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Social Landscapes of Transegalitarian Societies: An Analysis of the Chipped Stone Artifact Assemblage from the Crystal River Site (8CI1), Citrus County, Florida

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Social Landscapes of Transegalitarian Societies:

An Analysis of the Chipped Stone Artifact Assemblage from the

Crystal River Site (8CI1), Citrus County, Florida

by

Richard W. Estabrook

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Anthropology
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Keywords: weights-of-evidence, geographic information systems, cost-paths,
Middle Woodland, use-wear, chert provenience

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Dedication

For Debbie and Desiree
Acknowledgments

This portion of my journey began more than 40 years ago when becoming an anthropologist became a major life goal. Perhaps it was the lure of study in exotic lands and the possibility of travel to far-away places; and then again, perhaps not. I would like to thank everyone who contributed to my travels and have tried to illuminate the way, but I have learned so much from so many that I have only space to acknowledge a few of the people that I met along the way.

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Abstract

The research undertaken in this dissertation was designed to explore how the institutionalized social inequalities in prehistoric Woodland society are reflected in the differences in the procurement, in the life history, and the final discard locations of the flaked chert stone tools from the Crystal River site (8CI1). The Woodland period (1000 BC to AD 1000) was a time of both stability and change in Native American society. Many of the core institutions such as subsistence, hunting and ceramic technology, and residence remained relatively constant while religious and political institutions underwent dramatic changes. This study focuses on how these social inequalities were manifested in the chipped stone tool assemblage from this site.

The Crystal River site is an Early to Middle Woodland-period mound complex located in coastal Citrus County, Florida. Dedicated as a National Historic Landmark site in 1991, the Crystal River site is internationally known and respected. Despite extensive work at the site conducted by Bullen and others during the 1940-60s, little was actually published about the material remains excavated from the site. Work resumed on the site in the 1980s and has continued as required by park maintenance and repair issues. Since 2007, remote sensing and other non-invasive technologies have been employed to advance research further at the site. This research returned to the flaked stone materials recovered during the periods 1903-1964 and 1984-2001 to illuminate site activities better without additional ground-disturbing activities.

Multiple techniques were employed to develop the data sets that were used to investigate the research questions addressed in this study. The GIS-based weights-of-
evidence procedure was used to predict the locations of chert outcrops within a 50 km study area. This model validated the existing quarry cluster method of determining the provenience of Florida cherts. A cost-path analysis was used to identify those chert sources that would have been most accessible to the site’s inhabitants. These techniques defined a series of coastal chert outcrops that form the newly-proposed New Coastal quarry cluster.

A chaîne opératoire or operational sequence approach was adopted for the analysis of the chipped stone assemblage. A waste flake analysis, a hafted biface classification, and a raw material provenience classification were conducted for all flaked-stone materials. Use-wear determinations were made using both low-power (10-70x) and high-power (50-400x) magnification analysis techniques. A life history approach was taken to the hafted biface assemblage and hafted biface retouch index (HRI) values were determined for all hafted bifaces and biface fragments.

The provenience analysis demonstrated that the majority of the chert used by the inhabitants of Crystal River came from outcrops and quarries south of the site along the coastal marshes and the western margins of the Brooksville Ridge. These resources are all within a short canoe trip from the site. Two life history trajectories are suggested for the chipped stone tools from Crystal River. The majority of the chert was obtained from local sources. The second life history was defined for a small subset of the hafted bifaces that were transported from quarries located outside the core subsistence catchment of Crystal River site.

Four research hypotheses were developed to test propositions related to the ways in which institutionalized social inequalities are reflected in the patterning of the chipped
stone artifact assemblage at the Crystal River site. Although only some of these hypotheses were supported, the results of this investigation do support much of the research that has previously been conducted with the lithic assemblages from Woodland mound complexes in Florida. Chert acquisition is heavily reliant on local lithic sources. Chert procurement appears to be embedded in the collection of other resources. Stone tool use at the site follows the typical expedient flake tool/local raw material pattern that has been documented for other Middle Woodland sites in the region. There was no evidence to suggest that thermal alteration was used to enhance the quality of either the local cherts or those brought to the site from more distant sources. The analysis identified two distinct life histories for at least part of the stone tool assemblage. Many of the hafted bifaces, formed tools and flake tools recovered from the site were made from local cherts. These tool were likely made, used, and discarded at Crystal River. Some of the hafted bifaces and flake cores were made from cherts found on the outer edges of the 50 km study area defined for this investigation. These items were brought to the Crystal River site, used, resharpened, and broken in transit, and finally replaced by new tools at the site. The broken fragments of these tools were discarded in the midden debris to eventually become part of the archaeological record from this now-famous site.
Chapter 1: Introduction and Overview

The emergence of social inequality among hunter-gatherer peoples is important to our understanding of much of the archaeological record. For most of human history, people have lived in small, relatively egalitarian social groups. Social differentiation has probably always existed at some level; differences in age, gender, and natural abilities or skills have likely always set some individuals apart from others in their society. Elders typically exercise some level of seniority over younger persons, and some individuals may have been given higher status or elevated prestige for a natural talent as a basket maker, as a hunter, or as a story-teller (Brumfield 1992; Eisenstadt 1964). These differences were often negated by risk-leveling social mechanisms that prevent one individual, or group of individuals, from gaining too much status, prestige, or authority (Dalton 1968; Polanyi 1968; Sahlins 1972).

In the recent past, this egalitarian sharing ethic broke down and hunter/gatherer/fisher-folk societies along Florida’s west coast that once expressed only minor social differences between individuals or lineage groups underwent a fundamental change. Institutionalized inequality allowed some members of these societies to obtain permanent access to a larger share of that group’s status, prestige, and authority and to the symbols used to identify and convey these ideals. Clarke and Blake (1996:259) have referred to such groups as transegalitarian societies, middle range, or intermediary scale
societies. Here, I used the term transegalitarian societies because it describes the process as a transition or change from one state (egalitarian) to another (non-egalitarian) without the direction or scale implied by terms like “middle” or “intermediary.” Transegalitarian societies are cultures in flux, grounded in a nonstratified social order, but becoming societies with greater degrees of social differentiation.

The time when this change from egalitarian to transegalitarian societies occurred in west central Florida is the focus of considerable debate. Russo (1994, 2004) feels that this shift began relatively early, perhaps during Middle to Late Archaic times (circa 5,000 to 2,500 BC), while Widmer (2002:389) argue for a later shift during Middle Woodland times, sometime around AD 200-500. Putting a precise date on this change is always problematic, as Wiessner (2002) notes, because the process is often protracted, cyclical in nature, and likely subject to a series of rapid expansions (booms) and episodes when risk-leveling mechanisms rein excesses back in (crashes) (Nasaney 1992:113). The other issue is that there is often scant good archaeological evidence for these social differences (Wiessner 2002:233). By the time they are visible in the archaeological record, these institutionalized social differences are permanent and widespread.

From his investigation of sites associated with the Plum Bayou culture (circa AD 700-950) in central Arkansas, Nasaney (1992, 1996) identified three dimensions of stone tool technology that would reflect institutionalized social differences in Woodland-period societies. Nasaney focused on changes in raw material acquisition and use, labor allocation and craft specialization, and the intensification of chipped stone tool production. Should asymmetrical social relations exist, socially-ranked individuals would aspire to control access to the raw materials for stone tool production, to the tool
production specialists, and would move to intensify production of specific tool types for use in exchange (Nassaney 1996:197-188). Conversely, unrestricted access to raw materials, an expedient flake tool assemblage, and generalized as-needed tool production would indicate that social elites had failed to monopolize stone tool production.

I propose to test Nassaney’s three postulates on the chipped stone tools used by the inhabitants of Crystal River site, an Early to Middle Woodland mound complex located in coastal Citrus County. This research is strongly committed to the use of existing artifact collections and previously underutilized excavation data to address questions pertinent to our understanding and interpretation of prehistoric societies. The Crystal River site is of particular concern in that the site itself is widely known, yet much of the data recovered from the site remains underreported in both the archaeological and local popular literature. Although not explicitly a part of this research, it is the intent of this investigation to foster better public interpretation of this information and to add constructively to the dialog concerning the wider interpretation of the Crystal River site.

It is my contention that the use of chipped stone tools at the Crystal River site reflects the institutionalized inequality within Woodland society and was influenced by the physical and social landscape in which the site was situated. This investigation focuses on the chipped stone artifacts recovered from the famous Crystal River site - how they were manufactured, used, and finally discarded, and how tool acquisition, use, and abandonment provides insights into the way that Crystal River’s prehistoric inhabitants viewed and understood the landscape around them of which they were a part. Various materials are available from which tools could have been made. Silicified limestone, or chert, is available from quarries and outcrops throughout the Crystal River region. Chert
was available nearby from both upland and low-land coastal locates (Upchurch et al. 1981). Shell, especially from large gastropods and quahog clams, was both widely available in local estuaries and where close at hand as the discards from food collecting activities. Bone, especially the leg bone (metatarsal) of white-tail deer, were much sought after by prehistoric peoples as raw material for the manufacture of pins, points, daggers, and an assortment of bone tools and ornaments. Shark’s teeth and stingray spines are available in nearby Gulf waters and were also used as tools in appreciable numbers. Many of these materials found their way into inter-regional exchange networks (Greenman 1938; McMichael 1964; Ruhl 1981; Sears 1962; Seeman 1979; Struever 1964). The question remains as to why some materials were specifically selected for certain activities or tasks over others.

A reduction stage/functional analysis would explore the potential of some of these materials, like stone, for their use in tasks that required a sharp, but durable edge. Shell, a dense, flexible, but seeming less durable material might have been used for tasks which required frequent changing of working bits as literally thousands of potential replacements would have been immediately at hand. Bone, although readily available, may have been reserved for specific tool forms - bone pins and the debris from their manufacture were recovered in large quantities during excavations at the site in the 1950s. But were tool use decisions based solely on edge durability and hafting frequencies? How did the availability of knappable stone affect tool use decisions? Clearly there were other factors in the social and physical landscape of the site’s inhabitants that affected these choices. Functional studies appear to be inadequate to address fully the complexity of these issues.
For this study, the *chaîne opératoire* or operational sequence concept (Leroi-Gourhan 1993; Grace 1997) has been employed to characterize the life histories of various chipped stone artifacts from the Crystal River site. This approach is a distinct departure from the functionalist reduction sequence approach that has been used in Florida for many years (Austin 2006; Austin and Ste. Claire 1982; Estabrook 1986; Estabrook and Newman 1984; Estabrook and Williams 1992). By reconstructing the *chaîne opératoire*, this investigation was designed to reveal the range of choices made by the inhabitants of the Crystal River site rather than focus on seemingly arbitrary functional/typological categories of various tool types and their associated manufacturing and use discards.

Reconstruction of the chipped stone tool *chaîne opératoire* at the Crystal River site is a complex undertaking. It requires determining where the raw materials were obtained, the patterning involved in the manufacture, use, and reuse, of these tools, and the practices surrounding the transportation, eventual discard, and final abandonment of these materials. By reconstructing the operational sequence, this analysis will reveal the tool use choices made by the prehistoric people who lived at Crystal River site. A variety of analytical techniques were required to acquire the data necessary to address these research questions. These include an evaluation of chert quarry sources, a predictive model for chert source locations, a cost-path analysis, and both low and high-power magnification use-wear studies. Reconstruction of the *chaîne opératoire* will also require investigation into manufacturing sequences and decisions, hafting choices, tool use and resharpening, and discard/abandonment practices used by the site’s inhabitants.
Previous research (Austin and Estabrook 2000) indicates that chert exploitation in central Florida shifted from the use of specific sources of well-silicified stone during the Paleoindian and Archaic periods to the use of more-poorly silicified local materials during the Woodland and Mississippian periods. Availability of chert, regardless of its quality, appears to have become more important than the quality of the material. Analysis of lithic materials from coastal shell middens (Austin 1995a, 1995b, 2001; Bellomo 1995a, 1995b; Estabrook and Williams 1992; White and Estabrook 1994) and other Weeden Island sites (Milanich et al. 1984:69-74) suggests that chert tools were used in specific ways. Microliths dominate stone tool assemblages at many smaller coastal middens (Austin 1995b, 2002; White and Estabrook 1994) while appear to be completely absent from the assemblages of other sites dominated by bifaces and flake tools (Bellomo 1995a, 1995b; Estabrook and Williams 1992). These small composite tools were used for a variety of tasks including woodworking (White and Estabrook 1994) and to manufacture shell beads and gorgets (Austin 2002). Thus far, no microtools or microliths have been identified from the Crystal River site (Weisman 1995).

But knowing where stone tools came from and how they were used at the site is only part of the story. The peoples of Crystal River lived within a complex physical and social landscape that influenced in a variety of ways their raw material preferences for tool materials. Geographic Information Systems (GIS) is very good at manipulating large datasets and providing visualizations of spatially aggregated data. Use of GIS also has some drawbacks, including a tendency to focus on physical and environmental data and a strong tendency to rely on environmentally deterministic models and explanations (Conolly and Lake 2006; Wheatley 1993; Witcher 1999). Most current GIS-based
applications rely on defining an “objective” geographical space within which social interaction takes place and assumes that all social participants, both prehistoric and present-day, recognize the same physical reality (Preucel and Hodder 1996:32-33). This study uses Tilley’s (1994:11) concept of space as a socially-constructed medium for action, not simply a container within which action takes place. This research begins from the premise that landscapes within which Crystal River’s inhabitants interacted were socially constructed, subjectively experienced, and polysemic in nature (Tilley and Bennett 2004:24-26; Witcher 1999:13).

Two different GIS techniques were employed in this study - a Weights-of-Evidence (WofE) analysis (Bonham-Carter 1994) and the development of cost-paths from cost or friction surfaces (Conolly and Lake 2006:252-256). Although the geology of the region suggests that there is limestone at, or very near the surface throughout much of the region (Scott 1992), there are few known chert outcrops in the immediate vicinity of the Crystal River site. A search of information contained within the Florida Master Site File (FMSF), various survey reports, and discussions with archaeologists familiar with the region identified 75 outcrops within 50 km of the site. Because a field survey to identify additional sources was beyond the scope of this study, the WofE procedure was used to predict the possible locations of additional source areas.

Several variations of cost, sometime called “friction” surfaces, were developed to model the transport of chert from known quarries to the Crystal River site. The typical cost-path model focuses on foot travel either through open forest or along predetermined terrestrial paths, hence most, if not all are terrestrially based (Wheatley and Gillings 2002:152). They assume that the most “efficient” means of prehistoric transportation is
by foot over land. Anyone who has hiked the forests and swamps of west central Florida realizes that this not true for this region. Water travel, particularly by shallow-draft canoe, is by far a more effective way of moving around central Florida (White 2004:24).

The “costs” for acquiring and using various raw materials are very subjective. Cost is usually reduced down to transportation costs, handling costs, or manufacturing costs and argues that prehistoric peoples selected to employ those materials and manufacturing techniques that provide a “least-cost” solution (Austin 1997:42; van Leusen 2002:6-8). This research compares the GIS-derived least-cost solutions for knappable stone transport within the Crystal River site region with the socially-derived solutions expressed within the archaeological record at the Crystal River site.

Stone tool analysis, especially at Woodland-period sites in Florida, has long been underemphasized. With a rich expression of elaborately decorated pottery, non-local trade goods, monumental architecture, and burials containing exotic ornaments, breastplates, gorgets, and earspools, the chipped stone tools from mound complexes are often simply counted, weighed, and curated. A lack of research focus on Woodland-period lithic assemblages exists in part because the assemblages themselves are less than exciting. Lithic specialists often view working with these assemblages with some disdain. These lithic components seldom contain the carefully flaked tools, bright-red, heat-altered waste flakes, and high artifact densities that define Archaic period sites in Florida. A chaîne opératoire approach, combined with a GIS-based regional analysis framework, provides a new perspective within which to evaluate the expression of social inequality among the hunter-gatherer-fisher peoples who inhabited of the Crystal River region.
The Crystal River Site

The Crystal River site (8CI1) is perhaps the best known of the large mound complexes in coastal west-central Florida (Figure 1.1). Situated in coastal Citrus County, the site commands a powerful presence along the north shore of the Crystal River. The site dominates the shoreline along this portion of the river. First investigated by Clarence B. Moore in 1903, the site has been the subject of numerous archaeological inquiries (Bullen 1953, 1964; Weisman 1987, 1995). Ripley Bullen worked tirelessly through the 1950s and 1960s to interpret the site and make it one of Florida’s first historic memorials. Because the site is now protected as a state park, archaeological investigations continue using remote sensing and other non-destructive techniques (Collins and Doering 2009; Pluckhahn et al. 2008; Pluckhahn et al. 2010). A brief description of the site complex as it appears today is provided here. The mounds and features are discussed in alphabetical order (A-H) rather than in any implied ranked order of importance. A more detailed discussion of the site’s excavation history is provided in Chapter 3.

The Crystal River site complex, as it is currently defined, is composed of 15 named mounds, features, and objects. These include Mound A, Midden B, the central burial mound complex which includes Feature C, Area D, and Mounds E and F. Additional mounds at the site include Burial Mound G, Platform Mound H, Mounds J and K, and the double sand mound. Other features include the central “plaza” area and shell “causeway” connecting Mounds G and H. The objects include three vertical limestone monuments, or stela. The locations of all mounds, features, and objects are shown in Figure 1.2.
Figure 1.1. Location of the Crystal River Site (8CI1) Citrus County, Florida.
Figure 1.2. Map of the features identified within the Crystal River site.
The Crystal River site also serves as a powerful symbol of prehistoric occupation on Florida’s west coast. The site is often cited as an example of Deptford, Hopewell, Late Woodland, Middle Woodland, and Mississippian society. It is well established that the site was not intensively occupied prior to Early Woodland times (circa 500 BC). Pluckhahn et al. (2010:175) suggest a 200-300 BC date as the start of the first major occupation at the site. The time of its abandonment, or better the period of its significant decline in use, is subject to some interpretation, but appears to have occurred sometime after AD 600. This places the primary site use during the Deptford and Weeden Island periods, roughly 200 BC to AD 700 (Pluckhahn et al. 2010). Even Ripley Bullen, the site’s most ardent Mississippian occupation (Safety Harbor) proponent, felt that the Crystal River site was likely abandoned by AD 1200 (Bullen 1965:10), midway through the Safety Harbor period.

Mound A is the largest and most river-accessible platform (temple) mound at the site. Situated at the southern end of the site along the river’s edge, the roughly 10 m (28 ft) tall mound is the site’s most distinguishable feature. The mound’s ramp and a good portion of the east side were bulldozed-off by a previous owner to fill an adjacent area in the 1960s (Bullen 1965; Weisman 1987; 1995). Midden B is the designation given to what is thought to be the site’s main midden. Midden B extends from the area north of Mound A east along the river. The spoil from Mound A was used to fill in the area between Midden B and the river’s edge once a seawall was constructed.

The central burial mound complex contains Mound F, the central conical burial mound and Mound E, a lower shelf-like extension extending out along the northwest side of Mound F. Feature C is an elevated ring of midden that encircles Mounds E and F.
Feature D is the designation given to the depressed area separating Feature C from Mounds E/F. Whereas Feature C contained numerous burials and other features, Feature D is generally considered devoid of cultural remains. Mounds E and F, and to some extent Feature C were the target of investigation when the site was first discovered (Moore 1903, 1906, 1918), and were extensively damaged as a result. What today we see as the central burial mound complex was reconstructed by state park personnel in the 1960s during the site’s conversion into a park. Mound G is the second burial mound at the site. Lower, and much less conspicuous in the landscape, Mound G, also known as the stone mound, was first thought to be feature added late in the development of Crystal River (Bullen 1965), but has been shown to be contemporaneous with the other mounds at the site (Pluckhahn et al. 2010:174).

Mound H is the site’s second platform mound. It is also the northern-most mound yet identified and perhaps the most intact mound in the complex. Little has been done at Mound H except some limited test excavations by Bullen in 1960 and again in 1964 (Weisman 1995:60). Mounds J and K lie along the site’s western boundary along the edge of the sawgrass marsh. Mound K lies nearest to Mound A; Mound J is slightly northwest of Mound K. Both mounds are located atop Midden B, adding substantially to their heights. Park literature describes Mound K as the “priest’s mound” given its proximity to Mound A and the unsubstantiated belief that the site’s ceremonial leaders lived on its summit.

The double sand mound is one of the more difficult site features to locate with any accuracy as it is not currently interpreted as part of the Crystal River site, although is now located within the park boundary. Investigated twice by both Clarence B. Moore
and Ripley Bullen, the mound is thought to have been located west of Mound G and North of Mound J in the vicinity of what is now the park’s workshop. The site was destroyed by Bullen’s final investigations and was not reconstructed when the park was developed (Weisman 1995:65).

The plaza is a low-lying area lying between the central burial mound complex, Mound H and Mound G. Also devoid of midden materials and other cultural remains, the plaza has been interpreted as the site’s major “public” space, a location where public events took place. The causeway is an elevated walkway or ridge of midden shell and dirt that connect Burial Mound G and the ramp of Temple Mound H.

The three limestone stelae are perhaps the most interesting of the site’s features. First “discovered” during the clearing of the area during its conversion into a state park (Bullen 1966), these limestone fragments have become some of the most discussed site artifacts. Stela 1 is the larger limestone slab sited just off Feature C southeast of the central burial mound complex. Engraved on one side of the slab is the supposed image of the head and torso of a human figure. Stela 2 is a smaller, unmarked limestone slab located southwest of the central burial mound complex. Stela 3 now lies just south of the Park Museum. Made famous by Clark Hardman’s 1971 article in *The Florida Anthropologist*, Stela 3 may have been uncovered during museum construction (Hardman 1971:153; Weisman 1995:31-32).

Recent geophysical investigations of the site (Pluckhahn et al. 2009, 2010; Pluckhahn and Thompson 2009; Thompson and Pluckhahn 2010) have shown that the construction of the Crystal River site occurred in stages and that the site we see today is only the final manifestation of the site’s complement of mounds, middens, and public
Recalibrated radiocarbon dates from the site suggest an occupation perhaps starting as early as 300 BC, but certainly endings sometime soon after AD 600-700 (Pluckhahn et al. 2010). These findings situate the site at what is considered the end of Early Woodland, but with the major site occupation occurring during Middle Woodland times, a period marked by the development of regional cultures throughout Central Florida (Milanich 1994:111-116).

**Research Focus**

There may be any number of ways in which institutionalized social inequalities can be reflected in the patterning of the material culture left behind by the prehistoric peoples who built, inhabited, and finally abandoned the Crystal River site. My research set out to address a single research problem by defining and evaluating a series of research hypotheses. The overall project research problem can be stated as follows:

The institutionalized social inequalities in Middle Woodland society are reflected in the differences in the procurement, the life history, and the final discard locations of the chipped chert stone tools from the Crystal River site.

Four specific research hypotheses have been developed to evaluate the research problem. They include:

1) Social inequalities are reflected in differential use of specific quarry locations.

H₀: There is no difference in quarry use at the Crystal River site.

Cherts were acquired from the closest quarry sources or using
an “embedded” stone procurement strategy that acquired chert during other subsistence procurement activities.

H₁: Specific quarries were used to procure cherts with specific desirable qualities for tool manufacture and use. These locations were controlled by Crystal River elites who maintained control over both the local and inter-regional movement of these materials.

2) Social inequalities are reflected in the differing operational sequences (*chaîne opératoire*) of different tool types/categories.

H₀: There are no significant differences between the various operational sequences (*chaîne opératoire*) of chipped stone artifact assemblage found at the Crystal River site. Stone tool acquisition and use follows the typical expedient flake tool/local raw material pattern that has been established at other Middle Woodland sites in the region.

H₁: Stone implements had operational sequences (*chaîne opératoire*) that reflect their involvement with task-specific activities. Some of these tasks included non-specialized resource procurement activities; other tasks involved craft specialists who created the variety of socially valued goods and symbolically-inspired items recovered within the burial mound complexes at the Crystal River site.
3) Social inequalities are reflected in the use of thermal alteration, or heat-treatment of chert.

H₀: Thermal alteration was a technique used to transform locally available, low quality chert into serviceable stone tools eliminating the need to obtain higher quality chert from sources farther away from the Crystal River site.

H₁: Thermal alteration was a technique used by craft specialists and controlled through social elites to create hafted bifaces and other specialized stone tool forms that were carefully-flaked, a lustrous, bright red-pink color, and aesthetically pleasing. These artifacts were controlled by social elites and were used as symbols of their power and authority.

4) Social inequalities are reflected in the intentional placement of specific stone tools within the various mounds as symbols of the social status of the individual.

H₀: There are no differences between the discard locations of any of the stone tools recovered at the Crystal River site. Stone tools were discarded as part of the midden fill and other site occupation components which was later used to construct the various mounds and other structures within the site.

H₁: Social elites used thermally altered hafted bifaces and other patterned chipped stone tools as symbols of their power and authority. These items were interred with their owners within sacred contexts in the various burial mound complexes at
Crystal River, while expedient stone tools (i.e., utilized flakes, scrapers, and hafted knives) were discarded within midden fill.

This dissertation has been divided into ten chapters. The first five chapters provide background information and discuss the perspectives and approaches taken or used during this study. Further discussion of the theoretical perspective and the research design employed in this study are provided in Chapter 2. Chapter 3 discusses previous lithic studies at a variety of Woodland period mound and midden complexes throughout the Southeast with an emphasis on sites in Florida. Specific studies were selected based on a lithic materials emphasis and a similarity in approach taken here. Nine sites were selected, although many more probably could have been included. An attempt was made to identify sites that contained site components that were temporally similar to those at Crystal River, although that was not always possible. One of the major criterion for inclusion was a similarity in analysis techniques or approach. Chapter 4 provides an expanded history of investigations as well as a discussion of the environmental and cultural setting for the site. Chapter 2 includes a discussion of the GIS WofE and cost-path analysis. A brief background on the lithic analysis and use-wear studies is also included. As use-wear analysis is a technique that has been used in archaeological investigations for several decades, a detailed justification and explanation of its use was not considered necessary.

The results of the investigation are reported beginning in Chapter 6. I have chosen to discuss the results and implications of the GIS-based studies, the WofE and cost-path analysis, before the discussion of the chipped stone tools. Chapter 7 provides
the results of the stone tool analysis. A discussion of the research problem and the evaluation of the four research hypotheses are included in Chapter 8. Chapter 9 provides the summary conclusions and makes suggestions for future research.
Chapter 2: Theoretical Perspectives and Research Design

The Crystal River site has a unique history, both unique in its place in the world of the native peoples who built and maintained it and in the world and lives of the archaeologists and others who have tried to excavate, understand and interpret this site. This chapter is an attempt to situate my thoughts and approach to the research questions I have posed for this site. In large part this perspective defines the issues and frames the discussion. It defines the data I have chosen to collect and the analysis techniques I used to finally draw my conclusions. I have selected a single tradition of inquiry (Creswell 1998:20-21) rather than going with a more eclectic mix of approaches and perspectives. I did not come by this choice easily, and not before adopting and subsequently rejecting other possibly more insightful avenues of inquiry. The reasons for my selection are discussed at greater length below.

The remainder of this discussion will focus on the theoretical perspective employed in this study and the research design that was developed to frame this analysis and address the research questions I have proposed. During the course of the undertaking the background research and planning for this study I have had the unique opportunity to review the previous studies and analyses I have conducted (Deming and Estabrook 1994; Estabrook 1984, 1986; Estabrook and Williams 1988, 1992; Janus Research 1998) and to reflect on the successes and the shortcomings of these efforts. Two things always
troubled me when an analysis is completed and the report finished. First is the inability
to say much about the artifacts before they arrived at their recovery locations. The
second is my frustration with use-wear/microwear studies that cannot go beyond
reporting of the ratios of tools used for cutting verses those employed in scraping,
chopping, or cutting. Ratio calculation should be the beginning of the discussion of these
activities, not the conclusion. These two frustrations more than any others have inspired
my choice of theoretical prospective and my formulation of this research design.

Pauketat’s historical processualism (2001a, 2001b, 2004) provides the theoretical
framework for this study. This approach moves beyond the consideration of behavior,
which often tries to explain why people do the things that they do with the concepts of
tradition making and practice (Pauketat 2001b). Historical processualism frames history
as a process of tradition building through practice. The approach has generated
considerable discussion and some criticism, especially among evolutionary
archaeologists (e.g., O’Brien and Lyman 2004). It does, however, provide an appropriate
perspective within which to consider a chaîne opératoire approach to the analysis of stone
and stone tools. Below I compare and contrast the historical processual approach to
alternative schools of thought prevalent in anthropology today. I will also touch briefly
in the theoretical underpinnings of functional analysis (Ahler 1979; Odell 1979), quarry
cluster provenience studies (Upchurch et al. 1981); chaîne opératoire (Leroi-Gourhan

Geographic information system (GIS) is used to generate several of the models
that are used in this analysis. A Weights-of-Evidence (WofE) procedure (Bonhan-Carter
1994) was used to predict the probable locations of chert outcrops within a 50 km study
area around the Crystal River site. A cost surface, sometime referred to as a friction surface, was generated to develop the paths and model the travel “costs” for transporting knappable stone from the chert outcrops and quarries to the Crystal River site. These cost paths replace the straight-line distances that are often used as a proxy measure of differentiate local sources of stone from distant ones. Like all models, GIS-based models are simplifications of the real world and require choices and decisions that affect the outcomes of the investigation.

Theoretical Perspectives

There are now many different perspectives from which one can address the past; so many, in fact, that some justification is in order for the selection of one school of thought over those of another. As the breadth of the discussion on the existing perspectives and schools of thought is fairly wide, I have chosen to use the categories employed by Hegmon (2003:214) in her overview of theoretical perspectives used by North American archaeologists. These include three self-titled approaches: evolutionary ecology, behavioral archaeology, and Darwinian archaeology, and something Hegmon (2003:215) calls “processual-plus,” which becomes a catch-all category for a variety of approaches not included in the three categories above and that also are not post-processual or post-modernist related. To Hegmon’s list I add post-processual archaeology to define that group of European and American, but especially British archaeologists, who outright rejected much of the archaeological approach that came out of the United States in the 1960s and 1970s under the rubric of processual scientific or new archaeology.
Evolutionary ecology, behavioral archaeology, and Darwinian archaeology all have a core group of ardent and sometimes very vocal supporters. Evolutionary ecology, also known as human behavior ecology, is the intellectual heir apparent to Julian Steward’s cultural ecology (Steward 1955) approach, infused with a much more pronounced evolitional perspective (Hegmon 2003:214). Behavioral archaeology began as one of several variants of new archaeology (Reid, Schiffer and Rathje 1975), but now Michael B. Schiffer (1999, 2000) is the major proponent of this perspective. Darwinian archaeology, also called evolutionary archaeology or selectionism, has its roots in the writings of Robert Dunnell (1978, 1980) and his students. Darwinian archaeology is now championed by Michael J. O’Brien and R. Lee Lyman (2002, 2004). Darwinian archaeology attempts to supersede cultural evolutionary concepts (Steward 1955; White 1949) with those found in Darwinian evolutionary theory (Leonard 2001). A strong emphasis on a material culture is perhaps the strongest attractor of archaeologists to this perspective.

Evolutionary Ecology/Archaeology

Evolutionary ecology, also known as behavioral ecology or human behavior ecology, has its roots in the cultural ecology approach first forwarded by Julian Steward in the late 1930s (Steward 1937, 1955). Evolutionary ecology’s return to prominence in the early 1980s was precipitated by a general interest in the environment and ecological issues in the public at large, a renewed interest in hunter-gather studies (e.g., Lee and DeVore 1968, 1976; Jochim 1976, 1981), and the acceptance in archaeology of optimal foraging strategies (Winterhalder 1981; Winterhalder and Smith 1981). Optimal foraging...
theory, a concept adapted from ecology and population biology, focuses on the evolutionary fitness of a population to efficiently exploit the various plant and animal resources in a geographically circumscribed area, given a certain population size and growth potential (Smith 1981; O’Connell and Hawkes 1981). The approach assumes that individuals and societies adapt to the environment where they live in ways that maximize their reproductive success (Shennan 2002:3). Optimum foraging studies frequently used to model hunter-gatherer-collector groups as they are well suited for GIS-based studies because they rely heavily on environmental information (Brown et al. 2007; Foster 2003).

Sharing many of the biological underpinnings with evolutionary ecology is Darwinian archaeology, or evolutionary archaeology, originated in works of Robert Dunnell (1978, 1980), but now championed by Michael J. O’Brien and R. Lee Lyman (2000, 2002, 2004). Darwinian archaeology also draws strongly on the neo-evolutionary concepts of Julian Steward (1955) and Leslie White (1949) instilled with Darwinian evolutionary theory (Leonard 2001). One of the major theoretical underpinnings of evolutionary archaeology is the replacement of cultural evolutionary constructs with more stringent Darwinian evolutionary concepts (e.g., natural selection, lineage, random variation, and the like), and moving archaeology away from its anthropological roots and aligning it methodologically with paleobiology (O’Brien et al. 1998:487; O’Brien and Lyman 2000:17).

Evolutionary ecology and Darwinian archaeology studies have several drawbacks for the analysis of middle-range societies in central Florida. Evolutionary ecology models assume that all human groups strive towards exploiting their surrounding environment to their optimum advantage. Social pressures and relationships, non-
environmental factors, and cultural traditions are reduced to a set of loosely defined constraints, which are often cited as the reason that many groups fail to reach their optimal potential (Martin 1983:626-627). Both evolutionary ecological and Darwinian archaeology models are often cited as being both reductionist and deterministic (Martin 1983; Trigger 1989:306, 1998:364; Wylie 2000:299)

Behavioral Archaeology

Behavioral archeology (Schiffer 1972, 1975, 1987) developed in the 1970s as one of the first “reaction” positions to new archaeology. Michael Schiffer himself was trained as a new archaeologist and for much of his early career associated himself with this archaeological faction. As intended, behavioral archaeology was presented as an alternative to new archeology whose focus was the systematic interrelationships between material culture (the things people make or have) with human behavior (how people interact with these objects) throughout time and space (Schiffer 1975:4). Its primary contribution to archaeology has been to raise the specific awareness of site formation processes and transformations (C-transforms) (Schiffer 1987). It has also generated interest in the relationship between observations of material remains in the archaeological record and the inferred context of these remains (Graves and Zubrow 2007:9).

Behavioral archaeology does offer a systemic context for chipped stone tools (Schiffer 1975). From his work at the Joint site, a 36-room pueblo in Arizona, Schiffer (1975:158-178) presents four hypotheses, each investigating some aspect of stone tool acquisition, manufacture, use, and discard, at the site. Because the Crystal River site and the Joint site were excavated very differently, the research questions are not directly
applicable. Behavioral archaeology can contribute to research at Crystal River by critically examining the processes, both cultural and natural, that created the site. Behavioral archaeology suggests that archaeological sites were not always occupied at a single time, nor were they abandoned in a single moment (Schiffer 1975:152-153). Objects may have been removed, abandoned, and buried at a site by peoples who lived later in time for reasons that are not always explicitly obvious in the archaeological record.

**Processual (New) Archaeology**

To many American archaeologists (Watson 2007), new archaeology has its genesis in Taylor’s (1948) *A Study of Archaeology*. Taylor’s conjunctive approach brought forward the idea that archaeology was neither anthropology nor history (Taylor 1948:44). For Taylor, the goal of archaeology was to draw “the completest possible picture of past human life in terms of its human and geographic environment” (Taylor 1948:95-96). New archaeology entered into the mainstream of archaeological thought with the 1962 publication of Binford’s (1962) short article *Archaeology as Anthropology*. In this brief *American Antiquity* article, Binford (1962) outlined three terms: technomic artifacts, socio-technic artifacts, and ideo-technic artifacts and suggested how correlates among them related to prehistoric social systems. But it was not until the publications of *Archaeological Perspectives* in 1968 that new archaeology had the framework, the hypothetico-deductive method, for which this approach is best known (Binford 1968:23; Binford 1965). New archaeology includes a focus on empirically-based functionalist research following a deductive, but not necessarily a positivist approach. It makes
explicit statements about assumptions, ideas, models, and hypotheses employed in research. New archaeology tries to search out any data relevant to the research questions at hand and not necessarily rely solely on the archaeological record (Watson 2007:viii).

One of the overriding goals of new archaeology was to contribute to the advance of anthropological theory by developing general laws of cultural processes that provide explanations for differences and similarities in cultures throughout the world and throughout time (Watson et al. 1971:23). By the late 1970s, many archaeologists who were either aligned with or sympathetic to the new archaeology approach realized the development of such overarching postulates would prove difficult, but what was needed was intermediate-level theory that bridged the static, contemporary remains recovered from the archaeological record with statements of past cultural processes. Binford (1983:36) refers to these connecting postulates as middle range theory. Middle range theory will provide the approach that will allow this research to connect the various artifacts collected from the Crystal River site with the social processes that brought them to be recovered from this location.

In addition to being one of the leading motivators of new archaeology, Binford also became involved in lithic studies. His early works (Binford and Quimby 1963) focused on bipolar flake reduction. Binford’s later work with his then wife Sally Binford (Binford and Binford 1966, 1969) involved Middle Paleolithic (300,000 to 30,000 years BP) Mousterian stone tool assemblages. François Bordes, a French paleontologist, had recognized four distinctive types of Mousterian assemblages in Europe and had attributed each to a distinctive Neanderthal “tribe” (Bordes 1961, 1968). Lewis and Sally Binford refute Bordes’ claim with a functional argument that each of the different Mousterian
lithic assemblages reflect functional differences between sites rather than cultural differences between the groups that made the tools (Binford and Binford 1966:292). This Mousterian problem controversy reverberated back and forth between Binford (1969, 1973, 1983) and Bordes and his supporters (Collins 1969, 1970; Mellars 1970, 1973) in Europe for many years without any real resolution until Bordes death in 1981. This functional vs. cultural/ethnic distinction between American processual archaeology and French Paleolithic studies surfaced again with the introduction of the chaîne opératoire concept part of the post-processual argument (Bleed 2001:105).

During the 1970s and 1980s new archaeology, now commonly known as processual archaeology, began to dominate American studies. Paralleling the expansion of processual archaeology during this period was the growth of the cultural resource management (CRM) industry. Many of the principals and senior archaeologists of these firms graduated in the 1970s and 1980s, so it should not be surprising to find that many of the tenets of processual archaeology find their way into CRM-based studies (Redman 1991:298). Lithic studies in Florida are often conducted within the confines of processual functionalist approaches (Austin 2006:8-9). Another factor that influenced the choice of theoretical frameworks by CRM-based archaeologists is the portability of processual frameworks. As they were conceived to be applicable to data recovered from all time periods and all places they are often generic techniques that focus on specific classes of archaeological data (e.g., waste flakes, pottery, formal stone tools) which are applicable to a wide region rather than focusing on questions that explore locally specific historic processes. With no notable exceptions, every lithic analysis conducted in Florida since the late 1960s has either focused on constructing cultural history-based typologies
for stone tools (Bullen 1975, 1976; Purdy 1981; Schroder 2002) or has adopted a processual/functional framework for evaluating these materials (e.g., Austin 2006).

Post-Processual Archaeology

In Europe, reaction to the new archaeology or processual archaeology was strong and generally not supportive (Hodder 1986; Renfrew 1983; Shanks and Tilley 1987; cf. Clarke 1978). Acceptance in the United States was neither complete nor long-lasting (Hegmon 2003), as issues of agency, practice, gender, and political economy arose that did not blend well with the techno-functional studies prevalent in processual archaeology. It is easy to see why this occurred, particularly in lithic studies, by looking at the successes claimed by the Interstate 75 studies conducted by the Florida Department of Transportation in the early 1980s (Pollock 1986). Austin (2006:177-187) attributes advances in chronology, site function, settlement patterns, site structure, technology, methods and typology to these investigations. Nowhere is mentioned any advances in determining the use of specific quarries, individual household size or composition, gender division of labor, or the concept of socially-valued tools.

Gender studies and stone tool use (Gero 1991; Sassaman 1992) suggest that there are many facets of stone tool use and production that remain to be explored. Gero’s work (1991:167) suggests that women are often not seen as the makers of stone tools, although skill, not upper body strength, is all that is required to produce them. Ethnoarchaeological evidence from Australia (Gould 1977:166; Hayden 1977:183) and Ethiopia (Weedman 2005:194) shows that women often made their own tools, especially scrapers, flake knives, and other non-weapon type tools (Gero 1991:167). Women are
also attributed with making what are often referred to as informal, or expedient stone tools – those with a task-specific working edge, tip, or surface, but that cannot be neatly categorized into a formal morphological category, like a projectile or spear point, scraper or bifacial knife.

Social agency is a movement to re-personalize the archaeological record. It is sometimes referred to as “putting people back into the past” (Robb 2001). Agency includes the investigation of the nature of individual freedoms as they are modified by social constraints and the role socialization plays in the development of personhood (Bourdieu 1977). Agency is not a thing; it is the combined quality of multiple aspects of what it is to be a person and the relationship between those aspects (Dobres and Robb 2000). Agency operates on many levels, as an individual, as groups of individuals, and as groups as collective entities. For stone tool studies, agency on an individual level requires a resolution in the archaeological record that allows for the decisions of an individual stone tool maker to be recognized. Resolution at this level is rare in the archaeological record, even at well-excavated Middle and Upper Paleolithic sites (Gravina 2004:68; Morris 2004:62), but in very specific cases has been recognized here in central Florida (Ste. Claire 1996:193-194).

Practice theory stems from the works of both Bourdieu (1977, 1990) and Giddens (1979, 1984) as an extension and expansion of agency theory (Dornan 2002:307). Pauketat (2001:7) summarizes both approaches as the way that people “enact, embody, or represent traditions in ways that continuously alter those traditions.” Giddens (1979:57) offers his theory of structuration, which considers social structures both constraining and enabling. He sees the conduct of social actors as being influenced both by confines of
social institutions and the ability to make decisions based on the complexities of the social situation. Human practice becomes a combination of social conditioning, social knowledge, and the free will to make conscious decisions.

Agency and practice theory provide an interesting counterpoint to most processual and some processual-plus approaches. They provide a humanistic studies alternative to ecosystem and economic science approaches and they do not require people in the past to have acted optimally or even rationally. Agency and practice theory allow for the consideration of complex social structure yet still allow for the consideration of individual historical actors without being particularistic. On a practical level, however, agency and practice theory are difficult to operationalize in archaeological research without either injecting modern (especially Western) notions of human action (Dornan 2002:324) or providing an exceptionally broad base of archaeological context (Pauketat 2001a, 2001b, 2004).

**Processual-Plus Archaeology**

Processual-plus (Hegmon 2003:216-218) covers a broad range of theoretical perspectives that have their genesis in processual archaeology. This includes many perspectives that do not completely reject all of the major tenets of processual archaeology, but that also do not fully embrace all of the humanistic, historical, and relativistic aspects of post-processual archaeology. It includes agency theory, practice theory, archaeology and gender, and a variety of similar approaches. Post-processual archaeology includes a variety of frameworks, all with several features in common. Post-
processual archaeology emphasizes a humanistic interpretation and a historical prospective, and tends towards case-specific analysis (Hegmon 2003:217).

Thick prehistory has emerged as one of several processual-plus frameworks that emphasize the generative and humanistic aspects of the archaeological perspective (Hegmon 2003). It has been developed in response to the complexities of describing and interpreting middle-range Woodland societies, and in particular, that aspect of these societies that includes the Hopewelian interaction. Carr and Case (2006:33) outline six goals and underlying assumptions that differentiate thick prehistory from other theoretical and methodological approaches. One of the primary objectives of the thick prehistory approach is balance, both from historical perspective and from a methodological one. Thick prehistory attempts to counterbalance the excesses of some of the statistic-laden functional and structural models of new archaeology (cf. Binford and Binford 1966; Christenson and Read 1977) and the classificatory evolutionary models, like band-tribe-chiefdom-state (Service 1962; Fried 1967), holdovers from archaeology’s Classificatory-Historical period (Willey and Sabloff 1993:152-154).

Evolutionary ecology and Darwinian archaeology, otherwise known as evolutionary archaeology, contrast sharply with the thick prehistory approach (Carr and Case 2006). Both evolutionary ecology and Darwinian archaeology have a strong evolutionary emphasis, and both borrow heavily from the theoretical and methodological legacy of the biology, ecology, and paleontology. Thick prehistory has no evolutionary perspective. Evolutionary ecology adapts well to the analytical tools provided within GIS (Brown et al. 2007; Foster 2003; Zeanah 2004), but because of its ecological origins, most GIS application retains an environmental deterministic flavor. Darwinian
archaeology requires an adherence to a rather strict classificatory system (O’Brien and Lyman 2000:189) and an emphasis on measuring change in prehistoric societies in terms of replicative success. Successful reproduction is important to the survival of all societies, but it is not considered a key element in thick description. A thick prehistory approach (Carr and Case 2006) was first considered as the basis for this research, but was abandoned in favor of historical processualism (Pauketat 1994, 2001a, 2001b, 2004) when difficulties operationalizing thick prehistory for a lithic analysis.

**Historical Processualism**

Pauketat’s (2001a, 2001b, 2004) historical processualism brings together practice theory (Bourdieu 1977, 1990; Giddens 1979, 1984) and historical process into a coherent series of research directives that redefines the processual interest in behavior with tradition making and practice and includes a historical perspective. The goal is to illuminate how a specific social practice developed in a particular place and time rather than trying to explain why it occurred as a abstract law or principle (Pauketat 2001b:74).

Many of the social constructs assigned to “behavior” under the rubric of processual archaeology can better be considered as practice and tradition. Practices are actions and representations shaped by the historical process that came before them (Pauketat 2001b:74). Practice is a generative process that becomes both a medium of tradition providing for the continuity of social ways and a medium of social change. Tradition can be viewed a continuity with past or a collection of actions that are passed down from one generation to the next. Tradition is often seen as a groups ties to its past. It brings into the present the cumulative successes and missteps of prior generations.
Practice and tradition are what people do and how they do it without the functional constraints of why they are doing it (Pauketat 2001a, 2004).

The chaîne opératoire approach is a logical extension of the historical processual approach as it focuses on how tools were made and used to explain the process of tradition-making rather than emphasizing the functionality or styles of the tools (Pauketat 2001b:10-11). This stone tool making tradition includes the entire process from the acquisition of the stone, movement and transport from quarry to site, the shaping of the tools, tool use, tool resharpening and/or refurbishing, and finally tool discard or internment. The operational sequence chain for stone tools is but one of many such traditions involved with the site’s inhabitants and in many ways may only have a small peripheral role in the process of tradition building at the Crystal River site (i.e., Pauketat 2001b:11).

**Transegalitarian Societies**

The emergence of social inequality among the hunter-gatherer peoples is important to our understanding of much of the archaeological record (Earle 2002; Feinman and Neitzel 1984; Hayden 1995). For most of human history, people lived in small, relatively egalitarian social groups. Social differentiation has probably always existed at some level. Differences in age, gender, and natural abilities or skills have likely always set some individuals apart from others in their society. These differences may have been more pronounced in some societies than in others. Elders typically exercise some level of seniority over younger persons, and some individuals might gave some level of status or elevated prestige for a natural talent as a basket maker, as a hunter, or as
a story-teller. These differences were often negated by risk-leveling social mechanisms that prevent one individual, or group of individuals, from gaining too much status, prestige, or authority (Wiessner 2002:233). In the recent past, the social processes that encouraged egalitarian power sharing practices changed and societies that once expressed only minor social differences between individuals underwent a fundamental change. Institutionalized inequality allowed some members of these societies to obtain permanent access to a larger share of that group’s status, prestige, and authority and to the symbols used to identify and convey these ideals.

The timescale for the emergence of institutionalized social inequality and societies dominated by social elites in west central Florida is the focus of considerable debate. Russo (1994; 2004) feels that this social change occurred relatively early, perhaps during the Middle to Late Archaic (circa 5,000 to 2,500 BC), while Widmer (2002:389) argue for a later transition shift during Middle Woodland times, around AD 200-500. Assigning a precise date on this change is always problematic as Wiessner (2002) notes because the process is often protracted. It is also likely subject to a series of rapid expansions (booms) and episodes when risk-leveling mechanisms rein excesses back in (crashes). The other issue is that there is often scant good archaeological evidence for these social differences (Wiessner 2002:233). By the time they are obvious in the archaeological record, these institutionalized social differences are permanent and widespread.

Several models for the appearance of transegalitarian societies on central and south Florida have been proposed. Russo (1991) has proposed some of the earliest evidence in the southeast for social ranking among coastal hunter-gatherer-fisher groups.
He contends that the Late Archaic phenomena of shell rings, coastal midden sites that are constructed in a ring or semi-circular fashion, reflect differential ranking between the households that inhabited these sites (Russo and Heide 2001). The oldest known shell rings in Florida, Oxeye and Rollins, lie in northeast Florida and date from around 2600 to 1700 BC, respectively (Russo and Heide 2001:491). These shell rings represent some of the first monumental architecture identified thus far in coastal regions. The differing elevations of the individual house mounds that make up the rings suggest differing status among family groups that occupied them.

An ecologically-based model has been forwarded by Widmer (2002), who attributes the development of increasingly complex societies along Florida’s Gulf coast to population pressure (Carneiro 1981), but he attributes the rise in sea levels and hurricanes as the primary causal agent. Sea levels have been fluctuating along Florida’s Gulf Coast since the end of the Pleistocene, which began roughly 11,500 BC. Widmer (2002:392) argues the rise in sea levels created vast new estuary systems, which were exploited by a rapidly growing population. Ranked societies arose to provide the centralized leadership necessary to rebuild villages after a devastating storm. Widmer (2002:393) provides several archaeological examples of catastrophic events along the coast to support his leader-as-hurricane rebuild-manager position (Earle 1997:69; 2002).

Milanich (2002:360-361) returns to the ideas of Sears (1962) and Fairbanks (1982) and attributes the development of ranked societies, mound complexes, and the use of burial mounds to an increase in social differentiation between lineages and villages (McAnany 1995:16-20). Some lineages, with greater access to resources (likely subsistence resources), may have achieved higher status than others. These groups would
have been able to sponsor feasts or ceremonies that could solidify their higher social ranking. Religious specialists, particularly those involved with the ceremonies associated with burial or temple mounds, may also have achieved higher social status. At the McKeithen site (Milanich et al. 1984), Milanich suspects that a headman, or big-man (Sahlins 1963) (or head-woman or “big-woman”, as one of the high-status burials was female) controlled both trade with outside groups and the production of local subsistence resources. The power of this individual, however, waxed and waned with the productivity of the local environment. Without a substantial agricultural base, and with a growing population, Milanich (2002:361) suggests that the big-man’s status was dependent on the success of what the people in the village could hunt, gather, or collect. Truly stratified societies, with chiefs, warfare, and regional economic control came later with the expression of Mississippian societies.

Nassaney (1996) proposed that institutionalized social differences would be reflected in changes in the organization of tool technology, and in particular in the raw material acquisition, labor allocation, and productive intensification of chipped stone tools. Raw material acquisition was considered by examining all of the sources of stone within the region. Nassaney investigated labor allocation examining the locations within which stone tool production took place. The productive intensification of stone tools was examined by comparing the distances from source to site and the percentages by count and weight of various raw material types (Nassaney 1996:194).

Sassaman (1994) has proposed that a shift in settlement strategy resulted in a change in stone tool use, from one using formal stone tools, like hafted bifaces, to expedient stone tools made from flakes. This change occurred when relatively mobile
hunter/gathers adopted a more sedentary collector/foragers/fisherfolk adaptation with the introduction of fired ceramics around 4000 years ago. In central Florida, the adoption of ceramics towards the end of the Archaic also saw a shift from the manufacture of bifacial tools, like spear and arrow points, to the use of flake tools struck from expedient cores (Austin 1997) and a shift towards the use of local chert resources (Austin and Estabrook 2000). Parry and Kelly (1987) place this shift in a broader context and see this shift not as the devolution of stone tool production, but as a corporate decision among sedentary groups to reduce the time and effort spent on maintaining a tool assemblage based on formally-shaped and hafted chipped stone tools. They note that highly mobile hunter-gather groups sometimes also adopt an expedient core tool technology, particularly in regions where tool stones are common and other materials like shell and wood can be used to make tools (Parry and Kelly 1987:304).

