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Cover: (Left) View to the east of Mounds D (lower left foreground) and A (center background) at Kolomoki, (Right Top) Osceola's garter, (Right Center) Belle Glade Plain sherd showing large scraped facet and characteristic drag/scratches (Photo by Mr. Pat Payne), (Right Bottom) illustration of the fastening processes of a plank-built flat featuring the use of iron drift pins (Drawing by William Judd). Please see articles for more information.

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A Reevaluation of the Gainesville, Ocala, and Lake Panasoffkee Quarry Clusters

Jon C. Endonino

Department of Anthropology, University of Florida, Gainesville, Florida 32611
Email: endonino@ufl.edu

Determining the source of lithic material recovered from archaeological contexts has the potential to provide a number of insights into the lives of prehistoric peoples. Sometimes data derived from lithic tools and waste flakes are all that archaeologists have to work with, especially at sites dating to preceramic times and in areas where organic preservation is poor due to acidic soil conditions. Lithic sourcing data can also be used toward similar ends among more socially complex societies and has been used to investigate the political economy of Mississippian hoe production (Cobb 2000). Other questions that source attribution allows us to address are the movement (or lack thereof) of groups across the landscape (Austin 1996, 1997; Binford 1979; Daniel 1998, 2001; Gramley 1980; Sassaman et al. 1988), the organization of technology (Andrefsky 1994; Cobb 2000; Daniel 1998), as well as exchange and interaction between groups (Carr and Steward 2004; Endonino 2003; Odess 1998).

For sourcing efforts to be successful it is vital to know the "lithic landscape," the distribution of available chert resources within the natural environment, and it must also be possible for the sources of stone to be accurately and reliably determined (Endonino 2002, 2003; Meltzer 1989; Odess 1998). A fairly well developed body of knowledge has already been amassed for lithic types and source areas in Florida (Austin 1997; Austin and Estabrook 2000; Goodyear et al. 1983; Upchurch et al. 1982). Even with all of the work that has been done there are still some deficiencies that need to be addressed. A major problem facing lithic provenance studies, and the one under consideration here, is the inability to distinguish between different chert sources derived from the Ocala Limestone in a quantified and replicable fashion (Austin 1997; Austin and Estabrook 2000). Numerous large quarry and production sites in north-central Florida amply demonstrate the importance of Ocala Limestone chert to prehistoric peoples (Bullen and Dolan 1959; Clausen 1964; Hemmings and Kohler 1974; Purdy 1975, 1980, 1981). Unfortunately, Ocala Limestone cherts can appear nearly identical and the different quarry clusters that produce this material are not easily distinguished from one another (Upchurch et al. 1982:120). Given the significance of these quarry clusters to north-central Florida's prehistoric inhabitants it is all the more important to be able to accurately differentiate between them. Upchurch et al. (1982:121) recognized this difficulty 25 years ago and anticipated that revisions would be made to the extent and diagnostic criteria of the quarry clusters they proposed.

The goal of this paper is straightforward - to create a stronger foundation for the investigation of prehistoric interaction, exchange, and mobility in Florida by developing replicable and quantifiable criteria for sourcing cherts from the Ocala Limestone. By developing these criteria, the accuracy and reliability of lithic raw material source determinations will be increased. Upchurch et al. (1982) suggest that variations in the abundance and size of Orbitoid foraminifera (Figure 1), a group of fossils round in plan view with a cross section characterized by a central bulge and tapering edges (resembling a flying saucer), are a primary criterion used in distinguishing between the Gainesville, Ocala, and Lake Panasoffkee quarry clusters. Although many foraminifera occur in Florida cherts, only a few are used by paleontologists, geologists, and archaeologists to identify geologic formations. For Ocala Limestone cherts, Orbitoid foraminifera are the primary diagnostic fossil type and the one considered in this study. These will be generally referred to as "fossils."

Refining Upchurch et al.'s (1982) original quarry clusters using fossil abundance and size criteria requires more extensive sampling than the original study (only two samples from each). Toward this end chert samples were collected from Upchurch et al.'s (1982) Gainesville, Ocala, and Lake Panasoffkee quarry clusters. These samples were then analyzed to determine the number and size of fossils present in them. It was anticipated that if observed patterns in the abundance and size of fossils are valid criteria for characterizing specific quarry clusters, then they should be differentially distributed across the landscape and display a discernible degree of geographic clustering. Demonstrating this to be the case, the attribution of lithic artifacts to a particular quarry cluster is more reliable because it is empirically based. A brief example of the application of these refined criteria to a Mount Taylor period lithic assemblage from the St. Johns River Valley is presented later in the paper to demonstrate its usefulness. First, however, it is necessary to know the distribution of lithic resources across the landscape.

Chert Resources and Quarry Clusters

The presence of chert resources, how they are formed, and the geologic processes acting to expose them are important in understanding where chert occurs and why. Chert distribution is heavily influenced by the region's geology and is generally "restricted to the flanks of areas of uplift such as arches and domes" (Upchurch et al 1982:12). The distribution of stone outcrops is not uniform and is dependent to a large degree on uplift and erosion to expose them. Frequently they are found where overlying sand and clay have been removed; in and

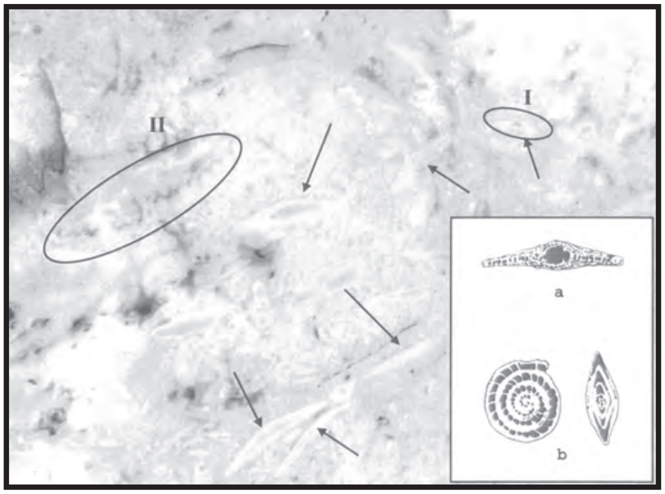

Figure 1. *Lepidocyclina* spp. fossils in sample from the Gainesville Quarry Cluster. Numerous examples are present and arrows indicate some of the more typical specimens. Circled specimen "I" is a classic example of a *Lepidocyclina* spp. fossil and "II" is a Pecten. Inset: a) *Lepidocyclina* spp. fossil, b) *Operculinoides* spp. fossil (adapted from Austin 1997: Figure 18).

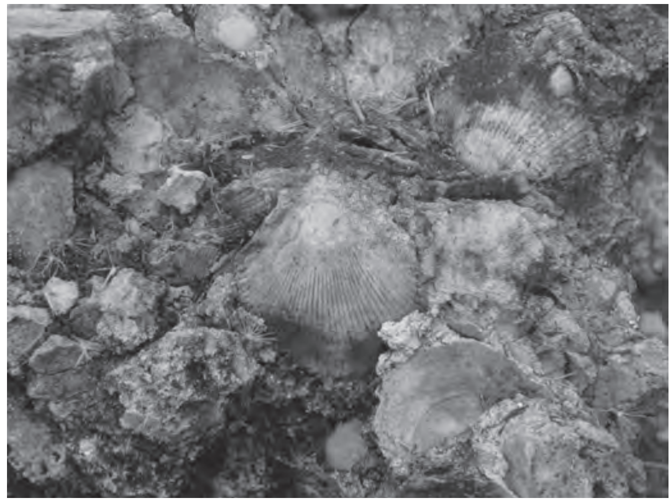

Figure 2. Pecten molds on the surface of a large Gainesville Quarry Cluster chert boulder.

along rivers, around lakes and streams, and on the crests and slopes of hills. In north-central peninsular Florida most of the Ocala Limestone chert is exposed along the flanks of the Ocala Uplift which is located on the western side of the Peninsular Arch, a Cretaceous period (70-135 million years ago) landform that forms the axis of the Florida peninsula and is characterized by highlands running north-northwest to south-southeast from southeastern Georgia into central Florida (Schmidt 1997; Upchurch et al. 1982:12). Other residual material (including chert) from younger deposits may also be present if they are resistant to erosion. However, it is the Ocala Limestone cherts that are of concern here.

