterhand 1970). Whatever the case, it seems unusual that the Florida Dalton is opposite beveled on the left side, similar to the Early Archaic Bolen type (Figure 8.14 top row, A-H). Three specimens (Figure 8.14 A, B, and D) have flutes for thinning whereas the others have basal thinning flakes. Their basal concavity is moderate to deep. The extent of re-sharpening can be rather dramatic (Figure 8.14 H) and in their nearly exhausted stages of reshaping (Figure 8.14 F and G), they appear similar to what Bullen (1968, 1975) called Marianna points.

Redstone

This is a well-recognized Southeastern Paleoindian point type (Cambron et al. 1990: 99) more common outside the coastal lowlands of the Southeast. Nevertheless, a handful of specimens have been identified in Florida (Figure 8.14 I and J). The first documented occurrence of a Redstone was misidentified in an article in The Florida Anthropologist as a Clovis point (Bullen 1969)(Figure 8.14 I). The specimens depicted here have the identifying traits of guide flakes set up to facilitate long fluting. Redstone points are related to the Northeastern Gainey type, a type that has been dated to late Clovis times and is derived from Clovis (Redmond and Tankersley 2005).

Chattahoochee Dalton

This is a point type that Bullen lumped with the type called Tallahassee points, a type that is problematic. The Tallahassee type is a Woodland form (see for example Farr 2006; Schroder 2006), not a Paleoindian type. To eliminate any confusion, the type name Chattahoochee Dalton
(Figure 8.14 K - P) is applied because it is basally ground consistent with other subtypes that have been lumped in the Dalton cluster and it has been identified with the Chattahoochee subtype name (Powell 1990: 12; Schroder 2006: 26-28). This form of Dalton is not beveled; rather it is re-sharpened on both sides of both faces. The lateral margins of the blade may be slightly to heavily serrated. A new discovery of what is most likely a Chattahoochee Dalton distal end at Little Salt Spring in southwest Florida promises to place this subtype temporally and also better define the culture’s toolkit that includes wooden, bone, and stone artifacts (Gifford 2012). Similar to the Florida Dalton mentioned above, extensively reworked specimens appear similar to what Bullen (1968, 1975) called Marianna points.

**Exotics and Uncommon Points**

**Biface Knife**

A unique biface knife from the Aucilla River displays both overshot flaking, fluting, and beyond-midline flaking similar to the Simpson type (Figure 8.15 A). This is a one-of-a-kind knife although other singularly unique Paleoindian knife forms also have been found in Florida. A case in point is a large knife found at Nutall Rise in the lower Aucilla. That knife is also asymmetrical and displays large overshot flakes on both lateral faces. It is not fluted.

**Dalton Greenbrier**

The Greenbrier Dalton in Florida is uncommon yet, examples do exist (Farr 2006: 51)(Figure 8.15 B). This type is typically found in Alabama and Georgia above the Coastal Plain (Cambron et al. 1990).

**Mustache Point**

This is the so-called Mustache Simpson point as named and known by collectors even though it bears no resemblance to the Simpson type in any way. It is more appropriate to identify it as the Mustache Point and exclude the term Simpson because there is no relation. The two examples shown here (Figure 8.15 C) are part of the Alvin Hendrix collection which is now curated in the Silver River Museum and Environmental Education Center in Marion County.
Mustache points are basally ground and most of the specimens have been recovered from the Santa Fe and Suwannee River basin area. According to Lloyd Schroder (2006: 14), they are rare and only a few dozen specimens have been documented. Sometime in the fall of 2011, an unidentified diver reported finding one in the Chipola River and requested information about its monetary value (http://answers.yahoo.com/question/index?qid=20111001012516AAV0RKp).

Norden Point

The Norden point is an unusual combination of a notched and auriculate-based point with expanding, rounded ears (Figure 8.15 D). The Norden type was named by Grayal Farr (2006) in his revision of Bullen’s typology. In an unpublished paper, it may have also been referred to as the Greenhaugh point (Malwin 1973). Another name for the point is the Pine Tree Auriculate (Schroder 2006: 37), however, I prefer the Norden type name because the point was found at the Norden site and it was the specimen from the Norden site that Schroder used to name the type. The Pine Tree and Pine Tree Corner Notched are common Alabama types, the Norden type is not.

It is interesting that the two rather exotic point forms, the Mustache and Norden points, are found in the Suwannee-Santa Fe river basin. The Santa Fe basin has continually been identified by investigators as having the single largest concentration of lanceolate points in Florida (Bullen 1962; Dunbar 1991b; Dunbar and Waller 1983; Simpson 1948a; Thulman 2006; Waller 1969; Waller and Dunbar 1977)(Figure 8.16). The occurrence of exotic forms is assumed to reflect the area’s long term and assumed well-populated habitation.

The Mustache point may be related to the Paleoindian lanceolate point-making tradition, but many archaeologists place forms such as the Norden point much later in the Early Archaic period with other notched points (Farr 2006: 74). The Norden point is mentioned here because there is a possibility, albeit remote, that the expanding auriculate base and the notch represents early experimentation with notching that also incorporates a waisted Suwannee-like base.

Agate Basin

The Agate Basin point is an uncommon variety in Florida and unlike other Paleoindian forms is spike-shaped (Figure 8.15 E). In Bullen's (1975) second edition of the point type guide,
he added a form called the Florida Spike. In Alabama, there is a point similar to the Florida Spike, named the Bradley Spike (Cambron et al. 1990). Both are crudely made and neither represents the specimen being considered here. The Agate Basin point depicted in Figure 8.13E is well-made and is basally ground about 20 mm on each side. It is manufactured from local Ocala Limestone Formation chert. The specimen is included here for the purpose of documentation, since normally it would be overlooked or ignored in most considerations. The specimen is about 5.5 mm wide at the base, 10.2 mm wide around the midpoint of its length, and 2.0 mm wide one half millimeter from the tip. Its thickness is 6.0 mm near the base, averages 6.5 mm through the middle section and is 4.0 mm near the tip and is 85.8 mm long. This is a well-made spike-shaped point with its width slightly more robust compared to its thickness. According to a web page developed by Mike Kunz with contributions from Tony Baker, John Garrett and Joshua Ream (http://www.ele.net/kunz/mesamonte.htm), the distribution of Agate Basin points extends into the North Florida panhandle and the specimen depicted here increases that range into the peninsula of Florida. Their web page also includes a much large distribution of spike-shaped points including the El Jobo type of South America and the Mesa, Hilltop, Bedwell, and Putu points of Alaska.

**Bi-pointed or Laurel Leaf-shaped Point**

This laurel leaf biface (Figure 8.15 F) is notable because it has a series of overshot flake scars along the crest of its midline. It was recovered by the late Wayne Grissett in the late 1960s to early 1970s from the Aucilla River. I scanned the point in 1997 thinking it was curious. During the assembly of this typology, the overshot flaking was noticed and deemed worthy enough to include it here for documentation purposes. In appearance and manufacture, it is similar to other laurel leaf points from the Atlantic coast and with most finds from the Chesapeake Bay area.

**Lanceolate Point Bases Modified as Hafted Tools**

Lanceolate point bases reworked into hafted tools have been recovered from a number of places in Florida. Hafted endscrapers some with protruding beaks appear to be most common
Osseous Point and Tool Types

There have been a number of published papers in the archaeological literature dealing with Paleoindian bone and ivory tools that need not be repeated here (see for example, Bradley et al. 2010; Dunbar and Webb 1996; Hemmings 2004; Hemmings et al. 2004; Webb and Hemmings 2001). There are a few areas worthy of consideration including the potential function of large beveled shafts manufactured from ivory and the variety of bone and ivory points, barbs, and pins that have been found in Paleoindian contexts. Consideration of the former is to revitalize the fading notion that spear foreshafts are among the possible functions of the ivory points. The latter is intended to show there is no one-size-fits-all when it comes to discriminating what is or is not a Paleoindian osseous point or composite part of one. Suffice it to say that not everything that is Paleoindian and an osseous tool is necessarily made from the bones and tusks of megafauna. Of the specimens that are, they are not all made to large-size specifications that have captivated so many researchers’ attention. Therefore, this part of the typology is concerned with function as well as production ideology.