The preponderance of flake tools, particularly at shell middens, along Florida’s west coast is well documented (e.g., Austin 1995a, 1995b; Estabrook and Williams 1992). However, most of the tools that were recovered from the Crystal River site are chipped bifaces, scrapers, and other formal category tools. Is this a reflection of the excavation techniques of Moore, Bullen, and Smith who kept the formal tools that they felt were chronologically sensitive and ignored flake tools? Or does it reflect a real difference in the artifact composition of the site, which indicates a preference for activities formal tool types?
Stone Tool Analysis

The production and use of stone tools is perhaps the oldest and most extensively studied of human activities. With the possible exception of the analysis of prehistoric ceramics, more frameworks, techniques, procedures, and processes exist for the study of stone tool production and use than for any other class of remains recovered by archaeologists (Andrefsky 1998, 2001; Hayden 1979; Kooyman 2000; Odell 1996; Plew et al. 1985; Swanson 1975; Wright 1977). The challenges at Crystal River stem from the site’s excavation history and current status as a National Historic Landmark.

Reduction Stage Analysis

Reduction stage studies focus on identifying the stages or sequences of production for stone tools and waste flake. First suggested by Holmes (1890, 1894, 1897, 1919) in the early twentieth century, these techniques have been used extensively in Florida since the early 1950s (i.e., Austin 2006; Estabrook 1986; Estabrook and Newman 1996). Functional analysis considers the reduction and manufacture of stone tools into stages, from the initial quarrying of stone at chert outcrops to the final deposition of broken, worn-out, or lost artifacts in archaeological contexts. Functional studies (Callahan 1979; Carr 1994; Hayden 1979, 1987; Kooyman 2000; Kuhn 1995; Plew et al. 1985; Semenov 1964; Swanson 1975) typically focus on reduction or manufacturing stage trajectories and some include some form of microwear analysis (e.g., Ahler 1975; Kay 1996; Lewenstein 1987; Yerkes 1987).

Several techniques are available to determine the sequence of events involved with the acquisition of the raw materials for stone tool production and the manufacture of
the tool themselves. Typically the kind of analysis employed is strongly dependent of the type and quantity of material to be analyzed. The manufacture of stone tools is a subtractive process. Once a large flake is removed from a chert nodule at a lithic quarry or outcrop, small pieces are carefully chipped away to make the desired implement (Crabtree 1972; Henry and Odell 1989). Each of the resulting waste products (debitage or waste flakes) as well as the final production implement can be used to determine manufacturing and tool refurbishment areas and provide insights into the technology used to produce them.

Reduction-stage stone tool analyses break down the manufacturing process into various manufacture or production stages, often relying on some variant of the three stage reduction continuum suggested by Holmes (1890, 1894). Modern experimental stone tool manufacturing (Whittaker 1994) is often used to identify reduction techniques and production sequences (Crabtree 1972; Callahan 1979). Making stone tools also produces waste flakes (debitage) and unfinished pieces that break during manufacture (failures). Each of these artifact categories has its own specific set of analysis techniques and categories (Andrefsky 2001; Hall and Larson 2004). One of the hallmarks of reduction stage studies is their focus on a particular aspect of stone tool manufacture and use, for example debitage analysis or use-wear/microwear studies.

Reduction stage studies in Florida, for all their statistics and invested time, have been able to confirm only the most obvious of hypotheses (Austin 2002:164-166). Archaeological sites that are closer to raw material sources tend to exhibit longer reduction trajectories and contain flakes that have more cortical (outer rind) material on their dorsal or outer surfaces. The most socially informed results of these studies have
come from the evaluation of where the stone for various kinds of tools was obtained and in what state or condition the artifact was in when it finally entered into the archaeological record. Although these techniques are very useful in extracting specific type of information about prehistoric behaviors and tool use (Austin 2002, 2006), they have not provided an adequate model to address the questions at hand. Lithic reduction stage and functional studies simply do not produce the kinds of information necessary to address questions proposed in this study.

The Chaîne opératoire Approach

The chaîne opératoire or “operational sequence” approach is part of the intellectual legacy of François Bordes and other European archaeologists (Leroi-Gourhan 1993; Grace 1985; 1997; Schlanger 1994). The approach considers stone tools from quarry to recovery context. By reconstructing the operational sequence, the range of choices, decisions, and gestures made by the inhabitants of an archaeological site can be exposed (Banning 2000:141). Shott (2003:95-103) argues that the chaîne opératoire and reduction stage approaches are much the same thing. While both approaches focus on lithic technology, each perspective differs decisively on emphasis and meaning. While reduction stage approaches emphasis manufacturing stages and flaking techniques, chaîne opératoire expands this to a consideration of the social interaction of stone tool production and use.

Grace (1997) divides the chaîne opératoire up into four basic links: raw material procurement, technology, use, and discard. Technology is further subdivided into primary reduction, secondary reduction, and typology nodes. Each link can affect all of
the others. For example, the need to manufacture a specific kind of stone tool may influence both the procurement source of the material and the technology used to reduce the stone down to the desired form. Chaîne opératoire also allows for the evaluation of these choices as cultural markers rather than as solely functional choices and decisions (Dobres 2000:155-156).

The chaîne opératoire approach offers an alternative perspective from which to evaluate the use of stone tools. It highlights the connection between the stone tools and human social interaction and provides a basis on which a locally contextualized use of stone and stone tools can be constructed. It avoids superimposing a reduction stage sequence that separates stone implements into arbitrary categories like blank, performs and finished tools based on overall weight to thickness ratios, or thinness of the overall tool, or the development of a hafting area. It allows a stone implement to be simultaneously considered as a useable tool, a core for the manufacture of smaller flake tools, and the source of raw material for a tool that is needed for some later task.

There are several techniques that are often associated with the chaîne opératoire approach: raw material procurement studies, refitting analysis (Bleed 2004; Morrow 1996), studies of flaking sequences, experimentation, and detailed intra-site mapping (Sellet 1993:108-109). This level of analysis requires all the lithic material recovered from a site, carefully excavated and piece-plotted, something common to European Paleolithic site excavations, but rarely possible in the large, loose deep-sand sites of Florida (Austin 2002:166).
Stone Tool Life History

Tool use life and use life histories have been suggested by several researchers as a bridge between the typologies and traditions used in Upper Paleolithic lithic studies (Kuhn 1990, 1994) and as a proxy measure of tool curation (Andrefsky 2006). The overall premise is that stone tools are not static objects; they were modified for hafting, resharpened, broken, and altered into other forms throughout their use life. A newly-flaked stone tool looked very different prior to being hafted than it did as a worn-out/broken implement when it was finally discarded. Estimating the difference between these two forms can provide a measure of tool curation (Clarkson 2002; Dibble 1987; Eren and Prendergast 2008; Kuhn 1990, 1992; Wilson and Andrefsky 2008).

Curation has come to mean several different things in stone tool analysis and use (Andrefsky 2008a:7). Since the term has been popularized by Binford (1973, 1979) curation has come to mean both the transport of tools to new locations in anticipation of future activities (curation of use) and efficiency of tool use through multiple uses, situational modification, and resharpening (i.e., Bamforth 1986). This term has also become associated with various kinds of stone tools, particularly extensively shaped or carefully chipped tools like hafted bifaces and unifaces. Curated tools are often contrasted with expedient, or flake tools, which are seen as more opportunistic, less patterned in shape, and less likely to be refurbished or sharpened when they wear-down or become dull. Andrefsky (2008a:8) argues that curation is a function of tool use, not tool type. He sees a range of variation for curation from very low to very high, all relative to a tool’s maximum potential use.
Andrefsky (2006, 2008b) has proposed the hafted biface retouch index (HRI) as a proxy measure of curation. The HRI measures tool curation by assessing the amount of tool retouch or resharpening that has been performed along lateral blade margins. The blade area is divided into 16 sections, eight on each side of the artifact. Each area is assigned a retouch value based on the extent and location of flake scarring. A segment with no evidence of retouch is assigned a zero value; significant evidence of resharpening is assigned a value of one. Regions of roughly proportional scarring are assigned a value of 0.5. The values are then totaled and divided by the number of sections identified on the tool. The HRI value ranges between zero and one. It is useful for broken artifacts because only existing portions of the blade need to be considered.

The average HRI value for tools from different quarry areas can then be calculated and compared. Andrefsky (2008b:208) associates greater intensity of resharpening, therefore higher HRI values, on tools that have been made from materials that were quarried at greater distances from their recovery site. Bifaces made from more local materials were not resharpened to the same extent, suggesting that they were replaced rather than refurbished.

**Quarry Cluster Chert Provenience**

Sellet (1993:108) defines four goals for the analysis of the raw materials used by prehistoric tool makers. The analysis should determine the types of raw materials that are being brought to and used at the site. It should determine the importance of these materials both in terms of the quantities of raw materials and the qualitative importance of these materials to the site’s occupants. The analysis should define the shape and size
Determining the specific sources of the tool stones used by Florida’s prehistoric peoples has been one of the primary goals of Florida lithic studies since stone tools came into their own in archaeological circles in the late 1960s. As early as the 1940s, Clarence Simpson (1941) published a concise discussion of chipped stone use in Florida that more recent researchers have done little to expand upon. Simpson (1941:32-33) defined the major chert-bearing geological formations, the locations of major outcrops, the use of silicified (agatized) corals, the prevalence of stone tool manufacturing sites around the major quarries, and the use of Florida’s many streams, rivers, and lakes as avenues for the movement and exchange of chert from the chert-rich to the chert-poor regions of the state. Over the past 50 years, archaeologists have been able to add the details to many of the broad insights made by Simpson. The ability to assign chipped stone tools to specific regions of the state and even to specific quarry areas marks a leap forward that even Simpson had not anticipated.

Stone tool analysis in the 1950s and 1960s focused on developing hafted biface typologies and classifications and assigning these tool types to various temporal and cultural phases. Investigations and subsequent publication focused on the larger lithic sites in central Florida like the Johnson Lake site (Bullen and Dolan 1959), the Bolen Bluff site (Bullen 1958), the A-356 site (Clausen 1964), the Suwannee and Whitehurst...
sites (Goggin 1950), and the Silver Springs site (Neill 1952, 1958). Interest focused on creating artifact typologies and assigning names and chronological affiliations to the various hafted bifaces that were being identified in much the same way that pottery types had previously been categorized during the 1930s and 1940s (Bullen 1963, 1967, 1968a, 1968b, 1969; Lazarus 1965; Neill 1963, 1964a, 1964b, 1966, 1971; Simpson 1948; Warren 1963, 1966; Warren and Bullen 1965). Ripley Bullen (1968) published the first typology of Florida points which was quickly updated, expanded and republished just prior to his death (Bullen 1975, 1976). Bullen’s “point guide” is still used as the primary naming reference for most of the hafted bifaces discovered in Florida, although several of his chronological assignments have been revised (Farr 2006; Mikell 1997; Tesar 1994).

Renewed interest in determining the provenience of Florida’s chipped stone tools developed out of Barbara Purdy’s interest in the use of thermal alteration and weathering to determine the age and origin of lithic implements. Purdy pioneered several early studies into the use of thermal alteration (1974, 1976) and the use of interdisciplinary collaborations to investigate specific issues in archaeological research (Purdy and Blanchard 1973; Purdy and Brooks 1971; Purdy and Clark 1979). She was also a pioneer in the use of petrography in provenience studies (Purdy 1976; Purdy and Blanchard 1973; Purdy 1981:137-140).

The question concerning where lithic materials came from can be addressed with a variety of different kinds of approaches. Geological science provides a variety of geochemical (elemental) analysis techniques including x-ray fluorescence spectrometry (XRF), particle-induced x-ray emission analysis (PIXE), electron microprobe analysis (EMPA), instrumental neutron activation analysis (INAA), inductively coupled plasma
emission spectroscopy (ICP), and atomic absorption spectroscopy (AAS). All of these techniques require the recovery of small (or sometimes not so small) samples of material to be analyzed. There are also a variety of techniques that measure the reaction of a sample to ultraviolet and other non-visible light spectra including ultraviolet fluorescence and cathodoluminescence (Church 1994; Luedtke 1992). Color, density, and even magnetism have been proposed as methods to determine the mineralogy and ultimately the source origins of knappable stone (Church 1994).

A promising approach for sourcing chert comes from a study of chert quarries in northeast Alaska. Malyk-Selivanova et al. (1998) have combined geological and geochemical approaches with an intensive sampling program from known quarry locations to source cherts. INAA and EMPA with x-ray diffraction were used to provide the geochemical signatures, while petrographic microscopy and the identification of mineral inclusions, fossil inclusions, and color were employed to provide the geological context (Malyk-Selivanova et al. 1998:677-678). From these data a regional lithic database was constructed. Comparison of the various archaeological samples to the known quarry locations was done by simple bivariate plots and correlations were established by visual comparisons. The authors report a 20 percent success rate matching prehistoric artifacts recovered from various museum collections and their quarry sample (Malyk-Selivanova et al. 1998:703). This infers that 80 percent of the artifacts could not be paired with a know quarry source that they had sampled.

There has been a strong interest throughout the Southeast to identify the specific quarry sources of what are regionally called “coastal plain cherts” (Goad 1979; Goodyear and Charles 1984; Upchurch 1980; Upchurch et al. 1981). Coastal plain cherts are all
replacement limestones that are found embedded within the various limestone strata that underlie the region; all chert from Florida is considered to be of the coast plain variety. Goad (1979) sampled a variety of coastal cherts in Georgia, and used INAA to attempt to identify specific quarry locations. The variability with her small sample did not allow her to distinguish specific quarry sources (Goad 1979:39). Goodyear and Charles’s work (1984) was assisted by Sam Upchurch, but focused on identifying various outcrops within the southern (Allendale County) area in South Carolina. Despite these promising beginnings, the search for sources of knappable stone in the Southeast has not moved much beyond these preliminary studies.

Chemical and elemental analysis has not played a major role in the determination of provenience for Florida cherts. Purdy (1976, 1981) used INAA and PIXE analysis on chert from the Senator Edwards site in Marion County. Purdy (1981:117-122) was able to differentiate cherts from Florida from English flint and cherts from outside the Southeast, but was unable find a clear signature that would allow the differentiation of one Florida chert from another. Clark and Purdy (1979) used EMPA in a sample of chert to determine the elemental composition of the outer weathering surface (cortex) in an attempt to establish a relative dating technique similar to obsidian hydration, but they were unable to find a stable rate of cortex formation.

Working under a grant from the Florida Division of Historical Resources and partly funded by the Florida Department of Transportation during the archaeological investigations conducted by the construction of the Interstate 75 bypass around Tampa (Pollock 1986), Sam Upchurch, Richard Strom, and Mark Nuckels with the University of South Florida (Nuckels 1981; Upchurch 1980; Upchurch et al. 1981) developed a
multifaceted technique for determining the quarry provenience of cherts in Florida. The procedure has become widely known as quarry cluster analysis (Upchurch et al. 1981:93).

Upchurch (et al. 1981) and Nuckels (1981) used both thin-section petrographic analysis and XRF to analyze the initial samples that were used to create the original 19 chert quarry clusters identified in Florida. Sixty-three samples were processed in the initial study and 54 more samples were processed by Nuckels (1981) for his Master’s thesis research. XRF analysis was destructive to the samples being considered, so the analysis was limited to only samples that were recovered from geological contexts. The results of both the elemental analysis and Ultraviolet Fluorescence (UVF) values were reported by Upchurch (et al. 1981), but these results have never used by archaeologists. The final results of the XRF analysis (Upchurch et al. 1981:147-160) indicated that iron, magnesium, titanium, sulfur, phosphorous and aluminum showed significantly greater variability between quarry clusters than within them. These elements should be able to identify specific quarry cluster or subclusters on a chemical (elemental) level. At present it is not possible to use either the element data or the UVF information to classify archaeological materials because there are too few comparative samples from each of known quarries. Quarry cluster determinations are made based on fossil content, rock fabric and inclusive materials, especially quartz sand (Upchurch et al. 1981).

Discussion

There are a large number of analytical procedures available that can be used to investigate the chipped stone assemblage from the Crystal River site. Previous
investigations at similar sites along Florida’s west coast (Austin et al. 1995; 2008; Estabrook and Williams 1992) suggest that some of the techniques, especially stone tool reduction stage and functional analyses procedures may not provide the types of information necessary to address the questions that were being asked in this investigation. A different set of measures were necessary. A set of measurements and observations that examined the same flakes, used, broken, and discarded stone tools from a perspective that provides different insights, different attributes, and a new and different set of data that can be applied to a different set of research questions. My goal is to add a new series of techniques to expand and complement these traditional functional studies.

The chaîne opératoire approach moves the study of stone artifacts beyond the constraints of a functional object and allows them to be considered in the realm of prestige goods or even as inalienable wealth (Weiner 1995). Some lithic analysts (Austin 1997; Purdy 1981) suggest that artifacts are scavenged from older archaeological deposits simply because they filled a utilitarian need or were an object of opportunity without ever considering their perspective role in a larger social context. I believe that while many stone tools were just made, used and discarded during the course of every life, some stone tools may have had a larger social meaning and larger social role and that the chaîne opératoire approach provides the best opportunity to describe these meanings and roles. However, without a complete artifact recovery many of the techniques required by this approach are simply not possible. Detailed artifact distribution maps do not exist, nor can they be created, and far too few waste flakes and other flaking debris were recovered to attempt to refit anything except the obviously broken parts of single artifacts.
The use of stone tool life histories (Andrefsky 2006, 2008a, 2008b) has shown to be a useful measure of the degree to which hafted bifaces have been curated. Distance from quarry sources and degree of curation, as measured by the HRI, indicated that similar tool styles, like hafted bifaces, had very different use life histories. The life history approach has recently been applied to an analysis of Early Archaic hafted bifaces from the Jennie’s Better Back site (Austin and Mitchell 2010), although the HRI was not used.

Previous research (Austin and Estabrook 2000) indicates that chert exploitation in Florida shifted from the use of specific sources of well-silicified stone during the Paleoindian and Archaic periods to the use of more-poorly silicified local materials during the Woodland and Mississippian periods. Availability of chert, regardless of its quality, appears to have become more important than the quality of the material. Analysis of lithic materials from coastal shell middens (Austin 1995a, 1995b, 2001; Bellomo 1995a, 1995b; Estabrook and Williams 1992; White and Estabrook 1994) and other Weeden Island sites (Milanich et al. 1984:69-74) suggests that chert tools were used in specific ways. Microliths dominate stone tool assemblages at many smaller coastal middens (Austin 1995a, 2000; White and Estabrook 1994) while appear to be completely absent from the assemblages of other sites dominated by bifaces and flake tools (Bellomo 1995a, 1995b; Estabrook and Williams 1992). Thus far, no microtools or microliths have been identified from the Crystal River site (Weisman 1995).

Many other factors can come into play when dealing with the availability of knappable stone. Quarry exhaustion, or simply using up the knappable stone, plays a major role in the availability of chert, especially when dealing with small local outcrops
that contain only limited amounts of material. Prehistoric cultural norms and territoriality were certainly a factor. Some quarries/outcrops may have been off-limits to specific groups, while individuals may have been obliged to use specific sources, even if the materials were of lower quality than might otherwise have been available (Austin and Estabrook 2000). Tied closely to this was the desire to use specific materials for specific tasks. Grainy, hard cherts may work well as bits for scraping and adzing type tools, but well silicified materials were often highly sought for making projectile points and hafted knives.

**Geographic Information Systems (GIS): Theoretical Overview**

GIS techniques were used extensively throughout this investigation. Two specific GIS techniques were employed: the Weights-of-Evidence (WofE) procedure (Bonhan-Carter 1994) and the development of cost-paths for modeling the travel of tool stones from various quarry sources to the Crystal River site. The WofE procedure was used to address a concern that there are likely to be known or unrecorded chert outcrops and quarries in and around the Crystal River region. A WofE was developed to predict chert outcrops locations by combining a series of geologically-based input datasets. These data, as well as information from known outcrops (Austin 1997; Endonino 2007; Upchurch et al. 1981) and the Florida Master Site File (FMSF) were used to identify the chert sources used in this analysis. A cost surface was developed to model the movement of chert along a series of travel pathways from quarry to final discard location. A series of paths are generated from the cost surface that provide an alternative to the “as the crow flies” straight line distances that are frequently used to evaluate the relations between
stone quarry locations and the locations where tools were finally abandoned (Austin 1997; Deming and Estabrook 1994; Janus Research 1998). In a region replete with salt marshes, rivers, creeks, sloughs, pine flats, and sand hills, and a correspondingly complex social landscape, travel in a straight line was probably rarely an option.

The development of a WofE model and a cost path model to evaluate the locations and probable modes of transport of knappable stone is a complex undertaking. Model development must be based on the careful integration of data, measurements, and information that is used to create the appropriate predictive surface. If any one component of the underlying information is biased, inaccurate, or incomplete, or if a significant component of the data or measurement is left out, the resulting model may be suspect and the implications and predictions derived from that model may be incorrect (i.e., Aldenderfer 1991). It becomes the classic data analysis conundrum – “garbage in, garbage out.” That being said, it should also be kept in mind that any computer-based model is just that – a model. Like a map, a model should strive to be an elegant representation of a real-world phenomenon.

GIS-based regional and landscape studies in the United States strongly focus on the development of predictive models and rely heavily on environmental data (e.g., Allen et al. 1990; Judge and Sebastian 1988; Westcott and Brandon 2000). This reliance is so strong that claims of environmental determinism are often made against them (van Dalen 1999:117). These studies often view physical space as an open container within which prehistoric cultural systems interacted - constrained by some environmental conditions and assisted by others. GIS-based regional studies in Europe view archaeological sites through landscape and agent-driven frameworks and consider sites within both their
social and spatial contexts (Whitley 2002:1). This approach emphasizes the individual’s cognitive viewpoint where perception is often a product of cultural identity and symbolic or ideological interaction (Witcher 1999:15-16). The European perspective dismisses the idea of absolute geographic space and begins from the premise that people in prehistory mapped onto social spaces that were situationally defined (Gillings et al. 1999; Lock 2000; Lock and Stančič 1995; Wheatley and Gillings 2002).

Mapping social space is a much more challenging task than mapping existing physical spaces. Data sets containing any number of different parameters of the physical environment are readily available. GIS layers for soil type, vegetation cover, elevation, various water bodies including lakes, rivers, and wetlands, have been developed for all of the United States and much of North America. Detailed environmental data sets can now be simply downloaded from the internet and plugged into any one of several off-the-shelf GIS software packages. This makes mapping physical space comparatively easy. Mapping social space requires a more considered evaluation as social spatial datasets are uncommon and often must be generated to address specific research objectives (Wheatley 1993:135).

The processual – post-processual debates also entered into the approaches taken by GIS studies; on both sides of the Atlantic users of this technology took sides. Wheatley (1993) argued that GIS was not a theoretically neutral tool and that the ecological bias of most datasets used by many (mostly American) GIS users strongly favored functionalist approaches, often with environmentally deterministic overtones. Kvamme (1996) identified considerable similarity between the American and European perspectives, and recent works by Wheatley and Gillings (2002) and Conolly and Lake
Canadian GIS applications appear to follow an American functional model (Elbert 2004). This chasm in approaches extends directly from the approaches taken by processual archaeologists in America and post-processual archaeologists in Europe (mainly in England).

In Europe, where spatial analysis and GIS have a long history (Bailey and Gatrell 1995; Hodder and Orton 1976), GIS has focused on landscape analysis and viewshed studies (Gillings et al. 1999; Lock 2000; Lock and Stančič 1995). Landscape and viewshed studies follow the work on the phenomenology of landscapes (Tilley 1994; Tilley and Bennett 2004). One of the primary differences between the American positivist approach to GIS data and the socially-inspired European GIS viewpoint is the way that both map landscapes. The positivist approach measures absolute space and absolute distance. These studies assume that geographic distance measured today is equivalent to the distances conceived by people in the past. The European approach considers social distances and how people map social space. The European perspective consider the idea that although two quarry locations are equally distant from a site, one might be much easier to access or is along the route to other resources that are not considered in the positivist perspective. The European approach attempts use GIS to map social landscapes whereas the positivist perspective employs GIS to map the physical environment.

GIS is a powerful tool for identifying features within a regional environment and has been used extensively to model and evaluate archaeological landscapes (Gillings et al. 1999). Various approaches have been forwarded to evaluate archaeological landscapes including site catchment analysis, cost surface analysis, and line-of-sight
Site catchment analysis (Vita-Finzi and Higgs 1970) was an early attempt to consider the human use of regional landscapes. Regular catchment sizes (5 km, 8 km, 10 km), standard territorial shapes (triangles, squares, hexagons) and other computational limitations hampered the usefulness of this technique. Cost surfaces and line-of-sight studies (Wheatley 1996) have attempted to address some of the theoretical and methodological limitations of site catchment analysis. Cost surface analysis employs a cost accumulation algorithm to track the “cost” of moving across a digitally defined landscape (Wheatley and Gillings 2002:151-152).

Line-of-sight analysis attempts to use the viewshed functionality of GIS software to determine the visibility of a given location within the surrounding terrain. This technique uses a digital terrain model to determine which areas are visible from an established location. Visibility studies are often made of sites that contain large monumental architecture, like hill-forts and signal towers (van Leusen 2002:6-9, 6-10). Of these techniques, cost surfaces provides a useful tool for evaluating the relative “costs” involved in the acquisition and use of raw materials for tool manufacture and use. Drawing analogies to modern economic theory, it is often assumed that the least effort, or the lowest cost solution, was employed to satisfy these raw material needs.

Socially-inspired GIS (Fisher 1999; Witcher 1999) provides the best first approximation of mapping prehistoric social landscapes. This approach avoids the environmental determinism that has thus far hampered efforts to use GIS to do much more than predict the likely locations of archaeological sites and identify likely areas of resource exploitation. While I do not see an application for the viewshed studies that are
currently in vogue in Europe and elsewhere, cost or friction surfaces can provide a good approximation or model of prehistoric lithic acquisition and transport.

The Ecological Fallacy and the Modifiable Areal Unit Problem

There are several potential sources of error in spatial analysis studies, but the two most prevalent are the ecological fallacy and the Modifiable Areal Unit Problem or MAUP (Openshaw 1983). The ecological fallacy involves inferences made about individuals based on the collective statistic calculated for a group to which the individual belongs. The fallacy assumes that all individual members of the group exhibit the same characteristics as the group at large (Lock and Harris 2000:xx). These members could be people, chert quarry sources, or any other spatial data that are typically aggregated into groups.

The MAUP is another source of potential error in spatial data and is closely related to the ecological fallacy (Openshaw 1983; Unwin 1996). MAUP issues arise from the aggregation of data at arbitrary spatial units or levels that are inappropriate to the analysis at hand (Wheatley and Gillings 2002:43-44). Spatial data often aggregated at levels that are arbitrary, modifiable, and subject to change. These arbitrary units can include areas like census districts, modern political boundaries (cities, municipalities, and the like) or standardize spatial units, like square miles or 90 meter cells. Within archaeology, site locations and other data are often aggregated by county (Simpson 1996) or some arbitrary distance (East 1998a, 1998b) without regard as to how that affects the spatial analysis being considered.
Scale takes on several meanings in a spatial analysis of this type. In the initial question, it refers to the physical size of the data in question and whether the required observations can be made with or without the need for instrumentation. Scale becomes an issue when considering things that are either very small or very large (Lock and Molyneaus 2006). Scale also becomes important in the consideration of the data themselves. Data can be captured on a variety of scales, and modern GIS allows these scales to be changed quickly, often with little or no regard to the scale at which the original information was generated (Lock and Harris 2000:xix).

An obvious example of these problems can be seen in the Florida Master Site File (FMSF) archaeological site location GIS layer currently available from the Florida Division of Historical Resources. The locations and the boundaries for all archaeological sites were originally digitized in the 1990s from standard 1:24,000 scale USGS quadrangle maps. The site locations and boundaries had been drawn on the original paper maps over the years by various people with widely different levels of mapping skills. The site boundaries and often the site locations can be considered general, at best. Today, these GIS-generated site locations and boundaries are often superimposed over 1:200 scale aerial imagery to determine the extent of archaeological resources onto specific properties. Often these boundaries do not match the actual extent of the site. This use is error-prone as it fails to consider the scale at which the original data was generated and assumes accuracy at scales for which it was never intended.
Cost (Friction) Surface/Cost Path Development

A cost surface is a raster-based (cell-based) GIS procedure that employs a series of square cells to represent a prehistoric landscape (Wheatley and Gillings 2002:152-154; Conolly and Lake 2006:252-256). Raster-based analysis was one of the first GIS data structures developed (Maschner 1996:3-4), and it has been extensively used within archaeology (Aldenderfer and Maschner 1996; Allen et al. 1990; Judge and Sebastin 1988; Lock and Stančič 1995). In many ways raster-based GIS is similar to a digital picture, with each pixel representing a single cell and the entire picture or image representing a portion of the prehistoric landscape in question. The size of the cell can vary from a few centimeters to over 90 meters, depending on the source of the imagery and the kind of analysis being considered. Each cell typically is only assigned a single “value” but a cost surface model is nearly always comprised of multiple layers, known as input grids, often one for each attribute being considered. Each of the cells in an input grid matches geographically to the cell above it and the one below. This allows the values in these cells to be manipulated in various ways (e.g., added, subtracted, and otherwise combined). The size of the cells, the way in which the cell value is generated, and the way in which the attribute data assigned to each cell is compared must be all carefully considered.

The “cost” of the surface is typically measured in one of two ways: as the time it takes to cross over a particular cell region or the energy often defined in terms of calories that it takes to make the crossing. Walking down a well-worn path or canoeing downstream on a free-flowing river requires comparatively little time or energy (calories) whereas traversing uphill through dense, upland scrub undergrowth or paddling upstream
requires the exertion of considerable energy and takes a good deal more time. Cost surfaces are often associated with digital elevation models (DEM), or digital terrain models (DTM), as slope, which is often derived from elevation, is one of the often cited “costs” in friction surface development (Carballo and Pluckhahn 2007:612; Hare 2004:802-803; Howey 2007:1835; Jennings and Craig 2001:488).

Travel and transport are but two of the many factors that need to be considered in a model of flaked stone tool transport and use. The inherent usefulness of specific kinds of stone, the use of alternative materials, like shell, wood, and bone, manufacturing and modification techniques and processes, use-life and the potential for replacement tools must also be considered. These social costs of stone tool use are the most difficult to quantify, but are the most interesting for the analysis. Researchers must also keep in mind that a cost surface model is an approximation of a complex and dynamic prehistoric social process. Like a map, a model is a simplification of the real world that includes approximations of the various processes, systems, and interactions in question and attempt to evaluate how they interrelate.

A cost surface overcomes the use of a simple direct path measurement of source to site, a seriously limiting factor of many lithic resource procurement studies in Florida (Austin 1997; Austin and Estabrook 2000; Deming and Estabrook 1994; Janus Research 1998). The optimal path between a raw material source and the final resting place within an archaeological site of the artifacts made from that material is rarely best represented by a simple straight-line. The procurement of knappable stone, like many other resources used by prehistoric peoples, required traversing a path through difficult terrain, overcoming natural and social barriers, or exploiting natural transportation corridors, like
rivers, lakes, and sloughs or trails and game paths. Procurement may have taken
advantage of some social relationship, like trading partnerships (Austin 1997:595-597) or
even help foster stronger kinship ties and other social alliances (Sassaman 2006:134-
135). Quarry “ownership” (Purdy 1981:83-85), territorial concerns, demand for material
(Luedtke 1984:65-66), regional conflicts and political alliances might also have played an
important role in resource procurement. Some of these barriers create considerable
resistance to the movement of materials, while others facilitate movement and result in
little resistance. An optimal path is one that passes through an origin (material source)
and a final destination (archaeological context) with a minimum accumulation of these
resistances or “costs.”

Selection of the input variables becomes the first important step in the analysis.
Most researchers (Carballo and Pluckhahn 2007; DeSilvia and Pizzolo 2001; Howey
2007; Jennings and Craig 2001; Kantner 2004) use a slope function, typically derived
from the elevation variable of a DEM or DTM, as the primary defining variable. Slope,
particularly when tied to the “hiking function” (Tobler 1993), a simple calculation that
quantifies how easily (or how quickly) a person can walk across an area of a given size
and slope. The next most common input data set is a landform or vegetation layer which
typically is used to calculate the difficulty of traversing various wooded, swampy, or
grassland environments. Specific transportation corridors, including historic trails, roads,
and rivers, have been proposed by Howey (2007), Kantner (2004), and Whitley (2000).

The creation of the cost surface assigns a value to each of the grid cell that reflects
the cost of moving through that cell. Once generated, each of the input grids must be
calibrated (Berry and Scholar 2004) at a consistent rating scale so that each of the grids
can be compared. This eliminates large differences between input grids. For example, an elevation grid established in meters about sea level could range from zero to 90 meters in Citrus County and be ranked from zero to 90, whereas a vegetation grid may only reflect six different levels of difficulty from one to six. Calibrating the grids returns them all to an equal scale so that a 90 meter elevation does not offset the maximum vegetation grid value by a factor of more than ten.

Weighting the various input grids allows the researcher to allow some variables to be considered more important in the overall cost surface value than will other variables (Berry and Scholar 2004; Howey 2007). In many models, slope is a major factor in the level of difficulty assigned to every cell. In mountainous terrain steep slopes make walking uphill much more difficult and abrupt slopes, like cliffs, make traversing downhill risky, if not impossible. In Florida, elevation plays a much less pronounced role in travel decisions and might be weighted as less important than perhaps vegetation or the availability of a trail or natural path, like a waterway or coastline.

Cost surfaces can be developed simply to evaluate movement or they can be configured to evaluate travel in some given direction. Isotropic surface analysis evaluates movement, but not direction. Anisotropic surface analysis evaluates both movement and direction (Wheatley and Gillings 2002:152). The typical anisotropic models focus on foot travel either through open forest or along terrestrial paths or valley floors (e.g., Whitley 2000); many least-cost paths are terrestrially-based. They assume that the most “efficient” means of prehistoric transportation is by foot over land. Anyone who has hiked the forests and swamps of west central Florida realizes that overland travel
can be difficult in the region. Water travel, particularly by shallow-draft canoe, is by far a more effective way of moving around central Florida (White 2004:24).

Weights-of-Evidence Model (WofE)

Weights-of-Evidence (WofE) evaluation was included in this study soon after it became apparent that the number of known chert outcrops in the vicinity of the Crystal River site was less than expected. The concern was that any cost surface model that was created from a limited number of outcrops would likely have missed one or more significant sources of toolstone. Without the time and resources to conduct an intensive survey of the area for outcrops, this technique identified specific target areas that could be investigated and sampled. The hope was that if the technique worked as planned, it could be applied to other regions in Florida and the southeast. This would help build a more comprehensive database of chert sources in the region.

WofE is a Bayesian statistical approach within a raster-based GIS model that combines a variety of support criteria, or “evidence,” to predict a series of outcome locations. It uses a body of information about the presence and absence of the event relative to other known features or events to make this prediction. It has been used extensively to predict the likely locations of mineral deposits (Agterberg et al. 1990; Bonham-Carter 1999; Bonham-Carter et al. 1988). It has been used in archaeological contexts to model the dispersal of early hominin out of Africa (Holmes 2007), late Maya settlement patterns (Ford et al. 2009), and predicting the locations of pre-Columbian sites in Trinidad (Reid 2003). WofE has recently been adapted to identify the probable source
locations for the tool stone used by Middle and Upper Paleolithic groups in Europe (Duke and Steele 2010).

Bonham-Carter (1999) discusses two approaches to WofE modeling, the first being knowledge-driven and the second being data-driven. A knowledge-driven model relies on the knowledge of experts to make predictions, much like an expert systems approach. The data-driven model uses a variety of different data sets to make the same predictions, but makes no apriorit assumptions about the predictive value of any particular attribute. Most models, in fact, are some combination of the two approaches, with a greater or lesser emphasis toward being knowledge or data-driven. The WofE approach allows for the interaction of these approaches.

The WofE approach is based on Bayes’ theorem, also called Bayes’ Rule of Probability (Raines et al. 2000:45). The mathematical complexities of Bayes’ theorem are discussed in Buck (et al. 1996:19-21), Bailey and Gatrell (1995:303-306), and Press (1989:15-18) and are not repeated here. Suffice to say that Bayes’ theorem provides a mathematical procedure for changing or enhancing your prior understanding of a phenomenon in light of new information. It is a formal procedure for incorporating knowledge obtained by experience with observational data, creating a greater understanding of the phenomenon in question. The process is cumulative, and allows for the calculation of specific posterior distributions (probabilities) that enhance our ability to predict outcomes to a much greater extent that does more conventional probabilistic statistics.

In the parlance of Bayesian approach, the known or current understanding described above is known as the ‘prior distribution.’ This distribution can be drawn from
imperial data, intuitive deduction, or some combination. It is the state of knowledge before taking into account any new data or observations. A ‘posterior distribution’ results from the combination of the prior distribution and additional data or observations within a Bayesian math model. The posterior distribution combines the prior distribution within the predictive value of the new data or observations to provide a better estimate of the values under consideration.

An example of how Bayes’ theorem works can be illustrated by Bonham-Carter’s (1994:302) chance of rain calculation, updated for central Florida. For example, someone is interested in predicting the likelihood of it raining on a single day in Tampa, Florida. The average chance of rain is central Florida is fairly high; it rains there a lot. Central Florida gets rain, on average, about 90 days of the year. A prior distribution of the chance of rain on any given day is 90/360, or .25 or 25 percent. A statement about the prior probability could be stated as – in central Florida it will rain one day out of four; on any given day there is a 25 percent chance of rain. But suppose two additional pieces of information are provided: the month of the year and whether or not it rained the day before. Central Florida has a very definite rainy season (and corresponding dry season). Also, the weather patterns that favor rain tend to stay in the region for several days. If the single day you interested in predicting falls in August, the height of Florida’s rainy season, the chance of rain rises to about 80 percent. If it rained the day before, that increases the rain chance the next day. With this additional information, posterior distribution (probability) of rain on a given single day rises significantly. In this way, a Bayesian approach allows for the cumulative consideration of existing information.
Not every new piece of information contributes to the posterior distribution. Some new data or observations may be negatively associated within the phenomenon in question. This would result in a lower value for the posterior distribution. Other values may be completely unrelated and would not affect the distribution either way. Conditional independence is one of the basic assumptions of the procedure (Bonhan-Carter 1994:309). This means that the evidence themes used should not be related to each other. Due to the relatedness of most geological information, this assumption is difficult to always justify; fortunately, the approach is fairly robust with respect to the violation of this assumption (Raines 1999:258) and contains procedures that can be used to lessen the dependence effect (Agerberg and Cheng 2002).

The WofE procedure uses exploratory data sets known as evidential themes to calculate a “weight” or predictive potential (Bonhan-Carter 1994; Hansen 2000). These evidential themes can be any spatial information, like geological formations, elevations, or the location of sinkholes, that might help predict the occurrence of an event, such as a chert outcrop. Evidential themes can be binary (presence or absence), categorical (e.g., soil types), or buffered distances, like a 100 meter area around a major river or stream. Training points, or known target locations, are used to calculate the weights or predictive potential for each evidential theme. The overall measure of the spatial association is called the contrast. Spatial association can be either positive or negative, so the contrast can be either positive or negative as well. The “weight” is a measure of the predictive value of the evidential theme based on its positive association to a training point. A positive weight indicate that more training point occur than can be attributed by chance;
negative weights indicate that less point occur (Raines et al. 2000:48). For each evidential theme weights are calculated based on (after Hansen 2000):

- The probability of an evidential theme element being present with a training point;
- The probability of an evidential theme element being present without a training point;
- The probability of an evidential theme element being absent with a training point; and
- The probability of an evidential theme element being absent without a training point.

The odds of occurrence, or logits, are calculated on a logarithmic scale and are added together to generate a value known as the contrast. The contrast associated with individual evidential theme components can then be compared to determine their overall predictive contribution. The weights of the best individual theme elements are added together to create a probability or predictive surface (Hansen 2000). Once a final predictive surface model is created, it can be compared to a subset of the original training data, to the results of other modeling techniques, or to suspected or anticipated element locations. For this analysis, I have chosen to use known prehistoric quarry locations from Upchurch et al. (1981), sites specifically identified as chert quarries in the FMSF, and locations provided to me from professionals and individuals working in the region. These locations were then compared to sites recorded on the FMSF that are suspected of being the source of lithic materials.
Chapter 3: Lithic Studies at Selected Sites in the Southeastern United States

There is a fundamental change in the lithic tool kits of prehistoric peoples at the end of the Archaic throughout the Southeast. The finely-chipped, thermally altered stemmed bifacial tool complexes that define many Middle Archaic assemblages and the resulting flaking debris that are ubiquitous at many Archaic sites fall from favor. Woodland peoples take up making expedient flake tools, often struck from amorphous cores, quarried from local, often low-quality lithic sources or scavenge left-over or broken implements from older sites for use as tools (Sassaman 1994; Parry and Kelly 1987). This chapter reviews the chipped stone assemblages recovered from nine Woodland mound complexes in Florida and the greater Southeast (Figure 3.1).

There are three broad trends that have been identified for Woodland societies in the greater Southeast that seem to have had a significant effect on the way that Woodland peoples considered lithic resources. The most notable is an overall trend: Woodland peoples tend to rely to a greater extent on local resources (Johnson 1987; Sassaman 1994; Stephenson et al. 2002). This includes a great variety of resources including plants, animals, and other foodstuffs, but stone for making tools figures prominently in this trend towards a greater local reliance. This is reflected in distance from quarry locations to habitation or special-use sites, which is typically lower than during the preceding Archaic period (Sassaman 1994:106). This shift has also been attributed an increase in sedentism
Figure 3.1. Woodland period mound complexes and other sites.
Woodland peoples are staying at specific locations for longer periods, changing residential locations less often, and are relying on specific local resources to a much larger degree than had peoples in earlier times.

There is a fundamental shift in the size and kinds of stone tools being made in peninsular Florida. Biface technology, which for thousands of years appears to have worked very well to cut, scrape, tip projectiles, and perform the tasks necessary to care for a relatively stable population, is replaced by a core/flake technology and limited-use flake tools. Expedient flake tools, requiring minimal modification and little production time, became the norm. Bifaces, when they are made, are now being made from relatively small flake cores and materials scavenged from the left over chipping debris found at older sites (Sassaman 1994:104). Johnson (1987:5) attributes this shift to the availability of raw materials. Amorphous core technology flourishes in regions where lithic raw materials are abundant. Bifaces use occurs in areas where higher quality lithic resources are available. Tools made from shell and bone become prolific, especially at coastal sites, where these materials begin to eclipse stone at the primary raw material for tool manufacture.

The trend toward the use of local lithic sources has been shown at sites within peninsular Florida. Austin and Estabrook’s (2000) overview of chert use in south and south-central Florida identified a shift at the end of the Archaic from the use of bifaces made from cherts coming from the Tampa Bay area to the use of flake tools and flake cores made from local cherts. Groups inhabiting the area east of Tampa in Hardee and DeSoto counties stopped relying on high-quality cherts from the Hillsborough River basin and began using stone from the Peace and Alafia river basins. Peace River cherts
are of lower quality, are more brittle, and tools made from these materials require more frequent replacement, but they were more readily available to groups living outside the Hillsborough River basin.

The final trend is not so much a Woodland period attribute, but a holdover from earlier times. Several researchers have noted that during Middle and Late Archaic times, biface exchange was a means of establishing and maintaining social alliances (Sassaman 1994:113). This practice is known for the greater Southeast where Turkey Tail, Benton, and similar large bifacial tools are made and traded in large numbers (Johnson and Brookes 1989). Caches, or small groups of these points, are often made on high-quality stone, or are made of materials that take additional time and effort in the manufacturing process, like thermal alteration. These materials and processes set these artifacts apart from the stone tools made and used for everyday tasks.

Biface exchange, or the production of specific bifacial tools, has also been noted in Florida (Estabrook et al. 2001). The Enclave site is a Late Archaic midden, quarry, and stone tool manufacturing site in central Pasco County (Austin et al. 2009; Estabrook et al. 2000a, 2000b; Estabrook et al. 2001). The analysis of material recovered from this site provided evidence for the extensive manufacture of well-made, thermally-altered, silicified coral Newnan points. These points are highly prized by local artifact collectors for their translucency, their bright red to orange color, and for their aesthetics. These points are often recovered at Mount Taylor shell middens along Florida’s St. Johns River (Estabrook et al. 2001). Austin (2008) has also noted the recovery of deep red to pink silicified coral points at Fort Center in south Florida and has noted their implications for social exchange.
Brose (1979:7) sees hafted biface exchange as a risk reducing mechanism to reinforce the social ties and obligations necessary to better cope with the demands of a growing population density, decreased mobility, and a resource base that is for the most part stable, but that can be subject to cyclical episodes of abundance and shortfalls. Sassaman (1994:99), after Wiessner (1982, 1983), focuses on the social aspects of this risk aversion behavior. He views the shift towards the use of an expedient core technology as a way of reinforcing social obligations and risk aversion for residence grouping or lineage.

**McKeithen site (8CO17)**

The McKeithen site (8CO17) is a Middle to Late Woodland mound complex located in western Columbia County (Figure 3.1) near Lake City (Cordell 1980; Kohler 1978, 1980; Milanich et al. 1984). This site is perhaps the most well-known and most extensively excavated Weeden Island sites in peninsular Florida. The site was first brought to the attention of archaeologists in 1966 when David Phelps and Charles Fairbanks recorded the site (Kohler 1978:42). Investigations began in the summer of 1977 and continued through 1979 under the direction of Jerald Milanich and Timothy Kohler at the University of Florida (Milanich et al. 1984:2-5). The McKeithen site covers roughly 20 hectares and consists of a complex of three mounds (Mounds A, B, and C) located atop a horseshoe-shaped village midden, which surrounds a central plaza devoid of both midden and artifacts (Kohler 1978, 1980; Milanich et al. 1984). The site was occupied just after AD 50 and was abandoned sometime around AD 900.
Chipped stone makes up about five percent of the McKeithen site’s artifact assemblage. Kohler (1978) oversaw the lithic analysis at the site; he also conducted the technological analysis of the site’s extensive ceramic assemblage as well. Rather than use the standard typology of the day (Bullen 1975; Cambron and Hulse 1975), Kohler created 27 worked lithic artifact “groups” based on similarities in shape and size. Ten groups were defined for the various hafted tools, points, and hafted knives. These included point styles that would typically be associated with a Woodland site in Central Florida (after Bullen 1975): Florida Copena, Santa Fe, Jackson, Duval, Tampa, Ichteucknee, and Pinellas points. Kohler (1978:115) also describes several categories of biface that did not fit well into Florida point types: Montgomery, Bradley Spike, Greeneville, and Nodena points (Cambron and Hulse 1975). Most of these points Kohler attributes to being made out of local cherts and many are made from silicified coral available on the nearby Suwannee River. There were at least four artifacts recovered that were obviously made from non-local materials.

Kohler (1978) indicates that, taken as a whole, the site’s chipped stone tool assemblage reflects a variety of point types, tool forms, presumed tool uses. Few illustrations are provided, but the tools that are shown take on a considerable variety of forms (Milanich et al. 1984:71-74). Frustration with his inability to easily categorize these artifacts, Kohler (1978:128) states: “objects which presumably shared common functions of cutting or scraping take on a bewildering variety of forms, as if the user had casually selected any remotely suitable item and made it work for the purpose at hand, discarding it after use.”
The production of hafted bifaces, cores, and most other formed tools apparently took place at or very near the McKeithen site. There was also a notable absence of large numbers of amorphous or prepared flake cores (n=4). Bifaces (n=152) outnumber modified and utilized flakes (n=84), and microtools (n=40) made from flakes. The ratio of bifaces to expedient flake tools is 152:124 for a value of 1.22 at the site (after Milanich et al. 1984:70-74).

Thermal alteration is relatively common in the McKeithen lithic assemblage. Thirty-seven percent of the silicified limestone (chert) artifacts recovered (n=2,405) from the village midden appears to have been heat treated; 23 percent of the silicified coral artifacts (n=72) were heat-treated (Milanich 1984: Table 4.3). These numbers indicate that the silicified limestone and coral were being heat-treated in much larger quantities than is typical at Middle Woodland sites in central Florida (Austin et al. 1995; Deming and Estabrook 1994; Estabrook and Newman 1984; Janus Research 1998). The greater percentage of heat-treated silicified limestone is also unusual as silicified coral is more difficult to flake in its unaltered form and is often heat-treated (Ste. Claire 1987:206).

Kohler (Milanich et al. 1984:70) assumed that source of most of the lithic material recovered from the McKeithen site was nearby stone outcrops and quarries. This is a reasonable assumption as there are many large chert outcrops just south of the site along the Suwannee and Santa Fe rivers. The site lies roughly midway between the White Springs and Upper Suwannee quarry cluster to the north and the Santa Fe cluster to the south (Upchurch et al. 1981:Figures 20C-20D). There likely are also smaller outcrops within close proximity of the site itself. There does not appear to be any effort on the part of the site’s inhabitants to secure better quality stone for tools. Locally available
resources were used mainly as expedient tools, used and discarded soon after the task at hand was complete.

The four artifacts made from non-local tool stone are diverse. One point, a Florida Copena-like Group 6 biface, was made from olive-green jasper (Milanich et al. 1984:71); another Copena-like point (Group 3) was made from milk (white) quartz. A Group 5 point, probably best categorized under Bullen’s (1975:8) typology as a Pinellas, subtype 4 point, was made from a “poor-grade consolidated sandstone-like material.” This material is probably Tallahatta quartzite, the nearest source of which lies in northwest Florida and southeast Alabama. One of the eight Group 15 hafted knives (Milanich et al. 1984: Figure 4.13B) is also made from non-local jasper. While not local to the immediate site vicinity, jasper, white (milk) quartz, and Tallahatta quartzite can all be obtained within 200 km (125 miles) of the McKethen site.

Five artifacts, categorized as the Group 22 tools, are described by Kohler to be stemmed, asymmetrical knives the size and shape of Archaic stemmed points (Milanich et al. 1984:73). All of these tools appear to have been thermally altered, and all but one is made from what appears to be made from a local chert; one, however, is made from heat-treated silicified coral. Kohler attributes these tools to scavenged and re-worked Archaic Stemmed points. A number of microliths/microtools were also recovered from the site. The Group 16 tools (n=29) and the Group 20 tools (n=11) are both described as being morphologically similar to specimens recovered from the Poverty Point site (Ford and Webb 1956; see White and Estabrook 1994).
**Fort Center Complex (8GL13)**

The Fort Center site (8GL13), now called the Fort Center Complex (FMSF), is located along Fisheating Creek in Glades County (Figure 3.1). This site complex contains 14 mounds, two middens, several earthworks features including the Great Circle and a charnel pond. The complex extends for roughly a mile along the west bank of the creek and extends across to the east side of the creek near the northern end. Outside of Marco Island (Gilliland 1975; 1989; Wheeler 2000), Fort Center contained the largest assemblage of carved wooden artifacts in South Florida. John Goggin began working at the site in the 1950s; this effort was later continued by Charles Fairbanks after Goggin’s untimely death in the mid-1960s. William Sears (1981) picked up on Fairbanks’s work at Fort Center in 1966 and completed the excavations in the early 1970s. Site reports include a monograph (Sears 1981) a master’s thesis by Karl Steinen (1971), and a recent reanalysis of some of the stone tools from the site by Robert Austin (1997, 2008). Steinen did the analysis of the non-ceramic artifact materials from Mounds A and B for his 1971 thesis (Steinen 1971). The remainder of these materials was considered in 1980-81 in preparation for the Fort Center monograph (Steinen 1981).

Chipped stone tools and related flaking debris made up only a small percentage of the materials recovered from the various site components. Steinen (1971:32) states that only 330 chipped stone artifacts were recovered from the site. His analysis focused on the 46 tools, mostly hafted bifaces/projectile points, recovered from Mound A and the 18 chipped tools recovered from Mound B. Also of note were 81 unworked chert nodules recovered from Mound A (Sears 1981:82). Like Kohler at the McKeithen site, Steinen, too, had difficulty assigning the points to the categories defined by Bullen (1968, 1975).
Steinen (1971) consulted other sources including Ritchie (1961) and Cambron and Hulse (1975), point typologies that were developed for New York and Alabama, respectively. Eight of the points recovered from Mound A Steinen assigned to the Alachua point type—a broad, well-made stemmed point typically associated with Archaic period sites. The rest appears to be typical Woodland point types. Mound B contained only typical Woodland points.