The Ocala Limestone is composed of upper and lower members (Scott 2001). It was deposited during the Eocene Epoch some 40 to 60 million years ago (Upchurch et al. 1982:13). Lower Ocala Limestone is light colored, granular, and dolomitic with fewer Orbitoid foraminifera. The upper Ocala Limestone is extensively silicified and contains abundant chert (Scott 2001; Upchurch et al. 1982: 17). Ocala Limestone cherts are a foraminiferal grainstone to packstone[1] with abundant fossils (Randazzo 1997:50). Diagnostic fossils include several families of foraminifera and mollusks. As a group, foraminifera consist of single-celled marine organisms belonging to the phylum Protozoa and their shells make up a significant portion of the ancient sediments that became the Ocala Limestone. Three genera of foraminifera occur frequently: *Lepidocyclina, Operculinoides,* and *Nummulites*. *Lepidocyclina* spp. fossils are abundant in upper Ocala Limestone and limited in the lower Ocala Limestone, making the upper member quite distinctive (Scott 2001). The former two are the most important for the purposes of the current discussion (see Figure 1). Mollusks are also common and Pecten (scallop-like shells) molds and casts are frequently observed in both (Figure 2). Ocala Limestone and chert crop out over much of central Florida, particularly along the Ocala Uplift, but it also occurs in northern Florida along the Chattahoochee Anticline (Upchurch et al. 1982:17). Upchurch et al. (1982) divided the known chert-bearing exposures of Florida, including those of the Ocala Limestone, into groups characterized by material of the same geologic formation that are more or less spatially isolated and distinct, pioneering the quarry cluster method of provenance determination.

Quarry Clusters

A quarry cluster is defined as "an area known to contain numerous exposures of chert, some of which must have been used by early man, and in which the chert is expected to be relatively uniform in fabric, composition, and fossil content." Moreover, they are "usually within the same exposure belt or a single formation" (Upchurch et al. 1982:9). Recognition of the geologic formation that a particular specimen comes from is a major step in provenance determination, especially if it is spatially distinct. Of all the geologic strata in Florida few are silicified and even fewer were available to prehistoric people (Upchurch et al. 1982). Few geologic formations in Florida contain significantly silicified deposits that would have been available to prehistoric peoples: the Ocala Limestone, the Suwannee Limestone, the St. Marks Formation, and the Hawthorn Group (Austin 1997; Scott 2001; Upchurch et al. 1982:23). Within the Hawthorn Group, the Tampa Member of the Arcadia Formation and the Peace River Formation contain chert utilized by prehistoric peoples. The Avon Park Formation also contains chert but does not have any significant surface exposures and thus was not likely a significant source of lithic material for prehistoric peoples.

Nineteen quarry clusters were originally proposed by Upchurch et al. (1982:93) (Figure 3). Additional sampling was expected to alter their findings and such has been the case. Austin (1997:215) modified Upchurch et al.'s original clusters because additional and more representative sampling lead to a recognition that the criteria previously used to differentiate between the Lower Suwannee, Gainesville, Ocala, and Lake Panasoffkee quarry clusters were not sufficient to allow for an

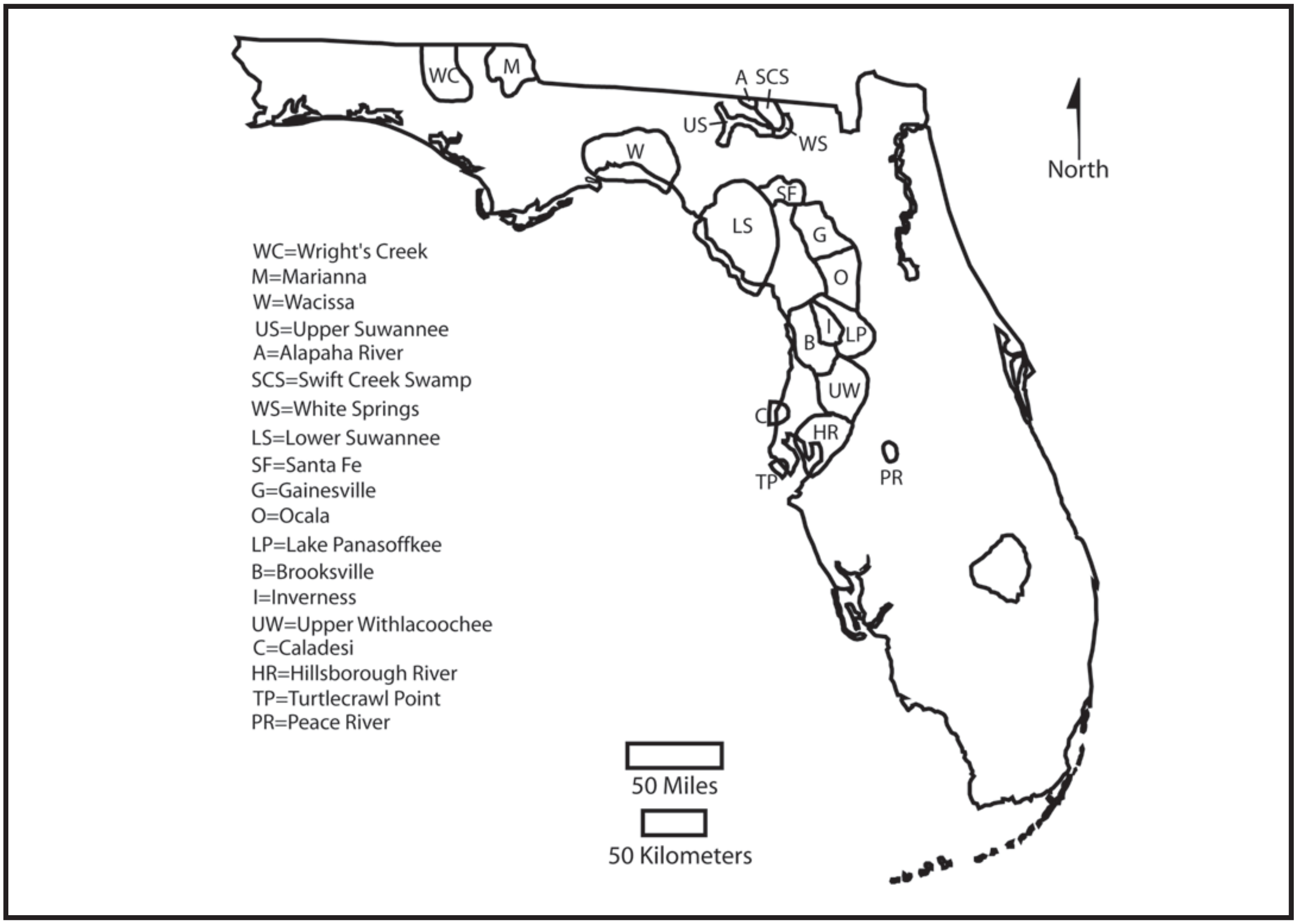

Figure 3. Quarry clusters proposed by Upchurch et al. (1982).

accurate source attribution (Figure 4). He proposed to combine those quarry clusters where cherts are derived from a single geologic formation and unambiguous criteria for distinguishing between them are lacking. The result was a decrease in the total number of quarry clusters from 19 to 16 by dividing the quarry clusters of central peninsular Florida into eastern and western megaclusters. The eastern group retained the Ocala Quarry Cluster name and consists of the Ocala, Gainesville, and the lower portion of the Lake Panasoffkee quarry clusters. The western group is made up of the Lower Suwannee, Santa Fe, and northern Lake Panasoffkee quarry clusters and is referred to as the Lower Suwannee/Lake Panasoffkee Quarry Cluster. The Inverness Quarry Cluster was subsumed within the Lower Suwannee/Lake Panasoffkee quarry cluster because it was proposed by Upchurch et al. (1982) based on presumed chert exposures and was never actually sampled. No outcrops of chert have so far been identified in this area. Based on my examination of a much larger sample of chert from outcrops in north-central Florida, I believe that real differences do exist between the Gainesville, Ocala, and Lake Panasoffkee quarry clusters. For this study Upchurch et al.'s (1982) original nomenclature is retained and I maintain that fossil size and abundance criteria used for separating them are valid but are in need of refinement and modification.