Ivory Shafts: Projectile Points or Spear Foreshafts?

Carefully crafted osseous shafts manufactured from the bones and tusks of now-extinct Pleistocene megafauna are a more compelling demonstration that Paleoindians occupied the Americas than stone artifacts such as El Jobo and Clovis points. In all areas except the frozen Arctic, Pleistocene bone and ivory had a short shelf-life in maintaining its green bone (fresh state) strength and resiliency. The important implication of this is that any osseous tool intended for use in activities such as prying, stabbing, thrusting, throwing or other demanding exertion, of necessity, had to be manufactured from new material with green bone consistency. The required need for green bone strength and resiliency in the manufacture of projectiles has been pointed out by a number of researchers (Bradley et al. 2010; Hemmings 2004). The option of using old bone would render the point dysfunctional and represents the primary reason why megafaunal
bone tools are not found in the archaeological record of the southeastern US in primary Holocene contexts.

But what were the functions of Paleoindian osseous shafts? C. Andrew Hemmings (Bradley et al. 2010; 2004) has addressed this issue in a very concise way pointing to three viable functions: 1) single-beveled projectile points, 2) single-beveled thrusting points, and 3) double beveled rods of less certain function. All three forms have been documented in Florida, though the most common are the first two. The straight and curved forms of single beveled specimens are shown in the schematic drawing in Figure 8.18 (N, M, and O) and Figure 8.19 (A and B). Both the straight and curved form have an obliquely truncated, basally roughened bevel on one end (Figure 8.18 G, L, and K and also depicted on the curved specimen); a trait that is as ubiquitous as it is diagnostic. The other end is pointed.

The discovery of bone shafts at the Anzick site in southwest Montana led to the conclusion that the bone shafts were spear foreshafts for hunting with a lithic point hafted to the foreshaft and the foreshaft attached to a spear main shaft (Lahren and Bonnichsen 1974). Subsequently, George Frison (1989) conducted successful experiments using replica foreshafts tipped with replica Clovis points propelled by atlatl on elephants that were being culled from herds in Africa. I proposed a distinctly new foreshaft concept that required only the single beveled-shaft and a Clovis-like point hafted to it (Dunbar 1991a: 14, Figure 1). This proposal was intended to explain why so many of the ivory shafts from the Aucilla and other Florida rivers display a particular type of impact fracture damage. Experiments conducted by Dale Guthrie found that the use of foreshafts promoted deeper penetrating wounds in prey animals (Guthrie 1983: 289) yet he questioned the use of osseous material over wood for that purpose. Others have also questioned the foreshaft idea, though not discounting it outright, and have called for controlled experimentation that simulates actual hunting conditions to facilitate a determination (Bradley 1995: 267-270; Bradley et al. 2010). What evidence is there to indicate single-beveled ivory shafts were employed as foreshafts?

The two forms of single-beveled ivory shaft are the straight (Figure 8.19 A, from the Page-Ladson site) and curved (Figure 8.19 B, from the Sloth Hole site) forms. The evidence that they may have been used as foreshafts lies in clues related to ivory’s malleability, its strength until green fracture failure, and the consistency with which the artifacts were made.
The malleability of ivory is dependent on its water content. Ivory is hygroscopic and loses more than two thirds of its tensile strength upon saturation in water (Rajaram 1986). These factors are also what make ivory such a desirable medium for carving. In its wet state, ivory can be more easily carved. If steamed after soaking, ivory can be carved most easily and bent into shapes such as hoops which set after cooling and drying (Semenov 1973: 160). This is important because all of the curved ivory shafts from Florida are specimens 25 cm in length or longer and all of the straight shafts are less than 25 cm long (Bradley et al. 2010: 120). Clearly curved ivory rods would be disadvantageous in that they would have a tendency to fracture more easily compared to their straight counterparts. Given the unique properties of ivory and the fully modern human populations that used it as a tool-making medium, it is just as likely that they knew how to, and did, straighten the ivory shafts rather than not bothering to do so. This leads to the topic of tool shaft strength.

In its dry state, ivory is incredibly impact resistant to head-on, longitudinal impact fracturing, though it is much more susceptible to side force or transverse torqued impact failure (after Bonfield and Li 1965:3183, Figure 5 see Figure 8.20 this document). The fracture pattern differs between longitudinal fractures which resemble a zigzag or saw-toothed, ragged collapse and transverse fractures which are conchoidal yet differ slightly because ivory, unlike bone, also may separate along its cone-on-cone, annual layers and interrupt an otherwise conchoidal fracture. It is the longitudinal impact fractures that are important to the hypothesis that some ivory shafts were used as foreshafts.

Manufacturing consistency for projectile points often draws attention to the hafting area under the assumption that the haft (proximal end) will remain unchanged through the life span but the working (distal) end will change as the tool is re-sharpened after breakage or other impact damage. Using a sample of 43 ivory shaft specimens from Florida, both the haft area and the tip are considered. As might be expected, the haft area of ivory shafts was manufactured to rather consistent specifications (Table 8.2 and Figure 8.21). What is surprising is that the distal ends (Table 8.3 and Figure 8.22) appear to have been manufactured to a tighter specification than beveled ends. This is unexpected because breakage and reworking of projectile point tips usually leaves their morphology noticeably variable. Therefore, it is possible that the so-called distal (pointed end) was manufactured to a specification so it could be socketed to a spear shaft. If the ivory shafts did function as foreshafts how were they connected to the main spear shaft? A

It is appropriate to continue the consideration of green stick fractures by examining the beveled ends (proximal) of the ivory shafts. With one exception (Figure 8.23 C) all green stick fractures of the beveled ends are saw-toothed longitudinal fractures that are located about two-thirds to three-quarters from the base of the hafting area on the hafting platform (Figure 8.19 G and H). To create longitudinal impact failure for ivory takes about thirty-three thousand pounds per square inch of stress (Bonfield and Li 1965)(Figure 8.20) and for bone about eighteen thousand pounds per square inch of stress (Bonfield and Li 1966). This is not the type of force generated by stabbing or thrusting, it is the type of force generated ay an atlatl propelled by a full-powered throw. An ivory foreshaft tipped by a flint point (Figure 8.19 C-F) may well have been why the longitudinal breaks occurred where they did, at the base of the lithic point where it is hafted on the foreshaft (Figure 8.19 G-H).

The replica of a foreshaft hafted with a lanceolate point was used by this author from two years on various non-living targets with the hope of reproducing the same type of longitudinal impact fracture without success. Instead the stone point had two impact damaged tips that were repaired by knapping a new tip while the point remained in its haft on the foreshaft. What can be said is that the foreshaft model functioned reliably without failing. The foreshaft, lanceolate stone point and the hafting was done by Claude VanOrder, one of Florida’s premier knappers and artisan of primitive weapons methods.

To argue against the foreshaft idea there can be no doubt that an atlatl-propelled osseous point can penetrate hard surfaces such as plywood more effectively than a stone point. Micah P. Mones, a doctoral student at the University of Florida, is another accomplished flint knapper and primitive weapons artisan. His experiments using an atlatl have placed a bone point through two sheets of three-quarter inch thick plywood. Having done so, the bone point made from horse bone extended through the second sheet of plywood about one inch. The use of a replica Clovis point also penetrated both sheets of plywood but barely so with only the end of the Clovis point tip showing through the second sheet. The only clear evidence of osseous shaft use is as projectile points. The barbed ivory harpoon from the Aucilla River (Bradley et al. 2010: 118) is unquestionably a projectile point (Figure 8.23 A) as is the pre-Clovis bone point imbedded in a
mastodon rib at the Manis site in Washington (Lawler 2011; Waters et al. 2011). Finally, experiments using osseous shafts as projectile points show that part of the impact fracture breaks occur in the hafting area (Figure 8.24). That being said, the types of impact fractures are not identified in the literature. There may be a reason to opt for the foreshaft-lanceolate point combination tool. Clearly George Frison believed the lithic point opened a pathway large enough for the foreshaft to penetrate fully (Frison 1989). Because we know osseous shafts were used as projectiles does not negate the possibility that foreshafts (Figure 8.19 C-F) also served a practical purpose. It is in the reproducibility of osseous foreshaft versus osseous point longitudinal fracture pattern on the beveled platform that will be informative and well-planned experimentation under controlled conditions is needed.