The chipped stone tools recovered from the charnel pond located between Mounds A and B contained a mixture of point types from both mounds. Steinen noted that different kinds of chert were used to make these points. The large stemmed points from Mound A and the similar points recovered from the pond appeared to be made from the same green/gray banded chert, whereas the tools from Mound B were made from pink or red chert (likely heat-treated). The only orange chert points came from the charnel pond (Sears 1982:91). Steinen classified the large stemmed points from Mound A and the charnel pond as knives and the smaller points from Mound B were seen as specialized woodworking tools used to create the specialized wooden carving found at the site. Two large chipped stone points recovered from the charnel pond Steinen ascribes to a “ceremonial” use although no evidence other than their lack of use-wear and their recovery context are offered to support this assertion (Sears 1981:92).

Austin’s (1997:321) reanalysis of the materials from Fort Center suggests that although projectile points played a significant role in the site’s activities, the small, unworked chert nodules at the site, and the tools made from them discovered within the “waste flakes” that Steinen did not inspect as carefully are the most abundant lithic material at the site. Austin (1997:Table 35) shows that the source of the majority of the
lithic materials found at Fort Center came from outcrops in the Tampa Bay region. The tools used for day to day cutting, scraping and boring activities seem to all come from the Tampa Bay region, whereas the specialized woodworking tools recovered from Mound B are almost all made from cherts that have their origins in north-central Florida (Austin 2008). Austin (1995b:Table 10.20) states that the biface to expedient tool ratio at the Fort Center site to be 125:65 for a value of 1.92.

From Steinen’s discussion (1973:75-83) and Austin’s (1997, 2008) re-analysis, there is clearly evidence of the use of thermal alteration within the assemblage. Of the 126 bifaces recovered from the site, 31 were described as thermally altered, 22 as “thermally damaged,” that is exposed to a heat source as evidenced by pot-lid fractures, crazing, or crenated fractures, but not necessarily intentionally altered, and 73 were classified as unaltered (Austin 1995b:Table 33). These data indicate that roughly 25 percent of the bifaces were intentionally thermally altered. This percentage rises to 74 percent when only the bifaces made from silicified coral are considered.

The patterns of lithic selection at Fort Center and the McKeithen site differ dramatically. The closest outcrops to Fort Center occur north of the site along the Peace River (Upchurch et al. 1981). These sources were known and were used by the site’s inhabitants, yet most of the chert found at this site was obtained from quarries and outcrops along the Hillsborough River. There is significant evidence (Austin 1997, 2008) for the use of stone imported from the Tampa Bay region and central Florida area. Tool quality stone at the McKeithen site appears to have been locally obtained, with only three reported instance of the use of an exotic or imported raw material.
Pineland Complex (8LL33)

The Pineland Complex (8LL33) is a large prehistoric site located at the northern end of Pine Island in coastal Lee County (Figure 3.1). When the site was first visited by Frank Cushing in 1897 it covered roughly 30 hectares, of which eight undisturbed hectares remain today (Marquardt 1992:48). The complex contains a complex of platform mounds and burial mounds, including Old Mound, the Smith Mound, Brown’s Mound and the Randell Mound, various middens (Citrus Grove Ridge), prehistoric canals, causeways, and plazas. Radiocarbon dates from the various site components range from AD 280 to AD 1460 (Marquardt 1992:Table 1). Like many coastal complexes, this site is an accumulation of material from multiple occupations and represents many time periods, but does contain a relatively large Woodland component. The site does, however, have a very interesting lithic assemblage. A monograph about the Pineland Site has been in the works since 1995. Chapter 8 of that monograph will describe the lithic artifacts recovered from the site. A draft was made available to me by the author Robert Austin (Austin 1995b), with permission from the series editors.

The lithic assemblage from the Pine Island site consists of 131 specimens: 25 bifaces and biface fragments, five microliths, six modified flakes, 11 utilized flakes, four hammerstones, three cores, and 77 waste flakes (Austin 1995b:9-10). Fifteen of the bifaces came from one site, Old Mound, and most of these came from a solid Caloosahatchee IIA (AD 650-800) context. They include Broward, Duval, Columbia, Taylor, Sarasota, and Ocala types (Bullen 1975) and all are firmly associated with Woodland contexts at other sites in the region. Almost all, except perhaps two of the bifaces appears to be a finished tool that was completely flaked and hafted. Two
specimens were classified by Austin (1995b:11) as unfinished; both display critical fractures that suggest they were broken sometime after being brought to the site but before they could be hafted and used. Austin (1995b) reports that although nearly all of the points were hafted and used (all displayed some form of use-wear along the edges), that tool use was not intensive. Only one of the tools appears to have been used to an extent where it could no longer be resharpened and reused (Austin 1995b:11-12). Five of the bifaces were made from cherts that originated from sources in the Tampa Bay area, two were made of Suwannee Formation materials (Brooksville/Inverness area), five were made of Crystal River Formation cherts (Gainesville/Lake Panasoffkee area), four were made from silicified coral. The provenience of five bifaces could not be determined (Austin 1995b:Table 10).

The waste flake assemblage from the site was discovered in a variety of contexts across various site components. No single reduction location or episode could be identified during the excavation (Marquardt 1992). Taken as a whole, the assemblage reflects the modification of previously modified tools and the production of flake (expedient) tools. The production of hafted bifaces, cores, and most other formed tools apparently took place before these items arrived at the Pineland site (Austin 1995b:43). Also notable is the absence of large numbers of amorphous or prepared flake cores. Bifaces (n=25) outnumber modified flakes (n=6), utilized flakes (n=11), and microtools (n=5) made from flakes. The ratio of bifaces to expedient flake tools is 25:22 for a value of 1.14 at the site (Austin 1995b:Table 6; Austin 1995b:Table 10.20)

Thermal alteration is relatively common among the bifaces in this assemblage but uncommon within the remainder of the chipped stone artifacts. Eleven of the 25 bifaces
are classified as heat-treated. Of these, three are made from silicified coral, the rest are silicified limestone (Austin 1995b:31). Evidence for heat treatment among the rest of the assemblage is more uncommon: nine of 77 waste flake, four of the flake tool/microliths, one small flake core, and a possible core/hammerstone were classified as being heat-treated.

Of note here is the observation that while the waste flakes, cores, hammerstones and other expedient tools were made from cherts originating in the Tampa Bay region, the bifaces (points) appear to have been made from stone from a much wider geographic range and from as far away as Sumter and Lake counties, 230 km (140 miles) north of the site. Tampa Bay, however, was not the nearest source of chert for the inhabitants of the Pine Island site. Outcrops along the Peace River (Upchurch et al. 1981:Figure 20H) and further south along the river at Zolfo Springs (Estabrook 1995) provided Woodland peoples in the interior regions with chert with which they made a variety of stone tools (Austin and Estabrook 2000). Peace River cherts are conspicuously absent from the lithic assemblage at Pine Island.

**Bayshore Homes Complex (8PI41)**

The Bayshore Homes site (8PI41) is a complex of mounds and middens extending along the shoreline of Boca Ciega Bay in southwest Pinellas County (Figure 3.1) situated in what is sometime referred to as the Jungle Prado section of the City of St Petersburg. William Sears worked at the site from 1956 to 1958 (Sears 1960) prior to and during the construction of the Bayshore Homes subdivision from which the site gets its name. Sears defined the site as a large platform (temple) mound (Mound A) and two burial mounds
(Mound B and C) located along a small stream that empties into Boca Ciega Bay. Sears also tested a linear midden extending south along the shoreline of the bay (Sears 1960:Figure 1). More extensive testing by Robert Austin and members of the Central Gulf Coast Archaeological Society (CGCAS) from 1998 through 2006 has determined that the site complex is a good deal more complex. The Bayshore Homes site complex now includes the nearly Abercrombie Park midden (8PI158), the Kutter Mound (8PI10650), the Ross-Rooney shell mound, as well as several other smaller unnamed sand mounds and middens, shell scatters, and areas of sheet midden. Despite all their many years of effort, the site boundaries are still somewhat inexact due to the intensive residential and commercial development in the area (Austin et al. 2008:2-8).

Sears (1960) focused most of his attention on Mound B, the larger of the two burial mounds at the site, and the overall ceramic assemblage from the complex. The only two lithic artifacts of note were two projectile points recovered from Mound B and photographed in Sear’s summary report (1960:Plate II b and c). Specimen b is a Marion-like Archaic stemmed point, while specimen c is a Hernando, subtype 1 point. Sears reports that the stemmed point was recovered in a cluster of graves that included four individuals: two flexed adult male burials, one adult male, and a forth that was probably female. The two flexed burials had co-mingled and that the point had been found near the ribcage of one of these two males (Sears 1960:23). In his re-evaluation of these materials, Austin (2008:130) reports that the stemmed point was thermally altered and that the stem was broken. Austin (2008:130) also reports that the Hernando point pictured by Sears was not included in the materials currently held in the FLMNH collections.
Austin’s (2008) re-evaluation of the lithic assemblage at the Bayshore Homes Complex included a review of the materials recovered by Sears held by the FLMNH, other artifacts from the site also held by the FLMNH, materials recovered from various site components during the nearly eight years that CGCAS worked at the complex, and artifacts from local private collections that were known to come from the site. The lithic component from Sear’s 1950s work proved to be relatively sparse. Sixteen chipped stone artifacts were recovered from Test #1 on the linear shell midden and two hafted bifaces (discussed above) and a single waste flake were recovered from Mound B. No chipped stone artifacts were recovered from Mound A. Sears recovered four bifaces from Test 1 (Austin 2008:Table 35; 128): a complete Broward point that had been scavenged and recycled from a older, more corticated biface, narrow rounded based-based biface with a broken tip (type undetermined), a small, crude biface implement, and a broken biface distal fragment. Also recovered were a small core and six unmodified chert fragments, two of which exhibited thermal damage.

Also included in this analysis were artifacts held by the FLMNH that were not recovered by Sears and materials collected by various individuals. These artifacts included a small stemmed point (Austin 2008:Figure 62c), a Pinellas point, a Levy/Putnam-like Florida Archaic Stemmed point, a Marion Florida Archaic Stemmed point, and a roughly-chipped biface that reportedly came from Mound B. Of these bifaces, none is typically associated with Woodland occupations.

CGCAS recovered 24 chert artifacts during their testing of the Ross-Rooney Mound component of the site (Austin 2008:Table 37). They recovered three hafted bifaces (two Browards/one Florida Copena), a uniface fragment, two biface fragments,
and five utilized flakes. Four flake cores, five large waste flakes, two “tested” chert fragments, and a hammerstone were also recovered from the mound spoil. Several of these artifacts are made from cherts that are not readily available in the immediate site vicinity.

The material recovered from the four test units included 34 chipped stone artifacts (Austin 2008:Table 39). None of the bifaces could be categorized as to type, although the single hafted biface fragment came from a basally-notched point. The excavations recovered three utilized flakes, one retouched flake, and 24 waste flakes from tool production and modification. One “tested” chert fragment and two unmodified cobbles were also recovered (Austin 2008:136). None of the artifacts from the Ross-Rooney Mound component or from Test Units 1-4 is described as having been thermally-altered. Based on these two site components, the ratio of bifaces to expedient flake tools is 8:9 for a value of 0.89 at the site (after Austin 2008:Tables 37 and 38).

Chert provenience analysis was only provided for the materials recovered from the Ross-Roony Mound and for Test Units 1-4. Of the two site components, the materials from the Ross-Roony Mound originated in the most diverse sources. Twelve artifacts were made from cherts the originated in the Tampa Member of the Arcadia Formation, and were likely obtained from sources nearby the site along Boca Ciega Bay or on Honeymoon Island. Eight artifacts were made on Suwannee Limestone materials, most of which appears to have come from Upper Withlacoochee Quarry Cluster sources, but one may have come from the Brooksville Quarry Cluster (Austin 2008:133). The large Broward point (Austin 2008:Figure 62a) is made from Ocala Limestone and appears to have been made from cherts originating in the Lake Panasoffkee Quarry.
Cluster. The materials from Test Units 1-4 were much less diverse. Twenty-one were made from local Tampa Member cherts and four were made from Suwannee Limestone cherts. With the noted exception of the single Broward point made from Ocala Limestone, all of the cherts used to make the stone tool assemblage at the Bayshore Homes site complex came from sources that are within 50 km (31 miles) of the site.

Kolomoki (southwest Georgia)

The Kolomoki site is the single largest and perhaps best known Woodland mound complex in southwest Georgia (Figure 3.1). The site complex is made up of at least nine mounds, and may have contained several more mounds as well as an earthen enclosure. First investigated in the late 1930s and early 1940s, it was not until the 1950s that excavations were conducted on six of the mounds and the village area (Pluckhahn 2003). William Sears, the archaeologist who ultimately excavated and interpreted the Fort Center site got his start at the Kolomoki site. The site covers some 120 hectares (over 300 acres) along Kolomoki Creek in the Gulf Coastal Plain east of the Chattahoochee River (Sears 1956). The site was first occupied around AD 350 and was eventually abandoned some around AD 750 (Pluckhahn 2003:4).

Sears (1956:27) focused much of his attention on the site’s extensive ceramic assemblage. His description and analysis of the stone tool assemblage barely extends for three-quarters of a page and are mostly impressionistic; Sears provides few data to support his claims. He stated that “less than fifty complete points” were excavated from the units he dug. Most were small (< 6 cm) and narrow and had straight blade margins. The example he provides in the text (Sears 1956:Figure 14) resembles a Duval variety
(Bullen 1975:13; Whatley 2002:38-39), a common Woodland projectile point type. Sears also talked about a collection of less than a half dozen large Archaic period projectile points that he described as being brightly colored. His description of the waste flake assemblage was that it was a large assortment and that it contained some quantity of utilized flakes, which were used without any additional intention modification. From Sears’ brief description, it appears that expedient flake tools were somewhat common at the site. Sears gave little indication about the source of this material, and dismisses any attempt to classify the material further citing that it “would only provide trait list enthusiasts with a few more items” (Sears 1956:27).

Pluckhahn’s (2003) more recent work at Kolomoki provides considerable insights into some of the observations made by Sears in the 1950s. Pluckhahn’s work included systematic shovel testing and a surface collection across portions of the site and block excavations in three areas (Areas A, B, and C). The intensive sampling phase of the investigations recovered 2,771 flaked stone artifacts including both early and late stage flaking debris, tools, which includes both shaped formal tools and unmodified or slightly retouched flake tools (Pluckhahn 2003:99). Over 70 percent (n=1,911) of these artifacts are made from local coastal plain cherts. The majority of the stone used to make these implements is a low-quality and is available in the immediate site vicinity, despite the fact that higher quality materials were available within a day’s travel from the site (Pluckhahn 2003:99).

Crystalline quartz is the next most common raw material used at the site. Crystalline quartz can be found in small cobbles in the nearby Chattahoochee River. This kind of quartz does not flake particularly well, as the crystalline structure of the quartz
and impurities in the rock makes controlled flaking of this stone particularly difficult. Roughly four percent of the material Pluckhahn (2003:104) recovered was quartzite, including Tallahatta quartzite and more vitreous, better quality quartzite varieties. Four artifacts made from what Pluckhahn (2003) classifies as Ridge and Valley chert. Artifacts made from this material were recovered from four scattered locations throughout the site. Ridge and valley cherts are high quality, dark grey/black cherts that are typically associated with the upland regions of northeast Alabama and northwest Georgia (Goad 1979; Pluckhahn 2003:104).

**Mandeville Site (southwest Georgia)**

The Mandeville site in southwest Georgia was investigated by the University of Georgia between 1959 and 1960 in preparation for the proposed damming of the Chattahoochee River north of Fort Gates (Figure 3.1). This project created Walter F. George Lake along the boundary between Georgia and Alabama. The Mandeville site was visited by C.B. Moore in 1907 and later by a crew from the University of Georgia in the early 1950s, but the first major excavations of the site were begun when the site was threatened by inundation (Kellar et al. 1962a). The site is made up of two mounds, a large platform mound (Mound A) and a conical burial mound (Mound B) with an intervening village deposit. The site is located on a terrace of the Chattahoochee River at the confluence of two small creeks that flow west into the river. Mound A is situated on the terrace overlooking the confluence; Mound B lies to the north along the river terrace. Uncorrected radiocarbon dates from the site suggested occupation from around AD 1 to AD 930 (Kellar et al. 1962b:354), although the AD 930 date seems suspect.
The 1959 Mound A (Stanley Mound) excavations contains the most completely described lithic component. Stone tools include various projectile points, including broad-stemmed Archaic varieties, micro-blades, prismatic blades, and prismatic flake knives (Kellar et al. 1962b). Flake scrapers, flake drills, and reworked projectile points were also recovered. Three of the prismatic flake knives were made from cherts originating in Flint Ridge, Ohio, while two others were made from a pinkish/white chert, and another was made from a non-local green chert or jasper. (Keller at al. 1962a:344). The issue of thermal alteration of the various lithic raw materials was not addressed in the final report (Keller at al. 1962a; 1962b).

The 1959 excavation on Mound A recovered a chipped tool assemblage that is contemporaneous with the occupations of the Crystal River site. This field season recovered 38 projectile points and 11 point fragments. A sizable expedient flake assemblage was also recovered including 15 blades, 45 flake scrapers, 13 flake knives, and four flake tools (Keller et al. 1962b:Tables 3, 6, 9, 12 and 16). The estimated biface to expedient tool ratio for Mound A at Mandeville is 49:77 or .64.

**Toltec Mounds (3LN42)**

The Toltec Mounds originally consisted of 18 mounds bounded by a roughly rectangular 40 ha area which was partially enclosed by a circular embankment (Rolingson 1982). The mound complex is situated on the bank of an oxbow lake along Plum Bayou, an abandoned channel of the Arkansas River (Figure 3.1). Several of the mounds and much of the circular embankment have been leveled or at least badly damaged by farming and rice cultivation. First excavated by Edward Palmer in 1882-1883 and published by Cyrus
Thomas in 1984, it was placed on the National Register of Historic Places in 1973 and became a National Historic Landmark in 1978 (Rolingson 1982:1). Excavations resumed at the site in 1966 with a nine-day training dig focusing on Mound C. Eleven 2x2 m test units were opened, five on the mound and six in the adjacent field (Miller 1982:30), which were later analyzed by David G. Anderson (Anderson 1979, 2008; Rolingson 1982:2). Long believed to be a Mississippian center, Rolingson’s work at the site documented an earlier Woodland component (White 1999:245). Dates of site use range from AD 700 to 1000.

There are no natural outcropping of knappable stone in the immediate site vicinity; all tool stone must have been transported to the site. The most common raw material type is small chert cobbles (Rolingson 1982:5). Other materials include crystal quartz, novaculite, sandstone (quartzite?), and various igneous materials. The chert cobbles are available nearby in secondary gravel deposits along the Arkansas River and its tributaries (Hoffman 1982:54). The novaculite and the crystal quartz both come from the Ouachita Mountains west of the site.

Hoffman (1982) inspected the materials recovered from Mound D and the Mound D Local gravel cherts make up 85 percent of the chipped stone tool assemblage in the submound component. Hoffman (1982:57) was unable to distinguish any greater reliance on flake tool production or biface manufacture in this component based on a preliminary inspection of the ratios of flakes vs. cores or by comparing the number of bifacial thinning flakes to the number of bifacial tools. Because of the relatively small size of the gravel chert cores, the overall differences between making bifacial tools and manufacturing flakes large enough for use as expedient tools. Novaculite comprises
roughly ten percent of the assemblage but was used exclusively for biface manufacture (Hoffman 1982:57).

Hoffman (1982:59) also inspected Feature D-1 within Mound D and found that novaculite played an even more limited role during later site occupations, and the focus changed from bifacial dart points to arrow points made from flakes struck from small cores. Even with the subsequent reinterpretation of the site’s submound component as zone of disturbed early mound construction (Miller 1982:34), an emphasis on biface production from chert and novaculite and the recovery of a small number of utilized flakes does not support the shift from dependency on bifaces to utilized flakes at this site.

Anderson’s (2008) report on the lithic materials recovered from Mound C and the artifacts contained within the Chowning collection supports Hoffman’s (1982) assertion that there was apparently no evidence for an intensive blade industry at the Toltec Mounds. His study supports the contention that novaculite was being transported to the site in some prior reduced form and finished as arrow points, especially during the Plum Bayou phase occupation. Crystal quartz was used for expedient use tools, but also for making arrow points. This material may have been conferred a status marker, as it was found with at least one burial at the site (Anderson 2008:23).

Anderson (2008:Table 1) provides a breakdown of the counts and weights of the artifacts recovered from the Mound C investigations. When the raw material categories are collapsed, 26 arrow and dart points and nine point fragments were recovered during the investigations. Anderson (2008) combines blades, and utilized flakes with unifaces, of which 60 were recovered in total. The estimated biface to expedient tool ratio for Mound C at the Toltec Mounds is 35:60 or .58. Anderson does report the recovery of
103 chert cores and two novaculite cores, a far larger number than was reported at any of the sites considered in this evaluation.

Thermal alteration and the specific properties it imparts on chert and novaculite, particularly a red and white coloration, respectively, and a waxy or glossy texture is considered one of the desired outcomes of the manufacturing process. Anderson (2008:24-25) suggests that biface color and gloss may have conveyed indications of kinship, status, war, conflict (especially red), peace, purity, and holy (especially white) and may have served as indicators of lineage or clan affiliation.

**Yat Kitischee site (8PI1753)/Rattlesnake Midden (8HI980)**

The Yat Kitischee site (8PI1753) and Rattlesnake Midden (8HI980) are two Woodland period shell middens that lie along Old Tampa Bay between Pinellas and Hillsborough counties (Figure 3.1). Their discussion here results from several overlapping considerations. Both sites were obviously occupation sites made up of the accumulated debris of many episodes of human habitation and both contain lithic assemblages that have been extensively analyzed. Both sites are roughly contemporaneous, both with each other and the Crystal River site. Both are situated in areas where a similar mix of resources, including chert, shell, and bone, are available for use as tools.

Yat Kitischee, also known as the Moog Midden, is located in northeast Pinellas County southwest of the St. Petersburg/Clearwater International Airport. This roughly 2.8 hectare site lies in an oak/palm hammock roughly 200 meters south of Old Tampa Bay (Austin et al. 1995). First discovered in 1992 when extensive looting was rampant at
the site, Yat Kitischee was the focus of a successful public archaeology program in 1994. The Pinellas County Planning Department, in cooperation with Janus Research, a local private consulting firm, carried out an extensive testing program at the site. This project resulted in 500 local residents experiencing archaeology first-hand and helping to preserve one of the last remaining intact shell middens in coastal Pinellas County (Pinellas County BOCC n.d.).

Much like at the Crystal River site, the inhabitants of Yat Kitischee used a variety of shell, bone, and stone tools (Austin et al. 1995). The stone tool assemblage included a variety of both formed tools, especially bifacial tools, microliths, and both modified and unmodified flake tools (Austin 1995a). Austin (1995a:212) considered all utilized pieces made on flakes or from flakes as expedient tools. Seventeen bifaces and 42 expedient tools were identified during both the 1992 Phase II testing and the subsequent 1994 excavations. Austin (1995a:212) considers the ratio of bifaces to expedient tools (.41) lower than similar ratios calculated for the Pineland and Fort Center sites (Austin 1995a:Table 10.20). This low ratio is attributed to the local availability of chert in the site area and the use of shell as an alternate raw material for expedient tool manufacture.

Of the 337 chipped stone artifacts recovered at the site, the vast majority came from outcrops within easy canoe distance of the site. Cherts came from the Hillsborough River, Turtlecrawl Point, and Caladesi Quarry Clusters, all sources which are found within coastal Pinellas and Hillsborough counties. Nearly 21 percent of the chert (n=70) was categorized as Type 4 chert (Goodyear et al. 1983:58) which is readily available along the shoreline of Old Tampa Bay (Upchurch et al. 1981). Only eight artifacts – a single biface and eight waste flakes were identified as originating from the Upper
Withlacoochee Quarry Cluster. These sources are located in eastern Pasco, western Polk and northern Hillsborough counties are within 50 km (31 miles) of the site. Of some interest are 23 silicified coral artifacts recovered from the site. Of these, five were bifaces and 16 were expedient tools. Only two of the silicified coral artifacts were not modified or utilized.

Excavations at the Rattlesnake Midden site (8HI981), also known as the Double Branch 3 site, were conducted as part of the 1984 USF Summer Field School (Estabrook and Williams 1992; Whitehurst 1988). The site is located within the Upper Tampa Bay Park along the bank of Double Branch Creek at point where the creek empties into Old Tampa Bay near Oldsmar, Florida. Discovered as part of an investigation when the park was first developed (Gluckman et al. 1978), the site was listed on the National Register of Historic Places as part of the Upper Tampa Bay Archaeological District (Estabrook and Williams 1992:39). The site’s ceramic assemblage indicates a multi-component deposit ranging from late Weeden Island through Safety Harbor times, roughly AD 500 to 1200.

The lithic component consisted of six bifacial tools, five utilized flakes, five broken or discarded biface fragments, and 489 waste flakes. The bifaces includes a Florida Archaic Stemmed variant, the base of a Bradford point, an Ocala point, two Pinellas points, and an ovate hafted knife (Estabrook and Williams 1992: Figure 4). All displayed some having been hafted or used as cutting/slicing tools or as the tips of projectiles. The flake tools were also used in a variety of cutting and slicing tasks (Estabrook and Williams 1992:46-47). The biface to expedient tool ratio is 6:5, or 1.2 for the Rattlesnake Midden site.
The source of much of the chert recovered from the site where the nearby outcrops along Rocky Creek or at Rocky Point, both well-known and prolific sources of silicified limestone. Common to both sources is Type 4 chert, a low-grade and fossiliferous material. Both sources are within six km (4 miles) of the site and are just a short canoe paddle east of the site. The majority of the waste flakes (n=361), the finished bifaces (n=3) and the broken biface fragments (n=5) were all made from Type 4 cherts. Only two of the five utilized flakes, however, were made from this material.

The preferred raw material for cutting and slicing activities was silicified coral. Six artifacts were made from this material: four of the chipped stone tools, including three of the six bifaces, two utilized flakes, and a manufacture failure (Estabrook and Williams 1992:47). Four were made from the common genus *Siderastraea* variety of coral, but two, the Archaic stemmed point and one of the two Pinellas points (1992:Figure 4a and 4b) were made from the coral species *Goniopora ballistensis* (Weisbord 1973:Plate 11), sometimes called “pinhead” coral. In 1992, the only suspected sources of this kind of coral were outcropping in Lake Thonotosassa region of Hillsborough County and the Wesley Chapel area of Pasco County. New sources have been discovered since that time. Pinhead coral can be found along the Hillsborough River near the State Road 60 (Kennedy Boulevard) Bridge and at Ballast Point on the Interbay peninsula (Weisbord 1973:17).

**Discussion**

Each of these nine sites adds to our understanding of tool choice, lithic raw material selection, transport and use, and the use of Archaic biface forms, especially thermally altered stemmed points, at Woodland mound centers in the Southeast.
Although these sites are not strictly contemporaneous or concentrated spatially, they do provide a good region-wide perspective on stone tool use. The trend of increased expedient tool use at the expense of formed bifacial tools is well-supported at some sites, but weak at others. As the numbers and ratios in Table 3.1 indicate, there is no overall support for the contention that flake tools dominate assemblages all Woodland sites. The biface to flake tool ratios at the McKeithen, Fort Center, and Pineland sites show greater to equal numbers of bifacial tools and fewer flake tools. The Toltec Mounds has a strong biface production assemblage (Hoffman 1982:57), but still produced a relatively low biface to flake tool ratio. The site with the lowest biface to flake tool ratios is Yat Katishee, a residential site located within a chert-rich area. Rattlesnake Midden is a similar site in a similar setting, but with a much higher ratio. This high ratio could be the result of relatively low artifact recovery counts.

Table 3.1: Biface to Flake Tool Counts/Ratios for selected Woodland Mound Complexes/sites in the Southeastern U.S.

<table>
<thead>
<tr>
<th>Site</th>
<th>Biface/Flake Tool Ratio*</th>
<th>Biface/Flake Tool Ratio</th>
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<tbody>
<tr>
<td>McKeithen</td>
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<tr>
<td>Fort Center</td>
<td>125:65</td>
<td>1.92</td>
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<tr>
<td>Pineland Complex</td>
<td>25:22</td>
<td>1.14</td>
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<tr>
<td>Bayshore Homes</td>
<td>8:9</td>
<td>0.89</td>
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<tr>
<td>Kolomoki</td>
<td>215:162</td>
<td>1.33</td>
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<tr>
<td>Mandeville</td>
<td>49:77</td>
<td>0.64</td>
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<td>Toltec Mounds</td>
<td>17:42</td>
<td>0.58</td>
</tr>
<tr>
<td>Yat Katishee</td>
<td>17:42</td>
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</tr>
<tr>
<td>Rattlesnake Midden</td>
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</table>

* Counts: Biface/Flake Tool

The incidence of thermal alteration is more anecdotal as complete data for this attribute is not provided for many of the sites. One apparent trend is the evidence for the
increased use of thermal alteration at those sites with a greater reliance on biface technology. This may indicate that thermal alteration is more strongly associated with a specific kind of tool production, like biface manufacture, or the kinds of raw materials used rather than with temporal affiliation (Ste. Claire 1987).

A strong reliance on local lithic sources, those less than 50 km distant from the site, is supported by most of the sites in this sample. Only two sites, Pineland and Fort Center, rely on lithic sources that are farther away than the nearest local source of stone. Both sites obtained the majority of the raw materials from sources in the Hillsborough River basin rather than using the much closer but much lower quality cherts in the Peace River quarry cluster. Not a single piece of chert from the Peace River was identified at either site despite an intensive effort to identify it (i.e., Austin 1995a).

Stone tool use at the McKeithen site follows the three overall trends noted for Woodland sites in the southeast. Although the analysis did not focus on identifying the sources of the stone, it does not appear that exotic lithic raw materials were used extensively at the site. At McKeithen, the selection of knappable stone appears to focus almost exclusively on local materials. This is likely the result of the site’s location. It is situated within the chert-rich karst regions of north-central Florida. The site’s inhabitants would not have had to travel far to procure a variety of quality materials from which to make stone tools. Transport appears to be of either finished tools or nearly finished tools. Milanich et al. (1984) did not find any stone tool manufacturing areas within the site, nor does the tool assemblage shown in Milanich et al.’s Figures 4.12 - 4.14: broken and misshaped pieces (manufacture failures) typical of intensive bifacial tool production. Discarded formed tools and expedient flake tools were noted by the site’s excavators.
throughout the village area. This suggests that stone tools were being made for the immediate tasks at hand and were discarded, rather than stored for later re-use, when the job was finished.

The recovery of well-made Archaic stemmed points is another trend that seems to hold true for this site. Purdy (1981) and Austin (1997) attribute these finds to scavenging or reuse of materials that Woodland people found at older sites. At the McKeithen site, all five examples were recovered from the midden deposits and all appeared to have been either used or reworked and resharpened.

The lithic assemblage at Fort Center differs in several ways from that of the McKeithen site. The inhabitants of Fort Center avoided the “local” Peace River chert outcrops and relied almost exclusively on materials obtained from the outcrops along Tampa Bay. The exception to this was the bifacial tools identified in Mound B. These tools, which Steinen (1971, 1981) associated with woodworking specialists at the site, are all made from chert originating from north-central Florida around the Gainesville/Ocala area. Picking up on Steinen’s suggestion about the possible ceremonial use of the heat-treated bifaces from Mound A, Austin (2008) speculates that these Mound B tools may have been owned or controlled by the woodworking specialists working on the carved wooden objects that were recovered from Fort Center.

The issue of local vs. non-local materials must be carefully considered at the Fort Center site. While the outcrops on the Peace River may be geographically closer to the Fort Center site than the outcrops along Tampa Bay, the Hillsborough River outcrops may well fall within the social space mapped by the inhabitants of Fort Center and could be indicative of other important social connections between these two regions.
The use of stone at Pineland suggests that the manufacture and use of lithic tools was clearly a minor activity at this expansive site. Most tasks performed here were performed with the shell and bone tools that cover the site. Stone tool use at Pineland does seem to follow the pattern seen at many sites in the Southeast in which expedient tools dominate the assemblage and the bifaces, when found, are poorly executed and were discarded or had stopped being used well before they would have been functionally obsolete. Pineland is the only site reviewed in the response that did not report any Archaic stemmed points. Like Fort Center, the inhabitants of Pineland also avoided the outcrops in the Peace River region in favor of the cert sources in the Tampa Bay and north-central regions. All of the expedient flake tools from this site were made cherts found along the Hillsborough River. The bifaces, however, have a very different origin. While five points are made from Tampa Bay materials, the raw material of two points likely came from the Brooksville area and five points came from the Gainesville/Lake Panasoffkee area. Austin (1995a) interprets this pattern to a lithic procurement strategy that emphasized coastal contact and communication, a pattern clearly evident 2,000 years later when the Spanish arrived in the area.

Kolomoki and Mandeville are both located long the Chattahoochee River drainage. The first occupations at Mandeville are several centuries older than those at Kolomoki, but Kolomoki is by most measures is a much larger site. The prehistoric inhabitants of both sites appear to have preferred local materials for the manufacture of their stone tools and an expedient flake tool technology was their primary tool focus. Bifaces, although not abundant, were present in appreciable numbers at both sites. There is good evidence at the Mandeville site that well-made stemmed Archaic points were
recovered (Kellar et al. 1962a). Such points may well have been recovered at Kolomoki as well (Sears 1956:27). How these artifacts operated within the social landscape of these peoples is unclear, but it is possible that these tools were obtained from any of the many nearby sites.

Of interest here, however, is the small amounts of exotic materials reported from both sites. Kellar et al. (1962b) attribute the exotic materials from the Mandeville site with the remainder of the other Hopewellian materials recovered from Mound B at the site and attributed them to sources in Ohio (Kellar et al. 1962b:344). Pluckhahn (2003) reports a small but significant assemblage of what he classifies as “ridge and valley cherts” which, from his descriptions, are certainly not unlike many of the cherts found in the northwest corner of Georgia and the northeast corner of Alabama (Goad 1979:Figure 2). Given Kellar’s identification, the “exotics” from Mandeville are clearly being transported from a considerable distance. The exotic materials from Kolomoki appear to have been obtained from quarries north of the site within the Piedmont and may have been brought to the site though either direct or indirect means. Knowing more accurately where the exotic materials are coming from will give us better insights into the possible selection and transport mechanisms used by Woodland peoples to obtain stone for tools.

Thermal alteration is clearly a technology that was still employed by Woodland peoples throughout the Southeast. Its use, however, seems to vary considerable by region and by the kinds of tool stone that were available. Since use of this technique is not evenly reported across all sites, a numeric comparison is not possible. As heat treatment improves the quality of many kinds of knappable stone, it would seem likely that a change to a reliance on local, lower quality cherts would result in increased use of the
technique. The data from several sites including McKeithen, Fort Center, and the Toltec Mound includes that the thermal alteration of chert, particularly for manufacture of haftable bifaces and possibly hafted knives, continued into Woodland times.

As shown by these nine sites, Woodland societies in the Southeast appear to have decreased their dependence on hafted bifacial tools and supplemented this with either tools made from alternative materials, like shell or bone, or for a flake tool technology using expedient stone tools. The question of the use of stemmed Archaic points by Woodland peoples remains unresolved. At some sites, like McKeithen, these tools are clearly being used for everyday tasks. At Fort Center, however, large red, thermally altered stemmed points left behind in both Mound A and the adjacent charnel pond have led both Steinen (1971, 1981) and Austin (2008) to propose that these tools may well have been considered differently, perhaps ceremonially, by the inhabitants of Fort Center. It is clear from work in the Pasco County area (Estabrook et al. 2001) that bright red coral points were being made in large quantities near coral quarry locations and that many of these bifaces appear to end up in late Archaic Mount Taylor period shell middens along the St. Johns River. Whether these points are being given to cement social alliances or are simply being traded hand-to-hand across the state, what is clear is that a traditional functional analysis of stone tools is inadequate to investigate the social landscapes of Woodland peoples.
Chapter 4: Site History, Environment, and Cultural Setting

Archaeological investigations and excavations at Crystal River have been taking place for more than a century. In many ways, the interest in the site reflects the development of American archaeology, from its speculative and artifact-focused beginnings, through the typology development and cultural-historical bent of the early twentieth century, and into the chronology and time-space synthesis of the mid-century. It is all too easy to view the work performed at Crystal River in the light of current archaeological method and theory and be critical of the past goals and methods that have been used in this endeavor (Weisman 1995:12-14; Milanich 1999:4-8). I believe that this investigative process is best reviewed in light of the times within which it occurred. Willey and Sabloff’s (1993) discussion of the history of American archaeology provides a chronological framework to help frame this process into an appropriate historical perspective.

This chapter provides various background and supplemental information necessary for the understanding of the current discussion of the Crystal River archaeological site before I move to a specific analysis of its stone tools. It includes overviews of the previous investigations and excavations conducted at the Crystal River Site; a summary of the region’s geography, geology, and discussion of sea level changes, focusing on those aspects particularly relevant to limestone exposures and chert outcrops;
and finally a condensed cultural prehistory of the region. These summations provide the necessary supporting information to add dimension to the research questions and provide the reader with those segments of general knowledge required to follow the line of argument proposed.

Each of these topics is discussed in greater detail in a variety of sources. An expanded overview of the previous investigations at the Crystal River site can be found in Weisman (1987, 1995), Ellis (et al. 1994) and Pluckhahn et al. (2008). I have only summarized the salient portions of this discussion and provided an update of the work that has been performed since 1995. The regional geography and geology is based on the works of White (1957, 1970), Scott (1992, 1997), Deuerling (et al. 1981), Puri and Vernon (1964), and Pilny (et al. 1988). The cultural prehistory of the region is discussed in some detail in the works of Willey (1949), Milanich and Fairbanks (1980) and Milanich (1995), as well as the many contributors to the journal of the Florida Anthropological Society, *The Florida Anthropologist*.

**Excavation/Interpretation History**

As well known as the Crystal River site is today, it played only a marginal role in the early post-contact story of Florida, defined by Willey and Sabloff (1993:12) as American archaeology’s Speculative Period (1492-1840). Much of interior Florida was unknown to the newly-arrived Europeans and most of Florida’s indigenous American Indian peoples had already been enslaved, killed by conflict or disease, or relocated to the “Indian Territories” in Oklahoma. The Crystal River Site, first known as the Spanish Mound, was first described by F.L. Dancy, with the U.S. Coastal Survey (Brinton 1859).
Brinton’s report of what Dancy described as the Spanish Mound (likely Mound A):

“It is about forty feet in height, the top surface nearly level, about thirty feet across, and covered with magnolia, live-oak, and other forest trees, some of them four feet in diameter. Its form is that of a truncated cone, as far as can be judged from external appearance, it is composed exclusively of oyster shells and vegetable mould. These shells are all separated. The mound was evidently thrown up by the Indians for a lookout, as the Gulf can be seen distinctly from its summit. There are no oysters growing at this time within four or five miles of it” [F.L. Dancy quoted in Brinton 1859:178-179].

Archaeological investigations began at Crystal River in 1903 with the work of Clarence B. Moore. Moore is best described as an antiquarian. In 1899 at 47 years of age Moore “retired” as the president of the Jessup and Moore Paper Company, the family business, to focus his full attention to prehistoric mound sites in the southeast U.S. (Knight 1996:2). Moore worked at literally hundreds of archaeological sites in his more than 40 years of investigation. He searched for and collected artifacts, some of which found their way into museums and public collections; others were given to locals and other interested parties or simply not collected. Moore traveled around the southeast in a stern paddlewheel steamboat known as the Gopher of Philadelphia. Moore’s field season lasted from later fall until early spring and typically employed a crew of thirteen trained excavators and five supervisors. The Gopher was captained by J.S. Raybon and based out of Tampa, Florida. Captain Raybon also served as Moore’s local contact person. Raybon made scouting trips in the off-season to find new sites, contact local landowners, and make arrangements for site access. Dr. Milo G. Miller, Moore’s long-time associate and personal secretary, assisted with the identification of the human remains and took most, if not all, of the artifact photographs (Knight 1996:1-3). It was Miller who also
worked out the logistics and made many of the arrangements for each field season (Milanich 1999:4).

Moore (1903:382) states that the site was famous, even in 1903, but in the nearby town of Crystal River, local residents and the site’s then owner, Robert J. Knight, knew little of the site’s existence. There was not any significant amount of previous digging in the mound when Moore first arrived. By 1900, recreational digging in coastal shell mounds and their removal for use as fill and roadway construction material had become widespread in Florida (Fewkes 1924; Shepard 1885; Walker 1880; 1883, 1885; Wainwright 1916). The shell mound (“heap”) portion of the site was evidently well known prior to Moore’s arrival in 1903; the burial mound complex evidently was not. Eighteen men and four supervisors spent seven days “demolishing” the central burial mound (Mound F) and most of adjacent Mound E.

Moore’s 1903 excavations at Crystal River removed at least 225 burials from Mounds F and E. Most of the interments were flexed burials (n=66), with various combinations of closely flexed and partly flexed positions, also right or left sided interments. Extended burials, what Moore termed “Full length on back” burials numbered 63, with “bunched” or bundle burials the next most common interment type (n=42). There were 11 single skull burials and seven infant burials. Moore notes that burial intrusions were common, with later burials cutting into, and sometimes removing portions of earlier interments (Moore 1903:382-383). Moore comments on this further by stating that there were so many disarticulated bones that it appeared as if the bones had “been gathered from the dead-house and scattered” during the construction of the
mound (Moore 1903:246). Apart from Bullen’s (1965) assertions, a charnel house or pond has not yet been identified at the site (Weisman 1995:7).

Although he does not discuss it in great length, Moore (1903:382) makes several comments about the mound’s construction. He specifically notes that the Mound F had an upper portion made from gray sand and a white sand lower portion, the lower portion being well-drained and dry. Moore also notes a “ledge” of shell along the base of this mound that was 60 cm (2 ft) high and some six meters (20 ft) wide extending from the eastern mound edge to the center. Moore does not associate this feature with any of the burials (Moore 1903:382).

Moore noted that Mound F was different in some ways from other mounds he had dug. It did not contain an east-side cache of ceramic vessels and all of the grave goods were deposited with the individual internments (Moore 1903:383). Moore also noted the lack of any materials of European origin. The Crystal River mound was noted for the amounts of copper, crystal, steatite, and hematite artifacts it contained. Many of these items took the form of plummets, pendants, copper disks, copper sheets, pan pipes, and ear spools. Although numerous, these items are not unique to mound complexes in Florida (Milanich 1999:22).

A large variety of ceramics were recovered from Mound F, both as whole pots and as sherds. Moore (1903:383) describes two general qualities of ceramics: inferior or poor wares and excellent or good wares. Of the 26 vessels described, nearly half are described as inferior wares or are simply not evaluated. Vessels 7 and 26 (Moore 1903: Figure 36) are described as “toy” vessels because of their diminutive size and shape that appear to be copies of some of the larger vessels found at the site. Moore found a piece
of a pot decorated with an incised hand that he photographed and included in his report. Another portion of this vessel was later found during his 1907 excavations. Vessels 13 and 20, both considered superior wares by Moore, were later identified as negative-painted ceramics by Willey and Phillips (1944) and Willey (1948).

Lithic artifacts were found throughout the week-long 1903 investigation including hammerstones, “pebble-hammers”, sandstone “hones”, flakes, chips, cherts “masses” and an object referred to as a “waster” (Moore 1903:397). Thirty-one chert lance-points, arrowheads, and hafted knives were recovered; these were often discovered in association with other objects, although Moore does not say what objects they were. Moore makes a single entry of note concerning the chipped stone assemblage from the site. In an area of the site containing a collection of celt fragments was found a cache of stone tools: three broken lance-heads made from brown chert, the base of a similarly broken tool, the distal ends of two other broken bifaces made from a light brown chert, three “rude” arrowheads, four chert chips, and the canine tooth from a large carnivore. Moore (1903:397) believed that the lance-heads were ceremonially broken similar to the way that ceramic vessels and shell dipper/cups had been “killed.”

Moore returned to the Crystal River site in the winter of 1906 (29 January – 14 February 1906). As Moore’s crew had dug most of the Mound F in 1903, he focused his efforts on the remaining unexcavated portion of Mound E and conducted some limited excavations in Feature C, the circular ridge surrounding Mounds E and F in the central mound complex (Moore 1907). Burials were common in Mound E and his crew recovered at least 186 individuals, 27 of whom were children. Most were extended burials “full length on back” with few grave goods. Moore comments on the difference
in body placement in the burials that were found in Mound F proper and those that came from the embankment (Mound E). It is clear from his writing that Moore (1907:408) was disappointed in the interments and mortuary artifacts recovered from Mound E. He saw these remains and the burial goods that accompanied them as inferior to the grave goods recovered in Mound F, the central burial mound.

Moore (1907) recovered many more artifacts, but by his own admission, the quantities of non-local trade goods (e.g., copper pendants, copper gorgets, and ear spools) recovered from the site had diminished considerably. A large number of pendants were found during the excavation of the remaining portion of Mound E. Many were made from the central columella of large gastropods. Others were made from locally available limestone and dolomite, and some were even made from fossil shark’s teeth, a material relatively common in the area (Moore 1907: Figure 27). Moore also comments on the large number of bone pins and ray spines found during the investigation. He also notes the recovery of large quantities of unfinished bone pins and unused ray spines.

The 1906 investigation recovered an additional 15 bifacial flaked stone tools ("lance-heads, arrowheads, and knives"). Five of these, four made from chert and one from chalcedony, came from a single interment. Moore (1907:419) comments that several of the bifaces (lance-heads) had been very carefully chipped and were visually pleasing, and that none was longer than 17 cm (6.5 inches). Before leaving Crystal River, Moore had his crew dig six “trial-holes” into the surrounding embankment (Feature C). Two burials and a single limestone pendent were all that were recovered (Moore 1907:425).
Moore returned briefly to Crystal River from 9 to 12 April 1918 (Milanich 1999: 7) to investigate what he felt were discrepancies between the burials found in the central burial mound (Mounds F and E) and those recovered from the circular ring enclosing Mounds E/F (Feature C). Most of his investigations focused on the southern portion of the feature (Moore 1918: 375-376), which, even today, is slightly more elevated than the rest of the ridge. Much of Feature C was constructed from a combination of midden debris and gray sand, and was quite unlike the white sand found in Mound F/E. Twenty-four interments were encountered. These burials were concentrated in the southern portion of the embankment and contained few burial goods. Those that did contain grave offerings had what Moore described to be locally-made pendants, shell drinking cups, and gastropod chisels. Moore attributed the difference in grave offering to a chronological difference in the interments (Moore 1918:375).

With Moore’s departure at the close of the excavation in 1918, digging at the site ceased, but interest in the Crystal River area remained strong. The botanist John K. Small visited the site in 1924. In two articles published in the Journal of New York Botanical Gardens (Small 1924, 1927), he describes the vegetation found on the mound but also describes other mound sites in the area, including the excavations conducted at a burial mound two miles north of town (Small 1927:16).

Moore’s work at Crystal River prompted others to take an interest in Florida’s central Gulf Coast. In 1933, Froelich G. Rainey, with the anthropology research program of the Peabody Museum at Yale University, conducted excavations at Buzzard’s Island, a locally known prehistoric cemetery on a small island in King’s Bay, roughly 3.4 km (2.1 miles) southeast of the Crystal River site. Rainey (1935) reported numerous bundle
burials in various states of preservation, a stratified ceramic component, and an extensive stone tool assemblage. Of note was the lack of any midden shell, shell tools, or marine shell of any kind (Rainey 1935:191).

Although much of Moore’s work focused on the recovery of specimens for display in museums located in Philadelphia and the greater northeast, his work did generate inter-regional comparisons which typify the Classificatory-Historical Period (1914-1940) in archaeology (Willey and Sabloff 1993:96). Greenman (1938) compared the artifacts recovered at Crystal River and at 17 other mounds investigated by Moore in Florida with materials recovered from Hopewell sites in Ohio, Illinois, and Wisconsin. According to Greenman’s trail list (1938:331) the Crystal River site contains a larger number of Hopewellian traits than any other site in Florida. It was these traits and the quantity and diversity of the items recovered from the site that thrust Crystal River into national prominence.

Moore’s publications and a growing body of Work Program Administration (WPA) research in Florida during the 1930s caught the attention of two Columbia University graduate students: Gordon Willey and Richard Woodbury. Willey and Woodbury’s summer 1940 survey of Florida’s Gulf Coast provided much of the information later found in Willey’s (1949a) Archeology of the Florida Gulf Coast, but also several articles related to discoveries at Crystal River (Willey and Woodbury 1942; Willey 1945, 1948a, 1948b, 1948c; Willey and Philips 1944). Because of the use of negative painting on ceramics in the Tennessee-Cumberland area, Willey and Phillips (1944:181) attribute the burial mound component of the Crystal River site to the late Weeden Island period. They justify this given all of the non-local grave goods that were
recovered from the mound by pointing out the distances these materials would have had to travel (hand-to-hand) to get down to Florida. They attribute the use of negative painting on ceramics to the use of this technique on non-ceramic remains (Willey 1948c).

Gordon Willey, A.J. Waring and Rufus Nightingale made a visit to the site on July 22, 1949 (Willey 1949b). A small surface collection was made (n=69) and they verified several of the features depicted on Moore's 1903 map. Willey had previously noted that the burial ceramics from Crystal River were predominately Santa Rosa/ Swift Creek. The 1949 surface collection, however, indicated a Weeden Island I timeframe. Willey indicated that the middens and temple mounds may date to different periods and suggested that the site had been occupied several times. There are several site features that did not seem to fit well with Willey’s temporal assignment of the site. Willey expressed some concern about the presence of the flat-topped temple mounds and the lack of any evidence for a Weeden Island II site use (Willey 1949b:43). He also saw some disparity between the presence of mounds and the apparent lack of maize agriculture or horticulture (Willey 1949b:45). He also noted that the area around the site was not particularly well suited for agriculture or horticulture and expressed concern about the occurrence of temple mounds in what appeared to be a basically fishing/collecting/hunting economy. This is the first time that the disjunction between the occupation context suggested by the ceramic sequence and the dates of occupation inferred from the temple mound construction was first questioned.

The early 1950s saw renewed interest in the Crystal River site, particularly in resolving the cultural chronology issues between the ceramic assemblages recovered from the midden deposits and the construction dates for the various burial and platform
mounds at the site. In February of 1951, Hale Smith, then with Florida State University, James B. Griffin with the University of Michigan, and several others conducted limited test excavation at Crystal River (Smith 1951). These excavations included a 5-x-5-ft test in Area B (village midden), a 2-x-2-ft test in Mound H (second Platform Mound) and “several” small tests (possibly 2-x-2-ft) in Mound E and Feature C (within the Central Burial Complex). Most of the pottery recovered was classified as Pasco Plain, St. Johns Plain, and Glades Plain (likely sand-tempered plain). Several residual categories including Dunn’s Creek Red and “limestone and clay-tempered” were identified. The two St. Johns Check Stamped sherds were identified by James B. Griffin from the work on Feature C, although it is unclear as to whether these sherds came from the testing or the surface collection. Their presence at Crystal River was the first time that materials associated with a later Weeden Island component were identified at the site. St. Johns Checked Stamped pottery is now typically associated with post AD 750-800 occupations on the Gulf Coast (Milanich 1994:262; Luer and Almy 1980:211-212). The artifacts from Smith’s 1951 excavation have never been located and a final repository for these remains has never been identified.

No archaeologist is more closely associated with the Crystal River site than Ripley Pierce Bullen. Arriving in Florida in 1948, Bullen was offered the position of Assistant Archaeologist with the Florida Board of Parks and Historical Memorials based in Gainesville (Wilkerson 1978). Under the supervision of John W. Griffin, Bullen began what would be a lifelong commitment to the Crystal River site. Six months after Smith’s 1951 work at the site, Bullen conducted his own test excavation and surface collection. Bullen (1951) had recently published a short article in which he questioned Willey’s
(1948a) chronological assignment of the site based on the idea that the practice of flexed burials predated the practice of bundle burials, a topic Bullen would later publish on many times. In 1953 Bullen published an article entitled *The Famous Crystal River Site*, which focused on correlating the results both his and Smith’s 1951 investigation within the middens and other site features with Moore’s (1903, 1906, 1918) previous work on the burial complex. From these data, Bullen recognized that the site contained several temporal components and still contained a wealth of information despite Moore’s near destruction of the central burial mound complex.