Quarry Clusters and Ocala Limestone Chert

Several quarry clusters contain Ocala Limestone chert but only the Gainesville, Ocala, and Lake Panasoffkee clusters are considered here. Diagnostic criteria for these quarry clusters are described by Upchurch et al. (1982) and are summarized in Table 1. Large and abundant Orbitoid foraminifera in a grainstone or packstone fabric are typical of the Gainesville cluster (Upchurch et al. 1982:122). The Ocala material generally contains fewer fossils in a packstone fabric and these occur in large homogeneous masses. Orbitoids such as *Lepidocyclina* spp. are common as are Pectens. Lake Panasoffkee cherts contain abundant large Orbitoids and scattered Pecten molds in a grainstone fabric and, less frequently, in packstone fabrics. Crystal-lined voids are another distinguishing characteristic of the Lake Panasoffkee Quarry Cluster. While the Ocala and Gainesville quarry clusters were heavily utilized by prehistoric groups, the Lake Panasoffkee Quarry Cluster appears not to have been used as intensively and this is attributed to the limited nature of the exposures (Upchurch et al. 1982:121). Although Upchurch et al.'s observations regarding the differences in fossil size and abundance between these three quarry clusters are still valid, they do not capture the range of difference that exists among them.

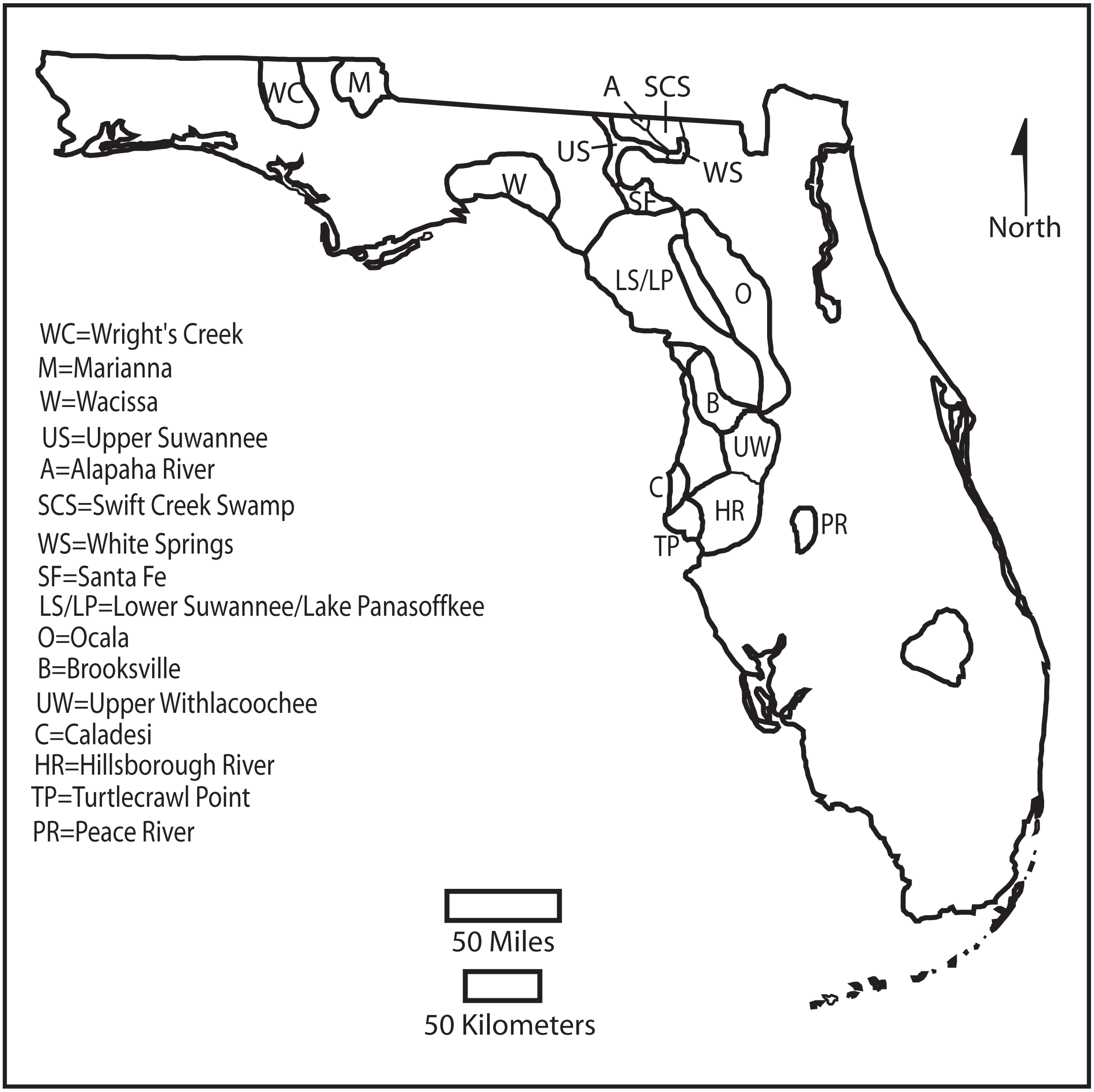

Figure 4. Revised quarry clusters proposed by Austin (1997).

Table 1. Upchurch et al.'s (1982) diagnostic criteria for quarry clusters characterized by Ocala Limestone chert in peninsular Florida.

Quarry Cluster	Host Rock Fabric	Diagnostic Criteria
Gainesville	packstone, grainstone	large abundant Orbitoids (especially *Lepidocyclina* spp.) with common miliolids and pectens
Ocala	packstone	large Orbitoids, Miliolids, and Pectens common, Orbitoid fossils less common than Gainesville, homogenous masses
Lake Panasoffkee	grainstone, minor and packstone	Orbitoids (*Lepidocyclina* spp.) large abundant, Miliolids common, scattered Pectens, quartz-lined cavities

Other quarry clusters characterized by Ocala Limestone cherts not sampled or analyzed in this study include the Santa Fe, Wright's Creek, Marianna, and the Upper Withlachoochee River clusters. It is worth noting that there also are some exposures in the vicinity of Dothan, Alabama (Claude Van Order, personal communication, 2000) and these are probably associated with the Marianna Quarry Cluster. While the quarry clusters listed above have not been sampled, the Santa Fe Quarry Cluster merits some comment relative to its characterization and relationship to the Gainesville Quarry Cluster and is presented later.

Methods

Increasing the number of samples used to re-characterize the Gainesville, Ocala, and Lake Panasoffkee clusters was critical to this research. Numerous samples from a variety of geographically dispersed locations throughout north-central Florida were sought and obtained (Table 2). Many of the chert sources were known prior to sampling and the majority of them come from the Ocala and Gainesville quarry clusters. Several from the Lake Panasoffkee area in Sumter County were located by driving throughout the area and looking for exposures in road cuts, fields, rivers, and creeks. Additional locations were sampled during the course of archaeological reconnaissance surveys (Mitchell 1997a, 1997b; Stokes 2000; Stokes et al. 2001). UTM coordinates were taken for all samples with a handheld Garmin IV GPS unit and each location was referenced using its county, nearby municipalities, and major roads. In all, 47 separate outcrops were sampled (Figure 5). Of these 16 are from the Gainesville Quarry Cluster, 19 from the Ocala, and 9 from the Lake Panasoffkee cluster. Two samples (S-25 and S-26) near the southern end of the Lake Panasoffkee Quarry Cluster are characterized by Suwannee Limestone material and likely belong to the Upper Withlacoochee River Quarry Cluster. These samples are not included in this analysis. One locality in northern Alachua County (S-36) is a silicified coral outcrop and does not contain any Ocala Limestone chert.