Others Osseous Artifacts

Ivory Harpoon

As mentioned, a barbed ivory harpoon was recovered from the Aucilla River (Bradley et al. 2010; Hemmings 2004; Hemmings et al. 2004)(Figure 8.23 A). A second possible specimen from the Aucilla does not have a barb though there is evidence to suggest that one might have broken. The distinctive burin cuts preserved on the main shaft where the barb was being formed are the most suggestive. These are unique weapons and imply the need not only to pierce the flesh of the prey animal, but also to hold it for retrieval and dispatching. The African Hadza, for example, use barbed wooden arrow points for hunting birds and other very small game (Woodburn 1970: 16-20). The ivory specimen from the Aucilla is too large for hunting small game but its barb served the same purpose. It is of sufficient size for hunting alligator, tapir, or similarly-sized animals.

Ivory Shaft Fragment from a Waisted Suwannee Point Site

Though admittedly the bevel fragment of an ivory shaft (Figure 18.23 C) came from a displaced context, it was found with other specimens concentrated around and eroding from the Suwannee level of the Ryan-Harley site. The significance of this beveled ivory shaft fragment is that it is indicative that waisted Suwannee point-making people coexisted with mastodons, the
source of ivory for their osseous tools. This is another indication of the importance of setting the
temporal context for waisted Suwannee point sites. If the Suwannee Waisted point tool
assemblage represents a Middle Paleoindian cultural manifestation as most archaeologists
believe, it means that Pleistocene megafauna survived beyond the Allerød-Younger Dryas
boundary in the Coastal Plain of the Southeast. If the waisted Suwannee makers are older than
we thought, it represents another culture contemporary with Clovis or pre-dating it. The first
attempt to date the waisted Suwannee point, at the Norden site, failed because of post-
depositional disturbance of the stratigraphic column. An attempt is now underway to date the
Ryan-Harley waisted Suwannee point site but the results are not available at this time.

**Bone Tools from Medium-sized Mammal Bone and Their Significance**

Bone tools made from medium-sized mammal bone, such as the metapodial elements or
antlers of white-tailed deer (*Odocoileus virginianus*) often go unmentioned in the literature about
Paleoindian tool technology. Part of the problem is that medium-sized mammals such as the
white-tailed deer are extant and it is more typical to feature osseous tools made from Pleistocene
megafaunal bone. Concentrating on bone from extinct megafauna and excluding extant species is
safer. Yet there are records of now-extant medium-sized animals whose Pleistocene ancestors
contributed skeletal elements as a resource for tool making. For example, the delicate eyed bone
needle or the antler pressure flaker from the Agate Basin Folsom site in Wyoming (Frison and
Stanford 1982), the antler implement from the Hanson site in Wyoming (Frison 1988), and
another delicate eyed bone needle from the Horn Rockshelter Number 2, Texas. The latter site
also yielded a waisted Suwannee-like point (Redder 1995). The occurrence of eyed ivory needles
also has been documented on Paleoindian sites elsewhere (Bradley et al. 2010).

In Florida, two notable Plaeoindian sites have yielded bone tools made from medium-
sized animal bone. They are the Norden and Dunnigans Old Mill sites in the Santa Fe River
flood plain. At the Norden site, two bone barbs or, alternatively, small bone points, and one eyed
bone needle were recovered from displaced contexts. The barbs/points (Figure 8.23 D-E) are
interesting in that both are basally roughened similar to the larger osseous shafts. Specimen D
(Figure 8.23) is also truncated or beveled like the larger osseous shafts but it is miniature by
comparison. Specimen E is made on a small flat section of bone that is only slightly truncated
and is the most likely candidate to have served as a barb attached to a larger point. The mix of
faunal bone at the Norden site, with both large extinct and small extant animals, yields evidence of a well-rounded dietary pattern among these waisted Suwannee point making Paleoindians (Dunbar and Vojnovski 2007). The small to medium-sized animal remains at the site suggest the development of tool kits for taking different game animals.

The Dunnigans Old Mill bone point (Figure 8.23 G) is manufactured from a metapodial most likely from a white-tailed deer given the bone wall thickness. The bone point was manufactured by using the splinter-groove technique to cut parallel slots down the long axis of the metapodial element, then snapping the long preform blank from the remaining bone. The burin cut marks are still clearly visible on both lateral sides of this point. Shaping and sharpening of the point was accomplished by grinding and honing the ventral and dorsal surfaces, particularly in the area of the distal point and the proximal haft area. As already mentioned, much of the lateral margins except for the haft and distal ends were left unaltered, permitting the original splinter-grove burin cuts to survive. In places, the bone point is lightly acid pitted while in other areas the surface is well preserved.

The Dunnigans Old Mill bone point was found in four pieces that refit to form a complete artifact. The three distal end fragments were found in articulated position with old bone breaks between them Test Unit 3. The proximal end was found separated from the distal fragments in Test Unit 1 more than a meter away. The sandy clay level where the artifacts were recovered lay below 30 cm of sand; bone point fragments were recovered 6 cm to 8 cm below the sandy clay’s surface. The break between the proximal and distal ends is a green stick, longitudinal impact fracture, which is why this specimen was identified as a projectile point. At Dunnigans Old Mill there is a mix of large, medium, and small-sized faunal remains and the bone point in question was likely used on smaller game (Dunbar and Vojnovski 2007).

Discussion

In the years during which Culture History and its normative approach was under fire by the Processualists, little has been accomplished on broad scale typological revisions. There have been sundry papers dealing with one type or another based on work on assorted sites. That is beginning to change and this investigation of Paleoindian lanceolate projectile point types is an attempt to show the diversity and variability of the Paleoindian typology. It is also intended to
show how researchers have applied the same type name to different types and potential types of lithic projectile points. It is hoped that this typological revision isolates points such as the Simpson into better-defined categories that represents Bullen’s (1968; 1975) original intent, while at the same time defining waisted Suwannee and Harney points as discrete types that will clarify the Southeastern Coastal Plain typology.

The discussion of Paleoindian ivory shafts, found largely in the Aucilla River, is intended to confirm the need to conduct ballistic tests of the ivory point versus ivory foreshaft concept of use. No researcher dealing with Paleoindian studies in the Americas should doubt that a certain percentage of osseous shafts functioned as projectile points; however, I contend that there is clearly insufficient evidence to bury the foreshaft idea as a possible alternative use. The best evidence that an osseous shaft can successfully be used with great effect on Proboscideans when employed as a spear foreshaft tipped by a lanceolate point was demonstrated by George Frison (1989). As noted above, there is other functional evidence and this type of possible use should not be discounted as a possibility. The barbed ivory harpoon makes a good case in point. Prior to its discovery and documentation, no researchers thought it possible. The ivory harpoon now resides in the literature as a recognized type (Bradley et al. 2010; Hemmings 2004; Hemmings et al. 2004).