The Florida Park Service disbanded its archaeological program in 1952 (Wilkerson 1976). Ripley Bullen moved on to become the curator of Social Sciences at the then newly-formed Florida State Museum (now the Florida Museum of Natural History). Bullen returned to conduct additional excavations at the Crystal River site in 1960, 1964 and 1965. But his primary influence over the site was his ability to convince two of the three landowners who then controlled most of the site to deed these properties to the state to form the Crystal River Historic Memorial, Florida’s first archaeological state park in 1965. Bullen was directly involved with the administration, planning, and development of the site. He made many suggestions for displays and much of the site interpretation provided in the museum is based on his work. Bullen worked to reconstruct the central mound complex (Features C and D, Mounds E and F), which after Moore’s work finished in 1918, had been left as a series of spoil piles (Weisman 1995:117-118). The Historic Memorial and museum opened on November 20, 1965. A commemorative brochure was given out which contained an edited version of Bullen’s
1953 work on the site with a few updates from Bullen’s work at the site during the 1960s (Bullen 1965).

One of the owners of the Crystal River site did not initially contribute land to the Memorial. This owner controlled the portion of the site directly on the river from roughly the middle of Mound A and extending east along most of central midden area known as Midden B. Instead, this owner chose to develop the area as a manufactured home park. In 1960, the ramp and roughly one-third of Mound A were bulldozed to fill-in the low-lying area between Midden B and the river’s edge (Bullen 1966:865). A seawall was installed to extend the property along the shoreline. This trailer park community existed alongside the archaeological park until 1993, when the Storm of the Century, a particularly strong non-tropical storm, flooded the park and inundated all of the trailers. Coastal zoning regulations enacted since the 1960s prohibited the replacement of the homes at their old base elevations, and would have required each home to be elevated on piling or stilts. Rather than rebuild to meet the new elevation codes, the trailer park’s owners decided to offer the land to the state. With minor clearing, the area that had been the mobile home park was annexed into the Crystal River Archaeological State Park in 1995.

During the development of the site as an archaeological state park, Bullen conducted several excavations which modified his chronological assignment of the site and contributed to his interpretations. In 1960, Bullen continued to work in the Midden B area. He discovered that the area of midden north of Mound A extended more than 60 m (200 ft) beyond where it had originally been defined. Bullen identified two shell mounds along this ridge, now designated Mounds J and K (Weisman 1995:50). These
mounds appear as rises or mounded areas of shell and midden debris perched on top of an area of linear midden extending northwest along the edge of the adjacent saw grass marsh. Because of its proximity to Mound A, Mound K is sometime referred to as the “chief’s mound” or the “priest’s mound” (Weisman 1995:62).

In 1960, test excavations were conducted at the Double Sand Mound, a site component not contained within the original park boundaries, within Feature C, and at Mounds E, F, G, H, and K (Weisman 1995: Table 3). The exact location of the Double Sand Mound is in doubt, although several candidate areas have been identified by park personnel. Both Moore’s 1918 excavations and Bullen’s 1960 trench through the mound recovered little information about the mound’s chronological placement or its construction (Weisman 1995:165). It was classified as “domiciliary mound,” the term assigned to low sand mounds that contain few artifacts. According to Weisman (1995: Appendix I) Bullen recovered 59 shreds, eight shells, four stone artifacts, and two chert flakes from his exploratory trench through this mound.

Bullen returned in 1964 to again excavate various components of the site. He placed two tests in Midden B between Mounds A and K and also tested Feature C and Mound H. During site clearing in 1964, two limestone boulders, identified as “steal,” were discovered (Bullen 1966). Stela 2 is situated west of the main burial mound complex and south of Mound G. Today, it is located directly behind the Museum building. Stela 1 is sited just to the southeast of the central burial mound complex. Stela 2 was actually discovered first, but since it is a rather non-descript, undecorated limestone boulder, it has been relegated to second-class status and designated as Stela 2. Stela 1 is the larger of the two boulders and contains what looks like the incised/pecked
face and upper torso of a human figure. The head and shoulders with eyes, and open
mouth, flowing hair (tied in a hair knot), and an ear spool can be seen in the stone. There
is also some indication of arms on the figure, although these features may have been
added to the image sometime between 1953 and its identification by Bullen in 1964
(Bullen 1966:864). Numerous meanings, cultural ties, astronomical implications, and
ethnic affiliations have been attributed to these stones. Bullen (1966:865) thought the use
of platform mounds, plazas, and steal diffused from southeastern Mexico, the Yucatan or
Veracruz. A complete discussion of the proposed origins and significance of these stone
monuments can be found in Weisman (1995:62-64), Hardman (1971) and Williamson

Over time, Bullen’s ideas about the site changed. When the Crystal River
Historic Memorial (now the Crystal River Archaeological State Park) opened on
November 20, 1965, Bullen reprinted his 1953 work along with a brief update of his
more recent findings (Bullen 1965). Many of Bullen’s observations were about site
features that had not been originally recognized, like the shell causeway connecting
Mound H with Mound G (the second burial mound) and the extension of Midden B and
Mounds J and K. Stela 1 and 2 are mentioned, as are the excavations Bullen had recently
completed. By 1965, the few radiocarbon dates obtained had altered Bullen’s original
chronological placement of the site. By 1965, he dated the site to the Deptford period
(200 BC), but did not think that it was occupied much past AD 1200, leaving open the
question about its occupation during the subsequent Safety Harbor period (Bullen
1965:10). Ripley Bullen died in 1976 without ever publishing the information recovered
during his time at Crystal River. Bullen published his work frequently in a wide variety
of journals (Wilkerson 1978). It was long assumed that a manuscript detailing his work at the Crystal River site was in progress, but upon his death Bullen’s field notes and any such manuscript could not be found (Weisman 1995:15).

The 1960s brought an end to the Classificatory-Historical Period in archaeology and ushered in American Archaeology’s Modern Period with a series of new archaeological paradigms (Willey and Selloff 1993), but not before two archaeologists left their distinctive mark upon the Crystal River site – William H. Sears and Edward V. McMichael. William Sears was at various times a professor at the University of Georgia, curator at the Florida State Museum, and ultimately the founder and long-time chair of the Anthropology Department at Florida Atlantic University. Director of the excavations at the Kolomoki site in Georgia (Sears 1956), Sears would go on to work on Fort Center, and the large Middle Woodland complex near Lake Okeechobee already discussed (Sears 1982). Edward McMichael completed his Ph.D. at Indiana University, worked with the West Virginia Geological & Economic Survey, and later taught at Indiana State University. Neither scholar actually excavated at Crystal River, although Sears was Ripley Bullen’s supervisor at the Florida State Museum and often accompanied him in the late 1950s and early 1960s during his various surface collections of the site. Sears was heavily involved in the transfer of the site from private to public ownership. To the best of current knowledge, McMichael never even visited Crystal River. But the writings of both of these individuals have had a significant effect on the interpretation of the Crystal River site and others in the region.

Sears (1962b, 1973) published a series of articles just more than a decade apart defining two concepts that had a profound effect on Middle Woodland research in Florida
for many years: the Yent/Green Point ceremonial complexes and the secular vs. sacred ceramic dichotomy. His work on the Yent/Green Point complexes (Sears 1962b) involved McMichael, who two years before Sears (McMichael 1960) defined what he called the Crystal River complex as part of his dissertation research, but was unable to publish this work until four years later (McMichael 1964). Both the Yent/Green Point complexes and the Crystal River complex have many points in common. Both attempt to explain the Hopewell an influences at several southeastern mound complexes, but particularly the Crystal River site, in terms of trait lists and the diffusion of ideas and people. Both Sears and McMichael start with similar approaches involving artifact trait lists, but end up in very different places.

The Yent and Green Point ceremonial complexes (Sears 1962b) were defined by Sears from seven Gulf coast mound complexes excavated by C.B. Moore. Sears identified seven mound complexes each containing a Santa Rosa Swift Creek ceramic assemblage that typified these complexes. Each has a robust Hopewell and material assemblage and Sear thought strong ties to the Hopewell complexes in the Midwest and Louisiana (Sears 1962b:16-17). The Yent complex was best expressed at the Crystal River, Pierce, and Yent mound complexes. The trait list included (Sears 1962b:Table 1): copper pan pipes, copper repose plates, elongated and double-ended plummets, cymbal-shaped copper ear spools, cut carnivore teeth/jaws, cut shell ornaments, and pottery with unique vessel decorations. The Yent ceramic signature includes negative painted pottery, the use of the human hand as iconography, and podal supports. Sears also felt that the continuous use of mound complexes was a key feature of the Yent complex.
The Green Point complexes include the Huckleberry Landing, Green Point, Andersons Bayou and Alligator Bayou mound complexes. The diagnostic traits of these sites were pottery assemblages dominated by Swift Creek and St. Andrews Complicated stamped pottery and fewer Hopewell and traits. The later mounds, also placed in the Green Point complex, are Anderson Bayou and Alligator Bayou, which have Trouville or Troyville-like pottery associated with complicated stamped pottery in an east-side deposit, a characteristic of many later Weeden Island sites. Sears saw the primary distinction between the Yent and Green Point complexes as temporal. The Yent complexes originated in Deptford times are represents direct contacts with peoples in what is now Ohio and Illinois. Green Point complexes were later in time, associated with Swift Creek assemblages, and showed increasing interaction with groups in the Lower Mississippi Valley rather than contacts with the Midwest. The shift in emphasis from the Midwest to the Lower Mississippi Valley sometime after AD 500 (Sears 1962b:17).

McMichael (1960, 1964) forwarded a hypothesis that the zenith of Ohio Valley Hopewell ceremonialism contained strong influences from coastal Mexico. The “mechanism” for this influence was provided by the Crystal River complex, a series of material culture traits that McMichael suggests were brought to the Crystal River site from Veracruz, Mexico, by a group of Maya-Huastec traders (McMichael 1964:131). The Crystal River complex, in many ways analogous to what Sears (1962b) referred to as the Green Point complex, is identified by a nearly identical list of traits that include various forms of pottery decoration (negative painting, burnishing, and use of red slip or “film”), various pottery motifs and vessel shapes, and the use of copper (pan pipes, ear spools, gorgets, and repoussé plates). This complex coalesced at the Crystal River site
before spreading to the Ohio Valley region. A graphic depicting this purported Mexican
contact has been incorporated into the display that hangs on the wall of the Crystal River
Museum to this day (White and Weinstein 2008:262; Wilkerson 2005:62).

The association that attracts the most public interest to the Crystal River site has
been its reported association with various astronomical alignments. At the urging of
Ripley Bullen, Clark Hardman, an instructor at Lake City Community College and
Crystal River resident, conducted a study which matched various site features with the
summer and winter solstices and the equinox. Hardman used a modification of Moore’s
1903 map and the reconstructed heights of the mounds and middens as they existed in the
1960s to make claims about the use of specific alignments to predict the occurrence of
various astronomical events. Hardman’s argument is that the alignment of some site
features, specifically of Stela 1 and 2 and the summits of Mound F (the central burial
mound) and Mound J align with the summer and winter solstices and the equinoxes
(Hardman 1971:Figure 20). Hardman was also the first to identify “Stela 3” which
reportedly was found buried in a low-lying area and was unearthed when the foundation
of the Museum was being excavated (Weisman 1995:34). Hardman proposes that Stela 3
was originally located on the top of Mound J (Hardman 1971:153). It is currently sited
along the path leading from the Museum to Mound J. Hardman asserts that based on the
celestial alignments he has identified that the sun worship dominated the ceremonial life
of the inhabitants of Crystal River (Hardman 1971:155).

In 1984, Brent Weisman and Jeffrey Mitchem, then graduate students at the
University of Florida, along with members of the Withlacoochee River Archaeological
Council, conducted a one-day exhibition dig at the site (Weisman 1995:51). The goal of
this testing was to isolate and test the Safety Harbor component at the Crystal River site and assess its potential for future research. Two 2-x-2-m excavation units were placed near Mound J, but were dug into Midden B. While the final analysis of these units has not yet been completed, the preliminary results indicate that the uppermost levels of the site were deposited during Weeden Island times (Weisman 1995:51-52).

In 1987, Weisman was again working at the Crystal River site, this time compiling and synthesizing both the published and unpublished information. He also attempted to track-down all of the artifacts recovered by Moore, Smith, Bullen, Willey, and others who had worked at the site. The report generated from this contract was later expanded and published as the eighth and final installment in the Florida Bureau of Archaeological Research’s *Florida Archaeology* series (Weisman 1995). These investigations determined the whereabouts of the Moore’s remaining artifacts and provided a synthesis of Bullen’s 1951-1965 work, and a summary of all of the artifacts recovered from the site up until 1995. It has been criticized for being overly descriptive (Brose 1996), but this volume provides insights into much of the unpublished information about the Crystal River site.

On March 1993, the Storm of the Century roared though the Crystal River site. While not technically a hurricane, which is a tropical event, this storm was spawned by a late winter cold front pushing through the region. This storm brought high winds, rain, possibly tornadoes, and a significant storm surge that pushed 1.5 to 2 m (4-7 ft) of water into the park, the museum, and the mobile home park adjacent to Mound A and the Central Burial Mound complex. The storm flooded the Museum, all of the mobile homes, and damaged and uprooted many of the trees within the park and on the site. A
tornado uprooted trees from the east side of Mound A north to Mound H, cutting directly through the center of the site (Nicholas Robbins 2009:personal communication). Tree damage included lost branches, broken limbs, but in some cases entire trees and their associated root balls tore free from the ground, lifting portions of the midden matrix and exposing subsurface materials and features. Five large upturned root balls were subjected to data recovery by Brent Weisman and Christine Newman, (Weisman and Newman 1993) then with the Florida Bureau of Archaeological Research assisted by members of the Withlacoochee River Archaeological Council and employees of Ellis Archaeology (now Gulf Archaeological Research Institute [GARI]). These included trees on Mound K (two trees), within the midden north of Mound K, Feature C, and Mound G. The results of this investigation have only been reported in brief letter reports, although the field notes from the investigation have been made available (Weisman 1993).

The 1993 storm resulted in several changes to the Crystal River Archaeological State Park. The mobile home park once located east of Mound A and south of the central burial mound complex was not rebuilt after the storm and the land was purchased by the state and incorporated into the park. The old seawall that had been built in the 1960s to hold back the displaced remains taken from Mound A was damaged in the storm. It was replaced in 1998. An archaeological investigation was performed in support of this project (Ellis 1998; Ellis et al. 2003).

In 2003 a boat slip was replaced at the east end of the seawall to accommodate the Park’s Heritage Boat Tour. The midden material within the old slip was dredged out and portions of it were placed on the shoreline for analysis. GARI conducted an analysis of several of the “features” that had been removed during this project. The results were
published as a GARI Field Report (Ellis et al. 2003). The remainder of the midden material was deposited in a specially-constructed frame located north of the boat slip within the old mobile home park boundaries. The park rangers have developed an outreach program using this displaced material called Sifting for Technology. School groups, Boy Scout troops, and civic groups from Citrus County and the surrounding areas recover faunal material and artifacts that will be used to further research and interpretation at the site.

While the 1993 storm of the century removed many of the weaker trees, tropical storms and even locally intense summer thunderstorms can sometimes down trees, or remove vegetation. When this occurs, the park rangers consult an archaeologist to monitor and assess the potential damage (Ellis 2004; Estabrook 2009). During regular maintenance at the park, dead trees are removed and the stumps are left to rot in place to minimize site disturbance. Small animals, like pigs, raccoons, opossums, and armadillos sometimes attempt to burrow into the mounds and middens within the park. In some instances, these activities uncover artifacts which are collected, cataloged, and sent to the Florida Division of Historical Resources in Tallahassee for curation.

Remote sensing and non-destructive documentation have dominated the investigations at the Crystal River site in the twenty-first century. Lori Collins and Travis Doering from the University of South Florida have conducted several short-range LiDAR scans of the site, including detailed scans of Mound A and Stela #1 (Weisman et al. 2007). A joint University of South Florida/University of West Florida 2008 field school combined several remote sensing technologies (GPR, magnetometry, and resistivity) and total station mapping into a comprehensive non-destructive evaluation of
the site (Pluckhahn et al. 2008, 2010; Thompson and Pluckhahn 2010). This study has produced the first accurate topographic map of the site, the first summary of calibrated ¹⁴C dates, and the first direct evidence for separate construction episodes for Mounds A and H. Five cores were removed from the site and analyzed. The chipped-stone component from these cores has been included in the current study.

**Environmental Setting**

Ever-changing is perhaps the best way to describe the environmental setting of the Crystal River site. Located along the west coast of Florida, the site has been subject to slow, but substantial changes in sea level, water salinity, and the availability and distribution of local resources. This changing environmental setting provides a physical framework within which the site inhabitants mapped their social existence. Today, it is easy to view the site from its terrestrial setting. We can drive to the site along divided highways and well-paved roadways constructed on causeways and earthen embankments. The site itself can be accessed by the public along asphalt and concrete walkways and guided pathways. This is likely far different than the approach that native people took to get to Crystal River. Over land transport to the site would have been through mesic flatwoods and hydric hammock environments, both of which could have been very wet and mucky for much of the year. Water transportation, especially by canoe, would likely have been the primary method of aboriginal access to the site.

From the water, the physical environments surrounding the site are much more inviting. Crystal River provides access to King’s Bay, a large estuary system that has formed around the springs that fed the river some 4.7 km (approximately three miles)
southeast of the site. The Crystal River Spring is a first-magnitude spring, pumping in excess of 244.51 million liters (64.6 million gallons) of water per day into King’s Bay (Stamm 1994). This brackish estuary is among the most productive environments in Florida. The Crystal and Salt rivers provide access to the Gulf of Mexico roughly four km (2.5 miles) west of the site. The Gulf provides a variety of saltwater resources, including oysters, which were the main shellfish species exploited by the site’s inhabitants.

The gradient of the off-shore sea bed slope is slight, making the waters in the Gulf of Mexico off of Crystal River particularly shallow. The water of the mouth of the river is less than two meters (six ft) deep. The lack of off-shore sand deposits and low-energy coastal environments means that there are no beaches anywhere along the coast of Citrus and adjacent Hernando counties. The shoreline vegetation transitions from upland pine forest to various marsh grasses and mangrove and then gradually to open water. Shorelines are poorly defined as there is often considerable difference between the low tide and high tide shorelines. These conditions also inhibit the development of coastal barrier islands. Many of the off-shore islands are limestone outcrops, consolidated mangrove vegetation mats, or partially-drowned prehistoric shell middens, and are often some combination of all three.

Crystal River lies at the transition between temperate and semi-tropical zones. Winter air temperatures and the Gulf water temperatures are such that mangrove, a salt-tolerant, tropical to semi-tropical plant, begins to grow from Crystal River southward (Nelson 1994:99-101). Mangrove-covered shorelines flourish along southern coastlines, providing a rich environment and a nursery for many species of fish and other aquatic
wildlife. The coastline north of the river is vegetated by various species of salt grasses and reeds which die back from the frosts and freezing temperatures brought by winter cold fronts and grow back in the spring. The grass flats range in size from relatively narrow to wide and extensive. Coastal strand and maritime hammock environments dominated by cabbage palm (*Sabal palmetto*), eastern red cedar (*Juniperus virginiana*), live oak (*Quercus virginiana*), and redbay (*Persea borbonia*). Intermixed with this is mesic pine forest characterized by longleaf pine (*Pinus palustris*) and saw palmetto (*Serenoa sp*). These environments provide habitat for a variety of plants and small mammals including deer, rabbits, raccoons, squirrels, reptiles such as turtles, tortoises, and snakes, and a wide variety of birds (Florida Natural Areas Inventory 1990).

**Regional Geology**

The Florida peninsula is situated on the Florida Platform, a complex sequence of marine deposits several thousand meters thick (Schmidt 1997:12). The platform’s sedimentary strata overlie a complex configuration of igneous and metamorphic rock formations. The basement formations of Florida came together during the Mesozoic Era, some 225 to 65 million year ago (Smith and Lord 1997). Over millions of years, repeated cycles of carbonate and evaporate sedimentation slowly built-up the limestone layers that today makeup the Florida peninsula and define all of the chert-bearing limestone formations that underlie the state (Randazzo 1997:48).

Most of the near-surface limestone formations were developed in shallow marine environments and contain an abundant, diverse, and well-preserved fossil record (Jones 1997). The fossil marine invertebrates that constitute much of the limestone mass have
been used to determine the depth, salinity, and temperature of the seas within which they were formed. Within each of the formations are key index fossils, also known as trace fossils, which can be used to characterize a particular formation. Common to these fossil groups are benthic (larger) foraminifers, ostracodes, bryozoans, mollusks, and irregular echinoids (Jones 1997:96). When the carbonate limestone is replaced by silica, silicified limestone, or chert is formed. This process often preserves the micro- and macrofossils present in the original limestone. By identifying the key index fossils present in the stone, the original parent formation of the chert (silicified limestone) can often be determined (Austin 1997; Austin and Estabrook 2000; Endonino 2007; Upchurch et al. 1981).

A brief overview of the lithostratigraphic framework will be provided here to give the reader a better understanding of the origin, development, and exposure of the basement limestones and the embedded silicified limestone, or chert, from which the stone tools used by the Crystal River site’s inhabitants were made. The formation of the bedrock of the Florida Peninsula was a complex and dynamic process, and its description here is a condensation or simplification of a variety of complex depositional, erosional, and transformational processes (Hetherington and Mueller 1997; Puri and Vernon 1964; Randazzo 1997; Scott 1992, 1997). The near-surface limestone formations of Citrus County region from oldest to youngest include the late Middle Eocene age Avon Park Formation, the Upper Eocene age Ocala Limestone, the Lower Oligocene Suwannee Limestone, and the Miocene age Hawthorn Group (Figure 4.1). Each of these has a unique history and each contains, or at least has the potential to contain, various
Figure 4.1. Surface geology of the study area. Data from the Florida Geographic Data Library (sergeo_2011).
quantities of tool-quality cherts. Each is also differentially exposed across the region. In coastal western Citrus County near the Crystal River site, Ocala Limestone is exposed on the surface and pieces of limestone outcrop in the immediate site area. Suwannee Formation materials are absent and Hawthorn Group deposits are not defined for this region. In the interior portions of the county, residual Hawthorn Group deposits lie directly over Ocala Limestone materials (Deuerling and MacGill 1981; Yamataki et al. 1988). Suwannee Limestone is not defined for eastern Citrus and adjacent Sumter counties (Yamataki et al. 1988:6) and appears to have been eroded away prior to the deposition of Hawthorn sediments roughly 40 million years ago. Suwannee Limestone outcrops at the surface south of the site in the center of what is now coastal Hernando County.

The Avon Park Formation is the oldest exposed limestone in peninsular Florida. This late Middle Eocene age formation developed in warm, shallow seas. It is best characterized as relatively fossiliferous grainstones and packstones, interbedded with dolomitic wackestones and mudstone. One of its diagnostic inclusions is fossil sea grass, although its fossil diversity is considered rather limited (Randazzo 1997:50). Avon Park limestone is known to outcrop on the surface in an area north of Crystal River at Inglis, but is most often encountered in dolomite mines along the coast of Citrus and Levy counties. Upchurch considered the limestone of the Avon Park Formation to have been too deeply buried and not sufficiently silicified to contain cherts that could have useful for prehistoric tool production (Upchurch et al 1981:13).

The Upper Eocene age Ocala Limestone is a complex series of limestone deposits often subdivided into upper and lower units. The upper unit is often referred to as the
Crystal River Formation, while the lower unit is sometimes referred to as the Lower Ocala Group (Yamataki et al. 1988) or individually as the Inglis and Williston formations (Deuerling and MacGill 1981). The Crystal River Formation, the upper unit of the Ocala Limestone, consists mainly of white to light gray packstones and grainstones with some dolomitized wackstones and mudstones (Randazzo 1997:50). The lower unit, the Inglis and Williston formations, contain more dolomite, and is the target of many commercial mining operations (McClellan and Eader 1997:144). Upchurch suggests that most of the cherts from the Ocala Limestone probably come from the Crystal River Formation because the Inglis and Williston formations are not silicified to any great extent (Upchurch et al. 1981:17).

The Lower Oligocene Suwannee Formation was deposited during a time of open marine environments; it is dominated by packstones and grainstones (Randazzo 1997:50). The upper portions of this formation become increasingly dominated by quartz sand, giving the resulting limestone a sometimes sandy or grainy texture. The upper Suwannee Formation was deposited at a time when local patch reefs and coral thickets were common (Jones 1997:101). Fossil casts of these coral heads are found within the portions of the contact between the upper Suwannee Formation and lower Hawthorn Group sediments (Jones 1997; Vaughan 1900; Weisboro 1971, 1973). The top of the Suwannee Formation marks the end of the major limestone accumulations on the Florida Platform.

The Miocene/Pliocene age Hawthorn Group is a complex and poorly understood series of deposits that often lies between the thick limestone bedrock of the peninsula and near-surface sands and clays. The Hawthorn Group is also much thinner (<300 m thick)
than any of the limestone formations that preceded it (Jones 1997:101) suggesting much slower rates of accumulation. The Hawthorn Group is highly variable and its components are regionally depended. This is likely the result of extensive geological reworking of these sediments during the late Miocene (Compton 1997; Jones 1997; Scott 1992, 1997). In coastal Citrus County, the Hawthorn Group is not defined; Pleistocene and modern sediments directly overlie the Oligocene-age Suwannee Formation. In interior Citrus County the Hawthorn Group contains various clays, limestone, and dolomite (Pilny et al. 1988:5). The unique depositional conditions during the Miocene and Pliocene allowed for the deposition of large beds of phosphorite-bearing materials, both as small pebbles and as hard (rock) phosphate within the Bone Valley Member of the Peace River Formation (Compton 1997:199). The Hawthorn Group also contains two well-known chert-bearing members: the Bone Valley Formation and the Tampa Limestone Member.

The Tampa Limestone Member is the name given to the lower portion of the Arcadia Formation, a limestone deposit often rich in cherts, but lacking in fossils and phosphate (Scott 1997:60). The Tampa Limestone Member is the source of most of the cherts found in the Hillsborough River and upper Withlacoochee River drainages (Upchurch et al. 1981; Austin 1997; Austin and Estabrook 2000). The Peace River Formation is stratigraphically above the Arcadia Formation in central Florida. Rich in phosphate (Compton 1997; McCellan and Eades 1997) and Miocene and Pliocene fossils (Brown 1988; Hulbert 2001; MacFadden 1997) the Peace River Formation also contains unique chert deposits that are rich in opal-A (Compton 1997:200), a relatively unstable
material that produces a chert that has a high luster and is easily worked, but produces stone tools that area lightweight and easily broken (Austin and Estabrook 2000:118).

The Coosawhatchie Formation is the uppermost unit in the Hawthorn Group in Northern Florida and the panhandle region (Bryan et al. 2008:187). Consisting primarily of sand, phosphatic dolostones and clay, this formation is defined in the very northern portions of the study area. Although the Coosawhatchie Formation was not previously known to contain chert like other Hawthorn Group members (Compton 1977:198), a recent study by Endonino (2007:88) has identified chert deposits that appear to be from this formation.

While many of the geological formations that make up the Florida peninsula contain cherts suitable to make stone tools, only some of this material is near enough to the surface to make it accessible to prehistoric peoples. There are several underlying geological features that expose limestone at or near the current ground surface. The “Ocala Uplift” is the often cited geological feature given as the reason that Eocene limestone and the corresponding Ocala Limestone cherts are exposed in central Florida (Upchurch et al. 1981:12 see also Figure 1; Endonino 2007). The name implies that this region may exist due to tectonic uplifting, but it is a regional titling of the basement formations and is not an uplift or fold (Smith and Lord 1997:25). This feature is now known as the Ocala Platform (Schmidt 1997:11).

There are other localized situations that can affect the exposure of bedrock limestone and the chert they contain. White (1970) and Knapp (1978) describe a topographic inversion in the northern Brookville Ridge area. White and Knapp both observed that the Ridge was inscribed into the surrounding limestone. At the edge of the
juncture between these areas was a raised area of Hawthorn Group erosion-resistant clays and sands. The older and softer limestone materials eroded away while the younger and more resistant clays and sand remained, forming a topographic high (Schmidt 1977:11). The same phenomena also allowed silicified limestone, or chert, to erode out from softer surrounding limestone and become exposed at or near the surface.

The surface lithology of west-central Florida is composed principally of undifferentiated deposits of sand and clay of Pleistocene and Recent age (Deuerling and MacGill 1981). These deposits are relict shoreline ridges running roughly parallel to the current coastline and eolian sand dunes. These shorelines and relict dune features are the result of fluctuation of Pleistocene and early Holocene sea levels. Cutting through these features are ancient estuaries, river drainages, and shorelines that define the modern physical environments of coastal west-central Florida.

**Geomorphology**

The Crystal River Site lies within Florida’s Central or Mid-Peninsular physiographic zone (Puri and Vernon 1964; White 1970). The site is situated in the Coastal Swamps physiographic province at the point where it intersects with the Northern Gulf Coastal Lowlands (White 1970: Map I-B). The Brooksville Ridge forms the uplands several kilometers east of the site (Figure 4.2). The Withlacoochee River flows through the Tsala Apopka Plain and the Western Valley east of the site. The Dunnellon Gap divides the Brooksville Ridge into northern and southern portions, and provides the Withlacoochee River egress to the Gulf of Mexico. East of the Tsala Apopka Plain and
Figure 4.2. Physiographic Provinces in the vicinity of the Crystal River site. Data from the Florida Geographic Data Library (phprov).
Western valley, the Sumter and Lake Uplands rise to form broad, flat terraces. These terraces support the Cotton Plant Ridge, the Fairfield Hills, the Ocala Hill, the Martel Hill, and the Rock Ridge Hills provide additional topographic relief. Eolian sands and relict sand dunes locally provide additional elevation

Most of the region is best described as flat to gently rolling, with few radical changes in topographic relief. Elevation in the region ranges from sea level at the Crystal River Site to 53.2 m (175 ft) above sea level at Bailey Hill in Hernando County. Most of the region varies between three and 30 m (10-100 ft) above sea level. Several relict shorelines, including the Pamlico 2.4-7.6 m (8-25 ft), Talbot 7.6-12.8 m (25-42 ft), Penholoway 12.8-21.2 m (42-70 ft), and Wicomico 21.2-30.4 m (70-100 ft) terraces, are mapped from west to east across this region (Healy 1975).

Surface sand deposits contain the surficial aquifer that is recharged through local rainfall. Water table depth ranges from ground surface to about one meter (3 ft) below the surface with seasonal fluctuations generally varying within a three meter (9 ft) range. The Crystal River Site lies within the coast area between the Hillsborough River and the Withlacoochee River (Kenner et al. 1967). This region drains through creeks, streams, and sloughs directly into the Gulf of Mexico. The park drains south and east directly into the Crystal River which is adjacent to the south, and into the sawgrass marsh west of Mounds J and K.

Specific Soils

The Homosassa-WeekiWachee-Durbin soil association has been mapped within this portion of Citrus County (Pilney et al. 1988: General Soil Map). These soils are
described as nearly level, very poorly drained sandy and mucky soils in tidal marshes. Although the site itself contains natural soils, or at least natural soils modified by pre-contact peoples, the area around the Crystal River site have been severely impacted by limestone mining and alterations for development. The areas immediately east and north of the site were mined in the 1940s and 1950s for limestone. This included the channelization of a creek that once flowed south into Crystal River just west of the site. Some of the mined areas have been cleared for residential development. Other portions still contain large tailings piles and other debris from the mining operations.

Nine specific soil series are mapped for the Crystal River site vicinity (Table 4.1). These include the following types: (after Pilney et al. 1988:Map Sheet 15):

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pomello fine sand, 0-5% slope</td>
<td>moderately well</td>
</tr>
<tr>
<td>Citronelle fine sand</td>
<td>somewhat poorly</td>
</tr>
<tr>
<td>Kanapaha fine sand</td>
<td>poorly</td>
</tr>
<tr>
<td>Okeelanta muck</td>
<td>very poorly</td>
</tr>
<tr>
<td>Weekiwatchee-Durban muck</td>
<td>very poorly</td>
</tr>
<tr>
<td>Okeelanta-Lauderhill-Terra Ceia muck</td>
<td>very poorly</td>
</tr>
<tr>
<td>Quartzipsamments, 0-5% slope</td>
<td>altered by earthmoving</td>
</tr>
<tr>
<td>Arents, 45-65% slope</td>
<td>altered by earthmoving</td>
</tr>
<tr>
<td>Matlacha, limestone substrate, urban land complex</td>
<td>altered by earthmoving</td>
</tr>
</tbody>
</table>

The Crystal River site has been modified by human activity over the past 3000 years; it retains little evidence of its natural soil profile. Poorly and very poorly drained mucky soils characterize much of the land surrounding the site itself. These soils are very poorly suited for agriculture, although most are naturally fertile. Water control, either too much or too little, is a constant problem for cultivating plants. There is a ridge
of Pomello fine sand, a moderately well drained soil, adjacent to the northwest of Mounds G and H. This area would have been the nearest abundant source of the white fine sand that Moore identified was used in the construction of Mound F within the Central Burial Complex, although recent coring across the site has identified a thin layer of white sand across the site that could also have been the source of the construction material for Mound F (Thomas Pluckhahn 2011:personal communication).

**Sea-level Variation during the Holocene**

It has long been accepted that sea levels at the end of the Pleistocene and beginning of the Holocene (circa 13,000 BC), the time when the earliest evidence human occupation of Florida can be firmly documented, were much lower than current levels. Since that time the sea level has risen, inundating large portions of the Florida peninsular (Milanich 1994:38-39; Milanich and Fairbanks 1980:37). The shore of the Gulf was between 64 and 112 km (40-70 miles) west of its current location. Much of the land inhabited by Florida’s first inhabitants is now inundated by the waters of the Gulf of Mexico.

There are two schools of thought on sea level rise during the Holocene: a steady-state model that sees a relatively constant rise in sea level throughout this period (Davis 1977; Scholl and Stuiver 1967; Scholl et al. 1969) and a second model that sees a series of oscillations in sea level, some minor, but some fairly significant, within a gradual rise in overall sea level (Fairbridge 1961, 1976; Mörner 1969; Stapor et al. 1991). It is easy to view these two positions as simple differences in scale. On a broader time scale, both result in a rise in sea level of about 50 m (160 ft); the difference is at a finer scale which
accounts for local variations in sea level and accounts for archaeological site locations. These trends can also be seen played at on a world-wide scale, with overall estimates for global sea level changes and evidence for local sea level fluctuations (Dorsey 1997; Fairbridge 1960, 1984; Pirazzoli 1991, 1996; Siddall et al. 2003).

Milanich (1999) in his overview of the Crystal River site asks a simple question: why did the inhabitants of Crystal River locate the site up river and not closer to the coast and the oyster beds on which much of their diet depended? Currently, there are extensive oyster beds off the mouth of the Crystal River (Davis 1997:Figure 10.18), some 4.8 km (3 miles) west of the site. Five kilometers is a relatively long way to transport literally tons of oysters. Milanich (1999:20) contends that the oysters used both to feed the site’s inhabitants and construct the mounds were not collected far off in the Gulf but gathered in the river adjacent to the site during a period of higher sea level. Based on evidence from sites in south Florida, Milanich contends that the sea level during the time of the primary site occupation, approximately AD 200-500, was as much as one meter (3 ft) higher than today. A sea level one meter (3 ft) above current levels would have had a profound effect on the way that the prehistoric peoples would have interacted with the Crystal River site.

During the winter months, the tides and winds at Crystal River mimic stands of higher sea level. In November of 2009, higher than normal high tides and a strong west wind combined to push sea water into the Crystal River. At the highest of high tide, almost the entire Crystal River site filled with water. All of the plaza area north of the area filled to create the 1960s mobile home park was covered with nearly a meter of water. Many of the elevated, paved walkways throughout the park were flooded. Had
the elevated paths not been constructed, there would have been unrestricted canoe access both to and across the main “plaza” area of the site. Feature C, the shell ring, was the only thing that prevented water from encroaching directly on Mounds E and F of the central burial mound complex. The shell “causeway” proposed by Bullen (1965) was one of the few features near Mound H that remained above the water. This flooding episode also appears to have had a profound effect on the acoustics at the site. A park ranger, speaking in a regular “outside” speaking voice on the summit of Mound H, could be clearly heard on Mound G and Feature C, some 125 m (410 ft) distant.

Archaeological investigations at several Florida Gulf Coast sites support the argument for oscillating sea levels during the last 3000 years (Donoghue and White 1995; Griffin 2002:30-4; Ricklis and Weinstein 2005:128-133; Widmer 1988:167-169, 2005:76-85). Evidence from several roughly contemporaneous sites along the Gulf Coast suggests that sea levels were as much as 1.2 m (3.6 ft) above current mean high water by AD 400. Archaeological, paleoecological, and geomorphologic evidence from the Wightman site (Walker et al. 1994), the Pineland site complex (Walker et al. 1995), the Solana site (Widmer 1986), and the Paradise Point site (Bradley 1982) support this contention. Walker et al. (1994, 1995) discuss these data at some length. They conclude that prior to AD 100, sea levels were roughly .4 to .6 m (1.3-2 ft) lower than current levels. Sea levels rose and stayed near current levels from AD 100 to AD 200, when level rose to .7 to 1.4 m (2.3 to 4.6 ft) above current sea level. By AD 600, sea levels had dropped to .5 m (1.6 ft) below current levels (Walker et al. 1995:216).

A recent study published by the Florida Geological Survey (Balsillie and Donoghue 2004) attempts to overcome many of the issues identified in evaluating
predicted sea level fluctuations during the Holocene. This study evaluates all available sea level data, assesses the error associated with these predictions, and employs a moving average technique to eliminate some of the variability in these data. Balsillie and Donoghue (2004:12-16) also address the problem of evaluating sea level indicators that are landward of the current mean high tide line and those that are seaward of the current sea level limits. Higher-than-current sea levels from about AD 50 to AD 350, a drop in levels from AD 350 to AD 500, and a subsequent rise in levels from AD 500 to 650 before again falling off (Balsillie and Donoghue 2004: Figure 8) are proposed. The magnitude of these changes varies within one meter (3 ft) of the current level, assuming no isosatic rebound or subsidence.

These data indicate that during the initial occupation of the Crystal River site, sea levels were lower and the site was farther inland than it is today. Sometime around AD 100, sea levels rose to levels approximately one meter (3 ft) higher than current levels, inundating much of the coastline and likely flooding the central “plaza” portion of the Crystal River site, perhaps not permanently, but certainly on a regular basis. Changes in sea level would have affected the flow of the various springs that form Kings Bay and ultimately Crystal River. This change in flow rate coupled with higher sea level stands would have raised salinity levels to the point where oysters might well have grown in the water directly adjacent to the site (i.e., Milanich 1999).
Prehistory of the Crystal River Area

American Indians have lived in what is now known as Florida for at least 14,000 years. At present, evidence from the earliest cultural periods suggests a relatively uniform adaptation across the north-central reaches of the state, while later periods (post 500 BC) exhibited differing cultural traits in the various archaeological areas around the region. The preceramic periods will be discussed as they manifest statewide, whereas the post-ceramic cultures will be discussed specifically as they relate to the Crystal River site. Because there is no firm evidence of a substantial preceramic component at the site, only a brief summary of the earliest prehistoric traditions, the Paleoindian and Archaic, will be provided.

Jerald Milanich and Charles Fairbanks (1980) synthesized the earlier regional studies of Gordon Willey (1949), John Goggin (n.d., 1952), Irving Rouse (1951), Ripley Bullen (1955, 1959), and others in Florida. Milanich (1994, 1995) has updated and revised much of the work he and Fairbanks presented earlier. Their cultural chronology will be followed in this overview. This prehistoric overview will serve as a framework for understanding prehistoric use of the region of which the Crystal River site is a part.

The Crystal River site is situated within the North Peninsular Gulf Coast archaeological area (Figure 4.3) as defined by Milanich (1994:xix) and Milanich and Fairbanks (1980:22). This region is a refinement of the Gulf Coast archaeological area first described by Nelson (1918), designated by Stirling (1936), and later redefined by Goggin (1947, 1949) as the Central Gulf Coast area. Goggin (1947:117) set the boundary of the Central Gulf Coast archaeological area to include the coastal areas north to the Big
Figure 4.3. Post 500 BC Archaeological regions of Florida. (After Milanich 1994:xix)
Bend region of the state and extending inland to the Central Lake Region. The southern boundary of Hillsborough County marked the beginning of the Manatee archaeological area, extending along Florida’s southern Gulf coast south of Tampa Bay (Goggin 1947: Figure 2). By 1980, enough sites had been recorded and investigated and sufficient archaeological information had been recovered to better define past Native American use of region and to redraw the boundaries. Milanich and Fairbanks (1980:Figure 1) recombined the Central Gulf Coast and Manatee regions and defined the North Peninsular Gulf Coast and the Central Peninsular Gulf Coast regions from this area. The Northern and Central Peninsular Gulf Coast regions were divided in the middle of Pasco County (Milanich 1994:xix) based on the tempering used in village/midden pottery. Limestone/fuller’s earth-tempered ceramics dominate the pottery assemblages to the north; sand-tempered wares are common in the central region focused around Tampa Bay. A diagonal line drawn through the middle of Pasco County provides an arbitrary but useful divide between these two ceramic traditions.

Paleoindian/Archaic Traditions

The earliest formally recognized prehistoric cultural manifestation in Florida and in the North Peninsular Gulf Coast region are the Paleoindians (Goggin 1947; Neill 1958, 1964). Paleoindians appear to have been well-established in Florida by approximately 14,000 years ago and persisted until roughly 8500 BC. Excavations of Paleoindian sites have contributed to the development of increasingly sophisticated models of early hunter-gatherer settlement that take into account the adaptive responses of human populations to both short and long-term environmental change (Anderson et al 1996). These models
suggest that Paleoindian groups in Florida may have practiced a more sedentary lifestyle than had previously been believed (Daniel and Wisenbaker 1987; Dunbar 2006b:534). Paleoindian groups were probably small groups subsisting by gathering wild foods and hunting both now extinct Pleistocene megafauna and several smaller animal species (Dunbar et al. 2006). Collecting of shellfish, fish, and other coastal resources is strongly suspected, as they exist elsewhere but current evidence is lacking as many suspected sites have been inundated by sea level rise during the Holocene (Faught 1988; Faught and Donoghue 1997). By late Paleoindian times (circa 9,000 BC), the large Pleistocene animals had disappeared, the climate changed and the sea levels rose, and the large lanceolate points considered diagnostic of Paleoindian groups were replaced by smaller side and corner notched varieties.

Archaic peoples were broad-range hunter-gatherers; they hunted, fished, and collected plants and shellfish. Acorns and other hardwood nuts were also harvested. Settlement patterns and social organization focused on effectively exploiting seasonally available resources (Milanich 1994). Larger populations could congregate at those times of the year when plant and animal resources were locally abundant and separate into smaller social units during less plentiful times (Milanich 1994:67-70). Seasonality is reflected in both site function and settlement patterning (Daniel 1985). Centralized base camps or villages, defined by the number and diversity of artifacts present, are habitation sites for larger social groups. Less extensive, limited activity/extractive camps and quarry sites suggest resource use by fewer people for shorter periods.

Early indications of interregional interaction are expressed in the archaeological record at a few sites dating to the Late Archaic (3000 to 500 BC). The use of clay
cooking "balls," grog-tempered pottery, and certain ceramic forms and steatite vessels at the Tick Island site (Jahn and Bullen 1978) and the Canton Street site (Bullen et al. 1978) indicates direct or indirect contact with the Poverty Point culture in the Lower Mississippi River Valley. Known in Florida as the Elliott’s Point Complex, this contact is best documented in the Florida panhandle, and especially in the Apalachicola Delta area (White and Estabrook 1994:73).

During the Late Orange Phase, also known as the Florida Transitional period (1200-500 BC), changes in pottery and stone tool styles occurred in Florida which marked the beginning of the Woodland period. A decline in the use of fiber (Spanish moss) and an increase in the use of sand and freshwater plants, especially sponges, as tempering agents in ceramics occurred during this time (Sassaman 1993). A variety of hafted biface styles, basally notched, corner-notched, and stemmed, all occur in relatively contemporaneous contexts. This profusion of ceramic and tool traditions suggests an increased social interaction between the various regions of Florida, other parts of the Southeast, and much of eastern North America.

Woodland Tradition

Around 500 BC, the peoples inhabiting the salt marshes of the Atlantic coast of southern Georgia and northern Florida and Gulf coastal regions from Alabama east to Tampa Bay adopted a particularly identifiable series of cultural traits. The manufacture of a coarse sand/grit-tempered pottery and a specific focus on the exploitation of marine and near coastal salt marsh resources were given the name Deptford culture, after the Deptford site in coastal Georgia (Caldwell and McCann n.d.; Milanich 1973). Deptford
peoples are the peoples of the coastal salt marsh. While inland sites are known (Bense 1985; Milianch 1994; Tesar 1980; White 1981), Deptford sites are more commonly located within the coastal strand on or immediately adjacent to rivers, streams, or creeks (Milanich 1973:53). Deptford ceramics are often decorated with paddle-stamped designs. Linear grooves and check-stamping are two of the most common motifs found (Milanich 1973: Table 3).

Deptford sites cluster in the coastal strand along Florida’s Gulf coast. Milanich (1994:116) suggested that they are most often found in live oak or cedar hammocks directly adjacent to the salt marshes. The Crystal River site would have been a particularly desirable location as it is situated in a limestone rise providing some limited drier areas within what is essentially a saltwater marsh. Unlike their Archaic predecessors who favored upland sand ridges, Deptford groups lived on or within the coastal salt marshes. This put them in direct proximity to salt water marine, brackish water marsh, and freshwater creek/riverine resources. Fish and mollusks, especially fish, formed the mainstay of their diet. Resources found within the adjacent pine flatwoods were also important, especially deer, raccoons, and other small mammals. The remains of large fish, rays, sharks, and large sea turtles indicate that saltwater marine resources were also important (Milanich 1973:Table 2).

The size, shape, and distribution of coastal shell middens that have been attributed to the Deptford peoples indicate a settlement pattern of small household units. Milanich (1973:56) suggests that earlier settlements were clusters of 5-10 households, each with its associated house midden. Later domestic sites were larger, with perhaps as many of 15 to 25 structures per settlement. The individual settlements were lined up along the
estuary shoreline with each household midden overlapping the next until, after several years, a sheet midden would form. Over time as the fish and shellfish debris accumulated, larger linear middens were formed. As the layers accumulated, they created raised living areas and provided the raw materials for mound construction. These hamlets were spaced out along the coastal strand to form the discontinuous communities within which Deptford peoples lived their lives.

Deptford material culture included the extensive use of shell tools, particularly those made from the shells of large gastropods, especially whelks (*Busycon* spp.) and various conchs (*Strombus* spp.) as well as bone and stone tools. Deptford stone tool technology employed a combination of expedient flake tools and hafted bifacial tools. Both larger stemmed points and smaller, basally-notched points are found at various sites. There is also a return of a lanceolate-shaped point technology, similar to that used by Florida’s Paleoindian inhabitants (Mikel 1994).

Deptford sites are most often identified by the specific “gritty” check-stamped and simple-stamped ceramics recovered from these sites (Willey 1949; Sears 1960; Brown 1982). The sand/grit used to temper Deptford pottery is much larger in size than most of the very fine-grained sands found in the vicinity of most sites. The use of paddle stamping surface treatments is common as well as the use of podal supports on the bottoms of vessels (Milanich 1994:130). Vessel shapes change as well with the adoption of the cylindrical pot as the main vessel form.

In other areas of Florida, the onset of Woodland times has meant the focus on the exploitation of local resources, especially lithic resources. A comparison of three Archaic period site components and four post-Archaic components strongly suggests a
change in emphasis between the use of local vs. non-local cherts during the post-Archaic periods (Austin and Estabrook 2000:126). Local Peace River cherts were used more extensively despite the low-quality of these materials. Local resource availability, and a shift away from an emphasis on the use of bifacial tools to the use of more expedient flake tools, was evident in the interior portions of the state.

Deftord society also displays an increase in the materialization of ceremonialism. Based on a comparison of several well-known sites in Florida, Sears (1962b) defined the Yent and the Green Point mortuary/ceremonial complexes. Sears (1962b:5) felt that the Yent complex predated the Green Point complex. He saw the Yent complex as being associated with Deftord groups and the later Green Point complex being associated with later Santa Rosa/Swift Creek peoples. The Yent complex has been defined by trait lists developed from three well-known Florida sites including the Crystal River site. Also included were the Pierce and Yent mound sites, for which the complex was named. Sears notes the direct connection between the Yent complex, these three sites, and the Hopewell complexes of Ohio, Illinois and Louisiana. The similarity between the burial remains recovered from these sites, all investigated by C.B. Moore in the early twentieth century, was noted by Greenman (1938), Griffin (1946), Willey (1949) and others.

By defining trait lists based on the remains recovered from mortuary contexts, Sears (1962b) limited the assignment of sites to this complex to the larger sites containing burial mound complexes. The trait lists included many items associated with the “Hopewell Interaction Sphere” (Struever 1964): copper pan pipes, worked copper, elongated plummets (especially those made with non-local materials), double-ended
plummets, cut carnivore jaws/teeth, two-hole stone bar gorgets, cymbal-shaped copper ornaments (ear spools), and cut shell ornaments (shell gorgets). Most of these items, particularly the native copper, are not found in Florida and would have been brought into the region through direct acquisition or trade (Sears 1962b; Milanich 1994).

Other traits associated with Yent include continuous-use burial mounds, specialized pottery found only in mortuary contexts, miniature ceramic vessels, and shell cups/dippers made from large gastropod shells. Sears (1962b:9) attributes much of the pottery to “non-local” manufacture. He also notes that those pieces of apparent local manufacture in the mounds were shaped and decorated in ways that were different than the ceramics found in domestic contexts. Milanich (1994:137-138) adds the intentional destruction or “killing” of both shell dippers and ceramic vessels to the Yent complex, and also suggests the possible extension of the Black Drink ceremony, known in historic times, back to the initiation or consecration of Yent mound complexes.

Deptford groups along the coast focused exclusively on marine and estuarine resources. The adaptation of inland Deptford peoples is less well understood, but seems to have followed a pattern of resource use established during the Late Archaic (Austin et al. 2009; White 1981). Coastal Deptford peoples lived in small hamlets strung out along the coast and various estuary systems associated with various river systems. They also maintained ceremonial centers which appear to be the focus of their religious world: their burial mounds, ceremonial centers, and religious paraphernalia seems to have been concentrated at these centers.

After around AD 200, the Deptford groups around Crystal River came under the influence of the extensive Weeden Island socio-political complex which is best known in
northern Florida, southern Georgia, and Alabama - the recognized "heartland" of Weeden Island cultures. Weeden Island in central Florida is defined primarily on a change in the ceramic assemblage. The gritty, stamp-decorated Deptford wares were replaced by carefully made and intricately decorated Weeden Island wares. A distinctive Weeden Island pottery was first identified by Holmes (1903) based on the early fieldwork work of C.B. Moore. It was not until Fewkes’s work at the Weeden Island type site in Pinellas County that the association between the Weeden Island pottery found in burial mounds and the peoples living on the adjacent shell middens was first suggested (Fewkes 1924: 14-15; 21). While new pottery styles were adopted during the Weeden Island period, the local lifestyle appears to have been little changed (Weisman 1995:7).

Weeden Island was first recognized for its elaborate and finely made ceramic complex (Holmes 1903:104-114) and later defined as a formal ceramic type (Sterling 1936; Willey and Woodbury 1942; Willey 1945, 1949). The period was first divided into two phases Weeden Island I and II based on the presence of Swift Creek types in Weeden Island I and Wakulla Check Stamped in Weeden Island II (Milanich 1994:159). Further refinement of this chronology has identified a variety of regional and temporal distinctions within the overall timeframe and shared socio-political and ceremonial complex we recognize as being “Weeden Island.” Each regional variant shares commonly used material culture and use of burial mounds, but retains a locally adapted subsistence adaptation, pottery style, and stone/bone/shell tool technology.