Samples were analyzed with the methods developed by Upchurch et al. (1982). A binocular microscope with an independent fiber-optic light source was used to visually inspect each sample. Magnification ranged from 10-x to 70-x. Lower magnifications (20-x and under) were the most useful. Occasionally higher magnification was necessary to determine the nature of certain aspects of fossil content, rock fabric, and secondary inclusions. Moistening the samples is useful in aiding the identification of the host fabric and fossil content (Austin 1997; Austin and Estabrook 2000; Upchurch et al. 1982).

One sample was selected from each outcrop location for the Gainesville (16 samples) and Ocala (19 samples) quarry clusters. Due to the paucity of outcrops sampled in the Lake Panasoffkee Quarry Cluster several samples were taken for four of the sample locations from this area. This was done in order to make up for deficiencies in the total number of sample locations and all were selected from spatially disparate locations within the same exposure/sample area. Three quantitative samples each were taken from locations S-21, S-22, and S-23 on the eastern side of the Lake Panasoffkee Quarry Cluster, totaling nine quantitative samples in all. An additional three samples were taken from S-24 on the western side. The remaining five locations each contributed a single quantitative sample, bringing the number of samples to 17 from the Lake Panasoffkee area.

Samples consist of an area 2-x-2 cm (4 cm^2) in size placed arbitrarily on a flat surface of the sample specimen. Within each sample square, data on fossil size and abundance were recorded. Whole and fragmented Orbitoids contained entirely or partially within each sample square were counted and their diameters measured. No differentiation of Orbitoid species was made although those present were noted. All of the fossils present within the quantitative sample square were measured with digital calipers and the minimum and maximum fossil sizes were recorded in millimeters.

Analysis Results

Table 3 summarizes the data on fossil abundance and minimum and maximum fossil size. Maximum fossil size and fossil abundance prove to be key criteria for distinguishing between the Gainesville, Ocala, and Lake Panasoffkee quarry clusters. Minimum fossil size was recorded during the original analysis, but it did not prove useful in discerning among the three quarry clusters. These data are presented for each of the quarry clusters in order to provide a more complete dataset, but they are not considered in depth. Fossil abundance is expressed and discussed as a density value, in this case the number of fossils per square cm (pcm^2), rather than the total number of fossils contained within the sample unit. Presenting abundance data in this way provides a baseline against which other samples can be compared.

Gainesville Quarry Cluster chert is defined by a packstone to grainstone fabric and a fossil density ranging from 7.0-13.0 fossils pcm^2, frequently more, with an average density of 9.55 pcm^2. Maximum fossil size ranges from 6.0-10.0 mm and average 10.5 mm. Pecten molds are common but may be abundant in some locations. Crystal-lined voids were also observed but are not frequent. Maximum fossil size varies from 3.6 - 29.7 mm with most measuring 6.3-9.5 mm. The majority have greater than 7.5 fossils pcm^2 with most of these possessing 7.25-12.5 pcm^2. Six of the 17 samples possess greater than 12.5 Orbitoids pcm^2. Large and abundant fossils are a key criterion in identifying this quarry cluster.

Ocala Quarry Cluster chert is defined by a homogenous packstone fabric with a fossil density ranging from 1.0-3.0 fossils pcm^2 and an average of 2.88 pcm^2. Maximum fossil size ranges from 4.0-8.5 mm with an average of 7.6 mm. Pecten molds are common and are generally small in size though large examples also have been observed. No crystal lined cavities were noted and materials typically occur in homogenous masses. Maximum fossil size varies from 2.6-22.9 mm with the majority measuring 4.3-8.4 mm. In terms of abundance, Ocala materials group tightly and, with the exception of two outliers, generally have four or fewer fossils pcm^2 with most of the samples containing 0.75-2.5 fossils pcm^2. The rarity and small size of the fossils and homogenous

Table 2. Sample Locations.

Sample	County	Quarry Cluster		
		Upchurch et al.	Austin	This Paper
S-1	Marion	Ocala	Ocala	Ocala
S-2	Marion	Ocala	Ocala	Gainesville
S-3	Marion	Ocala	Ocala	Ocala
S-4	Alachua	Gainesville	Ocala	Gainesville
S-5	Alachua	Gainesville	Ocala	Gainesville
S-6	Alachua	Gainesville	Ocala	Gainesville
S-7	Marion	Ocala	Ocala	Ocala
S-8	Alachua	Gainesville	Ocala	Gainesville
S-9	Marion	Ocala	Ocala	Ocala
S-10	Marion	Ocala	Ocala	Ocala
S-11	Levy	Ocala	Ocala	Gainesville
S-12	Marion	Gainesville	Ocala	Gainesville
S-13	Levy	Gainesville	Ocala	Gainesville
S-14	Levy	Ocala	Ocala	Ocala
S-15	Marion	Ocala	Ocala	Ocala
S-16	Marion	Ocala	Ocala	Ocala
S-17	Marion	Ocala	Ocala	Ocala
S-18	Marion	Ocala	Ocala	Ocala
S-19	Marion	Ocala	Ocala	Ocala
S-20	Marion	Ocala	Ocala	Ocala
S-21	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-21-a	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-21-b	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-22	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-22-a	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-22-b	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-23	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-23-a	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-23-b	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-24	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-24-a	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-24-b	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-25*	Sumter	Upper Withlacoochee	Upper Withlacoochee	Upper Withlacoochee
S-26*	Sumter	Upper Withlacoochee	Upper Withlacoochee	Upper Withlacoochee
S-27	Marion	Ocala	Ocala/Gainesville	Ocala
S-28	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-29	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-30	Sumter	Lake Panasoffkee	Lower Suwannee/Lake Panasoffkee	Panasoffkee West
S-31	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-32	Marion	Ocala	Ocala	Ocala
S-33	Alachua	Gainesville	Ocala	Gainesville
S-34	Alachua	Gainesville	Ocala	Gainesville
S-35	Alachua	Gainesville	Ocala	Gainesville
S-36*	Alachua	Gainesville	Ocala	Santa Fe
S-37	Alachua	Gainesville	Ocala	Gainesville
S-38	Alachua	Gainesville	Ocala	Gainesville
S-39	Marion	Ocala	Ocala	Ocala
S-40	Marion	Ocala	Ocala	Ocala
S-41	Marion	Ocala	Ocala	Ocala
S-42	Alachua	Gainesville	Ocala	Gainesville
S-43	Alachua	Gainesville	Ocala	Gainesville
S-44	Alachua	Gainesville	Ocala	Gainesville
S-45	Sumter	Lake Panasoffkee	Ocala	Panasoffkee East
S-46	Marion	Ocala	Ocala	Ocala
S-47	Marion	Ocala	Ocala	Ocala