Paleoindian bone tools made from white-tailed deer-sized metapodials are not generally considered to be Pleistocene artifacts. Some are, however, and they are important to document. For some years now, we seem to be confronted with all or none hypotheses, for example the proposal that Paleoindians only hunted big game versus the concept they did not because big game was too dangerous. The smaller bone points and barbs from Florida sites are suggestive of smaller game hunting while the larger ivory and lithic points are suggestive of larger animal hunting. The use of eyed bone and ivory needles suggests domestic activities, perhaps the sewing of hides for clothing. Most of all they suggest that one size does not fit all.
Figure 8.1. Bolen point reduction and re-sharpening sequence as determined from specimens recovered from the Page-Ladson site (adapted from Carter and Dunbar 2006:504, Figure 18.4). Bolen points in this sequence display a late stage preform prior to notching and completion (far left), an unbeveled Bolen point just after first stage completion and prior to re-sharpening (second from left), followed by progressively re-sharpened stages until exhaustion. Bolen point traits include: 1) notched hafting area, 2) notching by pressure or indirect punch flaking, 3) basally ground in haft area, 4) opposite beveling on left side with tip facing upward, 5) beveling was caused by 3 mm to 7 mm wide pressure flake removals, 6) peaks between each bevel flake create a serrated edge.
Figure 8.2. As in A Guide to the Identification of Florida Projectile Points (Bullen 1968), only outlines of projectile points and/or knives are shown. Unlike the projectile point guide, flutes are shown in light gray on the specimens having them. The specimens depicted represent digitized images that were outlined and solid-filled from Bullen’s type collection housed at the Florida Museum of Natural History in Gainesville, Florida.

* One of the lanceolate points John Goggin named Suwannee point recovered by Clarence Simpson at CO174 and depicted in his 1948 Florida Anthropologists article.
Figure 8.3. Images of selected specimens from Ripley Bullen’s type collection housed at the Florida Museum of Natural History, anthropology collections. Top right Clovis; top left Simpson; bottom Suwannee. Please note that the type name is indicated on each specimen.
Figure 8.4. Images of the Page-Ladson type: Top row, bifacially flaked variety, bottom row variety manufactured on thin flakes. Note that the Wakulla Springs Lodge site specimen was recovered *in situ* from pre-Clovis level (Rink et al. 2012).
Figure 8.5. This photograph was taken in 1970 by Dan Morse and shows the Simpson point that was once on display in the Wakulla Springs Lodge main lobby. At that time the point was displayed in a glass enclosed box lying on the upper maxilla of a mastodon. The mastodon is still on display in the same display case but the point was taken just prior to the state’s purchase of the property.
Figure 8.6. Images of the Simpson type.
Figure 8.7. Replica Simpson points broken using an atlatl for propulsion.
Figure 8.8. Clovis points, top row Clovis excavate, bottom row Clovis waisted.
Figure 8.9. Suwannee points; top row the Suwannee point/knife as defined by Al Goodyear with basal thinning; bottom row waisted Suwannee points, a projectile type sometimes found with impact damage.
Figure 8.10. Waisted Suwannee points. Specimens from the Ryan-Harley and Page-Ladson sites display pressure flaking in the thinning strategy whereas the point from the Santa Fe River displays overshot flaking. Together these traits are thought to represent a progressive transition from Clovis-like methods to the non-Clovis use of pressure flaking as a means to thin and finish the point.
Figure 8.11. Harney Points on top and bottom rows. Note that eight of the specimens have stacked step fracture terminations along their re-sharpened upper margins. Stacked step fracturing on three of the specimens (bottom row far right) is severe.
Figure 8.12. Long Neck points on top and bottom rows.
Figure 8.13. A-E Lozenge-shaped points from Harney Flats, F pre-Clovis Miller point from Cactus Hill VA, A the round-based variety of Lozenge-shaped point; B-E the flat-based variety of Lozenge-shaped point.
Figure 8.15. Exotics and uncommon points from Florida. A. Biface knife; B. Dalton Greenbrier; C. Mustache Lanceolate, D. Norden, E. Agate Basin F. Bi-point or laurel leaf-shaped point.
Figure 8.16. Paleoindian lanceolate point distribution plotted on a map showing the chert-bearing Tertiary Karst Region, Marginal Region, and Outlying Region.
Figure 8.17. Paleoindian lanceolate point bases reworked into hafted tools. Hafted endscrapers A-K, Drills L-N, and Hafted burin M.
Figure 8.18. This schematic was used as a measurement point reference template for Paleoindian osseous point single-beveled shafts. It is used here to show various views of the straight and curved specimens.
Figure 8.19. Osseous rod and foreshaft models; top green panel, top left ivory rod from the Page-Ladson site, middle left digitized representation of the incised ivory rod from the Sloth Hole site, bottom left modern replica of an osseous rod foreshaft with waisted Clovis point hafted to beveled end. Top and middle right; top and side views of foreshaft model, bottom right showing longitudinal fracture of beveled platform. Bottom left panel showing close-up of replica foreshaft; bottom right panel showing close-up of actual longitudinal fracture of beveled hafting platform on ivory rod.
Figure 8.20. Constant strain rate deformation to fracture ivory (from Bonfield and Li 1965: 3183, Figure 5).

STRESS (PSI)

0  10000  20000  30000  40000

STRAIN

0.02

① LONITUDINAL SPECIMEN
② TRANSVERSE SPECIMEN

ε = 3.3 x 10^{-4} \text{ sec}^{-1}

T = 26^\circ \text{ C}
Figure 8.21. Graphed results of mean and variance for ivory shaft beveled ends. On specimens E to F5 measurements were possible on 24 of 43 specimens and on C to D5 measurements were possible on 25 of 43 specimens.
Figure 8.22. Graphed results of mean and variance for ivory shaft distal ends. On specimens J1 to J6 measurements were possible on 15 of 43 specimens and on I1 to I6 measurements were possible on 15 of 43 specimens.
Figure 8.23. Bone and ivory points, rod, barbs and eyed needle; A. ivory harpoon from West Run Aucilla River, B. ivory rod from Page-Ladson site, C. beveled end fragment of ivory rod from the Ryan-Harley site Wacissa River, D and E, small bone barbs dorsal, ventral, and lateral views, F. eyed bone needle, G. bone pin manufactured from a white-tailed deer metapodial.
Figure 8.24. Model of osseous point hafted to a spear shaft showing the location and relative frequency of impact fractures (after Guthrie 1983: 291, Figure 9)
Table 8.1 Ivory shaft beveled end measurement data.

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Mean: 13.93, 12.31, 11.94, 11.50, 11.31, 10.28
Standard Error of Mean (SEM): 0.26, 0.29, 0.48, 0.25, 0.33, 0.33

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Mean: 13.93, 12.31, 11.94, 11.50, 11.31, 10.28
Standard Error of Mean (SEM): 0.26, 0.29, 0.48, 0.25, 0.33, 0.33
Table 8.2. Ivory shaft distal end measurement data.

### IVORY SHAFT DISTAL END DORSAL-VENTRAL MEASUREMENTS

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**Mean** | 5.88 | 7.32 | 8.35 | 9.04 | 9.65 | 10.36

**Standard Error of Mean (SEM)** | 0.23 | 0.21 | 0.20 | 0.22 | 0.22 | 0.24

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| Mean + SEM | 6.11 | 7.54 | 6.55 | 9.26 | 9.87 | 10.60
| Mean - SEM | 5.64 | 7.11 | 6.15 | 8.82 | 9.44 | 10.12
| Mean | 5.88 | 7.32 | 8.35 | 9.04 | 9.65 | 10.36

### IVORY SHAFT DISTAL END LATERAL MEASUREMENTS

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**Mean** | 5.57 | 7.04 | 8.11 | 8.89 | 9.61 | 10.10

**Standard Error of Mean (SEM)** | 0.22 | 0.21 | 0.20 | 0.19 | 0.21 | 0.25

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| Mean | 5.57 | 7.04 | 8.11 | 8.89 | 9.61 | 10.10
| Mean + SEM | 5.79 | 7.25 | 8.31 | 9.08 | 9.82 | 10.35
| Mean - SEM | 5.35 | 6.82 | 7.90 | 8.70 | 9.40 | 9.84
| Mean | 5.57 | 7.04 | 8.11 | 8.89 | 9.61 | 10.10
CHAPTER NINE

THE CONTEXT APPROACH AND CONCLUSIONS

Paleoindian Archaeology of Florida and the Adjacent Southeast

The development archaeology in Florida advanced slowly with clear uncertainty about the region’s earliest prehistoric occupants. The first report that ancient peoples occupied Florida and manufactured artifacts similar to those found in the Trenton gravels of New Jersey (Wyman 1875) was ignored. It is ironic that among the artifacts illustrated was a Clovis point. It was not until human remains were discovered with Pleistocene megafaunal remains at sites such as Vero (Sellards 1916a) that national attention set off a controversy that largely discounted the finds (Hrdlicka 1917). In 1930, prior to the time when the presence of Paleoindians in the Americas had been fully demonstrated, the remains of a mastodon were recovered from Wakulla Springs (Gunter 1931) and with it lanceolate projectile points. The controversy over the Vero Man site in Florida might have been incentive enough to remain silent. Mention of the lanceolate points recovered with the Wakulla Mastodon (Simpson 1941b) was made only after western Paleoindian sites with lanceolate projectile points had been confirmed (Bryan 1937a; Cotter 1937).