The local Weeden Island variant in the Crystal River vicinity has been designated by Milanich (1994:161) as the north peninsular coast, expending along an area from Pasco County north to Taylor County. Domestic middens in this region are dominated by
two different tempering technologies: quartz sand and limestone/fuller’s earth. These types are commonly referred to as sand-tempered plain (STP) and Pasco respectively (Cordell 1984; Goggin 1948; Luer and Almy 1982). Coastal sites are dominated by shell middens, a very visible and easily located site type. Weeden island peoples also occupied the rivers and lakes of the interior. Weisman (1986) identified two kinds of domestic archaeological sites within the Cove of the Withlacoochee: riverine shell middens and upland sandhill sites. The shell middens contain the remains of freshwater snails (*Viviparus* spp.), freshwater mussels (Unionidae), fish, and various reptiles and small mammals. The ceramic assemblages of these sites are dominated by limestone/fuller’s earth tempered Pasco wares. The upland sand sites lack abundant shellfish and faunal remains (Janus Research 1998) and their ceramic assemblages are a mixture of STP and Pasco wares (Weisman 1986:8). Around AD 600 Weeden Island peoples in the Cove were shifting away from their exploitation of riverine and freshwater wetland environments, and a shift towards the collecting of resources found in the upland, sandhill environments in the region (Weisman 1986:20).

**Mississippian Tradition**

The final pre-contact cultural manifestation along the North Peninsular Gulf Coast is the Safety Harbor phase, a Mississippian-influenced society that was centered at Tampa Bay. This phase, beginning about AD 900 (Mitchem 1990:165) is typified by yet another change in the shape and decoration in the pottery made for mortuary contexts. The Safety Harbor phase also saw the abandonment of some of the larger Weeden Island phase ceremonial centers, the expanding and enhancement of others, and the creation of
entirely new centers in places where none had existed before. Safety Harbor ceremonial centers follow a very typical site plan. They are often defined by several truncated platform/temple mounds surrounding an open plaza area with adjacent or nearby burial mounds and residential areas (Milanich 1994:389; Weisman 1995: 8). This settlement pattern is characteristic of Mississippian cultures to the north and was evidently adapted to west-central Florida by local groups.

Mitchem (1989) has subdivided the Safety Harbor period into four phases and five regional variants based on his extensive site review. The four phases include two pre-contact and two post-contact periods. The five subareas include a core Circum-Tampa Bay heartland variant and four related peripheral areas. The Crystal River site is located within the Northern subarea (Mitchem 1989: 568, Figure 33). With the Withlacoochee River as the socio-political boundary between Safety Harbor groups to the south, Alachua Tradition peoples to the north and east, and agricultural Fort Walton peoples to the north and west, the interaction between these regions is ripe for future investigation (i.e., Kohler 1991:96-99).

As with the shift from Deptford to Weeden Island, many local traditions, including the making of limestone/fuller’s earth tempered domestic ceramics, the employment of an expedientflake core stone tool technology, and an elaborate shell tool assemblage. The Weeden Island peoples of Crystal River area adopted some of the social, political and ceremonial customs of their Mississippian neighbors to the north, much as they did during the preceding Weeden Island-related period. But as Weisman (1995:8-9) points out, there is scant evidence for any long-term or large-scale use of the Crystal River site by Safety Harbor peoples.
Chapter 5: Methods – Artifact Analysis Methods and GIS Procedures

This chapter describes artifact recovery and data analysis procedures and the field and laboratory methods used in this study. There are two primary sets of analytical procedures that were used to provide the information necessary to address the five hypotheses proposed by this study. The first set of techniques focuses directly on the chipped stone tool assemblage. The second set of procedures discusses the GIS tools that were used to create the WofE chert outcrop predictive model and the cost-paths that was used to model chert acquisition.

As discussed in Chapter 2, there are multiple ways to characterize the chipped stone tool assemblage from the Crystal River site. The life history will be used address the questions of where the stone used to make these tools was first quarried, how the tool stone was shaped and fashioned into the various tools and implements necessary to work in specific tasks and activities, and how these tools came to be deposited within the archaeological context from which they were recovered at the site. A combination of a quarry cluster-based provenience analysis (Upchurch et al. 1981), both high and low-power magnification use-wear analysis, and an attribute-based waste flake analysis were used to provide the information necessary to address the research issues.
The spatial component of the analysis has been made possible by the spatial analysis tools available within GIS. The WofE approach provides a means of assurance that all of the major lithic outcrops in the region around the site have been considered. The lithic raw material cost surface analysis provides a measure of accessibility of chert to the site’s inhabitants. This baseline data were meant to measure which outcrops would have been most accessible to the site’s inhabitants before taking into consideration selection for the quality of the materials or the various modes by which chert may have come to the site. The WofE and the cost path analysis provide powerful tools with which to model the potential locations of chert outcrops and quarry locations and the possible pathways that brought chert and various chipped stone tools to the Crystal River site.

As stated previously, this research did not involve any new excavations or subsurface testing at the Crystal River site. It focused on previously excavated materials and collections. Archaeological investigation at the Crystal River site have been going on for a long time, for a variety of reasons, and by a number of different researchers, each with varied objectives. Little of this information, apart from Bullen’s 1953 and 1966 summaries and Weisman’s 1995 overview, has ever been widely published. Most of the recovered artifacts have only been subject to a cursory analysis; some still remain to be washed and cataloged. As discussed in Chapter 2, I have chosen to adopt a historical processual research approach, strongly influenced by the chaîne opératoire and a socially-inspired GIS perspective, to evaluate the available information and address the stated research goals.
Current Artifact Locations

The artifacts included in this investigation were recovered from the Crystal River site at various times and are now curated in a variety of institutions. These include the collections of the Florida Museum of Natural History (FLMNH) in Gainesville, the Florida Division of Historical Resources (FDHR) in Tallahassee, the National Museum of the American Indian in Washington, D.C., and the Crystal River Archaeological State Park (CRASP) in Citrus County. Nineteen of the hafted bifaces recovered by C.B. Moore between 1903 and 1918 are curated at the National Museum of the American Indian. The many artifacts recovered by Bullen in 1953, 1960, 1964 and 1965 as well as various surface collections and donations made by various researchers are curated by the Florida Museum of Natural History (FLMNH). The FLMNH also curates the material recovered by Weisman and Mitchem (1984) from the two test excavations they conducted. These materials were made available for study at the FLMNH.

Since the mid-1980s, the artifacts recovered from the Crystal River site have been curated by the Florida Division of Historical Resources (FDHR) in Tallahassee. Materials recovered during nine (9) distinct projects were made available by loan from FDHR. These projects include material recovered during the investigation of a tree fall (Weisman 1990); an investigation of the installation of a septic drain field by Henry Baker (Baker 1991); materials recovered during the 1993 Storm of the Century (Weisman and Newman 1993); an investigation to locate drowned midden deposits (Purdy and Weisman 1995); additional storm damage recovery in 1995 (Weisman 1995; Weisman and Newman 1996); a Crystal River Trailer Park slab removal project (Smith 2000); a fencepost relocation project (Wheeler 2001); and the seawall restoration project (Ellis
A small number of artifacts held by the FLMNH are on display in the CRASP Museum. This includes a number of hafted bifaces, points, and other stone tools. A careful inventory of these materials was made to confirm the identity of all artifacts currently housed in the CRASP Museum that were actually recovered from the Crystal River site itself. This investigation also helped to update the FLMNH loan records. Since the museum first opened in 1965 numerous updates and changes have been made to the collections from the FLMNH that are on loan to the CRASP Museum. Unfortunately, these changes were not always reflected in the loan agreement inventories. Fifteen person days were spent by me, park staff and volunteers, and FLMNH staff and volunteers at the Museum trying to update these inventories. Although some artifacts could be positively identified during this evaluation, most of the stone tools could not. The 1960s technique of gluing the artifacts into the displays accession number towards the back of the case kept us from positively identifying many of the stone tools. These materials have not been included in this study.

Crystal River Archaeological Site Park (CRASP)

There are two categories of archaeological remains currently housed within the CRASP: artifact recovered from the site prior to its becoming a state park in 1965 that are on loan from the FLMNH in Gainesville; and a few artifacts that have been recovered from the Sifting for Technology outreach program at the park. The Sifting for Technology program was developed by park personnel in 2003 using displaced Mound A and Midden B materials that had been removed from the boat slip area during the replacement of the failed sea wall.
During the cleanup after the 1993 Storm of the Century, small collections of artifacts were discovered in several of the garden sheds in the Crystal River Mobile Home Park. These materials were collected, placed in bags, and stored in the CRASP Museum storage room. Because their provenience was suspect, they were not transferred to the FDHR artifact curation facility. They were re-discovered in July of 2010 during an inventory of the artifacts on loan from the FLMNH. One of the exhibit areas had been turned into a video viewing area and the exhibits and artifacts that had once been on display were stored in the unused rest room which now is used for museum storage. The artifacts were simply left on a shelf for nearly two decades.

This collection of chipped stone tools, pottery sherds, faunal bone, and other artifacts were recovered from the gardens of the residents within the trailer park (Nicholas Robbins 2010:personal communication). When the residents discovered artifacts in their garden, they often simply collected it. Each resident kept a can, bucket, or box for artifacts in the storage shed at the far end of their carports. This collection came from one of these residential sheds during the cleanup. It is unclear how many residential collections this material may represent or how many similar collections were lost during the storm and subsequent cleanup efforts. These materials are some combination of artifacts from Midden B and the eastern one-third of Mound A which had been pushed into the park as fill in the 1960s.

Smithsonian Institution: National Museum of the American Indian

C.B. Moore recovered a select group of artifacts from the Crystal River site and returned with them to Philadelphia. The majority of the faunal remains, pottery sherds,
discarded stone and shell tools, waste flakes, and all on the human remains were left behind at the site in several spoil piles that surrounded the central burial mound complex. Most of the artifacts Moore recovered were displayed at the Academy of Natural Sciences in Philadelphia, an organization which also published many of Moore’s works as part of its Proceedings series and its journal publication. The collection remained on display for about a decade as Moore continued to travel to the Southeast every year to gather more material. In 1929, the Crystal River artifacts, the remainder of Moore’s collection, as well as several other collections of archaeological and ethnographic materials housed at the Academy of Natural Sciences of Philadelphia were abruptly sold to the Heye Foundation’s Museum of the American Indian in New York. This transfer caused quite a sensation at the time, with the assistant curator resigning in protest and Moore himself upset about the transfer, but finally acquiescing to the decision as it kept the collection intact and well-cared for (Wardle 1929:119-121). There are 19 chipped stone artifacts in the Moore collection from Crystal River currently held by the National Museum of the American Indian, now part of the Smithsonian Institution.

Not all of the material Moore recovered was given to the Academy. Some of the artifacts were donated to the R.S. Peabody Foundation in Andover, Massachusetts. In January of 1920, several plummets and stone celts were transferred from the Peabody to an unknown museum in Maine. Neither the specific museum nor the artifacts could be relocated (Weisman 1987:Appendix E). The inventory of artifacts from the R.S. Peabody Foundation catalogue (Weisman 1995:Appendix IV) indicates that there were no chipped stone artifacts included with these materials.
Florida Museum of Natural History

The artifacts recovered by Ripley Bullen and the materials recovered by Weisman and Mitchem (1984) are currently curated by the FLMNH in Gainesville, Florida. Guided by Weisman’s (1995) Appendix I: Inventory of Crystal River Artifacts in the Florida Museum of Natural History, I spent several months during the summer of 2005 looking through the collections to familiarize myself with the materials. Because of an asbestos abatement project at the FLMNH, the Crystal River collections were placed in storage. They became available again in the spring of 2011. Once the materials were again available for study, I applied for and obtained permission to conduct a non-destructive analysis of chipped stone assemblage. The initial analysis and collection of metric data were conducted within a temporary work space provided at the FLMNH.

Florida Division of Historical Resources

The artifacts recovered from the site since the mid-1980s have been curated by the Florida Division of Historical Resources, Bureau of Archaeological Research (BAR) in Tallahassee. These materials were made available for study under BAR Loans Number 2008-018 and 2009-013. BAR Loan Number 2008-018 included materials from nine different projects which represent 91 recovery proveniences, several of which contained multiple artifacts. All had been classified as “lithics.” Some of these, however, were not chipped stone artifacts. These non-chipped stone materials were identified for the staff of BAR, but are not included in the current analysis. BAR Loan Number 2009-013 included the materials recovered during the five hand core samples recovered by Pluckhahn et al. (2009). This assemblage includes ten (10) artifacts.
Materials Not Included

There are two artifact assemblages from the Crystal River site which are presently not available for study. The materials excavated by Hale Smith with Florida State University in 1951 could not be located. At first it was suggested that these materials were given over to Ripley Bullen (1953) as Bullen included an analysis of the ceramic component of Smith’s work in his 1953 publication. An intensive search of the FLMNH databases and collection failed to identify these materials. A search of the Florida State University Department of Anthropology archaeological collections was equally unproductive. These artifacts may someday be identified in some dusty corner of a storage room somewhere, and should then be added to the story of the Crystal River site.

On 19 December 2005 there was a break-in at the Crystal River Archaeological State Park Museum. By the time the park manager got from his residence on the park grounds to the Museum, the protective glass on the Projectile Points and Ornaments display case was smashed and 13 hafted bifaces and a “ceremonial knife” had been pried off their mounts and taken from the museum. The thieves took relatively common Hernando (n=7), Lafayette (n=2), and Citrus (n=4) points that were part of the collection donated to the museum in 1967 by Donald E. Ward. Many of these points are reported to have come from the Crystal River site itself or the immediate site vicinity. But without field notes, records, there is no way to verify this. The remaining materials that were part of the Ward collection were not included in the analysis.

There are more stone implements recovered from the Crystal River site that were not included in this analysis. These include a variety of ground stone tools, celts, and net weights and a variety of stone beads, plummets and stone meant to be worn or displayed.
Some of these objects were made from local limestone, but others obviously were not. Because of the number of items and complexity of these studies, the analysis of ground stone tools and ornamental objects was not made a part of this study.

**Chert Samples**

Chert samples came from a variety of places. Most of the original collection of samples collected by Sam Upchurch in 1980-81 was transferred from the USF Geology Department to the FLMNH in 1996. Some of these materials were retained by Robert Austin, who assisted in the collection and transfer of these materials. Robert Austin was very kind as to share some of the samples with me. Since the mid-1980s, Robert Austin, myself, and others have been actively collecting chert samples from around Florida and the Southeast. These samples are maintained by provenience by the author and have been used for a variety of investigations. These materials were often collected by various CRM crew members and returned at the end of fieldwork on a specific project. Since they were collected on an encounter basis, many of the samples came from the chert-rich regions around Tampa Bay, Pasco County, and from areas along the Brooksville Ridge – areas under a good deal of development pressure and the focus of many CRM-based investigations. Unfortunately, the area around the Crystal River site was not sampled extensively during this period. A collection of chert samples from Upchurch’s (et al. 1981) field work is maintained by the USF Department of Anthropology.
Laboratory Analysis

A variety of laboratory procedures were employed in this investigation. The procedures included a collection of various metric attributes, an inspection for microwear/use-wear, a raw material provenience analysis, and a waste flake analysis. All artifacts considered in the analysis were included in the initial three steps; only materials considered to be waste flakes or debitage were subjected to the final step. The standard metric data were recorded following the procedures used in previous lithic studies (Deming and Estabrook 1994; Estabrook 1986; Estabrook and Newman 1984; Estabrook and Williams 1992; Janus Research 1995). The only notable difference was the use of absolute measures of flake length, width, and thickness rather than the size categories (Ahler 1989; Andrefsky 1998; Stahle and Dunn 1982, 1984). The raw material provenience analysis employs the quarry cluster method developed by Upchurch et al. (1981) and modified after Austin (1995a, 1995b) and Endonino (2007). The waste flake (debitage) analysis was limited as when the study first began, the number of waste flakes was originally thought to be fairly small. The debitage analysis employed techniques which focus on distinguishing between waste flakes that were produced during the manufacture of bifacial tools from those resulting from core-flake tool production (Andrefsky 1998; Carr and Bradberry 2001; Parry and Kelly 1987; Prentiss 2001). It was limited to a flake size and flake attribute analysis. The results from all avenues of study were recorded in a relational database.
Metric Attributes

The chipped stone artifacts recovered from a variety on contexts within the Crystal River site were all subjected to a similar level of investigation. Non-destructive techniques allowed for all of the artifacts to be measured, weighed, and inspected for use-wear/microwear and in most cases to make a determination of the geological formation from which the chert originated. Permission was not granted from the artifact curatorial facilities to wash the materials, remove the extraneous dirt from the surfaces, or clean them in such a way as to make the surfaces as observable as possible, so many of the artifacts were inspected unwashed or cleaned. All measurements were made using a pair of digital or dial calipers accurate to 0.01 cm, but rounded to the nearest tenth of a centimeter. All weights were recorded using a digital scale accurate to a tenth of a gram. Tool edge angles and flake platform angles were measured using a metal goniometer accurate to within a degree (Butler 1980; Movius et al. 1968).

Use-wear

There are many ways in which stone tool use can be inferred. The oldest and perhaps the most widely used method to infer stone tool use is what Hayden and Kamminga (1979:3) call the speculative functional approach. In this traditional approach, tool use was inferred based on tool morphology, or the overall shape and size of the implement in question. Arrowheads were believed to always be used to tip projectiles and all steeply-chipped unifaces were categorized as “scrapers.” Based largely on ethnographic analogy and a comparison to modern metal tools, these use categories have long held sway in the identification and description of chipped stone
implements (Haden and Kamminga 1979:2-3; Vaughan 1985:3-6). The previous stone tool analysis at Crystal River had been limited to a brief discussion of biface types and a photograph of selected specimens (Bullen 1953). To date, there has not been a use-wear or microwear study conducted for any of the stone tools recovered from the site.

Use-wear analysis, also sometime referred to as micro-wear studies, have been used extensively to determine the probable use of stone tools (Andrefsky 1998; Gräslund et al. 1990; Hayden 1979; Juel-Jensen 1994; Kardulias and Yerkes 2003; Kay 1996; Vaughan 1985; Yerkes 1987). The technique was first developed in the former Soviet Union by S.A. Semenov (1964) in the 1930s and 1940s. It was not until the late 1950s that this robust series of techniques became better known in the Europe and the United States. The process involves the observation and evaluation under magnification of various scratches, flaking, chips, fractures and wear-spots on the edges and surfaces of stone and bone tools in order to infer tool use. Semenov (1964:222-23) applied these techniques to stone, bone, and ivory tools and used a variety of light microscopes of various configurations and magnifications to perform these analyses.

In the 1970s two different implementation of use-wear analysis emerged, both focusing on different aspects of Semenov’s work in the Soviet Union (Andrefsky 1998:5) and similar approaches that were developed in the West (Frison 1968; Keller 1966; Wilmsen 1968). One employed high-magnification (50x-500x) metallurgical microscopes and scanning electron microscopes. The other approach employed binocular microscopes of much lower magnification (10x-100x), but with much greater depth of field. The higher-power magnification approach to evaluating tool use-wear was championed by Lawrence Keeley (1974; 1980) at Oxford University. The low-power
magnification approach was first used extensively by Ruth Tringham (Tringham et al. 1974) and her students at Harvard University, but has been popularized by one of her students, George Odell and his colleagues (Odell 1975, 1980, 1981; Odell and Odell-Vereecken 1980).

Low-power magnification use-wear analysis focuses on the patterns of observable damage along a tool’s edge and the adjacent tool surfaces. Contact with various materials chips, breaks, or wears away small portions of the edge, resulting in definable tool use patterns (Ahler 1979; Ballo 1985; Hester and Follett 1976; Tringham et al. 1974; Odell 1981). Tool use is inferred from an evaluation of the kinds of edge damage present and its location on the tool. Using a stone tool to cut a piece of hard wood, like oak or hickory, will result in many small flakes being removed from both contact faces of the stone implement in addition to abrasion, or rounding, along the tool’s contact edge. Tools used in cutting or slicing activities typically display more extensive, but less pronounced kinds of edge damage (Ahler 1979; Frison 1979; Tringham et al. 1974). Edge damage was classified using procedures detailed by Ahler (1970:37-39); Brink (1978:46-55), Keeley (1980:24-25), Tringham et al. (1974), and Odell and Odell-Vereecken (1980: 93-95).

High-power magnification use-wear analysis employs light microscopes with magnification ranging from 50x to 500x magnification. This branch of use-wear studies focuses on two primary surface damage types: striations or small scratches left behind on the surface of the tool from use, and polishes or light-reflecting patches left on the tool’s surface from abrasion with another object (Keeley 1980; Vaughan 1985). The type of tool use (i.e., cutting, sawing, scraping, whittling) is inferred from the size, direction, and
orientation of the striations (scratches). The worked material is inferred from the character of the polish. The abrasion of bone against stone tools leaves a bright (very reflective) polish on the tool’s surface, but also a characteristic pitting that easily differentiates bone working tools from wood working tools (Keeley 1980:42-43; Lewenstein 1987:76-136; Newcomer and Keeley 1979:199-201; Vaughan 1985:31; Yerkes 1987:203-219).

From its inception of use-wear studies, there were differences in opinion about the reliability of the technique (Grace 1996; Grace et al. 1985; Hurcombe 1988; Ibáñez and González 2003; Newcomer et al. 1986, 1988; Keeley and Newcomer 1977; Moss 1987; Shea 1987, 1992) and the ability of the various techniques to differentiate between different tool use on different kinds of materials (Bamforth 1988; Bamforth et al. 1990; Brose 1975; Odell 1990; Odell and Odell-Vereecken 1980). As noted by Stevens (et al. 2010), accuracy to predict tool use decreases with specificity. The ability to determine whether or not a tool has been used is accurate 70-90 percent of the time. The ability to predict activation against hard vs. soft materials is accurate 60-75 percent of the time. However, the ability to identify use against specific contact materials is only accurate 20-70 percent of the time (Stevens et al. 2010).

A Bausch & Lomb StereoZoom® 7 binocular microscope (10-70x) was used for the low-power magnification observations. An Olympus® BHM binocular metallurgical microscope (50-400x) was used for the high-power magnification use-wear evaluations. Fiber-optic white light sources were used during both studies. The metallurgical scope provided both light-field and dark-field illumination. The low-power investigation was
performed first. Any evidence of use, possible or suspected polishes or striations were noted and then later re-investigated with the metallurgical microscope.

**Quarry Cluster Analysis**

Quarry clusters are defined as groups or clusters of chert outcrops that contain materials that are similar in fabric, composition, and fossil content and that come from the same geological formation (Upchurch et al. 1981). The four primary chert-bearing formations in Florida are, from oldest to youngest, the Crystal River Formation of the Ocala Limestone, the Suwannee Limestone, the Tampa Member of the Hawthorn Group, and the Coosawhatchie Formation also within the Hawthorn Group. Each can be identified by the different index fossils it contains, by the typical rock fabric or graininess of the parent rock, and by specific inclusions, like quartz sand. There were originally 19 quarry clusters defined in Florida (Upchurch et al. 1981). Each is dominated by cherts originating in one of the four chert-bearing geological formations.

Although the chert in each cluster comes primarily from a single chert-bearing formation, Upchurch also noted a good deal of variability in each cluster (Estabrook 2005). Most of the clusters from which Upchurch (et al. 1981) was able to obtain samples actually contained cherts from more than one zone. For example, Upchurch collected samples from six locations within the Marianna cluster. These samples represented cherts from the Tampa Member of the Hawthorn Group, the Suwannee Limestone, and the Crystal River Formation. The material from the Tampa Member was exposed on hill slopes and in the uplands. The Suwannee Limestone was also exposed in the sides of upland ridges. The Crystal River Formation material was found in outcrops
along the Chipola River at the entrance to the Florida Caverns State Park (Upchurch et. al. 1981:105). A single Suwannee Limestone outcrop, being the largest and best developed as a source of chert, was taken to represent the cluster as a whole. Nearly all of the clusters contain some residual amount of chert from strata other than the one designated as the dominant type.

Austin’s (1997) work in central and south Florida reduced the number of clusters from 19 to 16. This reduction requires the joining of all or portions of five of the Crystal River Formation clusters in central Florida into two groups - eastern and western super-clusters. This reduction was indicated because these clusters were adjacent to each other and because the major defining characteristic separating them was the size and relative abundance of specific key index fossils and rock fabric (Austin 1997:220). The Ocala, Gainesville, and lower portions of the Lake Panasoffkee cluster were combined into the new Ocala quarry super-cluster. The Lower Suwannee, Inverness, and upper Lake Panasoffkee clusters were joined into the new Lower Suwannee/Lake Panasoffkee quarry super-cluster. Austin (1997:216) adjusted the boundaries on several of the original clusters, most notably the Peace River, the Caladesi, the Turtlecrawl Point, and the Hillsborough River clusters. The Peace River cluster was expanded southward to include new outcrops along the Peace River near Zolfo Springs. The eastern and southern boundaries of the Caladesi and the Turtlecrawl Point clusters were expanded to the east and the Hillsborough River quarry expanded to the west to meet up around Tarpon Lake.

A recent re-evaluation of Austin’s (1997) super-cluster concept, Endonino (2007) has returned to Upchurch et al.’s (1981) nomenclature and has proposed revised criteria and boundaries for the quarry clusters in central Florida. Based on the relative size and
abundance of a specific large Orbitoid *Lepidocyclina* spp. and the abundance of Pecten molds (a scallop-like bivalve), Endonino (2007: Figure 12) has redefined the boundaries of the original Gainesville, Ocala, and Lake Panasoffkee quarry clusters and has refined the criteria for member in each of these clusters. The Inverness quarry cluster, a poorly defined construct to begin with, has been eliminated as a cluster (Endonino 2007: Figure 13). A single Lake Panasoffkee cluster has been replaced with East and West Lake Panasoffkee clusters. This returns the number of quarry clusters back to the original nineteen.

While this study has added many more quarry locations to the number of known outcrops in the region, problems remain. Endonino’s (2007) study was based on an evaluation of materials recovered from quarries, not from archaeological contexts. While the average size and average density of *Lepidocyclina* spp. in chert samples from specific chert sources is relatively constant, the range of sizes and density varies considerably (Endonino 2007:Figures 6-10). For example, both the Gainesville and Lake Panasoffkee West clusters have average fossil abundance values and minimum size values that are fairly close, 9.55 pcm² vs. 9.2 pcm² and 1.4 mm vs. 0.8 mm, respectively (Endonino 2007:Table 3). Both contain cherts with similar rock fabrics and colors. The only way they can be differentiated is by considering the maximum fossil size, which can differ considerably: 29.7 mm for Gainesville materials verses only 13.7 mm for the Lake Panasoffkee West samples. The problem lies with applying these numbers to archaeological samples. Samples recovered from known quarries can be as large as necessary, whereas 30 mm is larger than many waste flakes and even some smaller chipped tools recovered from archaeological contexts. Endonino (2007:85)
acknowledges these issues and suggests that both the size and abundance criteria be used to differentiate between materials believed to come from these clusters.

Extensive work in the chert-rich Hillsborough quarry cluster around Tampa Bay (Austin et al. 2008; Deming and Estabrook 1994; Estabrook and Williams 1992; Goodyear et al. 1983) has demonstrated that it is possible to subdivide larger quarry clusters into smaller units. Goodyear (et al. 1983) identified six specific chert types in this region, Types 1-6, which now can be identified based solely on petrographic analysis alone. This ability to identify cherts on a very specific level has allowed several studies to evaluate on a local level the use of specific chert quarry locales by prehistoric peoples (Deming and Estabrook 1994:70-74; Estabrook and Williams 1992:48).

The Crystal River site lies within the prolific Brooksville quarry cluster, a group of Oligocene age Suwannee Limestone exposures that extend along the Brooksville Ridge, a relict feature of Florida’s distant geologic past. Cherts are typically exposed along the west (Gulf) side of the ridge and in sinkholes and solution features along the ridge itself (Upchurch et al. 1981:128-131). Brooksville cherts are known for their often pink to orange color, even in the absence of heat-treatment or thermal alteration. High levels of iron (Fe) in the stone may account for this color. They typically contain a moderate number of Miliolids foraminifera, but are typically differentiated from other Suwannee Limestone clusters in the area by the abundance of quartz sand inclusions in the rock itself (Upchurch et al. 1981:Table 18). Brooksville cherts range from grainy to lustrous, and typically work very easily, especially when heat treated.
**Mineralogy**

Chert forms in limestone under very specific conditions (Andrefsky 1998:51-54; Luedtke 1992: 19-25; Upchurch et al. 1981:25-26). Most cherts found in limestone are thought to have formed in deep-sea environments. Chert forms from dissolved silica through the transformation of the silica from opal-A to opal-CT and finally to quartz. Diatoms, a small silica-secreting organism, get silica from sea water and use it the build their skeletons. When they die, diatoms fall to the ocean floor. Opal-A dissolves from the diatoms and precipitates as opal-CT. The Opal-CT dissolves again and recrystallizes within the underlying limestone, preserving much, but not all of the limestone fabric. Quartz can crystallize into any one of three fabrics: chalcedony, macrocrystalline, and microcrystalline. The large crystal structures in chalcedony and macrocrystalline quartz make them difficult to work, except in cases there the individual crystals are large enough to modify (Moore 1903: Figure 52). Both void-filing chalcedony and macrocrystalline quartz are sometime found within chert nodules dominated by microcrystalline quartz (Upchurch et al. 1981:44-47).

**Rock Fabric**

Rock fabric is an important criterion for identifying the sources of chert. Coastal plain cherts are replacement materials that reflect both the fabric of the original host limestone and the process of becoming silicified limestone, or chertification (Upchurch et al. 1981:40). Both processes have a significant influence on the process. Limestone, the parent material of most Florida cherts, can be classified based on the relationship of fine particles, like mud or sediment smaller than 64µ, to larger particles, like sand and fossils.
The fabric of the parent limestone has a good deal to do with the depositional environment in which it was formed. Low-energy environments allow mud and sediments to settle in between the particulate materials or even to form thick bands of fine-grained materials. High-energy environments are typically devoid of silts, mud, and other fine-grained materials. The limestones formed in high-energy environments contain larger particles and are more porous (Upchurch et al. 1981: 41-42).

The limestone classification system used by Upchurch (et al. 1981:41-42; Table 3) was based on the classification used by Dunham (1962) and has been retained for this investigation. Mudstones are created in low-energy environments and contain less than 10 percent grains. Silicified mudstones are uncommon in the coastal plain because the density of the sediments inhibits the flow of silica-rich water, and are rarely replaced. Wackestones are also created in low-energy environments. They contain more than 10 percent large grains, but the grains are generally not in contact with one another and the voids in between the grains are filled with mud or sediments. Like with mudstones, wackestone fabrics have limited porosity and are only rarely silicified.

Packstones are created in higher energy environments. The grains are in contact with each other, and therefore are supported, but the spaces between the grains are filled with mud or sediments. Because of the spaces between the grains, packstones are porous and permeable and are often silicified.

Grainstones are created in high-energy environments. They are grain-supported materials with little mud or sediment within the pore spaces. Grainstones are very porous and permeable, and silica-rich water can flow easily through them. Both the Suwannee and the Crystal River Formation, the upper component of the Ocala Limestone, are
composed of grainstone fabric materials. The movement of water through grainstone material is so rapid that silicification only takes place in areas where the permeability is reduced. The boundary between the Suwannee and Ocala limestones is one of these areas of reduced porosity and better conditions for silicification to take place.

Boundstones are special conditions found within limestone where mud and sediments are trapped within organic skeletal material. Coral is the most common boundstone material in Florida. There are two common ways that coral heads become silicified. If the aragonite structure of the coral head dissolves prior to surrounding limestone becoming silicified then void-filling quartzes form in the opening, often not completely filling it. These create the Tampa Bay geodes that are sold in local gem and mineral shops and that have been elevated to be the Florida State Rock. Stone tools are rarely made from this material. The second silicification process preserves the polyps and interior structure of the coral head in much the same way that petrified wood preserves the internal structure of the original wood. Silicified coral from this process was actively sought-out by Florida’s prehistoric peoples as the raw material for a variety of stone tools.

**Key Index Fossils**

The two dominant geological formations in the Crystal River area are the Ocala and Suwannee limestones. Both have very common and easily distinguished key index fossils. Most of the key index fossils are foraminifera, simple marine animals with shells made from calcium carbonate. The residual limestone in the area is the Hawthorn Group, a component of the Arcadia Formation. The underlying Avon Park Formation outcrops
in limited locations near Inglis, Florida, but is not known to be a significant source of chert for Florida’s prehistoric inhabitants (Upchurch et al. 1981:13). Upchurch (et al. 1981:59) simplified the identification of diagnostic foraminifera in Florida’s chert-bearing limestones by focusing in three groups whose identification was only necessary at the family or sub-family level. Ocala Limestone is recognized by the presence of *Orbitoididae*; Suwannee Limestone by the presence of *Miliolidae*; and Hawthorn Group members by the presence of *Peneroplidae*.

The Avon Park Formation is the oldest exposed limestone in peninsular Florida. It is best characterized as relatively fossiliferous grainstones and packstones, interbedded with dolomitic wackestone and mudstone. Its fossil diversity is considered rather limited. One of its diagnostic inclusions is fossil sea grass (Randazzo 1997:50). Although not thought to be a significant source of chert, it has been included because of the proximity of Avon Park Formation outcrops to the Crystal River site. Sea grass molds are considered the defining fossil inclusion for this type.

The Ocala Limestone is often subdivided into upper and lower units. The upper unit is referred to as the Crystal River Formation, while the lower unit is separated into the Inglis and Williston formations (Deuerling and MacGill 1981). The Inglis and Williston formations contain dolomite and are commercially mined throughout the region as road construction material. The Crystal River Formation consists mainly of white to light gray packstones and grainstones with some dolomitized wackstones and mudstones. Most of the cherts from the Ocala Limestone probably come from the Crystal River Formation because the Inglis and Williston formations are not believed to be silicified to any great extent (Upchurch et al. 1981:17). The Orbitoididae fossil species

Suwannee Limestone is dominated by packstones and grainstones (Randazzo 1997:50). The upper portions of this formation become increasingly dominated by quartz sand, giving the resulting limestone a sometimes sandy or grainy texture. Suwannee Limestone contains abundant Miliolid foraminifera, but also contains the genera Rotalia and Elphidium (Austin 1997:210; Upchurch et al. 1981:62). All are considered diagnostic.

There are two Hawthorn Group formations identified within the 50 km study area: the Coosawhatchie Formation mapped in the northern portion near Ocala, and the Tampa Member of the Arcadia Formation, mapped in the southern portion near Tampa (Scott 1997:60). The Coosawhatchie Formation defines the upper unit of the Hawthorn Group in north-central Florida. The Tampa Member of the Arcadia Formation forms the lower unit of the Hawthorn Group in west-central Florida (Bryan et al. 2008:27). The Coosawhatchie Formation is a phosphate-rich deposit; the north Florida equivalent of the Peace River Formation. Like other portion of the Hawthorn Group the preservation of fossils in the Coosawhatchie Formation is relatively poor (Jones 1997:105). Although this formation has not been widely sampled, and a study by Jones and Portell (1988) and Scott (1988) suggest that Peneroplidae foraminifera should be found in cherts from this zone.

The Tampa Member is a limestone deposit often rich in chert (Scott 1997:60). Although it is not known to outcrop in the Crystal River area, relict fragments of this material have been discovered in the region (Austin 1997; Estabrook 2005; Upchurch et
al. 1981). The Tampa Member is the source of most of the cherts found in the Hillsborough River and upper Withlacoochee River drainages (Austin 1997; Austin and Estabrook 2000; Upchurch et al. 1981). One of the more common features of Tampa Member cherts is their general lack of fossil inclusions (Austin and Estabrook 2000; Upchurch et al. 1981). Three species of Peneroplidae foraminifera are considered diagnostic: *Archaias*, *Peneroplis*, and *Sorites*.

A variety of different criteria have been developed to identify the quarry cluster origin of the cherts in central Florida. Although fossil content has long been the dominant criteria considered, other factors such as rock fabric, other inclusive materials like quartz sand, and even the average size and density of specific families of foraminifera (e.g. *Lepidocyclina* spp.) have now been included. Cherts will be assigned to quarry clusters based on the criteria outlined in Table 5.1 (after Upchurch et al. 1981 and Endonino 2007: Table 5).

**Thermal Alteration**

Thermal alteration, or heat-treatment, is the intentional heating of siliceous material in an effort to change specific qualities within the stone (Crabtree 1972:94). The two primary changes are color and texture. Thermal alteration has been shown to improve the flaking qualities of some cherts, facilitating the manufacture of thinner tools with sharper edges (Mandeville and Flenniken 1974:146-148; Rick 1978:44-56). Several criteria have been employed to determine whether the heat treatment of stone has occurred, including increased luster, red to pink coloration, and evidence of heat
fracturing such as potlid scarring (circular, concave flake scars) and crazing (minute cracking caused by improper heating).

Table 5.1: Criteria for assignment of cherts to specific Quarry Clusters.

<table>
<thead>
<tr>
<th>Quarry Cluster</th>
<th>Formation</th>
<th>Diagnostic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooksville</td>
<td>Suwannee</td>
<td>Miliolids and quartz sand common</td>
</tr>
<tr>
<td>Inverness</td>
<td>Arcadia (Suwannee?)</td>
<td>Fossil sea grass molds</td>
</tr>
<tr>
<td>Lower Suwannee</td>
<td>Ocala (Crystal River)</td>
<td>Orbitoids small/widely spaced</td>
</tr>
<tr>
<td>Ocala</td>
<td>Ocala (Crystal River)</td>
<td>Orbitoids small/widely spaced Avg. abundance 2.88 pcm² Avg. size 7.6 mm</td>
</tr>
<tr>
<td>Lake Panasoffkee East</td>
<td>Ocala (Crystal River)</td>
<td>Orbitoids small/widely spaced Avg. abundance 2.2 pcm² Avg. size 6.1 mm</td>
</tr>
<tr>
<td>Lake Panasoffkee West</td>
<td>Ocala (Crystal River)</td>
<td>Orbitoids abundant/vary in size Avg. abundance 8.2 pcm² Avg. size 7.6 mm</td>
</tr>
<tr>
<td>Gainesville</td>
<td>Ocala (Crystal River)</td>
<td>Orbitoids large and abundant Avg. abundance 9.55 pcm² Avg. size 10.5 mm</td>
</tr>
<tr>
<td>Upper Withlacoochee</td>
<td>Suwannee</td>
<td>Miliolids common, quartz sand rare</td>
</tr>
</tbody>
</table>

Most Florida cherts are course-grained and non-lustrous in their natural state (Purdy 1974:43; 1981:122-123) and some display a distinctive orange/red coloration (Upchurch et al. 1981). Purdy (1981:122) has determined that there is a range of temperatures that affect Florida cherts. The change in color to red/pink occurs at around 240-260° C, whereas the change to a more vitreous or glass-like material occurs at around 350° C (Purdy 1981:123). The presence of luster was used as the primary indicator of thermal alteration; a red/pink coloration was used as supporting evidence that thermal alteration had occurred.
Color

Color is one of the easiest of artifact attributes to identify, yet when considering coastal plain cherts, is one of the least diagnostic. Not only can color change between artifacts from the same quarry, color can change within an individual artifact. Other factors such as patination and cortication can also obscure the original color of the rock (Purdy 1981:82). Patination will turn an artifact a blue/gray color, whereas cortication turns artifacts white to very light tan. These cautions aside, there are some obvious trends in color for Florida cherts. Cherts from the Suwannee Formation are often light gray to buff in color and often have a “sandy” or grainy appearance. This due to their grainstone fabric is because they are often made-up of large numbers of very small Miliolids. Tampa member cherts are often black to dark gray in color, especially those from the Peace River quarry cluster and the areas around Lake Hancock in Polk County. There is also a particularly prolific quarry area near the City of Brooksville in Hernando County that is dominated by a well-silicified Suwannee Formation chert that is medium tan to nearly orange in color.

The range of color of each artifact was recorded using standard Munsell® color notations. The dominant color was recorded first. Variations and mottling were recorded in order of their contributing surface area. Color was only considered as significant during the analysis when it was corroborated by other more diagnostic elements.

Waste Flake (Debitage) Analysis

Often large quantities of flaking debris, sometimes called debitage, are recovered by the tens of kilos from sites in central Florida (cf. Bullen and Dolan 1959; Clausen
1964; Hemmings and Kohler 1974; Purdy 1975, 1981; Torp 1991). Various approaches including aggregate analysis, flake type analysis, various kinds of attribute analysis, and several “free-standing” analysis techniques (Andrefsky 1998, 2001; Hall and Larson 2004; Rozen and Sullivan 1989; Sullivan and Rozen 1985) have been proposed. Each has its various strengths and weaknesses, and each focuses on illuminating a specific lithic reduction technique or research issue. Because of the recovery techniques used by Bullen and others, there were few waste flakes ever recovered from any of the excavations performed at the Crystal River site.

Another portion of the debris from making stone tools is the broken and discarded fragments of the tools themselves that were fractured or became misshapen during the flaking process (Johnson 1981; Purdy 1975). Sometimes a percussive blow strikes too hard and breaks off more of the stone than was considered desirable. A study of the broken pieces left behind, often referred to as manufacture failures (Johnson 1979), can provide a relatively accurate picture of stone use in a region. Because broken and unfinished stone tools are often extensively modified, they are more likely to have been recovered by the efforts of C.B. Moore, Bullen, and the other early investigators of the Crystal River site. It is considered more likely that manufacture failures and broken and discarded tools will be found within the artifact assemblage than a large quantity of waste flakes.

Flake Size Analysis

Flake size distribution analysis is the investigation of waste flake counts over a series of flake size ranges. Flake size distribution studies have been undertaken by Carr
and Bradberry (2004); Gunn et al. (1976), Patterson (1977, 1982, 1990), Patterson and Sollberger (1978), Shott (1994), and Stahle and Dunn (1982, 1984). Many of these studies are based on the premise that the manufacture of stone tools by a patterned flaking method produces a characteristic flake size distribution curve (cf. Shott et al. 2000; Dibble and Rezek 2009). If systematic chipped stone tool has taken place, the resulting debitage distribution should plot as an exponential curve skewed towards the smaller flake size ranges (Andrefsky 2001; Morrow 1997; Patterson 1982; 1990). When the log-transform of these data are calculated, they should plot as a straight line (Patterson 1990:552; Stahle and Dunn 1982, 1984). Shott (1994:80) suggests that flake weight is a good measure of overall flake size as it co-varies with other flake attributes (i.e., Andrefsky 1998:96-97).

Flakes were measured in the maximum length and width. All measurements were taken relative to the striking platform, if one could be identified. Width was measured parallel to the plane created by the platform at the point of greatest width. Length was measured perpendicular to the platform plane at the point of greatest length. Flake weight was measured to the nearest tenth of a gram.

Platform Attributes

Platform attributes were recorded for all platform remnant-bearing flakes. Platform attributes included flat, faceted (1-2 facets or ≥ 3 facets), cortex-covered, and abraded. Platform lipping and the presence or absence of a bulb of force were also noted. Both platform with and thickness were measured from margin to margin and vertical to dorsal aspect, respectively (Andrefsky 1998:88-92).
Hafted Biface Retouch (HBR) Index

The Hafted Biface Retouch (HBR) Index was first proposed by Andrefsky (2006, 2008a, 2008b) as a measure of tool curation. It calculates the amount of retouch or resharpening that has occurred on a hafted biface. Since it is calculated as a standardized score, it can be calculated for bifaces of varying sizes, shapes, and can also be used on broken biface. The HBR index is only calculated on the blade portion of the specimen; the haft element is excluded. The blade portion of the biface is divided into 16 segments, eight on each side (ventral and dorsal faces). Each of the regions is then assigned a retouch value based on the location and extent of resharpening. A segment with no evidence of retouch, just long, well-defined manufacturing scars would be assigned a score of zero. A segment that displays extensive evidence of resharpening would be assigned a value of one. Segments over which the evidence appears mixed, that is some resharpening and some manufacture scars receive a score of .5. The index is calculated by dividing the sum of the retouch values by the total number of segments considered (Andrefsky 2006:746-747).

GIS: Weights of Evidence Analysis and Cost Path Surfaces

There were two issues with existing tool stone acquisition studies. First, many studies rely on a straight-line distance measure to calculate the distances between source/quarry and the archaeological context from which the tools were recovered (e.g. Austin 1997; Austin and Estabrook 2000; Andrefsky 2006, 2008; Deming and Estabrook 1994). The straight-line distances are easy to calculate. These distances are often seen
as imprecise, but reasonably accurate proxy measure of the “cost” of moving stone from one location to another. The idea is that it is easier to obtain stone from nearby sources and increasing more difficult (more costly) to get stone from more distant sources. Various tools, like distance-decay models, have been instituted to make these numbers more “real-world,” but they all still are based on the same premise – increased distance equals increase costs.

Unknown quarry sources are at the heart of the second issue. Large unrecorded quarry sources, gravel bars, and outcrops. Despite the fact that much of the area around the Crystal River site has been subjected to various levels of field survey, relatively few quarry sources are recorded in the area. This has much to do with the intensity of field investigations, the likely locations of many potential quarry sites, and even a lack of interest among the field crews themselves. To help overcome these issues, I have chosen to employ two GIS-based tools, a cost or friction surface to replace the straight-line distances and a Weights-of-Evidence (WofE) model to predict the locations of potential lithic quarry locations.

While the origin of the various artifacts was limited to those known to have been recovered from the Crystal River site, the sources of chert available to the site’s inhabitants was much less well known. Although much of the southern portion of the study area has been subjected to various CRM surveys, not all of the chert outcrops in the area have been identified. The search for chert quarry locations that began with Upchurch’s et al. (1981) original study and that has been updated since (Austin 2008) has identified 35 known chert quarries within 50 km of the Crystal River site. These locations include sources that may, or may not, have been accessible to the region’s
prehistoric inhabitants. It quickly became apparent that without a fairly complete knowledge of the locations of most, if not all, of the major sources of chert that a cost-surface analysis would be of limited utility as one could never be sure that there were not quarry sources nearby the site that has just simply not been discovered or recorded.

There are two issues with the existing chert quarry information. First, the FMSF records the information about lithic reduction sites (manufacturing) and lithic procurement sites (quarries) in a way that makes the two easy to confuse on the FMSF forms. The second is that even though there is relatively good coverage of the study area by CRM surveys, there are problems with the intensity of the efforts expended to identify specific kinds of sites, like quarries, and the techniques used to investigate various parcels has changed through time and by project scope.

**Cost Path / Friction Surface**

A cost (friction) surface was developed to model the movement of chipped stone tools along a series of travel pathways from their initial quarry locations to the final discard location at the Crystal River site. A series of paths are generated from the cost surface that provide an alternative to the “as the crow flies” straight line distances that are frequently used to evaluate the relations between stone quarry locations and the locations where tools were finally abandoned (Austin 1997; Deming and Estabrook 1994; Janus Research1998). In a region replete with salt marshes, rivers, creeks, sloughs, pine flats, and sand hills, and a correspondingly complex social landscape, travel in a straight line for source to site was probably rarely an option.
The process of creating a multi-criteria cost surface and the computation of cost paths involves seven aspects or steps (after Howey 2007):

1. Selection of the relevant variable to the cost of movement;
2. Generation of a friction surface for each of the relevant variables;
3. Calibrate the various surfaces (input grids) to achieve a consistent value scale;
4. Weight the various input grids;
5. Combine the multiple input grids into a total cost grid;
6. Calculate the accumulated cost surface;
7. Calculate the least cost paths from the defined starting points to the defined end point(s).

Selection of the input variables becomes the first important step in the analysis. Most researchers (Carballo and Pluckhahn 2007; DeSilvia and Pizzolo 2001; Howey 2007; Jennings and Craig 2001; Kantner 2004) use a slope function, typically derived from the elevation variable of a DEM or DTM, as the primary defining variable. Slope, particularly when tied to the “hiking function” (Tobler 1993), a simple calculation that estimates how fast (or how easily) a person can walk across an area of a given size and variable slope. The next most common input data set is a landform or vegetation layer which typically is used to calculate the difficulty of traversing various wooded, swampy, or grassland environments. Specific transportation corridors, including historic trails, roads, and rivers, have been proposed by Howey (2007), Kantner (2004), Whitley (2000a, 2000b), and Whitley and Hicks (2001).

Two modes of transportation were known to the prehistoric inhabitants of the region: walking and travel by canoe. Walking or hiking was likely a common mode of transport, but then relatively heavy objects, like oysters and chert tools and cores, would likely have been moved by boat whenever possible. Possible ways of identifying prehistoric trails and travel corridors was also considered. One possibility to map the
trails and travel corridors that existed in the region in the 1840s when the area was first surveyed and platted. A perusal of the General Land Office Plat Maps on file with the Florida Division of State Lands showed that although many roads and trails were indicated, most roads and trails appear to have been constructed for travel between forts, towns, and settlements important to the region’s historic settlers and are not a proxy for prehistoric overland travel routes. Breaks or changes in vegetation, known as ecotone breaks, are those regions along the boundaries between changes in vegetation. Ecotone breaks often have minimal plant contributions from the adjacent vegetation communities. They often make useful transportation corridors.

Rivers, lakes and streams, as well as the Gulf of Mexico, would have provided an integrated network of travel corridors for prehistoric canoe transportation. The layers for the state’s major rivers were combined with the extracted extents of the areas streams and lakes to create viable canoe travel corridors. Two terrestrial variables were considered: elevation and vegetation. The elevation model was derived from the USDA National Elevation Dataset (1 arc second). The roughly 30 m cell size became the defining size for the analysis. Vegetation community became the other limiting criteria. Traversing through relatively open areas like sandhill scrub or upland hardwood forests is much easier than trying to get through more difficult, and often impenetrable terrain like mangrove swamp forest or mesic flatwood forest. Several candidate data layers for this variable were considered, including modern (and historic) land cover, physiographic zones, and vegetation based on soil types. Most were either too complex, contained multiple modern land changes, or did not capture the subtle differences between various coastal environments. I chose the vegetation coverage based on Davis (1967). Within
the project study area, the following vegetation communities are defined (from easiest to most difficult to traverse):

- Sand pine scrub forest
- Pine flatwoods
- Hardwood forest
- Forest of longleaf pine and xerophytic oak
- Swamp forest mostly of hardwoods
- Mangrove swamp forests and coastal marches.

The defined starting points will be the known chert outcrops within the study area. The single end point will be the Crystal River site. Canoe access to and from these locations is provided by the various rivers, lakes and streams that flow through the area, but also along the Gulf of Mexico.

Weights of Evidence (WofE)

The Weights-of-Evidence (WofE) procedure used in this analysis is part of a series of analysis procedures available in the Spatial Data Modeler (SDM) extension (Release June 2009). The SDM version used here has been specially adapted to work under ArcGIS 9.3.1 (Sawatzky et al. 2009). SDM has specific input data requirements. All evidential themes must integer raster data, all must be in meters, and all must be in the same projection. The training files must be in the same projection, but can be left as point shapefiles. Beyond this, the choice of the input data used to develop the evidential themes is open to whatever data will adequately model the phenomena under consideration.
For this portion of the study I have selected to use a WofE procedure developed by Reid (2003) to predict the locations of pre-Columbian sites in Trinidad. He proposed a six step process to create a viable predictive model (after Reid 2003:86):

1. Development of a descriptive model of chert outcrop distribution
2. Selection of evidential themes base on the descriptive model
3. Refine model based on evidential themes
4. Select a training data set
5. Test the evidential themes to qualify them as viable predictor themes
6. Consolidate the viable themes into a chert outcrop predictive surface

Based on the description of outcrop locations in central Florida (Purdy 1981, 1982; Simpson 1941; Upchurch et al. 1981), a descriptive model can be developed. Most chert outcrops in places where the overlying sands and sediments have been removed and the limestone matrix exposed. This includes the areas adjacent to rivers and major streams, within major wetlands and swamps, in sinkholes, around aquifer-fed springs, and other sources of groundwater. In many of the upland area in the Florida Central Highlands, chert is found outcropping in a variety of places, and can often been seen piled up along the edges of farm fields and pastures, pushed aside to make disking and field maintenance easier and less damaging to equipment. In these areas there is a direct relationship between the depth of the surface sands and the geological formation that underlies a particular area. In areas where the Suwannee or Ocala limestones or members of the Hawthorn Group are near the surface and the overlying soils are thin, limestone outcrops can be seen on the surface.