* Non-Ocala Limestone, not analyzed

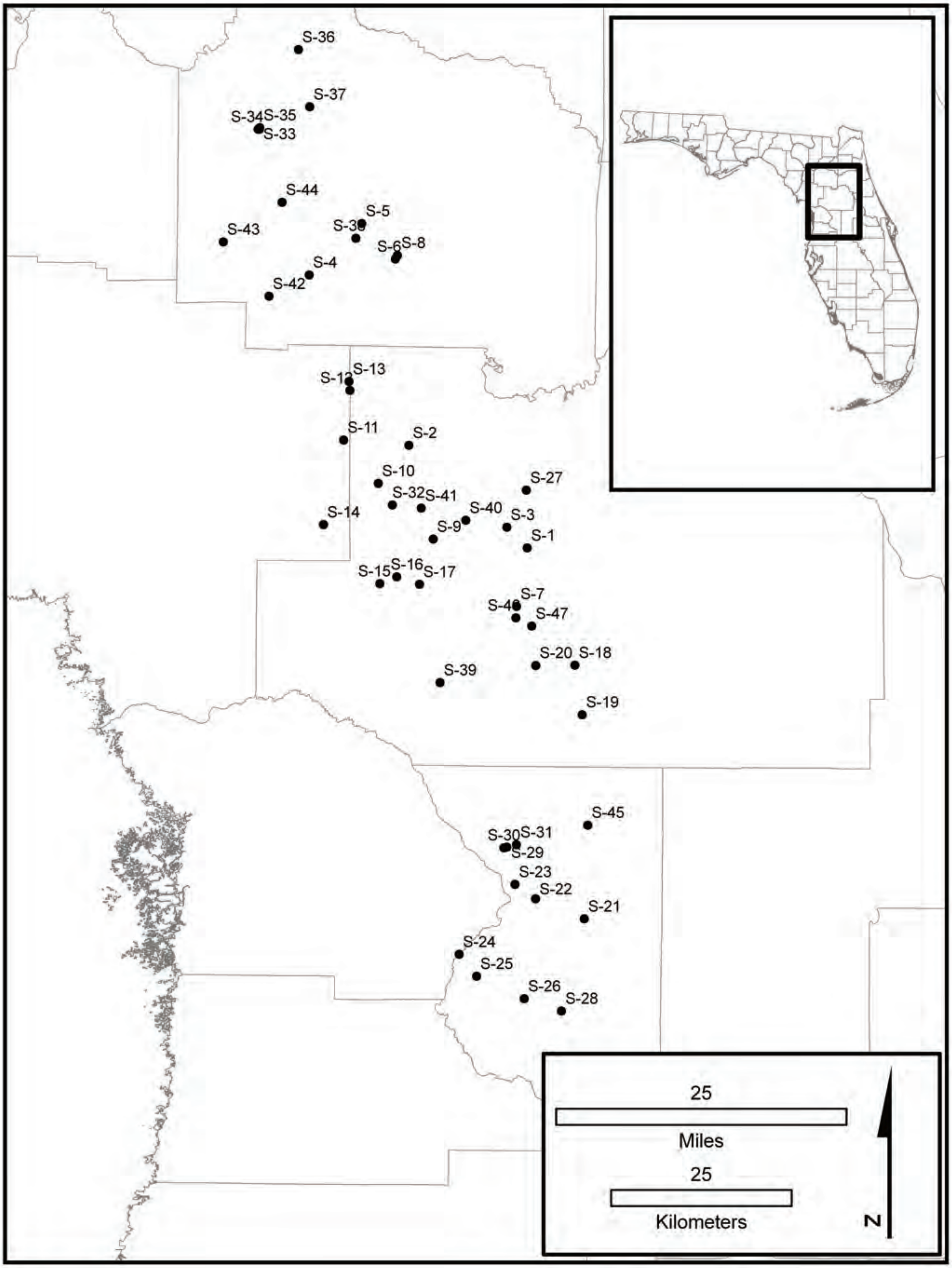

Figure 5. Sample locations.

Table 3. Fossil abundance and size data for the Gainesville, Ocala, Lake Panasoffkee East and Lake Panasoffkee West quarry clusters.

Quarry Cluster	Abundance			Min. Size (mm)			Max. Size (mm)		
	min.	max.	avg.	min.	max.	avg.	min.	max.	avg.
Gainesville	3.50	20.00	9.55	0.6	3.2	1.4	3.6	29.7	10.5
Ocala	0.75	6.25	2.88	0.9	6.8	1.7	2.6	22.9	7.6
Lake Panasoffkee East	0.75	3.75	2.20	0.1	3.4	1.2	1.4	14.6	6.1
Lake Panasoffkee West	5.25	15.00	9.20	0.8	1.2	0.8	3	13.7	7.6

nature of raw material packages distinguish the Ocala Quarry Cluster from the Gainesville and Lake Panasoffkee sources. The two samples (S-3 and S-19) deviate from the overall pattern observed in the Ocala sample group. The first (S-3) was exposed through commercial limestone mining operations and may or may not have been available to prehistoric hunter-gatherers but is still included in the analysis. The second outlier (S-19) is from an exposure that would have been available to prehistoric groups and is thus the only significant deviation from the observed pattern. Because of its location near the southern end of the Ocala Quarry Cluster area and near the northern end of the Lake Panasoffkee cluster, this sample may represent a transition between the Ocala and Lake Panasoffkee quarry clusters. Additional sampling in this area may help to clarify the matter. Both outliers represent variation within a group that is otherwise very consistent.

The Lake Panasoffkee Quarry Cluster merits special consideration due to the clear differences in fossil abundance within this source area. Samples are essentially identical in terms of size (Figure 6). However, differences in fossil abundance make it possible to distinguish between material from the eastern side of the quarry cluster and that from the west and south. Based on these differences I propose that the Lake Panasoffkee Quarry Cluster be divided into eastern and western sub-clusters, hereafter referred to as Lake Panasoffkee East and Lake Panasoffkee West quarry clusters.

The Lake Panasoffkee East Quarry Cluster is defined by a grainstone fabric with less than 3.75 fossils pcm^2 and an average of 2.2 fossils pcm^2. Maximum fossil size ranges from 2.0-8.0 mm with an average of 6.1 mm. Pecten molds are common and crystal-lined voids are common to frequent. Maximum fossil size ranges from 1.4-14.6 mm with the majority falling between 4.5-5.6 mm. Abundance varies from 0.75-3.75 fossils pcm^2 with most having 0.75-3.0 pcm^2.

Lake Panasoffkee West cherts are characterized by a grainstone and occasionally packstone fabric with 5.0-15 fossils pcm^2 that measure 3.0-14 mm in size. Pecten molds and crystal-lined voids are occasionally present. Maximum fossil size varies between 3.0 mm and 14 mm with most falling between 5.0-8.1. Samples contained a minimum of 5.25 fossils