The years following WWII showed great promise for Paleoindian research as well as underwater archaeology. Goggin championed underwater archaeology and site investigations on early sites in Florida were on the rise (Goggin 1948; 1950; Simpson 1948a; 1948b; 1950a; 1950b; 1950c). Paleontologist Alfred S. Romer, director of the Harvard Museum of Comparative Zoology, sent Olsen to inspect underwater sites in the Ichetucknee River including the Simpson’s Flats site where mastodon remains, lanceolate points, and ivory shafts had been recovered (Simpson 1935; 1941b; 1948a). Goggin investigated two Paleoindians sites (Goggin 1950) and Edwards and Simpson investigated several others (Dolan and Allen 1961; Edwards 1952). Little was resolved, however. Simpson died in 1952. Olsen insinuated that underwater sites were disturbed and therefore their context could not be determined. Goggin was unable to identify stratified deposits. Only the work on two unidentified sites by Edwards and Simpson yielded
results: one site with stratified deposits containing different forms of lanceolate points in separate levels and another site that yielded flat-based lanceolate points with mastodon remains. This was the extent of information documented elsewhere (Dolan and Allen 1961; Edwards 1952).

In the latter twentieth century a number of projects yielded mixed results. Work at the Paradise Park site near Silver Springs, Harney Flats near Tampa, sites in the Aucilla and Santa Fe Rivers, and at the Wakulla Springs Lodge site have advanced our knowledge. Investigation at the Guest Mammoth site in Silver River is an unfortunate example of adversarial assumptions levied against the principal investigator who was reluctant to publish given the criticism. The result is that too few substantive results were published other than a master’s thesis (citation) and a journal article (citation). What was published is important because it documents an odd type of lanceolate projectile associated with the mammoth remains the same type of point subsequently identified in the early levels of the Harney Flats site (Daniel and Wisenbaker 1987).

The Context Approach

The investigation and interpretation of late Pleistocene archaeological sites require a more rigorous and comprehensive approach compared to Holocene sites. Habitat and resources were not constants because climatic shifts switched from one mode to another in periodicities ranging from a few hundred to a thousand years. These factors affected subsistence and other evidence that is significant in site interpretation. There are also technical aspects of critical importance to dating, particularly the tricks and traps of radiocarbon dating Pleistocene samples. Paleoindian archaeologists should be aware of all of the potential contexts related to their questions and work in multidisciplinary teams with specialists whose work is anchored in these contexts.

Stratigraphic Context

The context of stratigraphy is obviously fundamental to the earth sciences and often is critical to archaeologists because they must obtain an optimal stratigraphic understanding using tight stratigraphic controls. The needs of archaeologists in Paleoindian sites is such an example in that the controls that are required are generally more exacting than those required of
paleontologists and geologists. The resolution of deposition and time are require exacting control to achieve the level of confidence that archaeologists need. There are fundamental reasons for this, not the least of which deals with the second context measure, temporal placement. Obviously geologists and paleontologists have worked with archaeologists in the past towards the betterment of Paleoindian archaeology (see for example Antevs 1928; 1935a; 1936a; Bryan 1928; 1937a). Today within the discipline of archaeology there are geoarchaeologists, professionals educated in archaeology and geology. This is an indication of the value that the archaeological profession now places on understanding this vital context. Nevertheless, all other contexts are equally important in their own way even though the context of stratigraphy and chronology are of primary concern before the aspects of the other contexts may be fully developed and appreciated.

**Chronological Context**

As mentioned above, stratigraphic and chronological contexts are tightly bound. Standing alone they are equivocal, but together they have meaning. Prior to the advent of radiometric dating, two geologists stand out in North American archaeology for their ability to estimate the temporal placement of Paleoindian sites in the Southwest US (Antevs 1936a; Bryan 1941; Bryan and Ray 1939). Both Ernst Antevs and Kirk Bryan also can be credited for making American archaeology aware of the needs and benefits of geoarchaeology (Haynes 1990). After WWII, the introduction of radiometric dating revolutionized our ability to establish chronological context. Over the past several decades, there has been a quest to better understand late Pleistocene climate shifts and this, in turn, led earth, oceanic, and atmospheric scientists to seek tighter chronological control. Similar to Paleoindian archaeology, the more tightly a temporal boundary can be established the better.

**Climate Change Context**

Perhaps this should be called the climate context because shifts in climate during the late Pleistocene primarily took place on a non-human scale. That is to say, no one generation of Paleoindians experienced noticeable climate change unless they lived during one of the abrupt climatic events (the shift from one climate mode to another) such as at the Younger Dryas-
Preboreal boundary at the Holocene onset. In contrast, the shifts from one climatic mode to another, such as from the Allerød-Younger Dryas boundary, were often gradual (Broecker et al. 2010: 1079) and probably not noticeable over a human life span. Climate change, as a context, was chosen in this study because there were many climate shifts that affected biomes and ecological successions. The concept of leads and lags is important here – the understanding that climate change leads and habitat change lags in response.

**Habitat, Resource, and Subsistence Context**

This tripartite set of contexts is intimately tied together and dependent on climate. Habitats may lag in response to climate but once established, affect available resources and their abundance and location. In turn, these factors impact subsistence. They are integrated in the dance of natural systems and relate to innovation, adaptation, and survival. Given the climate shifts of the late Pleistocene, it is not an understatement to say that ecosystems were ever changing no matter how slightly and that plant and animal communities were confronted with alternating Glacial, Modern, and Heinrich climate modes until the end of the Pleistocene epoch. In the southeastern US, there were two regional climate moderators tethered to certain aspects of the glacial recession. The first was the presence or absence of glacial meltwater in the Gulf of Mexico and the second was the cessation of the North Atlantic Conveyor currents and warming in the Caribbean during Heinrich events. The lead up to and onset of the Holocene in the southeastern US was probably not as benign as has been insinuated (Russell et al. 2009). The evidence now suggests that the last megamammals to become extinct did so during the middle to late Younger Dryas. On a human scale, the Younger Dryas to Preboreal transition is one of great change from Paleoindian lanceolate point-making to Early Archaic notched point-making.

**Artifacts and Technology Context**

Can we detect changes in the artifacts and technology that Paleoindians used to make their living and what these materials tell us about them? This is perhaps one of the questions contemplated by the first archaeologists. Yet to get competent answers, the other contexts mentioned above are needed for critical evaluation. It is possible to study a Clovis point in the
absence of these contexts, but it probably would not produce a much better result than the one promoted by Jeffries Wyman (1875). Archaeology is holistic. The ways of humans and nature are never as simple as we believe them to be and as we develop knowledge of the extraneous circumstances (the other contexts), we also develop a better understanding of the holistic archaeological context in which it is set.