From this model, several different categories of evidential themes are suggested. They include near-surface geology (bedrock geology), environmental geology (materials within 2 m [6 ft] of the surface), specific soils, physiographic provinces, elevation, the
extent of rivers, streams, lakes, and locations of sinkholes and springs. Some choices are obvious. The underlying bedrock geology of the region is critical. Without a near-surface limestone layer, the chance of a chert outcrop in any specific location is greatly diminished. Other data sets, like specific soil types (series) are less obvious. Soil type, in and of itself, is perhaps not a good indicator of chert exposure, although the United States Department of Agriculture, Soil Conservation Service (USDA, SCS) soil surveys for this region do indicate the locations of specific outcrops (e.g., Pilny et al. 1988: Map 15).

Most of the datasets used in this study were available from the Florida Geographic Data Library (FGDL), maintained by the GeoPlan Center at the University of Florida.

Some evidential themes already existed statewide in vector (shapefile) format, and simply had to be clipped to the study area boundaries and converted to raster format. This included the surficial geology, environmental geology, physiographic provinces, sinkholes, and springs. Other themes did not exist as separate shapefiles, (e.g., streams, lakes, marshes) and had to be extracted from various county data sets and combined before they could be clipped and converted to raster files. The theme for rivers and streams proved to be the most difficult to construct. Major rivers like the Withlacoochee and Steinhatchee are depicted in two statewide vector shapefiles, rivers as lines and rivers as polygons. This is because these are relatively long rivers that extend inland from the coast for considerable distances. The shorter coastal rivers, like the Homosassa and Crystal rivers had to be extracted from county hydrologic data sets. The hydrologic data was also used to create a raster for lakes and one for marshes and wetlands. These files required extra geoprocessing steps to merge, extract, clean, dissolve, and finally clip the files to the study area before they could be converted into raster files.
The soils data also required considerable evaluation before a meaningful
evidential theme could be generated. The property of specific soils considered most
pertinent was the depth of limestone below surface. This information is not something
that is currently provided as a field in the soil series shapefiles provided by the FGDL.
All soils that have limestone within two meters (six feet) of the surface were included in
the analysis. These data had determined for each soil type by consulting the published
USDA soil surveys for each county (Furman et al. 1975; Hyde et al. 1977; Pilny et al.
1988; Thomas et al. 1979; Slabaugh et al. 1996; Yanataki et al. 1988) and the soil types
updated to current descriptions and extents.

Several base parameters had to be established for the investigation. The study
was defined as the area within 50 km of the Crystal River site. The evaluation of lithic
resource areas at various Woodland sites in the southeast discussed in Chapter 2 indicated
that most lithic resources were acquired from within 35 km of the site location or at
distances much greater than currently possible. The base projection for the shapefiles
from the FGDL was Albers Conical Equal Area. The projected coordinate system used
in the analysis was NAD_1983_HARN_Albers. Albers is an equal-area projection. Such
projections maintain aerial extent, but distort linear measure and distances (Dent 1999:
38). However, since the study area under considered is relatively small, any distortions
are thought to be minimal. The cell size was established at the base for the NED
elevation data at 30 m (100 ft). Consideration was made to use a 10 m (33 ft) cell size,
but this greatly increased the computation time and defined a level of precision that could
not be supported by the evidential theme data.
The WofE training data set was developed from a variety of sources. Thirty-five quarry locations were identified from Upchurch (et al. 1981) and from data provided by Robert Austin. An additional 20 quarry locations within the defined study area were identified from the FMSF. Fourteen locations were provided by Jon Endonino from his research on Ocala Formation quarry clusters (Endonino 2007). Fourteen locations were identified by the staff of the Withlacoochee State Forest. Each location was verified on aerial mapping of the region and compared to the other potential quarry sites. Duplicate locations were eliminated. This was especially problematic with the locations provided by the Withlacoochee State Forest personnel as many of the quarries within the Forest had already been recorded on the FMSF.

None of the data files could be used directly as downloaded from the FGDL or USDA websites. In some cases, like the sinkhole or spring location shapefiles, minimum geoprocessing of the data was required for use. In other cases, like the rivers, streams, and lakes described above, extensive geoprocessing was necessary in order to get these data into a format that was usable in these analyses. The specific steps taken in to the geoprocessing and the specific outcomes and results of the WofE analysis and the development of the cost paths are provided in Chapter 6.
The identification and discussion of the chaîne opératoire used by the inhabitants of the Crystal River site to acquire the stone from which tools were fashioned requires that two data sets be evaluated. First, in order to discuss sources and control of sources of raw materials (cherts), all major chert outcrop areas in the region should be considered. Secondly, the accessibility of these stone sources should also be evaluated. Proximity and accessibility are not the same. There are chert sources near the Crystal River site that may be relatively easy to get to and are perhaps within a short walking distance from the site. Other chert sources are some distance away and would require more effort for transport or movement of the stone from the source to the site. In a low-lying coastal environment, travel by watercraft, especially canoe, often becomes not only a preferred means of transport, but also the only way to get heavy or large items from one place to another.

While the locations of some lithic outcrops have been recorded in the FMSF, other locations were identified by various archaeologists and land managers working in the area, the outcrop location data is, at best, incomplete. In order to avoid missing a major outcrop area and a potential source of chert for the inhabitants of the Crystal River site, a WofE chert outcrop predictive model was developed. This model was evaluated prior to the development of the cost-path models to ensure that no major outcrop locations were overlooked during the study.
The GIS data gathered during this study focused on determining the locations of known chert outcrops and quarries and the prediction of the possible locations of additional outcrops in the region. This chapter provides the results of the two major GIS analyses conducted for this study. Many of the data sets used in both the WofE and cost-path analyses are the same, and many of the geoprocessing and data modeling procedures overlap. As the data sets for the cost-path analysis are a subset of the data files that were used in the WofE analysis, the WofE will be discussed first. The additional data sets used specifically for the cost-paths will be discussed prior to the presentation of the cost-path results.

Of the six WofE steps defined by Reed (2003), the first two steps: the descriptive model of chert outcrop distribution and the selection of the types of evidential themes (data sets) to use in the analysis have already been discussed. The remaining steps are the refinement of the model, the selection, or in this case the refinement of the training points, the testing and qualification of the evidential themes, and the development of the final predictive surface. Refinements to the model are performed by evaluating the predictive potential of each of the evidential themes. The SDM toolbox (Sawatzky et al. 2009) provides most of the routines necessary to evaluate these data. Once a suitable set of evidential themes are developed they must be evaluated for conditional independence, because the WofE procedure assumes that the evidential themes are not related spatially. While the WofE procedure is relatively robust with respect to conditional independence, it may be possible to generalize or even remove a single evidential theme which significantly increases the conditional independence while not seriously diminishing the predictive ability of the overall model (Raines et al. 2000:48). The final goal of the
procedure is to produce an elegant model with the greatest predictive potential, but with low spatial dependence.

One of the outcomes of the WofE analysis to be considered is the “weight,” which can be positive or negative. A positive weight ($W^+$) indicates that more of the training points occurred within that evidential theme category than would be expected by chance. Negative weights ($W^-$) indicate the inverse, fewer training points were found than expected by chance. Contrast is the $W^+$ minus the $W^-$ which provides an overall measure of the spatial association of an evidential theme with the training points (Bonham-Carter 1994; Raines et al. 2000; Sawatzky et al. 2009). While this works well with binary evidential themes or for themes with few categories and many training points, a standardized (Student’s $t$ adjusted) value of the contrast is considered a better estimate of spatial association in situations with larger numbers of categories or fewer training points (Bonham-Carter 1994; Romero-Calcerrada and Luque 2006).

**Weights-of-Evidence (WofE) Data**

All of the data used in this study began as vector-based shapefiles with the exception of the elevation data which was acquired in raster format. Both the WofE and cost-path techniques require most of the data to be in raster format and all in a specific projection. These requirements demand that all of the data files be manipulated in some way. Most of the geoprocessing was done with the data in vector format and then converted to raster format prior to final analysis. A list of the data files used to create the evidential themes is provided in Table 6.1.
Table 6.1: Weights-of-Evidence data sources.

<table>
<thead>
<tr>
<th>Category</th>
<th>File Name</th>
<th>Source</th>
<th>File Name(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>National Elevation Dataset</td>
<td>USDA</td>
<td>n29w083, n30w083, n30w084</td>
</tr>
<tr>
<td>Geology</td>
<td>Surface geology</td>
<td>FGDL</td>
<td>surgeo_2001</td>
</tr>
<tr>
<td>Geology</td>
<td>Environmental geology</td>
<td>FGDL</td>
<td>fdepgeo</td>
</tr>
<tr>
<td>Geography</td>
<td>Physiographic Provinces</td>
<td>FGDL</td>
<td>phprov</td>
</tr>
<tr>
<td>Geography</td>
<td>Sinkholes</td>
<td>FGDL</td>
<td>sinkhole</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Springs</td>
<td>FGDL</td>
<td>springs, springs_fdep_2009</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Rivers (major)</td>
<td>FGDL</td>
<td>mjrivl, mjrivp</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Streams</td>
<td>FGDL</td>
<td>hy24p09/27/38/42/60</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Lakes</td>
<td>FGDL</td>
<td>hy24p09/27/38/42/60</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Marshes/wetlands</td>
<td>FGDL</td>
<td>hy24p09/27/38/42/60</td>
</tr>
<tr>
<td>Soils</td>
<td>Specific soils</td>
<td>FGDL</td>
<td>nrcs_soils_feb1009/27/38/42/60</td>
</tr>
</tbody>
</table>

The elevation data raster became the bases upon which all of the other raster files were developed. The study area defined for the project covered three different elevation files, so these files needed to be combined, “clipped” or cut to the limits of the study area, converted from a continuous to an integer raster, and then re-projected into the NAD_1983_HARN_Albers projection used in the study. Once complete, this raster became the model to which all the other rasters were modeled, resulting in raster files with the same cell side and count containing cells that matched up across all data categories.

Many of the shapefiles required only minimal geoprocessing prior to their conversion to raster files. The files containing the surface geology, environmental geology, physiographic provinces, sinkholes, and springs required a simple clip of the data to the study area prior to raster conversion. The rivers, streams, and marshes files proved to be somewhat more problematic. On Florida’s west coast, the size and extent of rivers, streams, creeks, sloughs, and marshes often vary a good deal by season. A somewhat damp linear wetland feature during the dry season can become a major stream
or slough during the rainy season. There is also the issue of short, spring-fed coastal rivers, like the Crystal River, Homosassa and Chassahowitzka rivers. Each of these rivers start along the edge of the Brooksville Ridge with a spring or series of springs forming its headwaters. These rivers are short in length and typically do not penetrate through the ridge and into the interior portion of the region. Because of their short length and poorly defined routes, they are not included in many of the river GIS shapefiles available from either the FGDL or the Florida Department of Environmental Protection (FDEP). The rivers and stream raster data files had to be created by combining elements of the two Rivers (major) shapefiles with elements of several local hydrological shapefiles. Even with these additional resources, the routes of some rivers and streams had to be augmented with patch files created from aerial photographs to ensure that connectivity along these routes was maintained.

Specific soils became a second set of problematic shapefiles. Within the five county study area there are too many specific soil types to consider. Hansen (2000) resolved this issue by reclassifying the specific soils into more generalized soil taxonomic classes. Although there is a great deal of information included in the attribute tables for specific soils, there is not an attribute entry for limestone within two meters (6 ft) of the surface. The USDA soil surveys for each of the five counties within the study area were consulted and all of the soils with near surface limestone deposits were identified (Furman et al. 1975; Hyde et al. 1977; Pilny et al. 1988; Thomas et al. 1979; Yamataki et al. 1988). These files were then compared to the current USDA specific soils identified within the files maintained by the FGDL. Names and soil types were adjusted as necessary to the current USDA soil designations. A list of the specific soils where
limestone is found within two meters (6 ft) of the surface is provided in Appendix B. Once these soils were identified, they were selected out of the combined county soil shapefiles and converted to raster files for further analysis.

Evidential Themes

Ten evidential themes were developed as potential factors in the prediction of chert outcrops based on the conceptual model. The name, base files, and classification attributes are provided in Table 6.2. Themes include both the surface and environmental geology of the region, physiographic provinces, specific soils, and elevation. Once the vector data files were clipped to the project study area, they were reprojected into the common coordinate system. Each file was then converted from vector format and into an integer raster file. Cells with missing data were given the code -99 and excluded from the analysis.

Table 6.2: Weights-of-Evidence evidential theme attributes.

<table>
<thead>
<tr>
<th>Evidential Theme</th>
<th>Base Data File</th>
<th>Classification Attribute</th>
<th>Type of Weight</th>
</tr>
</thead>
<tbody>
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<td>n29w083, n30w083, n30w084</td>
<td>elevation class</td>
<td>ascending</td>
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<td>surgeo_2001</td>
<td>description</td>
<td>categorical</td>
</tr>
<tr>
<td>Environmental Geology</td>
<td>fdepgeo</td>
<td>category</td>
<td>categorical</td>
</tr>
<tr>
<td>Physiographic Provinces</td>
<td>phprov</td>
<td>description</td>
<td>categorical</td>
</tr>
<tr>
<td>Sinkhole</td>
<td>sinkhole</td>
<td>distance in km</td>
<td>ascending</td>
</tr>
<tr>
<td>Springs</td>
<td>springs, springs_fdep_2009</td>
<td>distance in km</td>
<td>ascending</td>
</tr>
<tr>
<td>River/Stream</td>
<td>mjrivl, mjrivp</td>
<td>distance in km</td>
<td>ascending</td>
</tr>
<tr>
<td>Lakes</td>
<td>hy24p09/27/38/42/60</td>
<td>distance in km</td>
<td>ascending</td>
</tr>
<tr>
<td>Wetland/Marshes</td>
<td>hy24p09/27/38/42/60</td>
<td>distance in km</td>
<td>ascending</td>
</tr>
<tr>
<td>Specific Soils</td>
<td>nrcs_soils_feb1009/27/38/42/60</td>
<td>common name</td>
<td>categorical</td>
</tr>
</tbody>
</table>
Training Points

Training points are required for the WofE and as beginning/end points for the cost-path procedures. Training points are used by the WofE procedure to develop the spatial proximity models. The cost-path analysis uses the training points as the starting and ending points in the development of routes back to the Crystal River site. The training points defined for this study were the known lithic quarry sites within the project study area. These included 20 sites identified on the FMSF as lithic quarries, 14 locations identified by Jon Endonino (Endonino 2007); 35 locations identified by Upchurch et al. (1981) with interim additions provided by Robert Austin; and 15 outcrop locations identified by Colleen Werner, staff biologist with the Withlacoochee State Forest. The FMSF locations were extracted from the state-wide GIS database. Endonino’s locations were obtained by a hand-held GPS and provided to me as an Excel® file. The locations within the Withlacoochee State Forest were provided in a projected shapefile format. These outcrop positions were collected with a combination of hand-held navigation-grade GPS and differentially-corrected GPS equipment. The locations identified by Upchurch et al. (1981) were provided on 1:250,000 scale paper maps (Knapp 1978; Deuerling and MacGill 1981) that were provided by Robert Austin and digitized into electronic versions of the maps for this study.

Once in shapefile format, each training point dataset was inspected for duplicate sites. Recorded locations within 100 m (300 ft) were considered duplicate locations and excluded from the analysis. Sites recorded on the FMSF as quarry sites were considered the most reliable, so all were included. None of the 14 location within the project study area provided by Endonino had been previously recorded, so all were included. Twelve
of the 15 locations provided by the Withlacoochee State Forest were included, but only 13 of the 35 locations identified by Upchurch and Austin could be included. Some were eliminated because they were previously recorded on the FMSF; others were duplicates in the data provided by others. Many had been identified within old phosphate, dolomite, or sand mines around the area and were known to contain cherts that were likely not accessible to Native peoples. All of Upchurch/Austin locations labeled “not assessable” were excluded from consideration. With this exclusion, 59 of the 84 known quarry locations within the 50 km study area were selected as training points. The distribution of these locations is shown in Figure 6.1.

The FMSF contains many sites in the central Florida region that have the potential to contain stone outcrops and be considered as quarry locations. Part of the confusion about lithic reduction vs. lithic quarry sites comes from the categories used by the FMSF to identify site function or site type. Site type (SITETYPE) has six possible attribute entries – SITETYPE1 through SITETYPE6. Several entries can be selected from a response dialog to identify lithic quarries. Most often used is the response “quarry,” which can mean chert or lithic quarry, but can also mean a historic limerock or dolomite quarry, or even a coquina quarry. Another common entry is “lithic scatter/quarry (prehistoric, no ceramic)” which is often used to identify lithic scatters that do not contain prehistoric pottery, but are sometime used to denote lithic quarries and associated stone tool manufacturing areas. In some instances, the entry “specialized site from the procurement of raw materials” is used by some recorders to identify lithic quarries.
Figure 6.1. Locations of the Weights-of-Evidence training points.
Each of the 20 sites included as training sites were identified by query in the FMSF. The FMSF form for each site was inspected to ensure that it was, in fact, a chert quarry location. This exercise also identified an additional 195 potential quarry locations within the 50 km study area. These site locations were used as validation points to evaluate the lithic quarry potential surface created by the WofE analysis. The distribution of these sites is shown in Figure 6.2.

**WofE Results**

The conceptual model of chert outcrop distribution described previously in Chapters 2 and 5 has identified the kinds of data that were used in the analysis. The WofE procedure provides a series of tools for evaluating the predictive potential of each of the data sets. This allows each data set to be evaluated independently and included in the final model only if it significantly contributes to the model’s predictive potential. While multi-category datasets can be used, binary (1/0; yes/no) models have the greatest predictive aptitude (Agterberg et al. 1990; Bonham-Carter 1994; Bonham-Carter et al., 1998). One of the processes of the WofE procedure allows for the identification of those specific attributes in a dataset with the greatest contrast and combines them into binary categories. Converting these data to binary inputs does remove the ability to evaluate individual attribute features, like how much each specific limestone formation contributes to the overall predictive model. Converting these data to a binary format maximizes the spatial association between the evidential themes and the training points (Hansen 2000; Raines et al. 2000). Future development of this model would implement categorical
Figure 6.2. Weights-of-Evidence FMSF potential quarry/validation points.
reclassifications for several of the evidential themes (e.g., Dilts et al. 2009; Duke and Steele 2010; Ford et al. 2009; Homes 2007; Romero-Calcerrada and Luque 2006).

Generalizing Evidential Themes

Two methods of generalizing evidential themes were employed. The first was used on all evidential themes containing point or linear features where distance from the feature was considered important. These included the themes for springs, river/streams, and sinkholes. Tools within the WofE toolbox allows for the creation of buffers at set intervals around a given feature. This distance buffer can then be evaluated for contrast. Contrast is the measure of the spatial relationship between the training points and the evidential themes (Raines et al. 2000:48). It is calculated as the difference between the positive and negative weights (W+ minus W-). An example of the distance buffer for the sinkhole evidential theme is shown in Figure 6.3. Each band in the buffer shown in Figure 6.3 represents 1 km distance out from all of the recorded (major) sinkholes in the region. A weight calculation was then determined for the buffered sinkhole evidential theme. The values for W+, W- and contrast from this calculation are shown plotted against the distance from sinkhole value in Figure 6.4. The contrast shown in Figure 6.4 increases from zero to six km, when it abruptly flattens-off and begins to decline. This indicates that the distance from zero to six km is strongly associated with known chert quarry locations, but after six km the strength of that relationship diminishes. This evidential theme was reclassified into a binary theme with one class as distances from 6-50 km from a sinkhole (Category 1) and the other included distance from zero to six km from a sinkhole (Category 2). The results of this reclassification are shown in Figure 6.5.
Figure 6.3. Sinkhole buffer evidential theme showing the distance buffers used.
Categorical evidential themes were generalized based on their contrast values. The weights calculation for the Surface Geology (surgeo_2011) feature classes is provided in Table 6.3. The contrast values for the Avon Park Formation and the Holocene Sediments were zero, which conforms to the conceptual model. Neither geological feature was expected to contain any chert outcrops. The features with the greatest contrast are Suwannee Limestone and the Coosawhatchie Formation. The Suwannee Limestone (Contrast (std) = 2.2638) is one of two dominant chert-bearing formations in the area, so its inclusion in the model was anticipated. A slightly negative contrast was reported for the Ocala Limestone (Contrast (std) = -0.7726) which was somewhat unexpected. This can be interpreted as there being fewer training points associated with the exposures of Ocala Limestone given the extent of its exposure across the study area. A strong positive contrast for the Coosawhatchie Formation (Contrast (std) = .8537) indicates that known chert outcrops can be associated with this feature.
Figure 6.5. Sinkhole evidential theme showing the results of the binary reclassification.
This was not completely unexpected as a recent evaluation of the quarry sources in the southern Marion County area identified several non-Ocala Limestone outcrops in the area (Endonino 2007:88; cf. Estabrook 2005). A binary reclassification of this evidential theme included the Suwannee Limestone and the Coosawhatchie Formation as a “2” (inside) and all other features reclassified as “1” (outside).

Table 6.3. Weights and contrast calculations for the surface geology evidential theme.

<table>
<thead>
<tr>
<th>Feature Class</th>
<th>W+</th>
<th>W-</th>
<th>Contrast</th>
<th>Contrast (std)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avon Park Formation</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Holocene Sediments</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Undiff. Sediments</td>
<td>-1.1980</td>
<td>0.0407</td>
<td>-1.2387</td>
<td>-1.2281</td>
</tr>
<tr>
<td>Beach Ridge and Dune</td>
<td>-1.1633</td>
<td>0.0387</td>
<td>-1.2020</td>
<td>-1.1917</td>
</tr>
<tr>
<td>Hawthorn Group</td>
<td>-0.2930</td>
<td>0.0393</td>
<td>-0.3323</td>
<td>-0.7715</td>
</tr>
<tr>
<td>Ocala Limestone</td>
<td>-0.0973</td>
<td>0.1040</td>
<td>-0.2012</td>
<td>-0.7726</td>
</tr>
<tr>
<td>Undiff. TQ Sediments</td>
<td>0.3990</td>
<td>-0.0433</td>
<td>0.4424</td>
<td>1.0987</td>
</tr>
<tr>
<td>Suwannee Limestone</td>
<td>0.8379</td>
<td>-0.0736</td>
<td>0.9115</td>
<td>2.2638</td>
</tr>
<tr>
<td>Coosawhatchie Formation</td>
<td>0.9912</td>
<td>-0.0941</td>
<td>1.0853</td>
<td>2.8537</td>
</tr>
</tbody>
</table>

Each of the evidential themes was converted to a binary theme based on its respective contrasts (Table 6.4). All of the categorical themes were reclassified based on significant contract values. Categories that significantly contributed to the predictive ability of the theme were classified as inside (2); those that did not contribute were reclassified as outside (1) and excluded from the analysis. This included surface geology, environmental geology, physiographic provinces, and specific soils. Themes that included distances from specific features, like sinkholes, springs, lakes river/streams, and marshes were buffered at one km intervals, and then reclassified as shown above for the sinkhole data. The elevation data were first reclassified into five meter elevation.
increments and then the range of significant elevation classes were reclassified as being inside. The criteria for the binary reclassifications for each evidential theme are shown in Table 6.4.

<table>
<thead>
<tr>
<th>Evidential Theme</th>
<th>Type of Weight Table</th>
<th>Inside/Outside Class Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>ascending</td>
<td>5-35 m in, all else out</td>
</tr>
<tr>
<td>Surface Geology</td>
<td>categorical</td>
<td>Suwannee Lm, Coosawahatchie Fm in, all else out</td>
</tr>
<tr>
<td>Environmental Geology</td>
<td>categorical</td>
<td>Limestone in, all else out</td>
</tr>
<tr>
<td>Physiographic Provinces</td>
<td>categorical</td>
<td>Hills, Ridges in, all else out</td>
</tr>
<tr>
<td>Sinkhole</td>
<td>ascending</td>
<td>0-6 km in, all else out</td>
</tr>
<tr>
<td>Springs</td>
<td>ascending</td>
<td>0-7 km in, all else out</td>
</tr>
<tr>
<td>River/Stream</td>
<td>ascending</td>
<td>0-3 km in, all else out</td>
</tr>
<tr>
<td>Lakes</td>
<td>ascending</td>
<td>0-5 km in, all else out</td>
</tr>
<tr>
<td>Wetland/Marshes</td>
<td>ascending</td>
<td>0-6 km in, all else out</td>
</tr>
<tr>
<td>Specific Soils</td>
<td>categorical</td>
<td>13 specific soils in, all else out</td>
</tr>
</tbody>
</table>

**Evaluation of Evidential Themes**

Once the ten evidential themes were generalized as binary, an overall WofE model was developed. The themes based on geology, soils, elevation and physiographic provinces contributed significantly to the predictive potential of the model. The themes based on distance to the hydrological features, like distance to rivers and streams, lakes, and wetlands proved to be relatively poor predictors of chert outcrop locations. Only the sinkhole distance theme appears to help predict outcrop locations in the region which implies that outcrops tend to occur in the vicinity of sinkholes. This may be a result of the underlying geology of the region. Other themes that the conceptual model had proposed as good indicators, like the distance from lakes, wetland, and marshes, turned
out to be poor predictors of outcrop locations. In the final model, only six of the original
ten evidential themes were retained. The elevation, surface geology, environmental
geology, physiographic provinces, distance from sinkholes, and specific soils themes
remained in the final model. Distance from springs, lakes, rivers/streams, and wetland
and marshes did not contribute significantly to the model and were eliminated. This is
likely because there are so many of these features in the region. Since they are all
hydrologic features, they are likely to have been auto-correlated. There are few places in
the central Florida area where one is more than a few kilometers from a source of water.

Test for Conditional Independence and Model Validity

The WofE procedure provides several tests for conditional independence
(Agterburg and Cheng 2002; Sawatzky et al. 2009). Values of CI below one can be an
indication of conditional dependence between the evidential themes. Some dependence
had been expected as the data sets for the surface geology and the environmental geology
were likely originally created based on similar criteria, as were the physiographic
province and specific soil themes. Bonham-Carter (1994) suggests that values of above
0.85 indicate an acceptable level of dependence. The Conditional Independence (CI)
ratio for the final model was 0.95; the overall conditional independence (CI) value was
69.8 percent. The probability that this model is not conditionally independent with a test
stylistic (T-n)/Tstd = 0.3877 is 65.1 percent. At an alpha level of .95, the null hypothesis
should not be rejected. These results indicate that there is some degree of conditional
dependence in the data sets used in the final model, but the levels are not great enough to
reject the model or to eliminate additional evidential themes. However, since there is
some dependence between the datasets used and because the absolute values of the probabilities are not important to this discussion, the probabilities are presented as in ordinal ranked categories of favorability (after Raines 1999:269).

Predictive Map

The posterior probability is the final calculation of the WofE model. These values indicate which regions have a greater probability of containing chert outcrops. The model identified a fairly substantial area as being moderately favorable for the presence of chert outcrops. This area, shown in orange in Figure 6.6, is found in several different environmental zones, but especially along Marion Uplands, northeast of the Withlacoochee River, within southern portion of the Brooksville Ridge, and along the portion of the coastal plain between the Brooksville Ridge and the Gulf of Mexico. The regions defined within the floodplain and headwaters of the Withlacoochee River and along the Brooksville Ridge also contain substantial areas (shown in yellow) of highly favorable chert potential. There are only a few areas in the northeast portion of the study area within the Marion Uplands that the model ranked as being of very high outcrop favorability. These areas are designated in purple on Figure 6.6, although most of the areas designated as such as being of very high outcrop potential are too small to see at the scale of this map. These highly favorable areas are associated with specific soil types in areas underlain by the Coosawhatchie Formation, a Hawthorn Group member.
Figure 6.6. Map of the outcrop potential posterior probabilities.
Confidence Mapping

The WofE procedure also generates a set of probabilities that evaluate the confidence with which the outcrop locations predictions were made. Because of missing data and binary (all-or-nothing) reclassification of the evidential theme layers, the model can predict the occurrence of outcrops in some areas with greater confidence than it can in others. As shown in Figure 6.7, the model calculated a low confidence for chert outcrop prediction within the Gulf of Mexico. This is mainly due to the lack of geological, physiographic, and other environmental data for this region. The only evidential themes that extended into the Gulf are the distance buffers for the hydrologic features (see Figure 6.3). Most of these buffered distance themes were excluded from the final model. The central Brooksville Ridge and adjacent areas reflect a sizable area of only fair model prediction. This region is associated with a number of very well known outcrops and cluster of outcrops, especially those found within the upland portions of the Withlacoochee State Forest. These regional were also areas that the model predicted to be a moderate to high outcrop favorability. These data indicate that although the model predicted a moderate to high outcrop location potential for the Brooksville Ridge, the model is less confident in these predictions than those made in the Marion Upland of Withlacoochee River floodplain.

The model provides the highest confidence levels in the outcrop favorability predictions along the coastal plain, the Withlacoochee River and its floodplain, and the Marion Uplands. The model also projected moderate confidence in the model for the Gulf Hammock/Waccasassa River region, a region considered by the conceptual model to
Figure 6.7. Map of the posterior probability confidence levels.
be devoid of major chert outcrops and quarries. The model gives high to very high confidence levels to the area along the coastal plain and in the general vicinity of the Crystal River site. It can be concluded from these results that there is a strong likelihood of chert outcrops in the vicinity of the Crystal River site, especially in the portion of the Coastal Plain to the south of the site.

Model Validation

Both the training points and the validation points (the FMSF probable chert outcrop locations) can be used to compare how well the data points correspond to the WofE predictive surfaces (Figure 6.1 and Figure 6.2). Carranza and Hale (2000), Romero-Calcerrda and Luque (2006), and Duke and Steele (2010) employed a similar set of criteria to determine the validity of their final models. According to these researchers, a valid final model should be able to predict 70 percent of the training points and at least 50 percent of the “unknown occurrences” or validation points used to test the model. To test the current model, the 59 training points used to create the model and the 195 validation sites, FMSF sites within the study area classified at as “lithic scatter/quarry (prehistoric, no ceramic)” were used to evaluate the validity of the model. The graphic results of the model validation are provided in Figure 6.8 and 6.9. Forty-two of the 59 training points were identified within areas classified as some, moderate, or high potential to contain chert outcrops (Figure 6.8). This indicates that 71.2 percent of the training sites are located in areas considered to be Moderate to Very Favorable locations to contain chert outcrops. However, only 73 of the validation sites (37.4%) identified from
Figure 6.8. Map showing the distribution of training points with outcrop potential.
Figure 6.9. Map showing the distribution of FMSF validation points with outcrop potential.
the FMSF data as probable quarry locations fall within areas defined by the model as being more favorable locations to contain chert outcrops.

A shown in Figure 6.9, many of the FMSF validation sites lie near or in the vicinity of regions defined as moderate to highly favorable for containing chert outcrops. There are two areas where the FMSF data suggests outcrops are present that was not predicted by the model: the banks of the Withlacoochee River west of Lake Rousseau and in the coastal plain north of the Withlacoochee River. The model did not indicate that this region was more likely to contain chert outcrops. However, the model predicted only a fair level of confidence in the model’s ability to make predictions in this area (Figure 6.7). There are many known outcroppings of limestone and chert along the Withlacoochee River, but most are thought to be associated with dredging and channeling activities that took place in the early twentieth century.

The final validation of the WofE predictive model is the consideration of how well it predicts the boundaries and chert outcrop/quarry locations within the various quarry clusters defined for this region (Austin 1997; Endonino 2007; Upchurch et al. 1981). As shown in Figure 6.10, the final model was able to predict the boundaries and occurrence of chert outcrops within the Brooksville, Lake Panasoffkee, and Ocala quarry clusters very well. Both the general boundaries of each cluster and the concentrations of chert quarries within each of the clusters are well-predicted. The model was also able to suggest a few locations within the Lower Suwannee quarry cluster that appear to be more favorable as chert outcrops. The model also predicted a low favorability for most of the area defined as the Inverness quarry cluster (Upchurch et al. 1981:126-128). The ill-defined Inverness quarry cluster was defined by Upchurch (et al. 1981) as an area
Figure 6.10. Map of the quarry cluster boundaries and outcrop potential probabilities.
reserved for probable chert exposures. Only two of the training points and two of the FMSF validation points fall within this cluster. These data support the contention of Austin (1997) and Endonino (2007) that this cluster should be dissolved and the outcrops along its boundaries evaluated for reassigned to the adjacent Brooksville and Lake Panasoffkee quarry clusters.

The model also predicts a series of outcrops and a potential quarry cluster within the Coastal Lowlands along the coast that are not part of any currently-defined quarry cluster. The current model represents these areas by six training points, although the FMSF validation points suggest that there are more outcrop locations along the coast than indicated by the present model (Estabrook 1999; 2000, 2005; Walker 1879). There is some question about the geological origins of these cherts. Fieldwork in coastal Pasco and southern Hernando counties indicates that these outcrops are silicified Suwannee Formation materials (Estabrook 2000, 2005) and should be included in the Brooksville Quarry Cluster. The underlying geology of the portion of this region in northern Hernando and Citrus counties is the Crystal River Formation of the Ocala Limestone. If these outcrops are best characterized as Ocala Limestone materials, a new coastal quarry cluster should be defined. Until this new potential cluster can be field-verified, these coastal quarries will be tentatively assigned to the New Coastal quarry cluster in order to differentiate them from known Brooksville quarry cluster locations.

The results of the WofE evaluation suggest that the Inverness quarry cluster should be eliminated from consideration and the two quarry locations that had been assigned to this quarry be reassigned to the adjacent Brooksville and Lake Panasoffkee clusters. These results also indicate that the proposed redrawing of quarry cluster
boundaries proposed by Endonino (2007:89) within the study area defined is too limited. They do not include many of the known prehistoric quarries in northeastern Citrus and southeastern Marion counties. The boundaries proposed by Upchurch et al. (1981) and modified by Austin (1997) have been retained for this investigation. This is not to say that the quarry clusters defined by Upchurch et al. (1981) and Austin (1997) are entirely defendable. The WofE analysis predicts and the FMSF information supports the identification of a new coastal quarry cluster (New Coastal) that lies between the Brooksville Ridge and the Gulf of Mexico within the coastal plain. No outcrops from the Lower Suwannee quarry cluster exist within the study area.

The WofE model has shown that most of the significant quarry areas and chert outcrops in the region are represented, although not in proportion to their potential contribution or aerial extents. Coastal quarries appear to be underrepresented in the training points and validation points, although the distribution of the possible lithic scatter/quarry sites identified from the FMSF data suggest that these sites may be much more prolific in this area than previously considered (Austin 1997; Endonino 2007; Upchuch et al. 1981). The WofE model accurately predicts the extent and boundaries of the quarry clusters defined for the region and support the quarry clusters as a valid analytic construct. It is my contention from these results that the quarry sources represented by the training points are an incomplete, but seemingly accurate representation of the chert outcrops that would have been accessible to the pre-contact inhabitants of the Crystal River area.

In sum, the WofE evaluation was able to define better the extent and distribution of the chert quarries within the 50 km study area boundary. Specifically, it was able to
support the proposal of the New Coastal quarry cluster along the coastal stand in Citrus and Hernando counties. It also supported the elimination of the ill-defined Inverness quarry cluster and the expansion and boundary adjustments to the Brooksville and Lake Panasoffkee clusters to include those few sources known to exist within the proposed boundaries of the Inverness cluster.

**Cost Path Analysis**

Identifying the sources of chert in the region is important, but accessibility to those resources is equally important. If chert outcrops and quarries were difficult to get to or costly in terms of time or effort to access, alternative materials like shell, bone, and wood might be used instead, especially within a coastal environment where shell and bone are readily available. The second major data set developed to consider the chaîne opératoire used by the inhabitants of the Crystal River was a delineation of the possible routes taken to obtain chert for making stone tools. Previous studies have used straight-line distance (Austin 1997) or concentric distance circles (Deming and Estabrook 1994), or even spatial distribution contours (Austin and Estabrook 2000), but all have proven inadequate to the task of identifying why certain quarry areas were selected over others.

A cost-path analysis was performed in an attempt to identify those quarries within the vicinity of the Crystal River site would have been most likely to have been used. This technique uses environmental data to suggest which quarries would be the most likely to have been used by the site’s prehistoric inhabitants.
Cost-Path Data

Many of the data used to develop the WofE analysis were also used in the cost path study. The specific data sets used and their sources are provided in Table 6.5. The water features, especially the Gulf of Mexico, major rivers and streams, and lakes had been verified for the WofE study and required a simple reclassification to begin consideration in the development of the cost surfaces. The elevation raster was also re-used, but required a special conversion to consider slope rather than the raw elevation value. Several datasets were evaluated to provide an approximation of the vegetation cover in the Crystal River region during the time the site was occupied. Most modern land use coverages were much too complex and most contained large areas that have been altered or modified in recent historic and modern times. The categories defined by the Florida Natural Areas Inventory (1990) was considered, but was determined to be too general and the size of the natural community areas were too large to provide a proxy measure of how rapidly these environments might be traversed by someone on foot. The General Map of Natural Vegetation of Florida by Davis (1967) was ultimately selected as most appropriate scale for this analysis. Although fairly general, it provided a level of discrimination between coastal and upland environments that was specific enough to define the major environmental zones while being able to adjust for the environmental change that would have occurred during the changes in sea level during the time the site was occupied.

The final data issue that required a creative solution was the creation of a proxy for the terrestrial paths of trails that would have been used by Native peoples to transport materials over land. As discussed previously, the historic trails shown on the General
Land Office plat maps proved inadequate, so pathways along ecotone breaks were created as proxy travel paths. Buffers were created inside and outside the boundaries of the vegetation communities defined by Davis (1967), each 30 m or one cell wide. This generated adjacent corridors along the boundaries that were two cells (roughly 60 m) wide. These features were then extracted, dissolved, and converted to raster files. These pathways along the major changes in vegetation will serve as the terrestrial pathways or trails used by Native peoples to move across area. They are not meant to represent all of the various trails and pathways used by the peoples of the region, but they should approximate the major trails connecting various environmental patches within the region.

Table 6.5: Cost-path (friction) surface data sources.

<table>
<thead>
<tr>
<th>Category</th>
<th>File Name</th>
<th>Source</th>
<th>File Name(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>National Elevation Dataset (NED)</td>
<td>USDA</td>
<td>n29w083, n30w083, n30w084</td>
</tr>
<tr>
<td>Geology</td>
<td>Sinkhole</td>
<td>FGDL</td>
<td>sinkhole</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Rivers (major)</td>
<td>FGDL</td>
<td>mjrivl, mjrivp</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Streams</td>
<td>FGDL</td>
<td>hy24p09/27/38/42/60</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Gulf of Mexico</td>
<td>FGDL</td>
<td>coast_feb04</td>
</tr>
<tr>
<td>Vegetation</td>
<td>General Vegetation</td>
<td>FGDL</td>
<td>vcom67 (Davis 1967)</td>
</tr>
</tbody>
</table>

In the original model, lakes and marshes were included as possible transportation corridors. Lakes and marshes are extensive on Florida’s west coast and were likely intensively used by Native peoples to move about the region. Lakes became an issue during the analysis due to a situation known as “puddle-jumping” (Howey 2007:1835). Puddle-jumping occurs during cost-path modeling when lakes are assigned a lower transport cost than that given to the adjacent upland area and the model selects every body of water it evaluates as part of its corridor selection in the attempt to lower travel
costs. The real-time implication of this would suggest that Native peoples were crossing every disconnected water body by boat at every opportunity, which would skewed the model towards paths with far too many lake crossings and too low an overall cost estimate. Howey (2007) solved this issue by assigning lakes a relatively high cost ranking. Adjusting the cost ranking of lakes in the Crystal River model resulted in artificial impediments to travel along many of the major rivers and streams and across many of the larger lakes like Lake Panasoffkee, which are known prehistoric and historic travel corridors. The elimination of the Lakes shapefile from consideration solved the puddle-jumping issue and allowed for unrestricted travel along the larger rivers and streams.

Three cost surface rasters were created. One surface was generated for the hydrology including the Gulf of Mexico, rivers (including connected lakes), streams, creeks and larger sloughs. The terrestrial surface included the environmental zones defined by Davis (1967), the locations of all sinkholes, and the terrestrial pathways generated along the ecotones between environmental zones. Both rasters were evaluated to ensure that there was no overlap between them. This check prohibited any cell assigned a cost value on the hydrological raster from also having a cost ranking on the terrestrial raster, which could create cells with artificially high cost rankings. Elevation was captured as effective slope (Bell and Lock 1989; Howey 2007). Effective slope considers that the relationship between slope and effort required to cross a given degree of slope on foot is not linear. Effective slope is calculated by taking the tangent of the slope and dividing it by the tangent of one degree (0.01745) (Bell and Lock 1989:88). These values were then scaled between zero and 100 (Connolly and Lake 2006:217-218).
The cost ranking for the hydrology and the terrestrial rasters were assigned after the values used by Howey (2007:Table 2). The cost rankings are provided in Table 6.6. The values used by Howey (2007) were adjusted relative to the kinds of environments found in Central Florida. Dryer, more open environments like pine flatwoods were ranked as relatively easy to cross. As a fire-managed environment, flatwoods in their natural state contain low understory vegetation as it burns off regularly and contain few natural impediments to travel on foot. Mangrove forest is perhaps the most difficult of terrestrial environments to cross on foot as they are typically very wet, the soils are mucky, and the vegetation nearly impenetrable. Even when traveling along established foot paths, many of these environments would have been challenging to cross during the rainy or wet season.

Table 6.6: Cost-path (friction) surface cost ranking.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Cost Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology</td>
<td>Gulf of Mexico (0-5 km of coast)</td>
<td>5</td>
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<tr>
<td>Hydrology</td>
<td>Gulf of Mexico (5-10 km of coast)</td>
<td>25</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Gulf of Mexico (&gt; 10 km of coast)</td>
<td>90</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Rivers/streams</td>
<td>5</td>
</tr>
<tr>
<td>Paths</td>
<td>Terrestrial paths along ecotone breaks</td>
<td>30</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Pine Flatwoods</td>
<td>35</td>
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<tr>
<td>Vegetation</td>
<td>Forest of Longleaf Pine/Oak</td>
<td>40</td>
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<tr>
<td>Vegetation</td>
<td>Hardwood Forest</td>
<td>45</td>
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<tr>
<td>Vegetation</td>
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<td>50</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Swamp Forest/Hardwoods</td>
<td>55</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Mangrove Swamp</td>
<td>60</td>
</tr>
<tr>
<td>Elevation</td>
<td>Effective Slope</td>
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<tr>
<td>Geology</td>
<td>Sinkhole</td>
<td>100</td>
</tr>
</tbody>
</table>
Travel along all interior rivers and streams and along the coast in the Gulf of Mexico was ranked at the lowest possible cost (5). Travel out into the Gulf of Mexico was considered of greater risk the farther one traveled out into the Gulf. Beyond 10 km travel was assigned a value of 90 in order to make it cost-prohibitive for the model to propose cost-paths that cut straight across large open bodies of water rather than the more normal near-shore navigation using coastal landmarks.

Once each of the three rasters were aligned cost ranking and the elevation rater was scaled to match the 0-100 values of the hydrology and terrestrial rasters, the datasets were combined using map algebra. Each was equally weighted for the initial analysis by multiplying each of the rasters by one-third (.33) before they were combined. The resulting overall cost rater is shown in Figure 6.11.

The procedure used to create the cost-paths is series of tools that are included in the Spatial Analysis extension of ArcGIS 9.3.1. A cost surface and direction surface were calculated and a cost path from the Crystal River site out to each of the 59 known quarry locations (training points) was calculated. The polylines provided for each of the proposed cost paths were checked and extraneous lines and multiple paths were eliminated (Connolly and Lake 2006:253). Each line was then converted into a raster file. Zonal statistics were then calculated to obtain the length (cell count) and the accumulated cost of passage along each of the proposed routes. These values and a ranking of both the distance and costs for each quarry location are provided in Table 6.7. Table 6.7 also provides a ranking for each quarry location (Howey 2007:Table 4). Each quarry is ranked from one to 59 in terms of its cost-path distance from Crystal River. Each quarry is also ranked in terms of its accumulated least-cost path costs. The
Figure 6.11. Cost (friction) surface raster showing the distribution of cell “cost” across the study area.
Table 6.7. Cost Path Cell Counts, Accumulated Distances and Rankings.

<table>
<thead>
<tr>
<th>Training Points</th>
<th>Quarry Cluster</th>
<th>Cell Count</th>
<th>Cost Path*</th>
<th>Accumulated Cost**</th>
<th>Distance Rank</th>
<th>Cost Rank</th>
<th>Distance</th>
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</table>

* Cost Path length in meters  
** Accumulated Cost in accrued cell costs along path
Table 6.7. Cost Path Cell Counts, Accumulated Distances and Rankings (cont).

<table>
<thead>
<tr>
<th>Training Points</th>
<th>Quarry Cluster Count</th>
<th>Cell Cost Path*</th>
<th>Accumulated Cost**</th>
<th>Distance Rank</th>
<th>Cost Rank</th>
<th>Distance</th>
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</table>

* Cost Path length in meters
** Accumulated Cost in accrued cell costs along path

difference between these two rankings can be useful. A positive difference indicates that travel from the Crystal River site to this quarry is easier than the distance implies. A negative value indicates that travel is more difficult than the distance implies. For many of the quarries in the Lake Panasoffkee quarry cluster travel to them is easier than the distance implies, but it is still a very long distance away from the site.
The most effort-efficient quarries for the inhabitants of the Crystal River site to use would be those that are not more difficult to get to than their distances imply, nor those that require travel for a substantial distance irrespective of any positive difference indicated by cost ranking. Those quarries reporting a distance minus cost ranking of between -8 and 36 were selected as the best candidates for use as quarry locations. Locations with a ranking difference of less than -10 (-11 to -22) were considered to be too costly to access given the proposed travel distances and costs. Of the selected group, those with cost distance rankings greater than the median value (29 or greater) were eliminated based on their overall cost of travel from the Crystal River site. This elimination retains a group of quarries that are both in general proximity to the Crystal River site and that are not inherently “costly” to travel to. The results are provided in Table 6.8.

The 20 quarry locations shown in Figure 6.12 represent the best candidates for the quarry sources for the inhabitants of the Crystal River site. These quarries represent the western extent of the Brooksville quarry cluster and the entirety of the newly defined New Coastal quarry cluster. Because there are no rivers or creeks that flow through the Brooksville Ridge, this landform acts as a barrier to transportation, particularly to the use of canoes and other watercraft. The Gulf of Mexico and the short, spring-fed coastal rivers like the Chassahowitzka and the Weekiwachee provide access to the interior areas along the central and western side of the Ridge. The least cost paths extend from the outcrops to the nearest coastal river and from there to the Gulf. All paths defined south of the site extend along the Salt River, a coastal passageway that connects Bayport, Pine Island, Ozello, Homosassa, and Crystal River. This coastal channel was used historically
Table 6.8. Selected Cost Path Cell Counts, Accumulated Distances and Rankings.

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<thead>
<tr>
<th>Training Points</th>
<th>Quarry Cluster</th>
<th>Cell Count</th>
<th>Cost Path*</th>
<th>Accumulated Cost**</th>
<th>Distance Rank</th>
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<td>83</td>
<td>Brooksville</td>
<td>2125</td>
<td>61838</td>
<td>11473.3</td>
<td>15</td>
<td>21</td>
<td>-6</td>
</tr>
<tr>
<td>WSF-6</td>
<td>Brooksville</td>
<td>2182</td>
<td>63496</td>
<td>11708.1</td>
<td>19</td>
<td>25</td>
<td>-6</td>
</tr>
<tr>
<td>WSF-7</td>
<td>Brooksville</td>
<td>2096</td>
<td>60994</td>
<td>11012.9</td>
<td>14</td>
<td>18</td>
<td>-4</td>
</tr>
<tr>
<td>CI157</td>
<td>Brooksville</td>
<td>2060</td>
<td>59946</td>
<td>10636.8</td>
<td>11</td>
<td>14</td>
<td>-3</td>
</tr>
<tr>
<td>WSF-10</td>
<td>Brooksville</td>
<td>2069</td>
<td>60208</td>
<td>10698.7</td>
<td>12</td>
<td>15</td>
<td>-3</td>
</tr>
<tr>
<td>82</td>
<td>Brooksville</td>
<td>2071</td>
<td>60266</td>
<td>10701.3</td>
<td>13</td>
<td>16</td>
<td>-3</td>
</tr>
<tr>
<td>175</td>
<td>New Coastal</td>
<td>327</td>
<td>9516</td>
<td>2820.8</td>
<td>2</td>
<td>4</td>
<td>-2</td>
</tr>
<tr>
<td>WSF-12</td>
<td>Brooksville</td>
<td>2152</td>
<td>62623</td>
<td>11395.2</td>
<td>18</td>
<td>20</td>
<td>-2</td>
</tr>
<tr>
<td>115</td>
<td>New Coastal</td>
<td>70</td>
<td>2037</td>
<td>773.7</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>161</td>
<td>New Coastal</td>
<td>1523</td>
<td>44319</td>
<td>4453.7</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>156</td>
<td>Brooksville</td>
<td>1893</td>
<td>55086</td>
<td>7995.9</td>
<td>8</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>WSF-9</td>
<td>Brooksville</td>
<td>1921</td>
<td>55901</td>
<td>8394.6</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>219</td>
<td>Brooksville</td>
<td>1926</td>
<td>56047</td>
<td>8422.5</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>CI990</td>
<td>New Coastal</td>
<td>749</td>
<td>21796</td>
<td>1697.2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CI414</td>
<td>New Coastal</td>
<td>933</td>
<td>27150</td>
<td>2304.4</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CI868</td>
<td>New Coastal</td>
<td>1529</td>
<td>44494</td>
<td>3698.3</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

* Cost Path length in meters
** Accumulated Cost in accrued cell costs along path

to move good and materials along the coast and ultimately connected the coasts of Hernando and Citrus counties to Cedar Key, the nearest major shipping point. The two paths that extend south towards Crystal River follow well-known corridors. One follows Deer Creek, while the other extends along the Withlacoochee River before turning south along the Gulf towards Crystal River. All 20 paths traverse environments that contain the kinds of food and other resources used by the site’s inhabitants. All of the paths also occur within an area containing sites dominated by limestone-tempered pottery, shell
Figure 6.12. Map showing the 20 least cost paths from quarries to the Crystal River site.
tools, bone pins – a nearly identical material culture assemblage to that found at Crystal River.

In summary, the WofE analysis has shown that the quarry cluster concept as proposed by Upchurch (et al. 1981) is a valid construct within which to evaluate the use of chert within the 50 km study area defined for the Crystal River site. This study also validates the quarry boundaries established by Upchurch (et al. 1981) and updated by Austin (1997). It also supports the elimination of the Inverness quarry cluster and the reassignment of the two known quarries within the cluster to adjacent areas (Austin 1997; Endonino 2007). It does not support the quarry culture boundary revisions proposed by Endonino (2007:Figure 12) for the Ocala and Lake Panasoffkee quarry clusters. This may be the result of sampling bias as Endonino (2007:81) only included those outcrops to which he had access and could physically sample in his analysis.

The WofE evaluation also suggests that geological formations other than the dominant formation assigned to a particular quarry cluster contain cherts that would have been available for prehistoric use. Of particular importance is the strong loading given to the Coosawhatchie Formation, a member of the Hawthorn Group that includes the chert-rich Tampa Member and Bone Valley Member in the Hillsborough River and Peace River quarry clusters. This finding suggests that Hawthorn Group cherts from the Coosawhatchie Formation are present in the upper reaches of the study area (Endonino 2007:Figure 11).

Perhaps the most illuminating find of the analysis was the definition of a new coastal quarry cluster. Outcrops along the Gulf Coast from Tarpon Springs to Crystal River have been suggested in the literature (Estabrook 1999, 2005; Walker 1879;
Weisman and Newman 1990) and are indicated by some of the names used to identify geographic features along the coast (e.g., Rocky Creek, Rock Island Bay). Stone outcrops have even been mapped as impediments to navigation. Preliminary investigations of the coastal outcrops in coastal Pasco and Hernando counties suggest that the chert within the new cluster, tentatively named the New Coastal cluster is Suwannee Formation in origin, although it may include Ocala Limestone Crystal River Formation cherts in Citrus County.