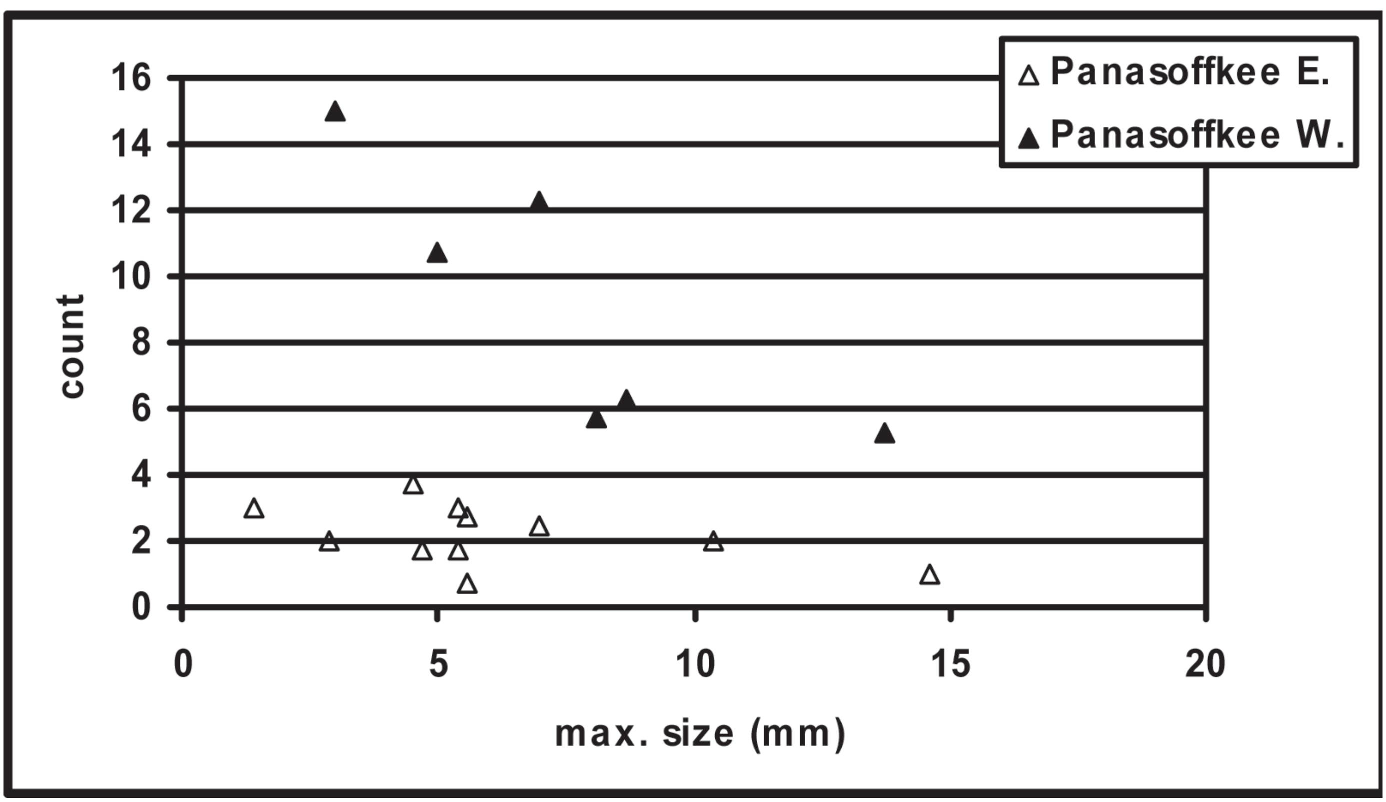

Figure 6. Scatterplot showing maximum fossil size and abundance for Lake Panasoffkee East and West quarry cluster cherts.

pcm^2 and a maximum of 15 pcm^2 with most having 5.25-6.25 pcm^2.

Discussion

In comparing the Gainesville, Ocala, and Lake Panasoffkee East and Lake Panasoffkee West quarry clusters, overlap between them is apparent (Figure 7). The Gainesville and Ocala quarry clusters overlap in both size and abundance (Figure 8). In terms of size, the lower end of the maximum size distribution of the Gainesville Quarry Cluster overlaps with the upper limit of the Ocala Quarry Cluster. Regarding abundance, the Gainesville materials have more fossils on average with over half falling outside the uppermost distribution of the Ocala cluster, outliers aside. It would appear, then, that abundance is the best indicator of difference between the Gainesville and Ocala clusters. The best approach to distinguishing among the Gainesville and Ocala quarry clusters is to consider *both* fossil size and abundance. This also applies when comparing Gainesville and Lake Panasoffkee quarry clusters. Gainesville and Lake Panasoffkee West chert are similar in abundance and both stand in contrast to the Lake Panasoffkee East Quarry Cluster which contains notably fewer fossils (Figure 9). Upchurch et al. (1982:126) noted the difficulty in discerning between these two source areas but suggest that quartz crystal-lined voids in Lake Panasoffkee cherts, both East and West, provide one means of differentiating them. Though similar in abundance, fossils in the Gainesville materials are still larger than those observed for Panasoffkee West. Lake Panasoffkee East materials are easily distinguished from Gainesville chert by the rarity and small size of their fossils as well as the presence of crystal-lined voids.

Ocala and Lake Panasoffkee East materials are very similar and with a small-sized archaeological assemblage, both in terms of the number of artifacts and their physical size, would be virtually indistinguishable (Figure 10). Some of the sampled Ocala Quarry Cluster cherts have more fossils than observed for Lake Panasoffkee East, but not many. While their maximum fossil sizes are similar, there are two samples from Lake Panasoffkee East that have fossils significantly larger than those observed for most of the Ocala Quarry Cluster samples. Differences between the Ocala and Lake Panasoffkee West samples mirror those observed for Lake Panasoffkee East and Lake Panasoffkee West and for Gainesville and Ocala. Lake Panasoffkee West materials are not easily differentiated from Ocala chert due to their similarity in fossil size. There are, however, marked differences in fossil abundance and this criterion can be used to differentiate between them. These differences, between the Gainesville and Ocala clusters, between Lake Panasoffkee East and West, and between Ocala and Lake Panasoffkee West, are in line with the differences observed by Austin (1997) that lead to his revision of these quarry clusters and the establishment of eastern and western megaclusters. Chert samples from the western side of the Ocala Uplift and those from the eastern side display fossil assemblages with clear differences in abundance and moderate differences in maximum size. Differing degrees of silicification and texture are also useful in differentiating between Lake Panasoffkee East and Lake Panasoffkee West. Cherts from the west and south are generally more homogenous, better

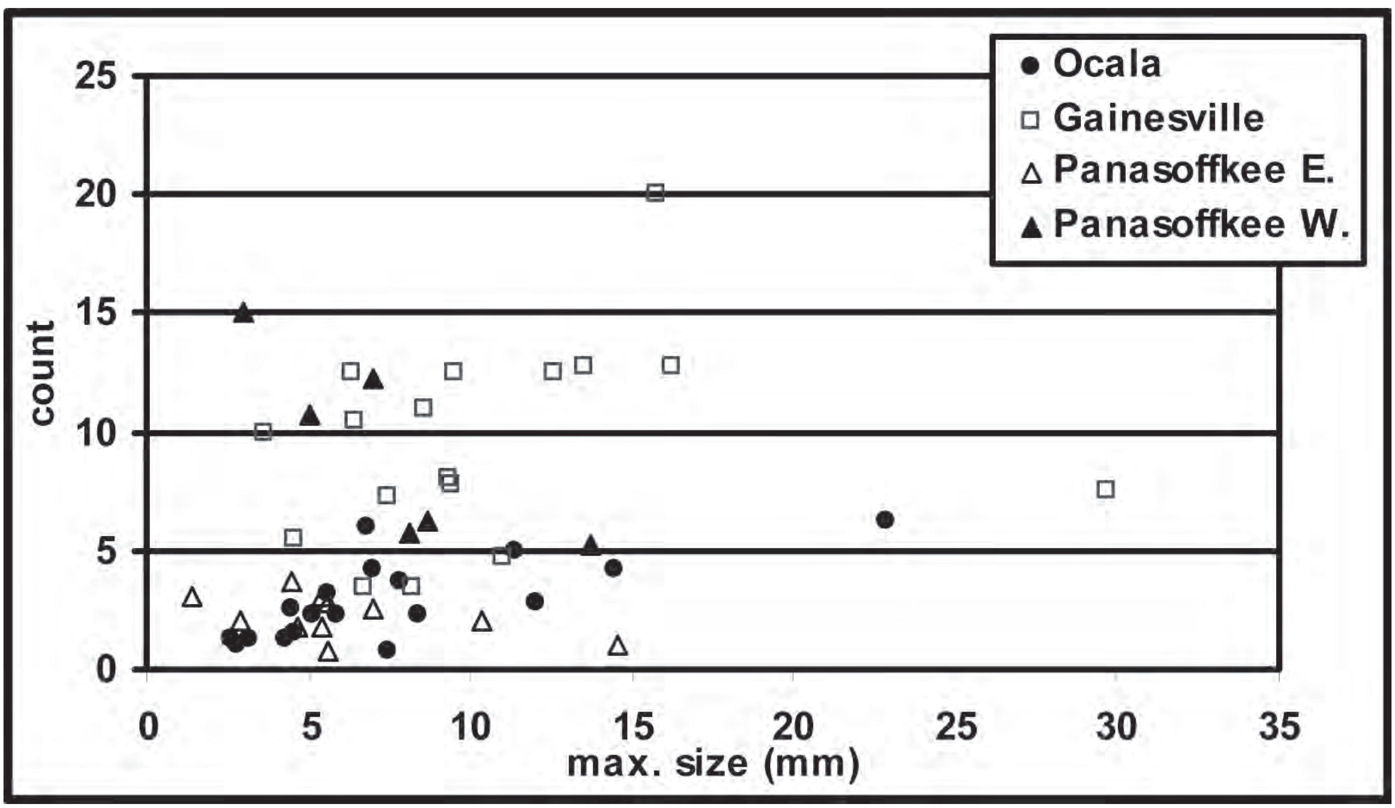

Figure 7. Scatterplot showing maximum fossil size and abundance for the Ocala, Gainesville and Lake Panasoffkee East and West quarry clusters.