Discussion

Ways to think about contexts collectively are provided, for example, in a discussion considering the significance assigned to charcoal as evidence of paleofires and the significance attributed to the Younger Dryas climate episode as it relates to late Pleistocene extinction. Only a few palynological studies in the southeast US have included tallies for the frequency of charcoal fragments as indicators of ancient fires. Yet it is now considered to be a significant part of paleoclimatology. Information about paleofires is available at: 1) http://www.gpwg.org/home.html and 2) http://www.ncdc.noaa.gov/paleo/impd/paleofire.html. In Florida, charcoal concentrations at Lake Tulane show minimum fire frequencies during the LGM but increase from ~15 ka cal BP until reaching a peak ~11.5 ka cal BP (Watts and Hansen 1988). The results at the Page-Ladson site are basically the same (Hansen 2006). While the peak of charcoal at ~11.5 ka cal BB (Younger Dryas-Preboreal transition) are seen as an increase in fire frequency in a dry climate regime (Bolen Drought), the earlier increase during the Allerød (~14.5 to ~12.9 ka cal BP) was thought to be related to possible Paleoindian influence (Hansen 2006: 178). But can it be said with any confidence that Paleoindians influenced fire regimes?

An alternative cause for fire, as well as Pleistocene extinction, has recently been proposed by the extraterrestrial (ET) impact hypothesis (Kennett et al. 2008). As previously discussed in chapter two, this hypothesis proposes that regional and continental-wide wildfires were among the outcomes caused by this type of disaster.

Sedimentary records from California’s Northern Channel Islands and the adjacent Santa Barbara Basin . . . indicate intense regional biomass burning (wildfire) at the Allerød–Younger Dryas boundary (. . 13.0–12.9 ka). . . Evidence for ecosystem disruption at 13–12.9 ka on these offshore islands is consistent with the Younger Dryas boundary cosmic impact hypothesis. . . . This is consistent with the hypothesis that wildfires in southern California and elsewhere on the continent were ignited by an intense radiation flux associated with multiple airbursts resulting from a cosmic
impact (Firestone et al. 2007). Hemispheric wildfires also increase abruptly at the beginning of the YD. [YD=Younger Dryas](Mayewski et al. 1993; 1997)

At the Page-Ladson site, charcoal concentrations of 30-100 µm size range are actually higher in concentration at 14.3 ka cal BP than they are at 13.0 t 12.9 ka cal BP (Hansen 2006: 170, Figure 6.4) when the ET impact is proposed to have occurred. At Lake Tulane and at the Page-Ladson site, the concentrations of charcoal are such that fires took place before, during, and after the proposed ET event. On a continent-wide basis, fires increased during modern mode and warm phases and decreased during cooling events (Danialu et al. 2010; Power et al. 2010).

Analyses of the palaeodata also show that fire responds immediately to rapid climate changes. Marlon et al. (2009) examined 35 paleofire records from North America during this interval and found a distinct shift in the average level of burning at the beginning and end of the Younger Dryas cold period, at about 12.9 ka and 11.7 ka, respectively. Fires were increasing prior to the cold period, from 15 ka to 12.9 ka, but stopped increasing when temperatures dropped at 12.9 ka. When the cold period ended with an extremely rapid rise in temperatures at 11.7 ka, a synchronous peak in both biomass burning and fire frequency is registered, after which levels of biomass burning resume their upward trend (Power et al. 2010: 58).

Through several Heinrich and other climate modes detected in the Lake Tulane data, paleofires appear to be similarly more prevalent during warm intervals (Grimm et al. 1993; 2003; 2006; Watts and Hansen 1988: 312, Figure 2). Another study finds no correlation between charcoal peaks and increased fire related to anthropogenic origins (Marlon et al. 2009).

Nicholas Pinter, Stuart Fidel, and Jon Keeley (2011) propose “novel anthropogenic sources of ignition, which have more to do with a continent-wide assessment and interpretation of the paleofire data. They conclude that the oldest coeval shift in vegetation and fire frequency is found in Alaska at 14.0 to 13.0 ka cal BP, then spreads along the Pacific margin with gradients moving eastward, and culminates in the Holocene arrival of humans in the Caribbean (Pinter et al. 2011). The problem with their proposal is its similarity to the Neolithic First, Clovis First, and ET Impact hypotheses. They view things too broadly and stretch the data based on the assumption that the oldest paleofires are in Alaska and promote this as fact. Next, they counter-direct the discussion to the potential impacts of human fire use. However, the charcoal database shows that paleofire occurrences in Florida, that state in the lower 48 extending into the Caribbean, predate the timing of paleofires in Alaska!
What can we make of the regional paleofire data? It is possible that the paleofires represent proxy evidence for the beginning of the extinction of *Mammuthus columbi*, a keystone species in the southeastern US. When *Mammuthus* first appear in Florida almost two million years ago, they alter the botanical terrain after which some traditional browsers became mixed feeders (MacFadden and Cerling 1996). If it is fair to compare *Mammuthus* to their cousins the African elephants, the introduction of *Mammuthus* resulted in a tolerance succession (Connell and Slatyer 1977: 1137) that impacted the botanical species. *Mammuthus* opened and expanded savannas and reduced the margins of hammocks which formed patchwork mosaics of habitats in the Southeast. By 15.0 ka cal BP, the reduction of *Mammuthus* herds heralded the beginning of their extinction as paleofires increased, not due to anthropogenic ignition, but to natural succession and fuel loads.

In Africa, when elephants are introduced to an area of stable botanical growth previously unaffected by them, their actions as megaherbivores are quickly noticed.

In Chizarira Game Reserve in Zimbabwe, elephants at a local density of about 1 per km2 converted a *Brachystegia* woodland with a tree density of 1,180 per km2 into an open tree-coppice grassland within ten years (Cumming 1981; Thompson 1975) -- (Owen-Smith 1987: 355).

Conversely, when African elephants are removed from the savannahs they have created, another succession of botanical species occurs. This succession includes savannahs of fire-resistant short grasses giving way to fire-accommodating long grasses as well as other botanical fuel loads and with it, an increase in fire frequency (Owen-Smith 1987).

If humans had anything to do with Pleistocene extinction, it was their pre-Clovis predation of the keystone species, *Mammuthus*, which was already under stress from fluctuating climate. The increase in fire frequency was first hypothesized by Owen-Smith to be evidence of proboscidean population decline that included human predation among the causes. I revive the Owen-Smith hypothesis here as being a pre-Clovis phenomenon in the Coastal Plain of the southeast US that is noticeable at the GS-2/GI-1e event stratigraphy boundary (14,692 cal years before 2000 AD with a maximum counting error of 186 years based on NGRIP oxygen isotope stratigraphy) (Hoek 2008). The GS-2/GI-1e boundary is also referred to as late Pleniglacial/Bolling boundary. In unit 3 at the Page-Ladson site, the average of seven statistically related carbon dates yielded an average age of 14,425 cal BP. The average of all nine carbon
dates from Unit 3 (two are older, unrelated assays likely originating from Unit 2) is 14,936 cal BP. These ages fall on either side of the Pleniglacial/Bølling boundary, which is close enough. Under this hypothesis, paleofires are seen as evidence that Paleoindians influenced fire regimes though predation and the responding decline of *Mammuthus* herds. Under this scenario humans did not ignite broad scale wildfires; rather the wildfires were of natural origin caused by increasing fuel loads during the ongoing demise of *Mammuthus*.

The decline of *Mammuthus* in the Southeast may have been an impetus for Clovis hunters to move west to seek new mammoth herds. Unlike their African brethren, Southeastern mammoths did not migrate over wide ranges (Hoppe 2004; Hoppe et al. 1999; 2006; 2007) so once herds were decimated in one region; new herds had to be located by humans that moved to other regions where mammoth herds still existed. Whether Clovis hunters were exclusively focused on *Mammuthus* as has been suggested (Haynes 1966; 1969a) yet it is unclear and this proposal has been critically questioned (G. Haynes 2002; 2009). Clearly the populations of both *Mammuthus* as well as *Mammut* were greater in pre-Clovis times when fire frequency began to increase. Before the last glacial recession, during and before the Pleniglacial, climate as a mechanism for large mammal stress was presumably not present. Human predation, if it took place, may not have had an impact on Proboscidean populations during the Pleniglacial as it did during the last glacial recession. Does the evidence of increased fire, beginning at the Pleniglacial-Bølling boundary 15.0 ka cal BP, have any meaning other than natural background noise? It is clear that several interpretations are possible.