The cost path analysis has shown that distance alone is an inadequate indicator of the effort required to move chert from a quarry site to a location where it can be shaped and used. As shown in Figure 6.12, most of the quarry locations that are the least effort to access from Crystal River lie south of the site along the coast and west of the Brooksville Ridge. This area contains the Brooksville and New Coastal quarry clusters. The Ocala, and West and East Lake Panasoffkee clusters are in some instances closer geographically, but require a greater expenditure of effort to travel to and from these locations. These data suggest that the lithic assemblage at the Crystal River site will be dominated by Suwannee Formation Brooksville quarry cluster materials. The relative contribution from the New Coastal cluster cannot yet be determined, but given the proximity of the known quarries and the suspected locations of potential chert sources, this cluster could also provide a significant quantity of the lithic raw materials used at the Crystal River site.
Chapter 7: Stone Tool Analysis and Results

The *chaîne opératoire* approach to the analysis of stone tools requires a new perspective on the description and discussion of the results. In the case of the Crystal River site, this approach requires looking at some of the same kinds of metric data that would be acquired during traditional functional analysis, collecting new data sets, and re-evaluating these data with a new perspective. My intention is not to abandon the functional analysis of stone tools, but to cast it in a light that addresses questions beyond the manufacture stages and reduction technologies, by moving the focus beyond the use of the tools themselves.

The stone tool assemblage from the entire site will be discussed as a whole rather than separated out by site feature or recovery area. This is primarily due to the differential recovery techniques and lack of specific proveniences for many of the recovered artifacts. Particular attention was focused during the study on the chert provenience determinations, the use-wear analysis, and the indications of the use of thermal alteration. Hafted biface retouch index (HRI) values (Andrefsky 2006, 2008a, 2008b) were calculated for all hafted bifaces that retained a sufficient portion of the blade margins to allow for measurement. The HRI is a measure of retouch along the lateral margins of hafted bifaces. This index can be used as a proxy measurement for the degree to which a biface has been resharpened, reused and curated. The HRI values, in
combination with the provenience determination data, provide interesting insights into
the use of stone tools both at the site and in the region within which it was a part.

I was unable to arrange access to the artifacts recovered by C.B. Moore during his
1903-1918 investigations at the Crystal River site. I was able to obtain good-resolution
photographs of 12 of the 19 hafted bifaces currently in the collections of the Smithsonian
Institution National Museum of the American Indian. An evaluation of the C.B. Moore
artifacts via photographs will follow my discussion of the chipped stone assemblage from
Crystal River that that I was able to access and evaluate.

In the following analysis, the waste flakes, flakes exhibiting use-wear (utilized
flakes) and flakes that exhibit post-detachment modifications will be discussed together.
The use-wear identified on the flake tools will also be considered both in the context of
site activities and in the discussion of discards. The debris from stone tool manufacturing
and the broken and discarded remains from stone tool use are perhaps the largest category
of remains recovered from prehistoric archaeological sites in the west central Florida
region. This abundance of stone artifacts is usually attributed to the large number of
lithic outcrops in the region. It is also a function of site preservation. Stone artifacts are
among the few artifacts classes that preserve in the sandy acidic environments found in
the region. Debitage is often seen as de facto refuse (Schiffer 1972, 1976), disposed of at
or at least very near the site of its creation or use. In reconstructing the operation
sequence, different classes of remains are assumed to have entered the archaeological
record.
Flake Analysis

Despite the recovery procedures used by the various investigators of the Crystal River site, the most common stone artifacts recovered were waste flakes or chipping debris. Of the 369 flaked stone specimens included in the analysis, 280 were identified as waste flakes, utilized flakes, or modified flakes. This number was a good deal higher than had originally been anticipated, but should not have been completely unexpected given the number of lithic quarries identified within the site region.

The metric dimensions of each specimen were recorded during the study. In order to make these data comparable to other studies in the region, each flake was placed in a size category based on its longest or largest dimension. Typically this was the artifact length. In some cases flake width was greater and this dimension was used to assign the artifact to a size category. The categories range from one to 12 cm and were established to correspond to the size opening used in other studies in the region. The results are provided in Figure 7.1.

For the unused and non-modified waste flakes, most specimens, 179 flakes (76.5%), were assigned to the 2 cm and 3 cm size categories. The recovery of only 10 waste flakes classified as 1 cm or smaller indicates that the assemblage composition has been biased by the use of ¼-inch or ½-inch mesh recovery screens or no screens at all. The largest waste flake recovered falls into the 8 cm flake size category. The lack of recovery of waste flakes in the larger size classifications indicates that this portion of the assemblage was also artificially restricted or that the reduction and modification of large bifacial tools, flake blanks, and flake cores was performed somewhere off-site. This assertion is supported by the utilized/modified flake size categories. The
utilized/modified flake count drops off markedly after the 7 cm size category only to be continued in the 11 cm and 12 cm categories. Larger flakes make better cutting/slicing tools. Very small utilized/modified flakes are uncommon whereas larger specimens are more easily identified and appropriately classified.

Figure 7.1. Waste flake and utilized/modified flake size distribution.

The categorization of the assemblage within the Sullivan and Rozen (1985) flake typology is provided in Table 7.1. Sites with lithic assemblages dominated by cores and flake tools typically have higher percentages of complete flakes and lower percentages of broken flakes and flake fragments (Sullivan and Rozen 1985:762). Assemblages with greater percentages of broken flakes and flake fragments and low counts for complete flakes and fewer cores are often associated with bifacial tool production. As the counts
and percentages in Table 7.1 indicate, there is no clear emphasis either way at the Crystal River site. While there is a slightly greater count/percent of complete flakes, flake fragments are a close second, and broken flakes are last when the waste flake and total counts are considered. Broken flakes edged out debris only among the utilized/modified flakes. Debris, blocky shatter, and other artifacts often classified in the “debris” category seldom have edges or surfaces suitable for their use as cutting, scraping, or slicing tools.

Table 7.1. Sullivan and Rozen waste flake analysis categories.

<table>
<thead>
<tr>
<th>Category</th>
<th>Waste Flakes</th>
<th>Utilized/Modified Flakes</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Flake</td>
<td>79 / 33.3%*</td>
<td>17 / 36.9%</td>
<td>96 / 34.2%</td>
</tr>
<tr>
<td>Broken Flake</td>
<td>35 / 15.0%</td>
<td>6 / 13.0%</td>
<td>41 / 14.6%</td>
</tr>
<tr>
<td>Flake Fragment</td>
<td>70 / 29.9%</td>
<td>22 / 47.8%</td>
<td>92 / 32.7%</td>
</tr>
<tr>
<td>Debris</td>
<td>51 / 21.8%</td>
<td>1 / 2.2%</td>
<td>52 / 18.5%</td>
</tr>
</tbody>
</table>

*Count/Percent

The result of the Sullivan/Rozen flake analysis does not clearly indicate the dominance of either core reduction or bifacial tool production in this assemblage. It also does not support the claim that both the waste flake and the utilized/modified flake assemblages are homogeneous; that is, that their data distributions are similar with respect to flake category membership. These differences are mainly in the flake fragment and debris categories. The utilized/modified flakes contain too many flake fragments and too few specimens classified as debris.

Flake platform attributes can be good indicators of tool production activities (Andrefsky 1998:89-92). Flakes removed from prepared cores or for the production of
flake tools are often removed from cores with prepared platforms that are perpendicular to the flaking surface. Core reduction produces flakes with flat platforms and flaking angles of 90° or greater. Flakes stuck during the manufacture of bifaces are often complex and have scarring from previous flake removals along the striking platform. Because they are removed from the margins of bifacially-flaked implements, the resulting bifacial thinning flakes often have platform angles of 90° or less. The flake attributes of all platform-remnant bearing (PRB) flakes are provided in Table 7.2.

Table 7.2. Flake Platform Attributes.

<table>
<thead>
<tr>
<th>Platform Configuration</th>
<th>Waste Flakes</th>
<th>Average Platform Angle</th>
<th>Modified/Utilized Flakes</th>
<th>Average Platform Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3 Facets</td>
<td>8</td>
<td>72°</td>
<td>1</td>
<td>80°</td>
</tr>
<tr>
<td>1-2 Facets</td>
<td>29</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>66</td>
<td></td>
<td>17</td>
<td>83°</td>
</tr>
<tr>
<td>Cortex-Covered</td>
<td>1</td>
<td>79°</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Crushed</td>
<td>9</td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Both the waste flake and utilized/modified flake assemblages are dominated by flake with flat, cortex-covered or crushed striking platforms. Flakes with complex platforms, those with one of more flake scars, comprise only one-third of the waste flakes and less than then one-quarter of the utilized/modified flake assemblage. Specimens with simple platforms and those with flat, cortex-covered and crushed platforms are well-represented in both the waste flake and modified/utilized flake assemblages. Bifacial thinning flakes were more commonly identified among the waste flake specimens, especially those with complex platform configurations. Nine of the 23 modified/utilized
flakes were also identified as bifacial thinning flakes. The average platform angle for the waste flakes with complex platforms is 72°. The average platform angle increases towards the 90° range for flakes with less complex platforms irrespective of their classification.

Evidence of the use of thermal alteration is uncommon in both the waste flake and the utilized/modified flake assemblages. As shown in Table 7.3, fewer than 34 specimens displayed both the red/orange color enhancement and the waxy luster change indicative of having been heat-treated. A number of specimens were classified as indeterminate for thermal alteration. These were often artifacts that displayed only one indication of having been thermally altered or displayed evidence of thermal damage – unintentional exposure to heat that can result in a color change or even increased luster but often also display crazing, potlid-fractures, and burning, evidence of exposure to a firepit, cooking pit, or other heat source unrelated to the intentional heat-treatment process.

Table 7.3. Waste Flake and Modified/Utilized Flake thermal alteration distribution.

<table>
<thead>
<tr>
<th>Thermal Alteration Classification</th>
<th>Waste Flakes</th>
<th>Percent</th>
<th>Modified / Utilized Flakes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermally-Altered</td>
<td>28</td>
<td>12.0%</td>
<td>6</td>
<td>13.1%</td>
</tr>
<tr>
<td>Unaltered</td>
<td>192</td>
<td>82.0%</td>
<td>37</td>
<td>80.4%</td>
</tr>
<tr>
<td>TA Indeterminate</td>
<td>14</td>
<td>6.0%</td>
<td>3</td>
<td>6.5%</td>
</tr>
</tbody>
</table>

Thermal alteration appears to be evenly distributed across both the waste flake and utilized/modified flake assemblages. Evidence of intentional heat-treatment appears
to represent a little more than 10 percent of each assemblage. There does not seem to have been any selection for heat-treated flakes for use as tools despite the consideration that heat-treated materials have thinner and sharper edges. This result also contradicts the assertion that Woodland peoples used techniques like thermal alteration to increase the workability of local materials.

Silicified limestone, or chert, is the dominant raw material for chipped stone industry at the Crystal River site. Only two silicified coral flakes have been recovered from the site. Both were recovered in level two (20-40 cmbs) of Unit 510N/490E during Weisman’s 1985 test excavations. One was categorized as a waste flake; the other as a utilized flake. A single, small bifacial thinning flake recovered during the 1998 seawall replacement project (Ellis 1998) was the only specimen that appears to be made from an exotic or non-coastal plain chert (artifact FDHR 02A.292.2.15). This well-silicified, very dark gray (10YR3/1) chert flake contained no fossil inclusions. In appearance the artifact resembles materials recovered from sites in the Ridge and Valley region of northwest Georgia (Goad 1979:18). Until this can be confirmed, however, the specimen has been classified as indeterminate. The count and weights of each of the contributing lithic sources is provided in Table 7.4

The waste flake and the utilized modified flake assemblages are similar in flake attribute categories percentages (Tables 7.1 and 7.2) and appear to have similar instances of thermal alteration (Table 7.3). Given the selection of larger, thinner flakes for use as tools and the rejection of blocky chunks and shatter (‘debris”), the size distribution, size sorting for utilized flakes, the flake size distribution, flake attribute categories, use of
Table 7.4. Waste Flake and Utilized/Modified Flakes by Formation and Quarry Cluster.

<table>
<thead>
<tr>
<th>Formation</th>
<th>Quarry Cluster</th>
<th>Waste Flakes</th>
<th></th>
<th>Utilized/Modified Flakes</th>
<th></th>
<th>Total Flakes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Count</td>
<td>Weight</td>
<td>Count</td>
<td>Weight</td>
<td>Count</td>
<td>Weight</td>
</tr>
<tr>
<td>Suwannee</td>
<td>Brooksville</td>
<td>185</td>
<td>898.3</td>
<td>35</td>
<td>805.1</td>
<td>220</td>
<td>1703.4</td>
</tr>
<tr>
<td>Ocala</td>
<td>Ocala</td>
<td>11</td>
<td>41.0</td>
<td>4</td>
<td>66.6</td>
<td>15</td>
<td>107.6</td>
</tr>
<tr>
<td></td>
<td>East Lake Panasoffkee</td>
<td>2</td>
<td>7.3</td>
<td>2</td>
<td>36.3</td>
<td>4</td>
<td>43.6</td>
</tr>
<tr>
<td></td>
<td>West Lake Panasoffkee</td>
<td>6</td>
<td>23.4</td>
<td>1</td>
<td>4.1</td>
<td>7</td>
<td>27.5</td>
</tr>
<tr>
<td>Hawthorn Group</td>
<td>Hillsborough River</td>
<td>3</td>
<td>7.2</td>
<td>2</td>
<td>18.5</td>
<td>5</td>
<td>25.7</td>
</tr>
<tr>
<td></td>
<td>Coosawhatchie Fm</td>
<td>6</td>
<td>13.0</td>
<td>1</td>
<td>22.5</td>
<td>7</td>
<td>35.5</td>
</tr>
<tr>
<td>Silicified Coral</td>
<td>Siderastrea (genus)</td>
<td>1</td>
<td>3.4</td>
<td>0</td>
<td>-</td>
<td>1</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Goniopora (genus)</td>
<td>0</td>
<td>-</td>
<td>1</td>
<td>1.2</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Undetermined</td>
<td></td>
<td>20</td>
<td>54.1</td>
<td>0</td>
<td>-</td>
<td>20</td>
<td>54.1</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>234</td>
<td>1047.7</td>
<td>46</td>
<td>954.3</td>
<td>280</td>
<td>2002.0</td>
</tr>
</tbody>
</table>
thermal alteration, are remarkably similar. These data indicate that the waste flake and utilized/modified flake assemblages from the Crystal River site were selected from the same universe of quarries, subjected to the same pretreatment techniques, and appear to be the product of both biface and core reduction.

These findings suggest two possible scenarios for the acquisition of flakes used to make flake tools. The inhabitants of Crystal River were bringing chert cores and bifaces back to the site in large enough sizes to remove suitable flakes on an “as-needed” basis or they were selecting large flakes at quarry locations and bringing these items back to the site for future use as tools. I will return to this discussion later after describing the various uses and probable activities in which the flake tools, but also the formal tools, were used.

**Chipped Stone Tools**

A variety of chipped stone tools have been recovered from the Crystal River site since modern excavations began in 1951. Forty-one specimens classified as utilized flakes and five specimens classified as modified flakes have been identified. The attribute data for these implements is provided in Table 7.5. In addition to having been intentionally flaked into shape, two of the modified flakes also appear to have been utilized. Several of the flakes display edge damage indicating the tool was used for several different actions, for example both cutting and scraping. The damage from both of these activations can be observed along the tool margins and in some cases overlapped
Table 7.5. Utilized and Modified Flake Attribute Data.

<table>
<thead>
<tr>
<th>Object Number</th>
<th>Horizontal Provenience</th>
<th>Thermal Alteration</th>
<th>Color</th>
<th>Weight</th>
<th>Width</th>
<th>Length</th>
<th>Thickness</th>
<th>Functional Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>98924-1</td>
<td>Feature C</td>
<td>No</td>
<td>10YR8/2</td>
<td>2.5</td>
<td>1.82</td>
<td>2.61</td>
<td>0.43</td>
<td>cutting</td>
</tr>
<tr>
<td>A-2477-1</td>
<td>General</td>
<td>No</td>
<td>7.5YR6/4</td>
<td>4.7</td>
<td>3.0</td>
<td>2.79</td>
<td>0.61</td>
<td>cutting</td>
</tr>
<tr>
<td>94674-1</td>
<td>General</td>
<td>No</td>
<td>10YR7/2</td>
<td>9.3</td>
<td>4.11</td>
<td>2.93</td>
<td>1.1</td>
<td>cutting</td>
</tr>
<tr>
<td>98897-1</td>
<td>Midden B</td>
<td>No</td>
<td>7.5YR6/1</td>
<td>33.9</td>
<td>5.79</td>
<td>4.48</td>
<td>1.6</td>
<td>cutting</td>
</tr>
<tr>
<td>98905-1</td>
<td>Midden B</td>
<td>No</td>
<td>10YR8/1</td>
<td>167.8</td>
<td>7.13</td>
<td>10.17</td>
<td>2.35</td>
<td>cutting</td>
</tr>
<tr>
<td>98904-1</td>
<td>Midden B</td>
<td>No</td>
<td>10YR7/3</td>
<td>28.5</td>
<td>5.51</td>
<td>4.06</td>
<td>1.75</td>
<td>cutting</td>
</tr>
<tr>
<td>99291-1</td>
<td>Midden B</td>
<td>No</td>
<td>2.5YR3/1</td>
<td>4.0</td>
<td>2.27</td>
<td>3.06</td>
<td>0.55</td>
<td>cutting</td>
</tr>
<tr>
<td>98903-2</td>
<td>Midden B</td>
<td>No</td>
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along the tool edge. As the summary of results in Table 7.5 shows flake tools were used for a variety of different activities. Eleven (11) specimens display edge damage indicative of cutting or slicing activities (Odell 1977). Two of these specimens display an extensive, dull polish indicative of cutting meat and/or flesh (Keeley 1980:55; Vaughan 1985:38). One specimen displays a bright, extensive, non-pitted polish indicative of woodworking. Another flake also classified as a cutting tool displays a bright polish localized in the flake scar arrises (ridges) and appears to be indicative of working bone or antler (e.g., Vaughan 1985: Plate 20). Polishes were not observed on the other flakes, so tool use was assessed by edge wear alone. Seventeen (17) flake tools were used as cutting tools. All display edge damage that is more intensive and extensive than those classified as cutting/slicing tools. The edge damage on specimen 2003-5-1-2 is both extensive and invasive. The damage extends across the entire working edge of the implement and has worn back the tool edge. Unlike many of the flake tools which appear to have been discarded as soon as the task was completed, this tool appears to have been discarded only after its use-life was well past.

Ten utilized flakes display the characteristic edge damage indicating use in scraping activities. Five additional specimens display a combination of scraping and cutting damage or cutting and scraping wear. The classification of “scraping/cutting” or “cutting/scraping” depended on the relative amount of intensive unifacial damage or extensive bifacial damage observed on the individual specimens. Care should be taken when interpreting these classes. The most extensive damage category appears to have been the last activation employed with the tool rather than the any measure of use-
intensity. If scraping was the last action performed, the edge damage could easily have removed any prior damage from use of the flake as a cutting tool.

Overall, the number of utilized flakes and utilized/modified flakes recovered from the Crystal River site is probably under-represented. Most of the flakes recovered by Bullen and identified as “utilized flakes” or “utilized chips” were so obviously used that the use-wear damage along the flake margins could be seen with the unaided eye. From the small sample of tools recovered thus far from the Crystal River site, it is clear that flake tools were involved with a variety of tasks from working bone and wood to cutting meat and perhaps butchering game. Most of these tool uses appear to be “expedient”, that is the task was evidently completed before the tool was reduced to a dull or non-functional edge. Every flake tool (with the exception of one) was discarded before its useful life as a cutting or scraping tool had been realized.

Cores

Ten specimens identified as cores (Table 7.6). While most were recovered from the Midden B area or during the seawall replacement project in 1998, cores were also recovered from the Double Sand Mound (DS Mound), Feature C, and even the central burial mound complex (Mounds E/F). Most are made from non-heat treated silicified limestone that originated from all three major chert-bearing formations in the region. Most are best described as amorphous cores because they do not have prepared striking platforms or scars from regular, patterned flake removals. Many appear to have had several platforms from which flakes were struck off in an opportunistic fashion before moving onto the next platform area. A small bipolar core was recovered from Shovel
Test 4 during the investigation for a fence replacement (Wheeler 2001). This specimen display scars indicting that flakes were removed from two opposing platforms, one on each side of the core. Only one of the cores was considered “exhausted.” Most cores appear to still contain sufficient material where additional flakes could still have been successfully removed. A second “exhausted” core was subsequently used as a hammerstone. Evidence of previous patterned flake removals was still evident under the pecking and surface attrition considered characteristic of hammer-type tools.

**Hammerstones**

Five chert hammerstones were identified during the analysis (Table 7.6). One was the tool made from the exhausted core described above. Four others were identified from Bullen’s 1951 work and Weisman’s 1985 work in Midden B. Most of the wear displayed on these implements is not extensive. Only one of the artifacts, the hammerstone recovered by Bullen in Test 1, had been classified by its excavator as a hammerstone. Identification of the others was only possible under low magnification and careful inspection of the tool surface. The relatively light amount of hammering/pecking damage observed on these artifacts indicates that while they may have been used to strike-off flakes and manufacture and modify stone tools, they could just as likely been involved to crack long bones, crush nuts and acorns, open shellfish, or any other of a number of activities that requires an impact activation. The degree to which the tools were damaged may be an indication of the duration of use.
Table 7.6: Cores, Hammerstone, Drill/Graver and Uniface Attribute Data

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Unifaces

A single tool classified as a uniface was recovered in Bullen’s 1964 Test 1 at 6-12 inches (15-30 cm) below surface (Table 7.6). Although classified as a uniface, the artifact is best described as a minimally modified flake shaped in the style of a turtleback or hump-backed scraper. The tool has two working edges at opposite ends. One edge has an average edge angle of 54°, the other 79°. There is no evidence of hafting, although these tools are more effective when hafted (Brink 1978; Keeley 1982:800; Weedman 2005). The kind and degree of edge damage indicates tool use on a moderately dense material like wood. This uniface was the only example of a tool specifically shaped (flaked) to scrape or gouge materials. These activities were otherwise performed with an unmodified flake or the edge of a broken bifacial tool.

Drill/Gravers

Three artifacts were identified that either display edge damage indicating use as a drill or graver or that are incomplete specimens but that morphologically resemble tools that have been modified to perform these functions (Table 7.6; e.g., Purdy 1981: Figure 21). All of these artifacts were discovered in a lawn shed during the 1993 cleanup of the Storm of the Century event and have been tentatively assigned to a Midden B context. A stemmed biface (Specimen #25) with expanding shoulders, but extensively reworked blade margins was recovered with its tip broken off. While the specimen exhibits no specific use wear, the extensive modifications made to the shoulders and blade indicates that it was reworked as a drill. A second specimen (Specimen #15) is made from the broken lateral margin of a biface that has been modified on one end to function as a drill.
and of the other end as a graving tool (Figure 7.2). The roughly triangular shape formed by the two former tool faces and the transverse fracture break parallel to the edge provides an effective surface to conduct both tasks. The third specimen (Specimen #35) is classified as a drill fragment. This specimen is best described as the rhombus-shaped shaft or reworked blade margins of a hafted biface that was reshaped into a hafted drill. Both the tip and haft portion of the tool have broken away

Biface Production Failures

Seventeen (17) artifacts have been categorized as bifacial production failures (Table 7.7). All are bifacial flaked implements that display some kind of critical fracture that inhibited the further modification to the tool. In many cases these include various kinds of
transverse fractures including lateral snaps, perverse snaps, or margins breaks (Johnson 1981; Purdy 1975; Rondeau 1981). Most of the critical breaks are transverse fractures and many are the classic “s-curve” lateral snaps (Purdy 1975:135), also known as “end-shock” (Crabtree 1972:60), which is considered a fracture type more common in the final stages of producing bifacial tools (Johnson 1979, 1981a, 1981b; Rondeau 1981). Many of the other fractures are transverse fractures with either fossil or crystal inclusions or void/abscesses causing weak points at these breaks. All are made from silicified limestone and two have been thermally altered. One specimen (87-96-1-4) displays potlid scars and crazing and appears to have suffered from thermal damage or unintentional exposure to a heat source, rather than being intentionally thermally altered. No specimen displays any use-wear of evidence of having been hafted or used. With the noted exception of one thick specimen (01A.037.3.7) recovered by Wheeler (2001), the thinning indexes are relatively low (less than 2.5) and well within the ranges established for finished or nearly finished tools (Austin and Ste. Claire 1982: 191-192; Johnson 1981a, 1981b; Ste. Claire 1996:190).

As can be seen in the reuse of Specimen #15, some broken biface fragments were re-used as special use graving or drilling tools, while others were apparently discarded once they no longer were serviceable for the task at hand. The re-use of stone appears to be one of the reasons that few bifacial cores large enough to make some of the larger flake tools (7-12 cm) were recovered from the site.
Biface Fragments

Thirteen (13) specimens were classified as biface fragments (Table 7.8). These were typically the broken fragments of used bifaces. They all either display some evidence of use-wear or impact damage. The critical fractures on two of the specimens have been classified as distal impact fractures. One of the impact-related specimens (Specimen #10) also displays a haft snap and evidence of use as a cutting implement. All of the other 11 specimens appear to have been involved in cutting or cutting/slicing activities. Twelve (12) are made from silicified limestone; only one of the specimens could definitively be identified as having been thermally altered. A second specimen displays a waxy luster, but not a red-orange color change, and was classified as indeterminate.

Hafted Bifaces

Thirty-nine (39) hafted bifaces were included in this analysis. The typological assignments and attribute data are provided in Table 7.9; functional and raw material provenience data are given in Table 7.10. These include all of the specimens currently within the collections of the FLMNH in Gainesville, the Florida DHR in Tallahassee, and the specimens recovered from the Crystal River Trailer Park sheds after the 1993 Storm of the Century and recently discovered in the storeroom at the CRASP Museum. This assemblage includes three points (two Duval and one Pinellas point) recovered by Bullen during his 1951-1966 investigations at the site that were removed from the FLMNH collections and used for display at the CRASP Museum. Attempts to identify all of the artifacts currently on loan from the FLMNH to the CRASP Museum were made, but
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<td>Siderastrea (genus)</td>
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<td>slicing/cutting</td>
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<td>1.41</td>
<td>cutting</td>
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</table>
specific artifact proveniences for the points could not be made at this time. These artifacts are discussed below as point type groups in alphabetical order.

*Broward points*

Two specimens identified as Broward points were identified during the analysis. The first specimen (87-96-2-1) was recovered from level one (0-20 cmbs) of Weisman’s 1985 excavation unit 500N/535E. The second (Specimen #31) was recovered from the Crystal River Trailer Park materials (Figure 7.3). Both specimens are basal portions; they display critical transverse fractures that bisected each blade. Artifact 87-96-2-1 is classified as a subtype 2. Specimen #31 is categorized as a subtype 4 because of a slightly incurvate basal margin. It displays edge rounding and scalar scaring indicative of use in cutting activities. No use-wear was observed on artifact 87-96-2-1. 87-96-2-1 is made from an Ocala Limestone chert, and given the size and distribution of the Lepodocyclina fossils, it likely originated from a West Lake Panasoffkee quarry. Specimen #31 is made from a Suwannee Formation chert, and has been assigned to the Brooksville quarry cluster.

Considered rare in Florida, few Broward points have been recovered from well-documented or dated contexts (Bullen 1976:36). The point type was named for a single specimen recovered from the Peace Camp site in Broward County (Mowers and Williams 1972:17, Figure 5c). Bullen (1975:4) attributes the Broward point to the Weeden Island period, sometime around AD 200 to 1200. Powell (1990:43) places them in a Middle Woodland context.
Two bifaces classified as Citrus points were identified. Both came from the artifacts found by CRASP staff after the Storm of the Century and neither comes from a secure recovery context. Specimen #14 and #18 both display a basally-notched “rocker” base, the characteristic that separates the Citrus point from the similar and more common Hernando point. Both specimens display critical transverse fractures and attempts were made to modify both implements after they had been fractured. Specimen #14 is made from a thermally altered silicified coral (Figure 7.4). Specimen #18 is made from a thermally altered Suwannee Formation chert. While no use-wear was seen on Specimen #18, the lateral margins of Specimen #14 still display evidence of use as a cutting/slicing tool.

Figure 7.3. Image of Specimen # 15, Broward point base.

Citrus points
Table 7.9: Hafted Biface Attribute Data.

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<th>Artifact Subtype</th>
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<th>Width</th>
<th>Length</th>
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<td>Alachua-like</td>
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<td>-</td>
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<td>Taylor</td>
<td>-</td>
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<td>99306-2</td>
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<td>Preform (?)</td>
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<td>1.27</td>
<td>8.45</td>
<td>Cutting</td>
<td>Siderastrea (genus)</td>
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Table 7.10: Hafted Biface Functional and Raw Material Provenience Data (cont).

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<th>Artifact Number</th>
<th>Artifact Type</th>
<th>Thinning Index</th>
<th>Planview Area</th>
<th>Functional Classification</th>
<th>Quarry Cluster</th>
<th>HRI index</th>
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<td>0.86</td>
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<td>23.8</td>
<td>none obs</td>
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<tr>
<td>87-96-1-16</td>
<td>Tampa-like</td>
<td>1.29</td>
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<td>cutting</td>
<td>West Lk Panasoffkee</td>
<td>0.84</td>
</tr>
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<td>99287-1</td>
<td>Taylor</td>
<td>1.5</td>
<td>8.78</td>
<td>cutting/slicing</td>
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<td>1.58</td>
<td>18.45</td>
<td>cutting/slicing</td>
<td>Brooksville</td>
<td>0.63</td>
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</table>
This artifact also displays a large flake scar originating at the transverse fracture and extending down the midsection of the dorsal face. Although it resembles an impact fracture, this scar is appears to be the result of an attempt to remove the flat fracture surface and modify the edge into a working surface. The attempt to re-work Specimen #18 had progressed further. The lateral margin was completely reworked before the artifact fractured again along a chalcedony-lined void in the middle of the tool, breaking it into two parts. This second fracture significantly reduced the further resharpening options for this artifact.

Figure 7.4. Image of Specimen #14, Citrus point base.
Citrus points are common in central Florida. Bullen (1975:25) considered the Citrus to be the knife form of the basally-notched point complex that included both the Citrus and Hernando varieties. Based on his excavations in the Cove of the Withlacoochee (Bullen and Askew 1965; Bullen and Bullen 1953) Bullen associated this biface type with the Florida Transitional period, a timeframe between the end of the Florida Archaic and early Woodland times (ca. 1200 – 500 BC). At the Askew site, Bullen and Askew (1965:214) associated Citrus points with the “Perico Period,” a post-Deptford and pre-Weeden Island chronological construct associated with limestone-tempered Perico (now Pasco) pottery. Similar artifacts recovered from the Battery Point site (Bullen and Bullen 1953, 1954) and Wash Island site (Bullen and Bullen 1963:90) in what appears to be a similar stratigraphic context.

Columbia points

A single specimen classified as a Columbia point was recovered in 1960 along the main access road along side Mound G (stone mound). This tool was collected by Bullen from an area along the roadway where displaced shell from the bulldozer cut through Mound G (Weisman 1995:37). This point is made from unaltered silicified limestone from the Suwannee Formation. Although the blade has been broken-off roughly midway along, enough of the blade margins remain to determine the tool’s use as a cutting implement. Modification and wear from hafting was also apparent. A wide stem and weak shoulders are the defining characteristics of this point type. Bullen (1975:19) states that Columbia points were hafted as knives or daggers. The use-wear observed on this specimen supports this contention. The Columbia point is chronologically associated
with the Weeden Island period (AD 200-1250) along Florida’s west coast (Powell 1990:45); similar forms are associated with similar contexts in other portions of the northeast United States and central Ohio Valley (Justice 1987:214).

Duval points

Seven (7) bifaces were identified that were Duval or Duval-like points. Two were identified as subtype 1; one as subtype 2; and three as subtype 3 (Bullen 1975:13). The subtype classification of one point is problematic. Two of the specimens (99946-1 and 98925-1) were removed from the FLMNH collections by Bullen and are now at the

Figure 7.5. Image of 02A-292-2-14, Duval point. Artifact loan courtesy of the Bureau of Archaeological Research, Division of Historical Resources, Florida Department of State.
CRASP Museum. The metric data from these specimens was acquired from outline drawings made by Bullen and found in the files at the FLMNH. Two of the specimens recovered from the seawall replacement project (Ellis 1998) had been miss-classified as Pinellas points. All seven points are made from unaltered silicified limestone. All except one (02A-292-1-23) were made from Suwannee Formation chert. Artifact 02A-292-1-23 was made from an Ocala Limestone chert originating in the Ocala quarry cluster.

Three specimens display distal fractures. Two of these fractures have been identified as impact-related and the specimens have been classified as projectile tips. One specimen (02A-292-1-14) displays several small distal fractures and an extensive dull polish extending down approximately five cm from the tip (Figure 7.5). This damage indicates use as a drill or perforating tool on a relative hard material like bone or antler (Semenov 1964; Vaughan 1985).

Bullen (1995:13) attributes Duval points to the Weeden Island period, although recognized that they had also been recovered in earlier Deptford and Swift Creek components (Milanich 1994:127). Duval points are morphologically similar to Mountain Fork and Bradley Spike points of Alabama and the adjoining regions (Cambron and Hulse 1975; Powell 1990) and throughout much of the greater Southeastern U.S. (Bense 1994:140).

**Florida Copena points**

A single specimen classified as a Florida Copena point (02A.292.2.13) was recovered at the Crystal River site during the seawall restoration project (Ellis 1998). This fairly crudely-chipped point has no critical fractures or observable use-wear, but it
has been extensively resharpened. It is made from a dark gray/black Hawthorn Group (Coosawhatchie Formation) chert that does not appear to have been thermally altered (Figure 7.6). Florida Copena points are part of an extended triangular point complex that includes the Santa Fe and Tallahassee varieties, although the Copena points are almost always less-well made (Bullen 1995:23; Powell 1990:380). Florida Copena points are often found with Deptford ceramics (Bullen 1969; Milanich 1973:60).

Tampa-like points

A single Tampa-like point was recovered in level 1 (0-20 cmbs) of Weisman’s 1985 510N/498E excavation unit. The specimen came from the column sample portion
of the excavation. The specimen is bifacially chipped with a biconvex cross section. It is considered Tampa-like due to its somewhat irregular shape. The left lateral margin extends out from the base, giving the specimen an asymmetrical plan view. Flake scars along this edge suggest that an attempt was made to remove this feature without any success. The artifact is made from an unaltered Ocala Formation chert that contains both fossils and rock fabric indicative of stone outcrops in the West Lake Panasoffkee quarry cluster. Flake scarring and extensive polish along the right lateral margin indicates use in activities involving cutting and slicing tasks. The irregular shape of the base may have facilitated the use of the artifact as a hafted knife. Tampa points are typically associated with Late Woodland – Mississippian occupations and are often found at sites that post-date AD 1000 (Bullen 1975:10; Powell 1990:49).

Jackson points

A Jackson point (98896-1) was recovered by Bullen 1964 from Test 2 at 18-24 inches (45-60 cm) below surface (Figure 7.7). This Suwannee Formation chert point is weakly side-notched and has a slightly convex base, typical of the Jackson variety (Bullen 1975:21; Powell 1990:46). This specimen displays no edge-damage or polish, but does have a significant impact-related dorsal fracture. Jackson points are often recovered from Deptford and early Swift Creek contexts in central Florida (Bullen 1950, 1958; Bullen et al. 1974:64-65).
Lafayette-like points

The base and mid-section of a Lafayette-like point (Specimen #11) was recovered among the artifacts discovered in the Crystal River Trailer Park after the 1993 Storm of the Century (Figure 7.8). This corner-notched Suwannee Limestone specimen retains portions a relict transverse fracture. Considerable efforts were made trying to remove this fracture and rework the artifact into a more useable form. Flake scars from the modification attempt obscured the edge damage along both margins and removed most, but not all, of the transverse fracture. It is suspected that the attempt to modify this tool was attempted while the artifact was still hafted as the haft element and lower blade
margins are unaffected by the resharpening effort. Lafayette points are often considered a late Archaic – early Woodland variant. Powell (1990:35) assigns them to a late Archaic context, as does Bullen (1975:6). Bullen (1975:26) also associates them with St. Johns Incised pottery at the Zamski site (Atkins and MacMahan 1967).

Figure 7.8. Image of Specimen #11, Lafayette-like point.

Pinellas points

Six Pinellas points have been recovered from the Crystal River site. Five were found among the artifacts recovered from the Crystal River Trailer Park after the 1993 storm. One was recovered by Bullen in 1965 from Feature C (98945-1). The specimen recovered by Bullen was loaned to the CRASP Museum for display, so no metric data
were available for it. Of the five available points, one was classified as a subtype 1, three as subtype 2, and one as subtype 3. All display some kind of distal or transverse fracture, although none is obviously impact-related (Figure 7.9). One point (Specimen #24) shows extensive distal modification in addition to a distal fracture. This point may have been modified and used as a drill or perforating tool, although there is no use-wear or edge damage to confirm this assertion. The remainder could certainly have been used to tip projectiles. Most of the points are made from Suwannee Formation chert flakes. One is made from silicified coral, and one is made from a Coosawhatchie Formation chert.

Figure 7.9. Image of Specimen #22, Pinellas point.
Pinellas points are small triangular points often made by pressure-flaking chipping debris. They are considered the Florida variant of the Mississippian triangular point, and are identical to Madison, Hamilton, and similar points found throughout the eastern U.S. (Bullen 1975; Cambron and Hulse 1975; Powell 1993; McGahey 2000; Whatley 2002). Use of small triangular points began sometime during Late Woodland times and continued though the Historic Period (Blitz 1988; Justice 1987:224-230). Milanich (1978:165; 1994:232) has identified several small triangular points similar in shape, but larger in size, to later Mississippian triangular points have been recovered from various Cades Pond site (AD 200-800) in central Florida. The remainder of the Cades Pond lithic assemblage (Milanich 1978:159) bears a striking resemblance to the Crystal River site.

Santa Fe points

Two Santa Fe points were recovered at the Crystal River site. Both came from the materials collected from the Crystal River Trailer Park after the Storm of the Century clean-up (Specimens #16 and #21). Both were made from Suwannee Formation cherts and both display critical transverse fractures. The fracture on Specimen #21 lies closer to the tip and appears to have been impact-related. Specimen #16 is more finely crafted and shows some indication of resharpening but no evidence of use-wear along the margins or of having an impact-related fracture (Figure 7.10).

Due to their relatively long and narrow blade margins and incurvate basal modifications, Santa Fe points, and their morphologically equivalent but serrated Tallahassee points, were associated with late Paleoindian assemblages like the Beaver
Lake and Dalton varieties. The recovery of Santa Fe and Tallahassee points in ceramic contexts, especially with fiber-tempered pottery, was suggested by Powell (1990:36). It was verified in Florida and specifically within the Gulf Hammock region by Mikell (1996) and in the Panhandle (Mikell 1997). Although Justice (1987:44) still attributes this point complex to an earlier late Paleoindian/Dalton context, many analysts now accept a Late Archaic and Early Woodland association for these points.

![Figure 7.10. Image of Specimen #16, Santa Fe point base.](image)

**Stemmed points**

Eleven specimens were recovered that have been classified as stemmed points. However, because the chronological assignment of these points remains in question, they
will simply be classified in the nominal classification of stemmed points. Most, if not all
of these points, fit within Bullen’s (1995) classification of “Florida Archaic Stemmed”
points. Following Bullen’s typology, five specimens can be categorized as Marion
subtypes, one as a Marion/Newnan subtype, two Levy-like subtypes, and one Alachua-
like subtype. One biface (95A.022.10.1) did not fit into Bullen’s categories because the
base had been reworked into a short nub stem. The eleventh specimen is a diminutive
stemmed variety now known as a Weeden Island point (Powell 1990:46). The use of
thermal alteration is relatively rare in this group of points. Only two could be positively
identified as having been thermally altered; another shows some indication of heat-
treatment, but cannot be positively classified as having been thermally altered. Every
specimen displays some form of use-related fracture (Figure 7.11). Five display
transverse fractures, two impact fractures, two display haft snaps, and two others have
distal tip fractures that appear to use use-related.

Six of these eleven artifacts were made from Suwannee Formation cherts and
appear to come from outcrops in the Brooksville/New Coastal quarry cluster. Two
artifacts were made from silicified Ocala Limestone. Specimen #17 is a nearly complete
point with a distal impact fracture. It is made from chert originating in the Ocala quarry
cluster. Artifact 98940-1 is a nearly complete point recovered by Bullen during a
dredging project at river’s edge (Figure 7.12). The fossil size distribution and rock fabric
indicate that the chert came from the West Lake Panasoffkee quarry cluster. Two
artifacts are made from chert from the Hillsborough River quarry cluster. The midsection
of a hafted biface recovered in the backdirt of the Double Sand Mound by Bullen in 1960
is a Type 5 or Bay-Bottom chert (Goodyear et al. 1983; Estabrook and Williams 1992).
This material is most commonly found in and around Tampa Bay, but can also be found in certain outcrops in the Ocala and Gainesville quarry clusters (Endonino 2007:88) associated with residual cherts from the Coosawhatchie Formation of the Hawthorn Group. A single silicified coral point (99309-1) was recovered by Bullen in 1951. The artifact was flaked with the grain of the coral polyps rather than against grain, making the boundstone fabric difficult to recognize.

These eleven bifaces were employed in a limited number of tasks. Five display edge damage and polishes indicative of use as cutting tools. Two additional specimens display both evidence of use in cutting activities and impact fractures. In both cases of duel use tools, it appears that the use as a cutting tool occurred prior to use as a projectile.
as the use-wear ends abruptly at the scars from the impact. A careful inspection was made of all the transverse breaks to check for possible modification into hafted end-scrapers (Purdy and Beach 1980:110) or expedient use as a scraping tool (Estabrook 1986: 179), but no such damage could be identified.

Figure 7.12. Image of 98940-1, stemmed point. Collections of the Anthropology Division of the Florida Museum of Natural History, FLMNH Acc. No. 98940.

Stemmed bifaces of the Florida Archaic Stemmed (FAS) variety are frequently recovered from Woodland period and later sites. Most researchers attribute these tools to scavenging behavior. Woodland peoples would find earlier points during their travels or even sought out older sites to acquire still serviceable stone implements which they
would rework and modify to suit the task at hand (Purdy 1981:47). Bullen (1975:3) attributes FAS occurrences at later sites as “holdovers” and attributes the specialized forms of this biface, the highly stylized Hillsborough and Newnan forms and the persistence of smaller, diminutive varieties. These diminutive types have now been reclassified as a separate type called Weeden Island points (Powell 1990:46).

**Taylor points**

A single Taylor point was recovered from Bullen’s 1951 Test 1 in Midden B. This artifact was recovered at 16-20 inches (40-50 cmbs). This specimen is made from a Suwannee Formation chert that was not thermally altered. This artifact has no critical break or fatal use-related fracture, but it has been extensively resharpened (Figure 7.13). All edge damage with the exception of a small area of hafting damage along the left shoulder has been removed by the pressure-flaking modification. Use-wear was evident as an extensive bright, pitted polish along the major flake ridges of the interior portions of both the ventral and dorsal tool aspects. This damage indicates use as a cutting/slicing tool on wood (Keeley 1980: 35; Vaughan 1985:34). Neill (1963:102) originally defined the Taylor point from specimens he had recovered from a series of site along U.S. Highway 98 in Taylor County. Based on their morphology and evidence of basal grinding, Neill attributed Taylor points as a stylistic bridge between late Paleoindian Suwannee points and Early Archaic Bolen points (Neill 1963:104). Bullen’s definition of Taylor points (1975:20) omits the basal grinding attribute and reassigns the point to a Deptford-Swift Creek timeframe (Powell 1990:42).
Three artifacts have been classified as ovate bifaces. All three were recovered by Bullen in the lower levels of his Test 2 excavation (Bullen 1953: Figure 12.4, bottom row). The first two specimens (99306-2 and 99306-3) were found between 36 to 40 inches (.91-1.01 m); the third (99313-2) was found between 72 and 78 inches (1.83-1.98 m) below surface. Bullen describes them as lanceolate-shaped knives. Edge damage indicative of cutting was observed on two of the specimens (99306-3 and 99313-2) but not the third. Relatively bright polishes were also observed on both specimens, particularly along the arrises of the blade interiors and along the right lateral margins. Morphologically, these specimens resemble performs, the unfinished and often unutilized
forms from which other tools especially hafted bifaces were made. In this case these implements were used as cutting tools and then abandoned in Midden B. Ovate bifaces are considered a relatively common tool form at Woodland period sites, but their form is not temporally diagnostic. Similar forms are recovered from sites throughout central Florida.

**Clarence B. Moore Collection**

During his three visits to the Crystal River site, C.B. Moore assembled a sizeable collection of artifacts. Few, however, were made from chipped stone. In 1903, Moore reported recovering 31 “lance-points, arrowheads, and knives” all made from chert and many recovered in association with other burial objects. In addition, he also recovered various hammerstones, chert “masses” (possibly cores) and something he called a “waster” of chert (Moore 1903:397). Another fifteen (15) bifaces were recovered upon his return in 1906 (Moore 1907:419). During his final visit to the site in 1918, he reported the recovery of only a single flint arrowhead in association with one of the few intact burials he uncovered in Feature C. Out of the 47 bifaces Moore recovered and reported, nineteen (19) are now in the collections of the Smithsonian Institution’s National Museum of the American Indian. Moore kept none of the other chert artifacts except for some chert pendants. All others were evidently discarded. Moore’s collection at the National Museum of the American Indian was not available for study at this time, but images of 12 of the 19 specimens were available and are discussed below (Figures 7.14, 7.15, and 7.16). From the photographs, point type, basic metric data (length and
width), material type, and an evaluation of the use of thermal alteration could be made. These data are provided in Table 7.11.

These artifacts mirror the point types recovered from the rest of the site with a few significant differences. The Florida Adena point (Figure 7.14) is made from what appears to be a non-local perhaps even a non-coastal plain type chert. A large lancolate point was recovered that specifically resembles a Suwannee point, a common Paleoindian point type. Several of the points are nearly identical to specimens recovered from other

Figure 7.14. Moore’s Mound F/E bifaces (Catalog # 171631). Image adapted from the National Museum of the American Indian, Smithsonian Institution, Collection Report, dated 14 July 2010.
Table 7.11. Moore’s Hafted Biface Recovery - Attribute Data.

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Artifact Number</th>
<th>Point Type</th>
<th>Material</th>
<th>Thermal Alteration</th>
<th>Length</th>
<th>Width</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>082056</td>
<td>1</td>
<td>Columbia</td>
<td>Coastal plain chert</td>
<td>No</td>
<td>6.1</td>
<td>2.3</td>
<td>Basal fracture</td>
</tr>
<tr>
<td>082056</td>
<td>2</td>
<td>Jack’s Reef Crn-notched</td>
<td>Coastal plain chert</td>
<td>No</td>
<td>3.7</td>
<td>1.6</td>
<td>Basal fracture</td>
</tr>
<tr>
<td>082276</td>
<td>3</td>
<td>Florida Copena</td>
<td>Poss. Suwanee</td>
<td>No</td>
<td>4.5</td>
<td>2.3</td>
<td>Articulate tip</td>
</tr>
<tr>
<td>171631</td>
<td>4</td>
<td>Stemmed Point</td>
<td>Coastal plain chert</td>
<td>Yes</td>
<td>13.0</td>
<td>4.2</td>
<td>Newnan</td>
</tr>
<tr>
<td>171631</td>
<td>5</td>
<td>Taylor</td>
<td>Coastal plain chert</td>
<td>Ind</td>
<td>4.8</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>171631</td>
<td>6</td>
<td>Stemmed Point</td>
<td>Coastal plain chert</td>
<td>Ind</td>
<td>9.7</td>
<td>5.1</td>
<td>Marion</td>
</tr>
<tr>
<td>171631</td>
<td>7</td>
<td>Florida Adena</td>
<td>Undetermined</td>
<td>No</td>
<td>10.3</td>
<td>4.8</td>
<td>Not coastal pln chert</td>
</tr>
<tr>
<td>171631</td>
<td>8</td>
<td>Lanceolate Point</td>
<td>Coastal plain chert</td>
<td>No</td>
<td>14.5</td>
<td>4.4</td>
<td>Basal fracture</td>
</tr>
<tr>
<td>171631</td>
<td>9</td>
<td>Stemmed Point</td>
<td>Poss. silicified coral</td>
<td>No</td>
<td>11.5</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>171631</td>
<td>10</td>
<td>Stemmed Point</td>
<td>Coastal plain chert</td>
<td>Yes</td>
<td>6.7</td>
<td>4.0</td>
<td>Basal fracture</td>
</tr>
<tr>
<td>171631</td>
<td>11</td>
<td>Stemmed Point</td>
<td>Coastal plain chert</td>
<td>Yes</td>
<td>9.1</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>171631</td>
<td>12</td>
<td>Duval/Florida Spike</td>
<td>Coastal plain chert</td>
<td>No</td>
<td>4.7</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>
contexts within the site, but especially like those recovered from Midden B. These include the Columbia, the Taylor, the Florida Copena, and the Duval-like/Florida Spike points. These biface types were used as various cutting tools and projectile tips by the site’s inhabitants. Even several of the specimens recovered by Moore from Mounds E/F and Feature C show some indication of resharpening, basal fractures, and acuminate tips that are often found on specimens that were used in more day-to-day kinds of activities. None appears to have been made expressly for interment in the Central Burial Complex.

Two of the points, the Jack’s Reef Corner-Notched point and the Florida Adena point are types that are not often found in Florida. The Jack’s Reef point is more commonly found in the Ohio Valley, Great Lakes, and northeastern United States (Justice 1987:219; Richie 1961:26-27), but is also known from sites in the Southeast (Cambron and Hulse 1983:68). Richie (1961:26) attributes them to a later Middle Woodland to Late Woodland timeframe, but notes their association with burial within the Mound City Hopewell group in Ohio.

Florida Adena points (Bullen 1975:22) are defined as an ovate point with the stem slightly narrower than the blade. They are often made from materials not found in Florida. The specimen shown in Figure 7.14 shows banding and coloration more typical of banded cherts found in the lower Midwest (Ray 2007; DeRegnaucourt and Georgiady 1998). Bullen (1975: 22) attributes Florida Adena points to contact with the Early Woodland Adena cultures of the Ohio River Valley. Justice (1987:192) attributes these points from sites dating from 800 to 300-200 BC and associates them with other Adena complex artifacts like celts, gorgets, and other ceremonial grave offerings.
The most extensive collection of bifaces is classified as stemmed points; most if not all would have been attributed to Bullen’s Florida Archaic Stemmed classification (Bullen 1975:32). All appear to be well-made, often using what appears to be a thermally-altered coastal plain chert. One specimen (Figure 7.14) appears to have been made from either of rather grainy *Siderastrea* genus coral or even a Tallahatta quartzite. All of the stemmed varieties are complete and three are clearly thermally altered. None appear to be extensively resharpened or reworked.

The most intriguing point in the collection is the large lanceolate point that resembles a Suwannee point (Bullen 1975:55). This well-flaked point is made from a
fossiliferous white chert. It appears to have a minor basal fracture and a blunted or reworked tip. It appears to be too well made and overly long to have been a Florida Copena (Bullen 1975:23; Powell 1990:42). Because of the color, it is not possible to evaluate any degree of patination or cortication on this specimen. This specimen could be a Paleoindian point that was salvaged from a nearby site, as there are many such sites in the region.