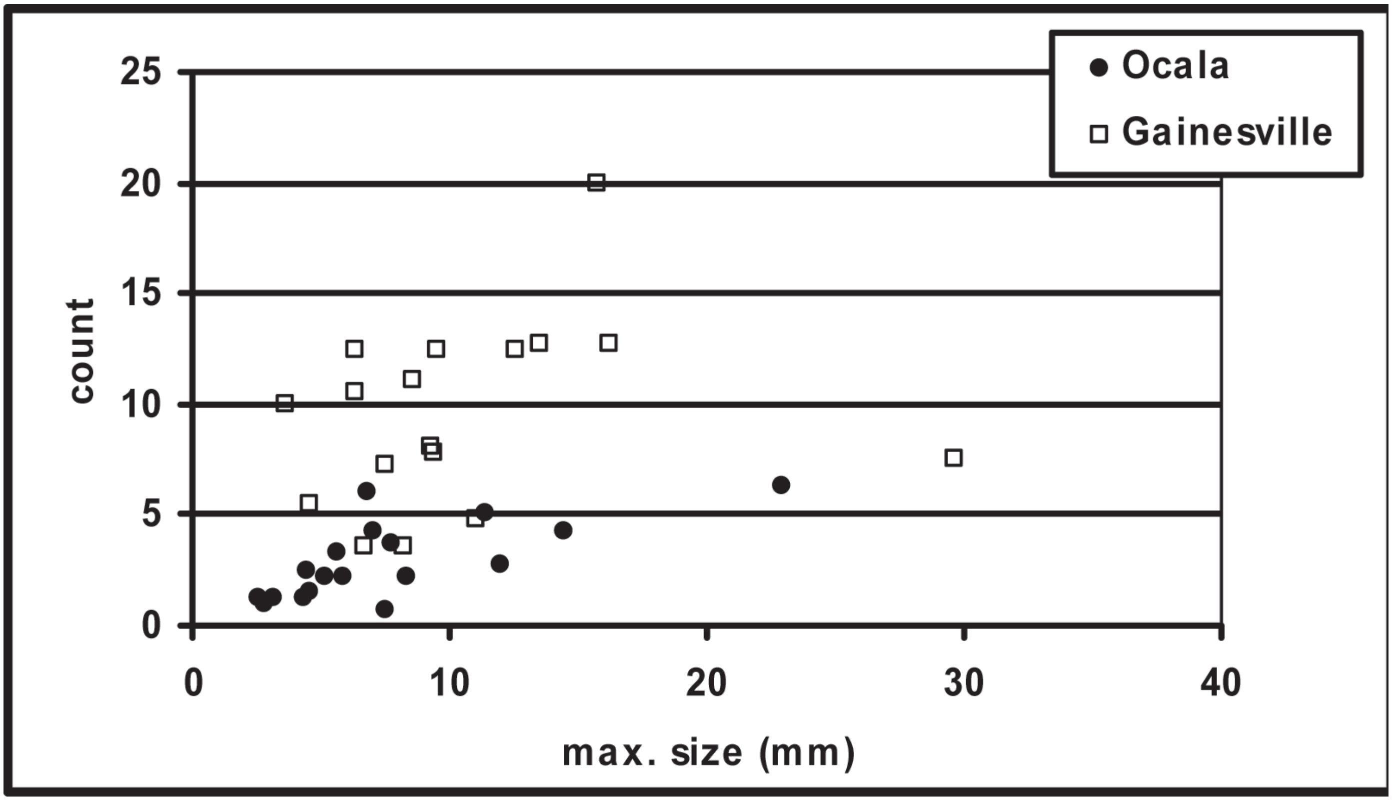

Figure 8. Scatterplot comparing maximum fossil size and abundance for the Ocala and Gainesville quarry clusters.

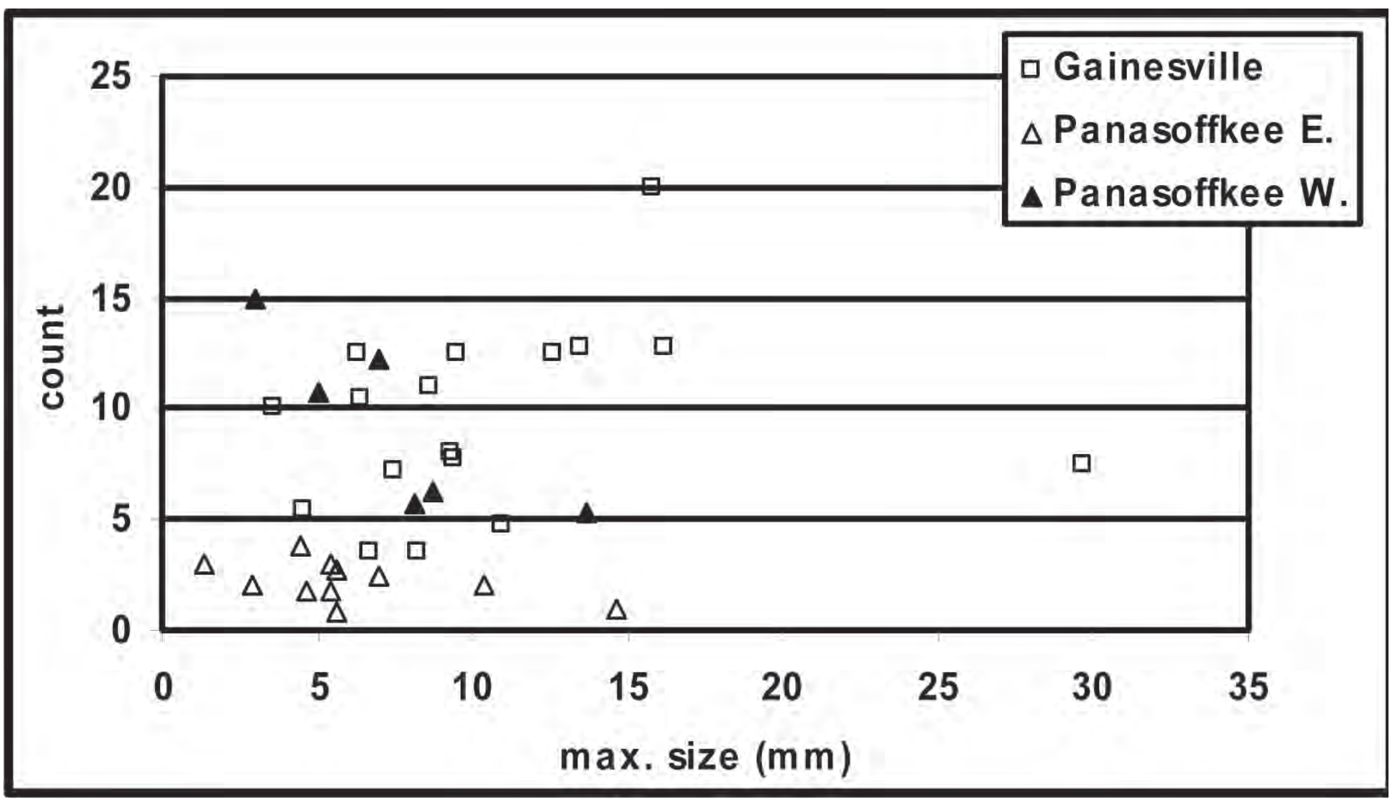

Figure 9. Scatterplot comparing maximum fossil size and abundance for the Gainesville, Lake Panasoffkee East, and Lake Panasoffkee West quarry clusters.