The contexts of artifacts and technology also must be considered because there is credible evidence that pre-Clovis, lanceolate point-making hunters were in Florida. At the Page-Ladson site, the Page-Ladson point type is suspected to be the most likely candidate to represent a pre-Clovis type. At the Wakulla Springs Lodge, where a Page-Ladson point was found in situ (Jones and Tesar 2000; Jones and Tesar 2004), OSL dating of this early Paleoindian level provides a pre-Clovis age (Rink et al. 2012). Archaeological evidence of the charcoal dataset, evidence of Proboscidean hunting (*Mammut* in this case), and pre-Clovis hunting technology all date to the same general timeframe and all are pre-Clovis.

Next we must consider the proposed sudden megafaunal extinction at the Allerød-Younger Dryas boundary (Firestone et al. 2007; Haynes 2008) and the “abrupt” onset of a devastatingly “unique” Younger Dryas event at 13.0 t 12.9 ka cal BP (Fiedel 2011). The
Younger Dryas was one among many Heinrich mode phases known to have occurred during the buildup to and decline of Pleistocene glacial periods (Bond et al. 1999). During the last glacial recession, Heinrich 1 was clearly more intense and impacting compared to the Younger Dryas (Heinrich 0)(Hemming, Broecker et al. 1998; Hemming et al. 2000; Marshall and Koutnik 2006; Watts et al. 1992). Research in China indicates that Heinrich and other glacial climatic modes were components of repeating natural phenomena common to all glacial episodes seen in that record (Cheng et al. 2009). In other words, Glacial, Heinrich, and Modern modes of climate represent naturally occurring phases of a glacial stage and they are not unique.

The Younger Dryas did not have an abrupt onset; rather it had an abrupt end (Broecker et al. 2010). Its 12.9 ka cal BP appearance in the Greenland ice cores has more to do with that location’s northern latitude near the Arctic Circle. The concept of leads and lags is relevant in this situation when climate changes led and habitat change followed. Stuart Fidel (2011) does a masterful job in detailing just how variable the global chronologies are for the beginning of Younger Dryas but remains insistent that it was sudden and deadly. Fidel, one of the last to leave the Clovis First camp (Pinter, Fiedel et al. 2011), has not strayed far from that pedigree. His concept of an abrupt Younger-Dryas onset and sudden Pleistocene extinction is consistent with an ideology supporting a late as possible entry to New World. But if the Younger Dryas was sudden, and it immediately devastated late Pleistocene species, why are there so many post-Allerød to mid-Holocene examples of megafauna in the Old and New World (Boeskorov 2006; Coltorti et al. 2012; Ficcarelli et al. 2003b; Ghilardi et al. 2011; Gonzalez et al. 2000a; Gutiérrez and Martinez 2008; Hubbe et al. 2007; MacPhee et al. 2002; Politis and Messineo 2008; Stuart et al. 2004; Veltre et al. 2008; Woodman and Beavan-Athfield 2009)? Added to these findings is the evidence that the late Pleistocene extinction was a protracted event taking place over many thousands of years, and well before the Allerød-Younger Dryas boundary (Barnosky et al. 2004), and it is difficult to find the sudden extinction event credible. There is little doubt that a noticeable extinction event took place in the Desert Southwest around the Allerød-Younger Dryas boundary (Haynes 2008), but the Pleistocene extinction event took place over 50.0 ka cal BP years differentially on a regional basis (Barnosky et al. 2004). It is apparent that many arguments continue to be couched in outdated Clovis First rhetoric.

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Concluding Remarks

If there is one thing to be learned from the lengthy research and debate over the peopling of the Americas, it is that two things need to change. First, we now have sufficient expertise and no longer doubt that different cultural expressions of Paleoindian occupation took place. Through two major paradigm shifts, the notion that New World evidence should be validated by assumptions based on Old World origins has failed and should no longer be used as validating criteria. Second, one region’s Paleoindian sites, once they become well established should likewise not be used to judge the validity of another region’s archaeological evidence for Paleoindian occupation. The Desert Southwest, and all the excellent archaeological evidence for that part of the country’s Paleoindian occupation, is not an appropriate proxy for what happened east of the Mississippi River much less in Central and South America. It is amazing that Clovis has manifestations in so many geographic locations and considering them together on a large scale is worthwhile, but utilizing Clovis criteria from the Desert Southwest to eliminate sites such as Taima Taima was fundamentally wrong. Different cultural expressions are fundamentally different.

What we do need to establish are regional views of the Paleoindian occupations in the Americas. For example, in the Southeast, the Paleoindian culture expressions of the Coastal Plain from South Alabama and Florida northward to the South Carolina border may be somewhat different than elsewhere in the Southeastern region. This area is a part of the Coastal Plain but has only two rivers extending very long distances inland to the Appalachian Mountains. In other areas of the Southeast, Paleoindian sites are located in the foothills, mountains, or coastal areas where no less than six rivers emanate from the Appalachians and provide natural, fairly short pathways to and from coastal and mountainous terrains as well as their resources. Below that is the Southeastern Coastal Plain that was the heartland of the Pleistocene warm thermal enclave with its unusually rich paleofaunal assemblage (Russell et al. 2009), and the chert-bearing Tertiary limestone that holds the Floridan Aquifer and where most of the Paleoindian sites are concentrated (Dunbar 1991b). As paleontologists have shown, Florida and the adjoining coastal areas of the Southeast hosted a late Pleistocene assemblage rivaling that of the African Serengeti (Olsen 1963; Russell et al. 2009). Throughout Pleistocene glacial episodes and their corresponding lower sea levels, the continental shelf acted as an access point for western and
Neotropical species migrating to the Southeast (Morgan and Emslie 2010). With this late Pleistocene game animal diversity and abundance, there is also an equally diverse Paleoindian point assemblage.

There is much more to learn. For too long we have been trying to force a one-size-fits-all mentality on Pleistocene archaeological sites and this, given the new evidence, should stop. To do otherwise means that we are incapable of seeing the truth of the evidence before our eyes and prefer to remain embedded in a paradigm that offers no progress in understanding the earliest occupants of the New World.
APPENDIX A

GLOSSARY OF TERMS
GLOSSARY OF TERMS

Aliquot - As applied in OSL dating an aliquot is a subdivision of an original much larger sample into subsamples of a known amount. Therefore a subsample of sand might be subdivided in 200, 100, or 20 grain aliquots of three different sizes.

Anastomosing stream or river - Branching and reconnecting characterized by multiple channels separated by semi-permanent islands. Distinct from braiding in that braided channels are separated by ephemeral mid-channel bars and that anastomosing rivers are the low-energy, fine-sediment end of the range of multi-channel rivers (Neuendorf et al. 2005: 23).

Biomantling - The process of soil mixing caused by animals such as gophers, beavers, armadillos, ants, or any other organism that displaces and mixes the earth’s uppermost mantle by excavation (this is not a geologic term). It can alter the original surface and subsurface by up-building, and deepening the biomantle. Go to the animated web site of Domier and Johnson at: (https://netfiles.uiuc.edu/jdomier/www/temp/biomantle.html). Under their extreme depiction of biomantling the archaeological potential of a site is completely ruined. It is up to the on-site geoarchaeologist or soil scientist to make the determination regarding the degree and type of soil disturbance. The Domier and Johnson web page, hosted by the Department of Geography at the University of Illinois at Urbana-Champaign, includes a glossary of terms in addition to the animation of the biomantling process.

Bioturbation - The reworking of a sediment by organisms (Neuendorf et al. 2005: 69). This is by far the more recognized term in the earth sciences and archaeology.

Dansgaard-Oeschger - one of a series of climate changes during the last glacial period that occurred roughly every few thousand years. Twenty-five Dansgaard-Oeschger (D-O) events have been identified in the Greenland ice-cores as taking place over the last 80 ka cal BP. Each DO cycle consist of abrupt climatic warming to near-interglacial conditions followed by gradual but substantial cooling (http://www.ncdc.noaa.gov /paleo/abrupt/data3.html).