Moore makes several comments in his writings that reflect on the use of chert at the Crystal River site. His thoughts also provide some possible insights as to why not all of the bifaces made it to the Smithsonian collections. Moore (1903:397) states that chert

Figure 7.16. Moore’s Mound F/E biface (Catalog # 082278). Image adapted from the National Museum of the American Indian, Smithsonian Institution, Collection Report, dated 14 July 2010.
hammerstones, flakes, chipped masses of chert (possible cores), and various other chipped stone fragments were found during his investigation. Many of these items were not collected. This indicates that there was a much larger chipped stone artifact component at the site than Moore’s selective collection indicates. Moore (1907:419) also describes many of the points as having “rude” workmanship indicating that they were poorly executed, broken, or extensively resharpened. Moore also describes the workmanship of a few points as excellent, suggesting that the better executed points were retained and less-aesthetically pleasing points were not. Moore was, after all, looking for specimens for his collections and for the collections of museums in the Northeast. Moore (1907:419) describes two non-chert bifaces in the assemblage: one made from quartzite, the other from chalcedony. These many indicate the two points above, the Florida Adena and the coral/quartzite stemmed point may be these specimens.

While many of the points Moore found appear to have been recovered either in direct association with burials or among the material culture interred with the dead, Moore only specifically discusses the recovery of bifaces with two burials. During his 1903 investigation he discovered several broken bifaces that he states were “ceremonially broken.” Three “lance-heads” made from brown chert each broken into two parts and with both parts being interred with the burial. Moore (1903:397) attributes this to a ritual breaking of the points, analogous to the ritual “killing” of pottery by punching a hole in the bottoms of the pots. Moore also mentions fourteen celts that were also found that had been broken in a similar way. During his later work Moore (1907:419) reports finding five lanceheads with a single burial, four chert points and one made from chalcedony. He describes several of these points as being “beautifully wrought” with one being finally
pointed and barbed. From these two contexts, Moore suggests that hafted bifaces, particularly well-made and astatically attractive ones, were part of the burial items interred with specific individuals in the central burial mound complex.

**Use of Thermal Alteration**

As the analysis of waste flake assemblage indicated, thermal alteration, or the intentional heat-treatment of chert, is uncommon in the chipped stone assemblage from Crystal River. As the totals in Table 7.12 indicate, only eight of 51 hafted bifaces, six utilized/modified flakes, one biface fragment, and one implement from the Other Tools category displayed the color change and increased luster of thermally altered chert. This low occurrence of thermal alteration can be seen across all tool categories and across all material types. Chert from the nearby Brooksville quarry cluster was no more likely to have been heat-treated than materials from the outer edges of the 50 km study area defined for this investigation or even cherts from as far away as Tampa Bay. The typical dichotomy between thermally-altered chert and thermally altered silicified coral (i.e., Estabrook 1986) is not apparent in this assemblage.

An inspection of the use of thermal alteration by hafted biface type (Table 7.8) does not suggest that a particular point type or hafted biface style was more commonly made with heat-treated materials than with non-altered cherts. Of the eleven points classified as stemmed points, but more commonly known as Florida Archaic Stemmed points (Bullen 1975), only two specimens appear to have been made from heat-treated materials and a third could have been made from heat-altered material. Had these points
Table 7.12. Thermal Alteration by Quarry Cluster and Artifact Category

<table>
<thead>
<tr>
<th>Quarry Cluster</th>
<th>Hafted Bifaces*</th>
<th>Biface Fragments</th>
<th>Utilized/Modified flakes</th>
<th>Other Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TA</td>
<td>NTA</td>
<td>Ind</td>
<td>TA</td>
</tr>
<tr>
<td>Brooksville</td>
<td>4</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ocala</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Et Lake Panasoffkee</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wt Lake Panasoffkee</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hillsborough River</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coosawhatchie Fm</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Siderastrea</em> (genus)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>Goniopora</em> (genus)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Undetermined</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>8</td>
<td>36</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

* Includes the 12 points identified in the Smithsonian Institution Museum of the American Indian Collections.
been made during the Archaic period, this subset of points should have displayed a much
greater incidence of heat-altered cherts (i.e., Ste. Claire 1987:204). Nor is there any
indication that the particular cherts selected to make these tools were of a higher quality
of chert. Although comparatively free of voids and large inclusions, none of the chert
used to make the stemmed points appears to be on any higher quality than that used to
make the other chipped stone tools.

These data support the contention that use of thermal alteration as a technique
decayed during the post-Archaic periods in central Florida even as the use of local raw
materials increased (Austin and Estabrook 2000:126-129). These data also suggest that
thermal alteration, although a fairly easy way to modify stone to make tools with sharper
edges, was not always performed even in cases, like at Crystal River, where activities
involving cutting and slicing of various materials were regularly performed.

**Hafted Biface Retouch Index (HRI)**

Hafted biface retouch index (HRI) values (Andrefsky 2006, 2008a, 2008b) were
calculated for all hafted bifaces that were available for study and that retained a sufficient
portion of the blade margins to allow for measurement. Thirty-one hafted bifaces were
included in this portion of the analysis. The HRI is a measure of retouch along the lateral
margins of hafted bifaces. The index is scaled to allow for partial blade margins and is
standardized from zero to one, with “0” indicating no marginal retouch and “1” indicating
complete marginal retouch. The raw HRI values are provided in Table 7.9.

As shown in the boxplot of the HRI values in Figure 7.17, hafted bifaces made
from chert from the Hillsborough River quarry cluster, Ocala quarry cluster, the West
Lake Panasoffkee quarry cluster, and materials assigned to the Coosawhatchie Formation, have the highest average HRI values. The groups also display the smallest range of HRI values. This indicates that hafted bifaces made from cherts from these quarry clusters were retouched and resharpened more intensively that were bifaces made from Brooksville quarry cluster cherts. Only two bifaces contribute to the silicified coral (*Siderastrea*) category. One has a relatively high HRI value (0.95) and the other a low value (0.41); however the average HRI for coral artifacts is just below that of artifacts made from Brooksville quarry cluster cherts.

![Boxplot of Hafted Biface Retouch Index](image)

Figure 7.17. Box Plot of the Hafted Biface Retouch Index values.

Andrefsky (2008b:208) attributes high HRI values and the use of non-local quarries to extended foraging trips away from residential locations. The idea goes
that hafted bifaces used on foraging trips further away from a residential location will be used for longer periods and resharpened a greater number of times than those used more local foraging trips. Hafted bifaces used on local foraging trips will be returned to the local residential location for refurbishment or replacement with locally-available cherts. The debitage analysis and tool classification suggest a slightly different scenario for the Crystal River site.

The HRI values indicate, as Andrefsky suggests, that both high values and use of non-local chert sources are reflected in the chipped stone assemblage at Crystal River. But rather than this being the result of extended foraging trips away from the site by the site’s inhabitants, it might well be the result of people residing on the edge or outside the 50 km study area bringing hafted bifaces made of chert that are local to their residential locations to Crystal River. Having been resharpened or broken on the journey, these hafted bifaces should have been replaced at Crystal River with local chert (Brooksville or New Coastal quarry cluster materials) and the worn-out or broken tool discarded at the site. This pattern would result in the high HRI values, the broken and discarded tools made from non-local cherts, and the relatively low waste flake counts for non-local stone. These individuals may have come to the Crystal River site to trade, attend religious ceremonies, fulfill various social obligations, feast, or any a numbers of different reasons. When they came, they brought their tools with them, and they no doubt resharpened and refurbished them along the way.
Functional Analysis

Both low and high-power use-wear techniques were used to identify edge and surface damage on the available stone tool assemblage from Crystal River. Although these techniques can assist in the determination of tool use, they only provide indications of the kinds of activities, for example, scraping, drilling or graving, on which that tool was the last used and in some instances the kind of material it was used to work on. It cannot indicate whether the scraping activity was involved with the manufacture of a ceremonial mask, the shaft of an atlatl dart, or a child’s toy.

The stone tools at the Crystal River site were used in a variety of cutting, cutting slicing, scraping, drilling and hammer/pounding activities. They were also used as tips for various kinds of projectiles. A summary of uses identified on the artifact categories in provided in Table 7.13. Cutting and slicing activities, especially employing utilized flakes is one of the major tool uses at the site. Damage from scraping and use as projectile tips are the next most common activation observed. Activities involving pounding and drilling are much less common in the assemblage. Each of these activities will be discussed below.

Table 7.13. Tool function by artifact category

<table>
<thead>
<tr>
<th></th>
<th>Cutting</th>
<th>Scraping</th>
<th>Hammer/Pounding</th>
<th>Drill/Gravers</th>
<th>Projectile Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilized Flakes</td>
<td>30</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Biface Fragmts</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Other Tools</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Hafted Bifaces</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Totals</td>
<td>53</td>
<td>13</td>
<td>5</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>
Tasks involving cutting and slicing relied heavily on various flake and hafted stone tools. For the flake tools, use was likely for a single activity, with the tool being discarded after the task was completed. Few of the utilized flakes appear to have been worn-out during the use. Most appear to have been still functional as cutting tools when they were discarded. The bifacially flaked tools, especially hafted bifaces, were used more intensively. Many display evidence of multiple uses. Some appear to have been used, resharpened, and used again, while others were used as cutting implements and then later as projectile tips. There is also evidence of attempts to refurbish broken tools.

Scraping activities were the second highest in occurrence, but relatively minor in intensity. This activity was performed with unmodified flake tools that appear to have had an edge suitable for the task. Scraping tasks appear to have been limited to a few low-intensity activities. Few flake show extensive damage indicative of this action and the areas of scraping damage on those artifacts were relatively small. Flakes selected for these tasks were not large, indicating that the objects on which they were used were also small. No use-wear evidence indicative of large-scale woodworking, like adzing or chopping, was noted on any of the stone artifacts.

Hammerstones and pounding tools were small and in many cases display only the most minor evidence of use. The intensive surface pecking and deformation often observed on hammerstones was only seen on a single specimen. While it can be suggested that these small implements were used to produce flakes tool from the small cores found at the site, they might also have been employed in any number of pounding or hammering activities.
Drilling and graving functions were identified only on formal tools; none were noted on any of the flake tools. This includes one specimen with basal modifications as a drill/perforator, but with the distal, or working broken-off, the edge of a biface modified as a drill/graver, and the tip of a Duval point used in a rotary or drilling motion. There was no indication of a microtool or microlith tool assemblage at this site (e.g., White and Estabrook 1994). The graver/drill made from the edge of a broken biface is the opportunistic use of what would have otherwise been a discarded biface fragment. One end of the tool was reworked into a drill tip while the other was left in the roughly triangular shape of the biface edge and used as a graving tool.

Ten of the 39 hafted bifaces analyzed in this study display evidence of an impact or impact-related distal fracture. This number would be higher if the specimens displaying a haft snap were included in this total. There were also two biface fragments that display impact-related damage at what would have been the distal tip. Both have been classified as impact-related fractures. Some of the bifaces with impact fractures also display use-wear or evidence of resharpening along the lateral margins indicating multiple uses for many of the hafted tools.

A cross-tabulation of tool function by quarry cluster is provided in Table 7.14. Most of the tools, including the flake tools and hafted bifaces, are made from cherts that originate in the Brooksville quarry cluster. These materials may also include cherts coming from many of the coastal quarries identified in the New Coastal quarry cluster as well. Tools used for cutting, scraping, hammering (pounding) and as drill/gravers appear to have been made on a variety of materials without regard to the quarry of origin. There does not appear to be any intentional selection of material from a particular geographical
area to make the majority of the single-use flake tools or extended-use hafted tools used for most site activities. The exception to this is the tools identified with impact-related fractures. While seven of the 12 projectile tip specimens do come from the Brooksville quarry cluster, five specimens are made from chert and silicified coral that originated either in the outer reaches of the 50 km study area or outside of the study area altogether.

Table 7.14. Tool Function by Quarry Cluster

<table>
<thead>
<tr>
<th>Quarry Cluster</th>
<th>Cutting</th>
<th>Scraping</th>
<th>Hammer/Pounder</th>
<th>Drill/Gravers</th>
<th>Projectile Tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooksville</td>
<td>38</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Ocala</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>East Lake Panasoffkee</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>West Lake Panasoffkee</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
<td><em>Siderastrea</em> (genus)</td>
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<tr>
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<td>5</td>
<td>4</td>
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</table>

The biface to flake tool count ratio for the Crystal River site is 1.32 (61:46) which is very close to the value reported from the Kolomoki site in southern Georgia (Pluckhahn 2003). When compared to the values derived from similar sites in the Southeast (Table 3.1) Crystal River has a comparable ratio (1.22) to the McKeithen Weeden Island site (Milanich et al. 1984) and the Pineland Complex (1.14) (Austin 1995b). These findings support the contention that bifacial tools formed an important component of the overall stone tool assemblages at Woodland sites.

In summary, the analysis of the available chipped stone tools from the Crystal River site provided numerous insights in the *chaîne opératoire* for toolstone procurement.
and tool use at this important mound complex. As most of the materials recovered thus far from the site come from Midden B and the relocated mound fill from Mound A, most of the observations focus on the site activities reflected in the midden material that provided much of the material from which the rest of the mounds within the complex were constructed.

The waste flake and utilized/modified flake assemblages appear to be similar, despite the above noted differences in the Flake Fragment and Debris categories. It is likely that the utilized and modified flakes found at the site are a subset of the overall waste flake assemblage. The utilized flakes appear to have been selected out from the larger waste flakes produced during biface manufacturing or were struck from cores specifically as flake tools. The waste flake attribute study indicates that both activities were undertaken at the site.

The analysis showed no indication of selective use of knappable stone for the various quarry clusters within the region for flake tools. The utilized/modified flake assemblage reflects the same distribution of quarry locations as does the waste flake assemblage. It is possible that larger flakes of a size suitable for use as tools could have been collected during a visit to a quarry location and brought back for later use. This practice, if it was employed at all, was not done frequently enough to alter the ratio of large flakes to smaller ones.

Overall, the waste flake analysis indicates that core reduction and biface manufacturing were both being performed at the site. Raw materials were being brought to the site in well-reduced form; no large cores, early stage biface manufacture failures, or other evidence for extensive lithic reduction activities was noted. Lithic production
involved small flake cores, the reduction of late-stage bifaces, and the refurbishment of existing hafted bifaces. And despite the plethora of shell artifacts like shell beads, gorgets, pendants, plummets, and other objects recovered from the site, no microliths or microtools were identified in the assemblage. These shell items were evidently made elsewhere and brought to the site in finished form.

Use of thermal alteration was identified in both the waste flake and formed tool assemblages, but at relatively low levels. There is no indication the use of this technique was used to enhance the quality of any of the various kinds of chert found in the immediate site vicinity. The incidence of thermal alteration within the hafted biface assemblage was equally low.

The HRI values and the distribution of impact-related fractures on hafted bifaces made from cherts that originate on the margins of the 50 km study area or from regions outside this area suggest that some of the hafted bifaces recovered from the site follow a different operational sequence than those made from locally-quarries cherts. Points made from local cherts appear to follow an operation sequence similar to the other tools used at the site. Extensive resharpening values, impact fractures, and the use of non-local raw materials seen in a significant portion of the hafted biface assemblage indicates that these implements followed an alternate operational sequence. The people who made these bifaces brought them from sites in the Marion Uplands and the Tampa Bay area. After hafting them as atlatl dart tips or hafted knives, these individuals used, resharpened and refurbished these tools during their travels to the Crystal River site. These tools were used to dispatch animals which were perhaps brought along as food or tribute. Once at
Crystal River, the broken and exhausted stone tools were replaced with new ones, the old ones were discarded in the middens.
Chapter 8: Hypothesis Evaluation and Discussion

There are a number of ways in which institutionalized social inequalities can be reflected in the patterning of the material culture left behind by the prehistoric peoples who built, inhabited, and finally abandoned the Crystal River site. This research set out to address the material expression of institutionalized social inequalities in Middle Woodland society as reflected in the differences in the procurement, the life history, and the final discard locations of the chipped stone tools left behind at the site. Four distinct research hypotheses were proposed in Chapter 1. In this chapter, each hypothesis and its alternate hypothesis are evaluated in light of the data presented. Each set will be considered individually focusing on the relative contribution each makes, or fails to make, about how social inequalities are manifested in the stone tool assemblage.

Social inequalities in quarry use

The first hypothesis was developed to evaluate whether social inequalities are reflected in differential use of specific quarry locations. This is based on the assertion that social elites would have maintained control over the procurement of a variety of key resources, especially access to high-quality knappable stone, in order to maintain their elevated position in the community. Knappable stone was an important resource used by individuals to manufacture cutting and scraping tools, tips for projectiles, and other tool
forms. Control over this supply through “ownership” of quarries (i.e. Purdy 1984) or limiting access to these outcrops would regulate which people or groups could access this important resource.

The null hypothesis stated that there is no differential use among the quarry areas available for use by the inhabitants of the Crystal River site. This hypothesis assumes that stone for chipped stone tools was acquired from nearby chert outcrops and quarry areas using an “embedded” stone procurement strategy that obtained chert during trips to collect other subsistence procurement activities. The alternative hypothesis stated that specific quarries were used to procure cherts with specific desirable qualities for tool manufacture and use. These locations were controlled by Crystal River elites who maintained control over both the local and inter-regional movement of these materials.

The results of the WofE analysis confirmed what many (Estabrook 2000, 2001, 2005; Newman and Weisman 1995) had suspected for some time: there were many more coastal chert quarries than had been originally indicated by the Upchurch et al. (1981) investigation. Upchurch and his associates could not visit or sample every outcrop. The WofE analysis was able to validate the quarry cluster boundaries within the 50 km study area defined for this study and lend support for the notion that some of the clusters, like the Inverness quarry cluster, needed to be redefined or eliminated (i.e., Austin 1997; Endonino 2007). The twenty known outcrops defined within the Brooksville and New Coastal quarry clusters and the 195 other suspected outcrop locations indicated by the FMSF information show that suitable sources of this raw material were readily available in the immediate vicinity of the site.
The cost path analysis indicated that the quarries most easily accessible to the inhabitants of Crystal River are located to the south of the site within the coastal marshes and along the western flank of the Brooksville Ridge (Figure 6.12). This includes outcrops and quarry locations from the redefined Brooksville quarry cluster and the newly-defined New Coastal cluster. The waste flake and utilized flake analysis has shown that nearly 80 percent of the flakes, 70 percent of the other chipped stone tools, and 60 percent of the hafted bifaces recovered from the Crystal River site were made from chert obtained from sources that are less than a few hours canoe trip from the site. More importantly, the coastal marshes and the western edges of the Brooksville Ridge are regions that also provide many of the subsistence-related items and raw materials like clay, wood (especially cedar), fish, oysters, turtles, rays, and sharks.

Acquiring chert from the quarries south of the site may have had important social ramifications as well. The Woodland period sites from Crystal River south along the coast all share a common material culture. The ceramic assemblages at these sites are dominated by the limestone-tempered Pasco series (Milanich 1994:218-220). Many of the coastal sites show a similar dependence on coastal resources found in the near shore areas of the Gulf and the brackish estuarine areas at the mouths of the major rivers and streams. Sites inland from the coast maintain the same limestone-tempered ceramic assemblage and much of the same lithic technology, but rely primarily on terrestrial and freshwater/riverine resources, especially freshwater snails and mussels, rather than brackish and saltwater resources (Austin et al. 2009; Weisman 1986).

The limestone-tempered ceramic technology that dominates sites immediately south of Crystal River shifts to a sand-tempered technology south of the Pithlachascotee
River drainage in central Pasco County. Sand-tempered wares are one of the key traits that define Manasota culture (Luer and Almy 1979, 1980, 1982), the early and middle Woodland peoples from the Tampa Bay area south to Charlotte Harbor. This unnamed cultural manifestation in the region north of the Pithlachascotee River is sometime referred to as “Weeden Island-related,” especially in the CRM literature. Despite the lack of a phase or culture name, these early and middle Woodland peoples share a similar material culture. These shared traits indicate that the peoples of Crystal River interacted with the other groups in the region south of the site on a regular basis and likely also shared a common language, religious, and descent system.

Although likely outside of the daily interaction sphere of the peoples of Crystal River, the quarries along the Withlacoochee River were also accessible by canoe. Although the distance ranks for many of the Ocala and Lake Panasoffkee quarries were relatively high (Table 6.6), the cost ranks in some cases were relatively low, indicating that travel to and from these chert sources would not have been a significant undertaking if one was to travel by canoe. Cost paths that emphasized a more terrestrial route to these areas were generated, but overland travel costs mounted very quickly. It was relatively easy to demonstrate that walking or hiking overland is more costly in terms of time and effort than is traveling to the same destinations by boat. Although it is possible to travel more directly to many of these resources by land, travel over the Brooksville Ridge presented a considerable logistical challenge as food and other resources, like chert and clay, would have had to be carried on foot rather than transported by canoe. Use of chert outcrops and other resources along the Withlacoochee River and with the interior areas
like the Tsala Apopka region were possible, even likely, but apparently did not contribute significantly to the material culture of the peoples of Crystal River.

The results of the stone tool raw material provenience analysis, when combined with the results of the WofE and cost path studies, indicate that the null hypothesis cannot be rejected. These data indicate that there is no significant preference in quarry use at the Crystal River site. These results indicate that most of the cherts used by the site’s inhabitants were obtained from local outcrops and quarry locations within the coastal marshes and Brookville Ridge area south of the site. Obtaining these materials was apparently embedded in the procurement of other resources. Although special trips could have been made to obtain chert on some occasions, stone for tools appears to have been gathered on an opportunistic or as-needed basis.

**Social inequalities in the chaîne opératoire**

The second hypothesis examined the concept that social inequalities within the societies using the Crystal River site would be reflected in differing chaîne opératoire trajectories, or stone tool life histories, of different categories of stone tools used at the site. The null hypothesis states that there are no significant differences between the various chaîne opératoire trajectories of the chipped stone artifact assemblage. It asserted that stone tool acquisition and use follows the typical expedient flake tool/local raw material pattern that has been established at other Middle Woodland sites in the region, as discussed in Chapter 3. The alternative hypothesis stated that stone implements had chaîne opératoire sequences that reflect their involvement with task-specific activities. Some of these tasks included non-specialized resource procurement activities;
other tasks involved craft specialists who created the variety of socially valued goods and symbolically-inspired items recovered within the burial mound complexes at the Crystal River site.

The stone tool analysis provided in Chapter 7 shows that there were different sequences in the chaîne opératoire evident within the stone tool assemblage at Crystal River. The first involves the tool manufacture, flake stone tools, and most of the hafted bifacial tools recovered from the site. Although specific hafted bifaces follow a different trajectory that removes them from their local use context and distributes them more widely within the region. It is useful to separate these two trajectory paths intellectually; in practice, it is somewhat more difficult. As the life history of the majority for the flake tools, cores, hammerstones, and some of the hafted bifaces and bifacial tools is local and limited, this local path will be considered first.

The results of the waste flake study and an examination of the manufacture failures and items discarded during manufacture indicate that both small flake cores and nearly complete bifacial preforms were being brought back to the Crystal River site from the various local outcrops in the region. The flake size analysis and the overall size distribution of the cores and manufacture failures indicate that most of the thinning, removal of cortex and other extraneous surface materials, and even possibly the heat-treatment of the chert in those few instances performed, took place off-site. This off-site location may have been at or near the quarry locations, as many short-term reduction areas are found adjacent to many of the quarries in the region. These locations could have been the smaller middens or domestic settlements that line the shores of the Gulf.
Chert tools, cores, and larger flakes were brought to the Crystal River site in nearly completed form, where they were used and then discarded in the midden fill.

Some hafted bifacial tools follow a different life history. From the limited data recovered thus far, this alternative life history appears to involve only hafted bifaces, but other implements including small flake cores may have been included in this alternative life history as well. These chipped stone implements were transported from quarries located within 50 km of the Crystal River site, but outside the region within which food and other resources could have been easily procured. These stone bifaces and small flake cores may have been brought back to the site by peoples who lived in the Crystal River region but who had traveled outside of the immediate site area, returning with preforms, flake cores or hafted stone tools made from non-local cherts. Given Crystal River’s position as a ceremonial/burial center, it is also likely that people who lived outside the immediate area traveled to Crystal River bringing with them the flake cores and hafted tools made from cherts obtained from their local chert procurement areas. The tools would then be used or broken on the way to the Crystal River site. While at Crystal River, these items could have been replaced with tools made from chert local to Crystal River, and the worn-out and broken tool fragments made from non-local cherts discarded at the site.

Of the cores and hafted bifaces recovered from the site, three of the ten cores and 12 of the 39 hafted bifaces are made from materials that can be considered non-local to the Crystal River vicinity. That is, individuals would have had to travel past other, more local sources of chert, to obtain these materials. The cores made from non-local cherts all come from within the 50 km study area defined for the project. Two of the hafted bifaces
are made from Type 4 and Type 5 cherts, materials that are primarily found in specific coastal locations within the Hillsborough River quarry cluster (Goodyear et al. 1983; Upchurch et al. 1981). However, neither of these points nor any of the other ten local hafted bifaces show any particular use damage suggesting that they were used for any specialized activities. As the data in Table 7.12 suggests, most were used either as cutting tools or as projectile tips, as were most of the other formed tools from the site.

These data support different life history trajectories for at least some of the cores and hafted bifaces. They do not, however, support rejecting the null hypothesis. There is no way to connect the items found within the burials in the Central Burial Complex or Mound G with any of the activities involving these tools. People visiting the Crystal River site from more distant locations bringing chert cores and hafted bifaces were unlikely to have been specialists, as the bifacial tools they brought were used as projectiles (probably for hunting) and the cores they brought were used to manufacture flake tools. The stone tool assemblage from Crystal River does appear to follow the flake tool/hafted biface tool pattern observed from other Middle Woodland ceremonial complexes in the southeast.

These data also shed new light on Sassaman’s (1994) discussion concerning biface exchange. First, bifaces are only one part of a larger composite tool. Bifaces, especially hafted bifaces, were typically attached onto a hafting element such as a knife handle, a foreshaft, an atlatl dart. These hafts provided the leverage and control for the working edges. Perhaps it was these composite tools rather than the bifaces themselves that were exchanged.
Social inequalities expressed in thermal alteration use

The third hypothesis was developed to explore the possibility that social inequalities are reflected in the use of thermal alteration, or the heat-treatment of chert, by the site’s inhabitants. The null hypothesis states that thermal alteration was a technique used to transform locally available, low-quality chert into serviceable stone tools thus eliminating the need to obtain higher quality chert from sources farther away from the Crystal River site. The alternative hypothesis suggested that thermal alteration was a technique used by craft specialists to make hafted bifaces and other specialized stone tool forms that were carefully-flaked, lustrous, bright red-pink in color, and aesthetically pleasing. These artifacts were controlled by social elites and were used as symbols of their power and authority.

The incidences of thermal alteration within both the waste flake and chipped stone tool assemblage from Crystal River are low. Only 15.7 percent of the hafted biface assemblage was attributed to the use of this technique. Similar low percentages were reported for the other tool categories. Only 13 percent of the utilized/modified flakes, 7.7 percent of the biface fragments, 10 percent of the Other Tools category, and 17.6 percent of the manufacture failures display both the color and luster change indicative of heat-treatment. At least five specimens that were classified as being unaltered or indeterminate display a crazing (random small cracks) fracture pattern or potlid scars indicative of an unintentional exposure to a heat sources, like a hearth or firepit. No thermal shatter, thermally-shattered preforms, or other evidence of on-site treatment of stone was noted. These data suggest that chert was being thermally-altered at an off-site location and brought to the Crystal River site in as heat-treated cores and preforms.
There was no evidence to suggest that thermal alteration was used to enhance the quality of either the local cherts or those brought in from more distant quarry clusters. As the incidences reported in Table 7.11 suggest, the use of thermal alteration is not more common in the chert from a particular quarry cluster nor was it observed more frequently within one tool category than another. Overall, hafted bifaces and utilized/modified flakes were about equally likely to have been made from a heat-treated chert or from unaltered materials.

The use of thermal alteration does appear to be more common among the bifaces recovered by C.B. Moore within the Central Burial Complex. Moore (1903, 1907, 1918) recovered 47 specimens that likely would have been classified as hafted bifaces. Of these, 19 specimens were retained and are now in the collections of the Museum of the American Indian in Washington D.C. From Moore’s writings it is likely that he kept the specimens that he thought would make better museum displays and discarded implements that were misshaped or broken. Of the 12 specimens that were available for study, three of the stemmed points appear to have been thermally altered. A fourth displays a pinkish color indicating that it may have been thermally altered. These data, when combined with the other findings, show a slightly greater incidence of thermal alteration among the stemmed points than any other point type.

Stemmed points, also known as Archaic Stemmed Points, are perhaps the most common point type in Florida (Bullen 1968, 1975; Purdy 1981). These points and their associated manufacturing debris are ubiquitous at many inland lithic scatter sites (Austin 2002). They are also commonly found at Early and Middle Woodland mound sites throughout Florida and the Southeast (Austin 1995a, 1995b, 1997, 2008; Estabrook and
Williams 1992; Milanich et al. 1984; Kohler 1978; Sears 1956, 1960). Although many have attributed these finds to “holdovers” or points scavenged from earlier sites (i.e. Bullen 1975; Purdy 1981; Purdy and Beach 1980) Farr (2006:86) notes that Florida Archaic Stemmed points have been found in secure Late Archaic and Early Woodland contexts. These finds draw into question the use of this point type as a chronological marker.

The incidence of thermal alteration at Crystal River is relatively low. Heat-treatment was occasionally used to alter the knapping qualities of local materials, and also to alter materials from sources further from the site. Since thermal alteration does not appear to have been used to create specific tool forms used by specialists, the null hypothesis cannot be rejected. Ste. Claire (1987:204) reported that the lowest incidence of thermal alteration occurred during the Early Woodland period (500 BC - 0 AD) with a gradual increase in its use during Middle Woodland times. The data from Crystal River show a low incidence in thermal alteration from late Early through the Middle Woodland period, with little indication of an increase through time.

**Social inequalities expressed in artifact deposition location**

The fourth hypothesis evaluated whether social inequalities are reflected in the intentional placement of specific stone tools within the various mounds as symbols of the social status of the individual. The null hypothesis states that there are no differences between the discard locations of any of the stone tools recovered at the Crystal River site. This hypothesis assumes that stone tools were discarded as part of the midden fill and that they would find their way into various other site components as part of construction
fill. The alternative hypothesis suggested that social elites would use thermally altered hafted bifaces and other patterned chipped stone tools as symbols of their power and authority. These items were interred with their owners within sacred contexts in the various burial mound complexes at Crystal River, while expedient stone tools (i.e., utilized flakes, scrapers, and hafted knives) were discarded within midden fill.

As shown in Tables 7.5, 7.7, and 7.8, the majority of intentionally-shaped tools, the cores, hammerstones, manufacture failures, and hafted bifaces, were recovered from Midden B, the large linear midden feature extending along the bank of Crystal River. Only a few implements can be directly tied to recovery contexts in other mounds. A Columbia point was recovered from a shell road near Mound G; however the actual recovery context of this artifact is suspect. A Duval and a Pinellas point were recovered from Feature C. Two stemmed points also were found – one from the Double Sand Mound, the other was dredged from the river near Mound A. The only material known to definitively come from Mound F/E are the stone tools recovered by C.B. Moore.

At first, these data appear to support the null hypothesis that there are no discernable differences between the discard locations for most of the stone tools recovered from the Crystal River site. Worn-out and broken bifaces, utilized and modified flakes, expended cores and waste flakes were apparently thrown onto the debris that would become Midden B along with the left-over oyster shells, fish bones, and broken and discarded pottery. Some of this material was later removed and used a construction material for the various mounds found throughout the complex (Pluckhahn et al. 2009; Pluckhahn et al. 2010). Even in areas that were less affected by prehistoric borrowing and modern filling activities, the recovery methods used to excavate most of
the remains do not allow for the identification of activity areas or manufacture locations within the midden area itself.

The only definitive context known for the internment of bifaces with burials comes from Moore’s 1903, 1906 and 1918 investigations. From his initial 1903 work Moore notes that “lanceheads” are often found in association with other objects in the mound (Moore 1903:397), but only in a single case does Moore state the recovery of anything that could be considered a flaked stone tool. Moore (1903:412) describes the remains found in one burial:

“With a burial were: one canine tooth of a large carnivore; two “celts” of polished rock; two sheets of mica; three lance-heads of chert; two sandstone pebble-hammers; four shell gouges; four shell “celts”; parts of other “celts” of shell; two sandstone hones; several bits of clayey material.”

These burial goods are made from materials that come from a variety of places. The shell celts, sandstone, and clay-like materials can be found within the general vicinity of Crystal River. Canine teeth can be obtained from a variety of large mammals, like bear, wolf, and panther that once inhabited the areas around the site. Mica, however, is a material that clearly had to be brought in from some considerable distance, likely from somewhere in Georgia. The polished rock celts likely came from areas outside of central Florida. Moore’s description suggests that these remains, including the three lance-heads, were intended as burial offerings and were not simply materials included with the mound fill. Additionally this was not part of one of the seemingly common instances of aboriginal burial disturbance (Moore 1903:382).

Upon his return in 1906, Moore again describes finding additional chipped stone tools during his continuation of work on Mound E. Some were found in association with
burials; others were not (Moore 1907:419). Five of the 15 “lanceheads” Moore recovered in 1906 came from a single burial. Four were made from chert and one was made from quartzite. This quartzite artifact may be the one pictured in Figure 7.14. Moore describes these points as “…beautifully wrought, one of medium size being finely pointed and barbed” (Moore 1907:419). Later in this description Moore (1907:424) relates finding five “lanceheads” (four made from chert and one made from quartzite) with the skull of an extended burial. Also found with this individual was a fossilized (petrified) wood object square in cross-section. It is not clear whether Moore is describing the same burial (the single burial vs. the extended burial), but the artifact descriptions do match.

Moore mentions one additional “lancehead” recovered from Mound E/F. This fragment was found near the throat of an extended burial that also contained a variety of shell and stone pendants, mica fragments near the shoulder and pelvis, and a mass of green material along the right forearm identified as “arenaceous [sandy] clay colored by iron” (Moore 1907:424). Upon his return in 1918, Moore focused his attentions on Feature C, revealing twenty-four additional burials during this brief visit. Within one of these burials (Number 21) Moore recovered a single “arrowpoint of flint” near the throat of the individual (Moore 1918:572). It does not appear that there were any additional mortuary remains recovered with this burial.

From Moore’s brief descriptions, there is a good indication that at least some of the “lanceheads” (hafted bifaces) he found were associated with grave goods interred with specific individuals. At least two of the burials Moore describes come from Mounds E and F, which contained all of the copper earspools, pan pipes, gorgets, and breastplates, the stone plummets, the crystal pendants, shell plummets and celts found at the site.
Some of these objects, like the earspools and breastplates, are not usually associated with the daily activities for most of the inhabitants of the Crystal River area. Other items, like the shell and limestone plummets (possible net weights), clearly have a role in the subsistence technology of a hunter/gatherer/fisher society and may, like specific hafted bifaces, been able to move between the sacred and secular spheres.

The life histories proposed for the hafted bifaces at Crystal River support the notion that some of the hafted bifaces would be discarded in a domestic context (Midden B) while others accompanied the burials. It can be inferred that the implements were involved in the interregional movement of hafted bifaces, as well as some flake cores from sites within the interior reaches of the Withlacoochee River basin and south to the Tampa Bay area. Based on this evidence, the null hypothesis can be rejected. There is sufficient support from Moore’s descriptions of the biface internments with burials, in addition to the identification of two distinct life histories for the stone tool assemblage that specific stone tools can move from the realm of hunting tools and cutting/slicing implements into the realm of inalienable goods.

Discussion

Several things are readily apparent in the analysis of the stone tools from Crystal River. The assemblage is consistent with the other stone tool assemblages in Florida and the Southeast. With a biface-to-tool ratio of 1.32, it puts the Crystal River site at the same mix of biface vs. flake tool use as the Kolomoki site in Georgia and the McKeithen Weeden Island site in Florida. These data suggest that there is at least a small full-time residential population at the site, although major occupation/residential areas have yet to
be identified. The use-wear analysis emphasized cutting and slicing activities. Little evidence of heavy-duty woodworking activities was observed, at least woodworking activities involving stone tools. Thermal alteration was occasionally used, but not on a scale that suggests it was used to enhance the quality of local cherts, which are typically grainy and somewhat fossiliferous. Nor does it seem that cherts from outside the general vicinity of the site were being imported to Crystal River to make tools.

The provenience analysis and the hafted biface retouch index values do suggest that there was a second life history trajectory for some of the hafted bifaces. This pattern has been identified at the Fort Center Complex (Austin 1997, 2008; Steinen 1971, 1981) and the Pineland Complex (Austin 1995b; Marquardt and Walker n.d.). At Fort Center, the recovery context of the hafted bifaces from Mound B allowed Austin (2008) to identify an assemblage of specialized bifacial woodworking tools. Although some evidence of woodworking was identified at Crystal River, the use-wear analysis was unable to identify specific manufacturing activities. As such, the recovery context at Crystal River was less than ideal. Many of the bifaces used in the analysis were reportedly collected from former gardens within the Crystal River Trailer Park, which extended across Midden B, and contains fill from the bulldozed portions of Mound A. Austin (2008) was also able to determine that many of the specialized tools from Fort Center were made from cherts that originated in north-central Florida. The biface evidence from Crystal River is less clear. While there are bifaces made from chert acquired outside the Brooksville quarry cluster, most of these tools show similar cutting and impact-related damage as the tools that were made from local Brooksville quarry cluster cherts.
The data from the lithic analysis of the Crystal River site support the acceptance of the null hypothesis for three of the four propositions proposed for this research. These data indicate that the acquisition of chert was embedded in the everyday subsistence activities of the site’s inhabitants and was not controlled by socially-advantaged members of society. Thermal alteration, a technique often used to enhance the quality and flakability of chert, was not used extensively to alter local materials. There is no evidence that material used to make bifacial tools was heat-treated to a greater extent than any other chert used at the site. There also does not appear to be any spatial differences in the discard of various tools recovered from the site, although the lack of specific recovery contexts for many of the tools examined in the study has compromised this effort.

These data do, however, support the alternative hypothesis that there were at least two life history trajectories for tools classified as hafted bifaces. Hafted bifaces made from cherts acquired from local Brooksville quarry cluster were made, used, and discarded at the Crystal River site. Hafted bifaces made from cherts from the Marion Uplands, Lake Panasoffkee drainage, and Tampa Bay area at the edge of the 50 km study area (and further) made their way to the Crystal River site. While in route, these tools were employed as projectile tips and knives. These implements were resharpened, reshaped, and finally replaced likely with locally-available cherts at the Crystal River site.
Chapter 9: Conclusions and Suggestions for Further Research

The Crystal River site is a late Early to Middle Woodland-period mound complex located in coastal Citrus County, Florida. First investigated by the noted antiquarian Clarence B. Moore (1903, 1906, 1918) in the early part of the twentieth century, the site’s Central Burial Complex became well-known for the assemblage of finely-crafted burial goods it contained. Many of these objects are associated with the Hopewell Interaction Sphere, a Woodland exchange network and many are made from materials that likely have come from as far away as the southern Piedmont, Ohio Valley or Great Lakes (Greenman 1938; Sears 1962b).

Mid-twentieth century investigations at the site by Ripley Bullen (1951, 1953, 1965, 1966) and Hale Smith (1951) returned to the Central Burial Complex but also included investigations in other portions of the site, especially in Midden B and Mounds J and K. Brent Weisman conducted a small-scale excavation at the site in early 1980s to explore the potential for a Mississippian/Safety Harbor site component (Weisman 1984, 1987, 1995). Since then, all of the investigations at Crystal River have resulted from archaeological monitoring during site alterations or emergency monitoring after storm events (Ellis 1999, 2004; Ellis et al. 2003; Weisman 1990, 1993). Current investigations at the site focus on remote sensing techniques and reevaluating materials previously recovered from the site (Collins and Doering 2009; Pluckhahn and Thompson 2009;
This dissertation research was undertaken to further explore the interpretive potential of the artifacts already excavated from the site that are now housed in various museum and curation facility collections.

This research program was designed to explore how the institutionalized social inequalities in Middle Woodland society are reflected in the differences in the procurement, the life history, and the final discard locations of the chipped chert stone tools from the Crystal River site. The Woodland period (1000 BC to AD 1000) was a time of both stability and change in Native American society. Many of the core social activities like ceramic technology, hunting, plant and shellfish collecting and residence location remained relatively constant while religious and political institutions appear to have undergone significant changes. The construction of mound complexes and the differential burial goods suggest that institutionalized social ranking was also common. This study focuses on how these social inequalities were manifested in the chipped stone tool assemblage from the Crystal River site.

Multiple analytical techniques were employed in this investigation. The GIS-based Weight-of-Evidence (WofE) procedure was used to predict the locations of chert outcrops within a 50 km study area. This model validated the existing quarry cluster concept for determining the provenience of Florida cherts. A cost path model was developed to identify those chert sources that would have been most accessible to the site’s inhabitants. A chaîne opératoire approach guided the analysis of the chipped stone assemblage. A waste flake analysis, a hafted biface classification, and a raw material provenience classification were conducted for all flaked stone materials. Use-wear determinations were made using both low-power magnification (10-70x) and high-power
magnification (50-400x) analysis techniques. A life history approach was taken to the hafted biface assemblage and hafted biface retouch index (HRI) values were determined for all hafted bifaces and biface fragments.

All of the artifacts used in this analysis came from museum and curation facility collections or from specimens discovered during the evaluation of the CRASP Museum collections during the course of the investigation. Only a limited number of artifacts came from securely-dated contexts. Many artifacts were poorly provenienced, especially those collected from the sheds within the Crystal River Trailer Park in 1993. Given the limited number of chipped stone specimens (n=369) and the provenience issues, a decision was made to combine them into a single analytical unit rather than separate out the suspected Deptford component artifacts from the later Weeden Island materials. This approach may have masked some of the changes in stone tool use through time at the site. Although unavoidable at this time, it is hoped that future investigations will identify additional artifacts from each of the site components and that this will allow for a more fine-tuned chronological evaluation of chert procurement and tool use.

The WofE analysis produced a valid predictive model for locating chert outcrops within 50 km of the site. This model also validates the quarry cluster boundaries established by Upchurch (et al. 1981) and updated by Austin (1997). The model does not support the quarry culture boundary revisions proposed by Endonino (2007) for the Ocala and Lake Panasoffkee quarry clusters, although it does explain Endonino’s discovery of Hawthorn Group cherts in the Marion Uplands. The predictive model also supports the dissolution of the Inverness quarry cluster and the reassignment of the two known quarries within the cluster to adjacent areas (Austin 1997; Endonino 2007). These
procedures also suggested the definition of the New Coastal quarry cluster, a group of outcrops and potential outcrops along the Gulf coast from the Anclote River north to the Withlacoochee River.

The analysis of the chipped stone tool assemblage from the Crystal River site provided does not support an argument for extensive social differentiation among the site’s inhabitants. The study indicates that the acquisition of chert was embedded in the everyday subsistence activities of the site’s inhabitants and was not controlled by socially advantaged members of the society. Thermal alteration, a technique often used to enhance the quality and flakability of chert, was not used extensively to alter the chert used at the site. There is no evidence that material used to make bifacial tools was heat-treated to a greater extent than was any other chert used at the site. There also does not appear to be any spatial differences in the discard of the various tools recovered from the site, although the lack of specific recovery contexts for many of the tools examined has compromised this effort.

The analysis does indicate that there are at least two life history trajectories for tools classified as hafted bifaces. The quarry cluster analysis and the HRI index both show that hafted bifaces made from chert outside the immediate site vicinity were much more likely to have been either have been extensively resharpened or display critical distal fractures (impact breaks). Hafted bifaces made from cherts acquired from local Brooksville quarry cluster stone were made, used, and discarded in the Crystal River middens. Hafted bifaces made from cherts from the Marion Uplands, Lake Panasoffkee drainage, and Tampa Bay, areas at the edge of the 50 km study area and further, made their way to the Crystal River site. Along the way, they were used as projectile tips and
knives. These implements were then resharpened, reshaped, and finally replaced likely with locally-available cherts at the Crystal River site.

The stone tools from the Crystal River site express little indication of the social inequalities suggested by the burial goods recovered by C.B. Moore (1903, 1907, 1918) or by the construction of large mound complexes (Pluckhahn et al. 2009; Pluckhahn et al. 2010; Pluckhahn and Thompson 2009; Thompson and Pluckhahn 2010). There is little evidence for the use of stone tools in heavy/intensive woodworking activities, like canoe construction or wood carving. No microliths or microlith cores have been identified suggesting that shell and stone bead production took place off-site. No specialized stone tools of any kind were identified during the analysis. Taken as a whole, the lithic assemblage from the Crystal River site is best described as unremarkable and quite unlike the materials recovered from the Central Burial Complex.

It appears that the majority of the stone tools recovered from the Crystal River site were employed in domestic activities involved with the procurement and preparation of food. Bifaces with impact fractures and broken bifaces exhibiting cutting and or slicing edge damage are the two dominant functional activities identified in the assemblage (Table 7.10). The biface to flake tool ratio of 1.32 (61 bifaces to 46 flake tools) is very similar to the values calculated for the McKeithen site in north Florida (Milanich et al. 1984) and the Kolomoki site in southwest Georgia (Pluckhahn 2003), both sites with significant evidence for domestic activity. No house floors, post molds or other evidence of domestic architecture have been yet discovered at Crystal River, although materials recovered during the seawall replacement and boat basin monitoring projects (Ellis 1999; Ellis et al. 2003) suggest that such deposits may someday be identified.
Suggestions for Further Research

As like many studies of its kind, this research has probably generated as many questions as it has addressed. There are three general areas of further research I believe would assist with future studies at the Crystal River site specifically and at similar sites along the Florida Gulf Coast. The first research area is site specific and deals with the missing data sets from the Crystal River site. The second suggestion for further research would expand the techniques and results of the WofE study and cost-path analysis to other portions of Florida and the Southeast. The third area of future research requires a targeted field investigation to identify the significant sources of chert within the boundaries of the proposed New Coastal quarry cluster and determine whether these sources should remain as a new cluster or whether they should be recombined into the existing Brooksville and Caladesi quarry clusters to the east and south.

There are three missing sets of data from the Crystal River site. The first set is housed in the CRASP Museum. Without a complete inventory accounting for all of the materials on loan from the FLMNH these artifacts are in effect inaccessible to researchers. Work with FLMNH staff to try to correct this issue is ongoing, but the efforts are hampered by the way in which the original CRASP Museum displays were constructed. The artifacts are glued to the backboard, making access to the accession and artifacts numbers difficult, if not impossible, without removing them. The second missing data sets are the artifacts and field notes from Hale Smith’s 1951 excavation. These materials are not curated by the FDHR or the FLMNH. They are also not housed in the FSU collections. There is some speculation that these materials were inadvertently thrown away when Hale Smith retired and his office was cleaned out. All of the
unprovenienced materials were de-accessioned, and the Crystal River artifacts may have been discarded with them. However, given the recovery techniques used in Florida during the 1950s, the resources expended to find these artifacts may not be worth the limited information they might provide.

The third and perhaps most interesting missing data set are the hafted bifaces recovered by C.B. Moore that are now curated by the Smithsonian Institution Museum of the American Indian. It would be very useful to have the results of both a use-wear analysis and chert provenience study for the 19 bifaces recovered by C.B. Moore from 1903-1918. The key to further exploring social inequality at Crystal River may lie in an evaluation of these unique artifacts. The question remains, however, whether the analysis of these artifacts, given their unique recovery locations, should be incorporated into the evaluation of the chipped stone tools from the site or viewed with respect to the array of plummets, pendants, ear spools, and other materials interred in the Central Burial Complex.

The WofE and cost-path analysis were strong supporting components of this investigation. Originally added to the study to address questions about the possibility of missing outcrops, the WofE analysis was shown to be a very useful tool. It has been used to help predict where chert outcrops may occur, especially those related to the various Hawthorne Group formations, like the Tampa Member or the Coosawhatchie Formation, which can contribute cherts that were accessible to prehistoric groups. These tools would be helpful in finding small, residual sources of chert outside the well-known major quarries areas. It also might shed some light on the diversity of cherts and perhaps other knappable stone available to the prehistoric inhabitants of the state. The cost-path
analysis provided useful insights into the potential transportation corridors along Florida’s west coast. It was also able to support the notion that increased surface water in lakes, streams and rivers after the Holocene Transgression resulted in higher water tables and swamp-like conditions (Bryan et al. 2008:242) that allowed for travel by watercraft, especially by canoe, throughout the state. The increased ability to travel long distances at a time when settlement ranges appear to become increasing smaller likely significantly affected the social landscape potential of the Florida Peninsula.

A field study is recommended to verify the locations of the various quarries identified in the newly proposed New Coastal quarry cluster. From the surface geology, these outcrops could contain either residual Suwannee Formation cherts, which given the distribution of materials from the Crystal River site is considered likely, or they may form the coastal expression of Ocala Limestone cherts. This investigation would determine if the proposed New Coastal quarry cluster contains cherts which make it different from the adjacent Brooksville and Caladesi quarry clusters. If Suwannee Formation materials are found at these locations, the New Coastal quarry cluster should be extended south to the Anclote River vicinity near the Pasco/Pinellas county border. If Ocala Limestone materials are present, then the New Coastal cluster might need to be divided into two clusters with the separating boundary somewhere in the area of coastal Hernando County.
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Simpson, Clarence J.  

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Slabaugh, J. Douglas, Alfred O. Jones, William E. Puckett, and Joseph N. Schuster  

Small, John K.  
Smith, Douglas L., and Kenneth M. Lord

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Smith, Hale G.

Smith, Henry Leroy

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Steinen, Karl T.

Stevens, Nathan E., Douglas R. Harro, and Alan Hicklin

Steward, Julian H.
Stirling, Matthew W.

Struver, Stuart

Sullivan, Alan P. III, and Kenneth C. Rozen

Swanson, Earl (editor)

Taylor, Walter W.

Tesar, Louis D.

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Thompson, Victor J. and Thomas J. Pluckhahn

Tilley, Christopher

Tilley, Christopher and W. Bennett

Tober, Waldo

Torp, Lyle C.

Trigger, Bruce G.
Tringham, Ruth, Glenn Cooper, George Odell, Barbara Voytek, and Anne Whitman

Unwin, David J.

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Van Dalen, Jan

Van Leusen, P. Martijn

Vaughan, Patrick C.

Vaughn, Thomas W.

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Wardle, H. Newell

Wainwright, R.D.

Walker, Karen, J., Frank W. Stapor, Jr., and William H. Marquardt

Walker, S.T.

Warren, Lyman O.

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Wheeler, Ryan J.

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Whittaker, John C.

Widmer, Randolph J.

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**2003-5-1-1**

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## Appendix A: Crystal River Site Artifact Inventory (cont.)

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## Appendix A: Crystal River Site Artifact Inventory (cont.)

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Appendix A: Crystal River Site Artifact Inventory (cont.)

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FDHR:  Florida Division of Historical Resources, Tallahassee  
FLMNH: Florida Museum of Natural History, University of Florida, Gainesville  
CRASP: Crystal River Archaeological State Park, Crystal River
### Appendix B: Specific Soils with Near-surface Limestone

#### Hernando County

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<td>Hommosassa mucky fine sandy loam</td>
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<td>Lacoochee fine sandy loam</td>
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<td>66</td>
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<tr>
<td>Weekiwachee muck</td>
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<td>Aripeka-Okeelanta-Lauderhill association</td>
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<td>Weekiwachee-Homosassa association</td>
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Appendix B: Specific Soils with Near-surface Limestone (cont.)

Citrus County

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<td>Boca fine sand</td>
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<td>Redlevel fine sand</td>
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Appendix B: Specific Soils with Near-surface Limestone (cont.)

Levy County

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Appendix B: Specific Soils with Near-surface Limestone (cont.)

Marion County

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Appendix B: Specific Soils with Near-surface Limestone (cont.)

Marion County (cont.)

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<td>Shadeville-Othelo complex, 1-5% slopes</td>
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<td>ZuC</td>
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About the Author

Richard W. Estabrook is a Registered Professional Archaeologist (RPA) who has been working in Florida and the Southeastern U.S. for the past 30 years. He holds a Bachelor’s degree in Anthropology from Stony Brook University in New York and a Master’s Degree in Applied Anthropology (Public Archaeology) from the University of South Florida (USF). He also has a Graduate Certificate in Geographic Information Systems from USF. For much of his time in Florida he has worked in the private sector, serving as Project Archaeologist, Principal Investigator, or Project Manager on over 600 cultural resource assessments and excavations. He currently serves as the Regional Director for the Florida Public Archaeology Network (FPAN), USF Central Regional Center located at the Crystal River Preserve State Park. He lives in Gainesville with his wife and plethora of cats.