El Nino Southern Oscillation - periods of increased discharge of icebergs from the margin of ice sheets into the North Atlantic Ocean during the last glacial. They are preserved in deep-sea cores as sediment layers rich in debris eroded from land areas.

Eluvial deposition - A secondary mineral deposit resulting from the disintegration or decomposition of the original rock host, with minimal transportation of the material; thus eluvial deposits remain relatively close to the primary deposit from which they are derived. (Neuendorf et al. 2005: 207)
**Eluvial horizon** - A soil horizon from which material has been removed by the processes of eluviation. Cf. *illuvial horizon*. (Neuendorf et al. 2005: 207)

**EPS** - Extracellular polymeric substances (EPS) are high-molecular weight compounds secreted by microorganisms that bind colonies together and are therefore important in biofilm formation.

**Fallotella cookei** - Formerly *Dictyoconus cookei*, is an index fossil (foraminifera) of the Oligocene, chert-bearing Suwannee Limestone formation.

**Floridan Aquifer** - is the principal artesian aquifer in Florida and is composed of Tertiary limestone formations. It is also located beneath the coastal regions of the Southeastern United States and is one of the world's most productive freshwater aquifer systems. It not only underlies all of Florida, but also extends into large parts of coastal Georgia and areas of coastal Alabama and South Carolina.

**Glacial Mode** - Episodes during the late Pleistocene cycle when the climatic conditions in the northern hemisphere were cooler because of glacial conditions.

**Granulometric** - The size of grains in a sediment column. The grain size might be relatively consistent or of different grain sizes. Granulometry is used as a relative means of determining a sediment level’s origin of deposition.

**Heinrich Mode** - periods of substantial iceberg discharge from the margin of ice sheets into the North Atlantic Ocean during the late Pleistocene. Proof that Heinrich episodes took place is evidenced by lithic debris held in icebergs that rafted out to sea. Upon slowly melting the icebergs lost their rock debris which fell to the ocean’s floor as rock layers. North Atlantic rock layers originated great distances from their points of origin on the continents. Most frequently the source rock came from the Canadian Shield (also known as the Laurentian Plateau) when glacial ice from the Laurentide glacier discharged to the North Atlantic as icebergs. Full blown Heinrich episodes such as Heinrich 1 (H1) brought with them climatic conditions cooler than glacial mode episodes and much colder conditions occurred in the north and westerns Atlantic. At first Heinrich mode episodes, such as H1, appear to have resulted in noticeably cooler conditions in the Caribbean and Gulf of Mexico, but once the Atlantic Conveyor current shut down, climatic conditions moderated substantially in the Southeast because water in the tropics of the eastern Atlantic became stagnant and warmed up because of the non-circulating conditions.

**Humate** - A salt or ester of humic acid (Neuendorf et al. 2005: 308)

**Illuvial horizon** - A soil horizon to which material has been added by the processes of illuviation, Cf. *eluvial horizon* (Neuendorf et al. 2005: 321)

**Illuviation** - The accumulation, in a lower soil horizon, of soluble or suspended material that was transported from an upper horizon by the process of eluviation. Adj: illuvial (Neuendorf et al. 2005: 321). An example would be the breakdown of organic material such as leaves on the ground surface to a carbon-based humic solution that percolates downward.
Karst - A type of topography that is formed on limestone, gypsum, and other soluble rocks, primarily by dissolution. It is characterized by sinkholes, caves, and underground drainage (Neuendorf et al. 2005: 348)

Karstification - The action of water, mainly solutional but also mechanical, that produces features of a karst topography, including such surface features as dolins, karren, and mogotes and subsurface features as caves and shafts (Neuendorf et al. 2005: 349)

Marl Prairies - In the Everglades, marl prairies tend to be slightly more elevated compared to deeper sloughs and is seasonally dry, a factor that inhibits peat accumulations and favors the formation of substrates that consist of calcitic marl produced by algal periphyton mats.

Modern Mode - Modern Holocene warm climatic conditions also occurred during the last glacial recession sometimes as modern-like (less warm) conditions.

Periphyton - Micro-organisms, primarily algae and heterotrophic microbes that coat rocks, plants, and other surfaces on the water bottom (Neuendorf et al. 2005).

Spodic horizon - A mineral soil horizon that is characterized by the illuvial accumulation of amorphous materials composed of aluminum and organic carbon with or without iron. The spodic horizon has a certain minimum thickness, and a minimum quantity of extractable carbon plus iron plus aluminum in relation to its content of clay (Neuendorf et al. 2005: 620).

Sagaie - Ivory, bone or antler projectile point that is at the head of a harpoon or a spear and a distinctive artifact of the Solutrean as well as other Upper Paleolithic cultures in Europe.
APPENDIX B

CALENDAR YEAR ADJUSTMENTS FOR ARCHAEOLOGICAL AND PALEONTOLOGICAL SITES IN THE AUCILLA RIVER, NORTH FLORIDA
Appendix B, Plate 1. CalPal run of averaged and single \(^{14}C\) dates converted to calendar years BP for samples from the Page-Ladson sites.
Appendix B, Plate 2. Latvis-Simpson site CalPal run of individual $^{14}$C assays of late glacial maximum and older dates set against the Laschamp and Mono Lake magnetic excursions. The time of the magnetic excursions is included because some researchers believe the weakened magnetic field of the earth caused major variations in atmospheric $^{14}$C (Leduc et al. 2006). Although it has also been proposed that the half-life of $^{14}$C is incorrect and alternatively may account for most of the perceived variations (Chiu et al. 2007).
Appendix B, Plate 3. Sloth Hole and Crag Hole sites CalPal run of individual $^{14}$C assays of late glacial maximum and older dates set against the Laschamp and Mono Lake magnetic excursions. The time of the magnetic excursions is included because some researchers believe the weakened magnetic field of the earth caused major variations in atmospheric $^{14}$C (Leduc et al. 2006). Although it has also been proposed that the half-life of $^{14}$C is incorrect and alternatively may account for most of the perceived variations (Chiu et al. 2007).
Appendix B, Plate 4. Little River Rapids and three other sites CalPal run of individual $^{14}$C assays of late glacial maximum and older dates set against the Laschamp and Mono Lake magnetic excursions. The time of the magnetic excursions is included because some researchers believe the weakened magnetic field of the earth caused major variations in atmospheric $^{14}$C (Leduc et al. 2006). Although it has also been proposed that the half-life of $^{14}$C is incorrect and alternatively may account for most of the perceived variations (Chiu et al. 2007).
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BIOGRAPHICAL SKETCH

From the time I marveled at the battle of humans and beasts in the classic B-movie One Million Years BC, I knew I wanted to be an archaeologist. Preparation for that career began at Lake Sumter Community College in Leesburg, Florida, and continued at the University of Florida in Gainesville where I was awarded a Bachelor of Arts in December of 1975. I began my professional career at the Florida Department of State, Division of Archives, History and Records Management in February of 1976 as a Salvage and Exploration Field Agent. My first published paper was submitted in 1977 and over the years there have been a number more covering a variety of topics many of which are related to Paleoindian sites of Florida. By 1983 I was fortunate to become one of the co-founders of the Aucilla River Research Project (1983-1999), which became an opportunity for me to conduct considerable research and add to my publications on Paleoindian archaeology. After my two daughters were in their high school years, I returned to school for a Master’s Degree at Florida State University, Department of Anthropology. That degree was awarded in 2002. A few years after that I began pursuing a doctoral degree at Florida State University taking most of the course work while working for the Public Lands Archaeology program of the Florida Bureau of Archaeological Research. During my time with the Public Lands Archaeology program, I had a unique opportunity to conduct archaeological survey work from one end of Florida to the other. It was an invaluable experience and I learned a great deal from it. My career continued until retirement on June 30, 2011 with 35.5 years of service. I now look forward to completing the doctoral requirements and continuing work on Plaeoindian archaeological research in Florida. I suppose I have helped to demonstrate what the power of a B-movie can do to a person.