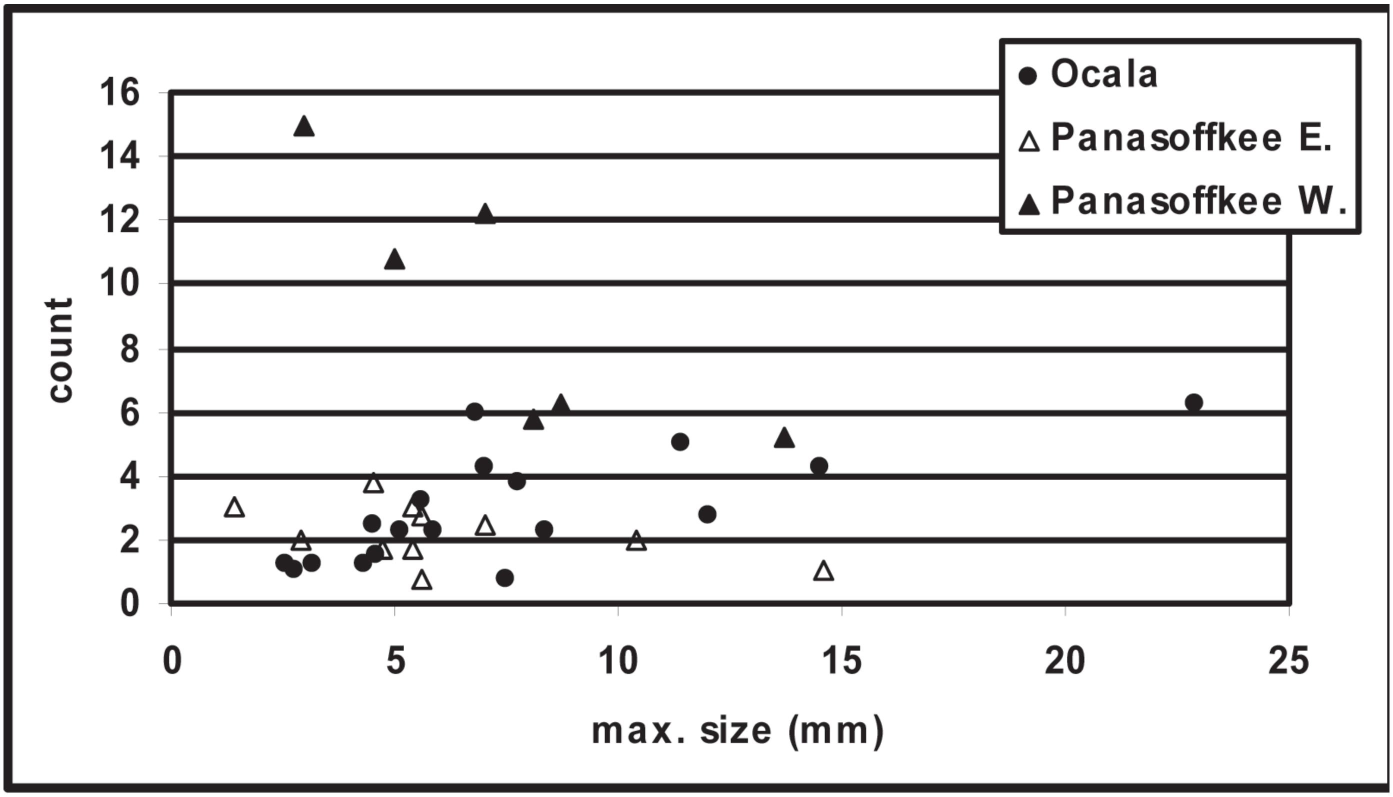

Figure 10. Scatterplot comparing maximum fossil size and abundance for the Ocala, Lake Panasoffkee East, and Lake Panasoffkee West quarry clusters.

silicified, and have a smoother texture than those from the east. Caution should be exercised when using these criteria, however, since the degree of silicification within a single exposure can vary widely.

Santa Fe Quarry Cluster

As noted earlier, the Santa Fe Quarry Cluster was once thought to be characterized by Ocala Limestone chert and is located at the northern end of the current study area. Samples collected during this work, as well as others prior and subsequent, have different diagnostic criteria than originally proposed by Upchurch et al. (1982). The Santa Fe Quarry Cluster is characterized primarily by Suwannee Limestone chert and occasionally silicified coral. Outcrops of Ocala Limestone material are present in northern Alachua County south of High Springs. As one moves north from the Gainesville Quarry Cluster and approaches the Santa Fe River, Suwannee Formation chert appears to the exclusion of Ocala Limestone chert. Samples collected in the vicinity of High Springs, O'Leno State Park, and the Santa Fe River confirms this. A single sample from an archaeological site near the confluence of the Santa Fe and Ichetucknee rivers in Columbia County was analyzed by Upchurch et al. (1982) and lead to the designation of this quarry cluster. It may, however, be best to include this location in the Lower Suwannee Quarry Cluster. The Lower Suwannee Quarry Cluster also is characterized by the single occurrence of Ocala Limestone chert at Fanning Springs in Levy County. The isolation of this exposure and the absence in general of silicified exposures in the area make this source somewhat anomalous. Materials from this source most closely resemble those in western Alachua County. Further sampling is needed in this area in order to clarify the relationship between this Ocala Limestone exposure and those of the Gainesville Quarry Cluster to the east.

Residua: Non-Ocala Limestone Chert and Corals

During the collection of chert samples for this study a few specimens that were clearly dissimilar to the usual Ocala Limestone material from the Ocala Quarry Cluster were encountered. Additionally, several locales that produced silicified coral were brought to the author's attention by Claude Van Order, expert flintknapper and prehistoric technologist from Lakeland, Florida. The presence of "atypical" materials is not insignificant and demonstrates the variability that can be present within a single quarry cluster, a phenomenon observed by Upchurch et al. (1982) but one that was not pursued further. The masking of variation in the definitional criteria of quarry clusters has recently been brought into focus by Estabrook (2005) who notes that quarry clusters have the potential to contain a greater diversity of material than previously recognized. The failure of archaeologists to address this variation can and will lead to misattribution of residual material to more distant sources when in fact they may be quite local. To help lessen the risk of such mistakes it is appropriate to discuss cherts that are "out of place" within the Gainesville, Ocala, and Lake Panasoffkee East and Lake Panasoffkee West quarry clusters.

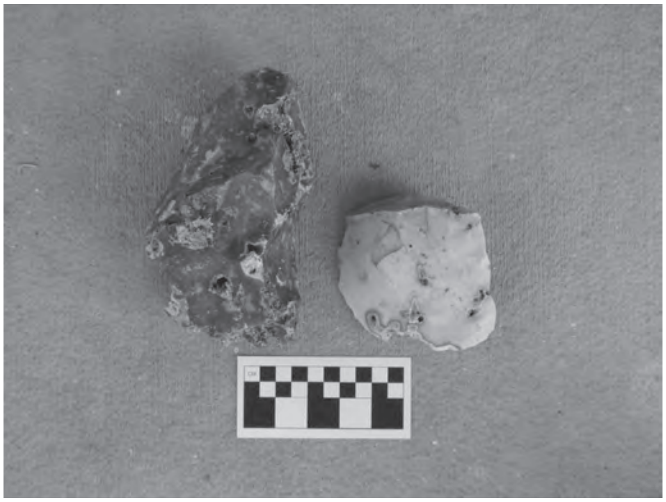

Figure 11. Non-Ocala Limestone chert from the Ocala Quarry Cluster.

Two chert samples resembling Hawthorn Group material were collected by the author from locations within the Ocala Quarry Cluster (Figure 11). The first atypical specimen (Figure 11, right) comes from an area near the junction of U.S. 301 and U.S. 441 in Marion County. Poorly silicified limestone was frequent at this location and good quality chert was not abundant though better material is likely in the vicinity. A medium-sized nodule collected from this location and has a relatively fine texture and a slight luster. Its fabric is reminiscent of Hillsborough River Quarry Cluster material and it appears to have a mudstone or wackestone fabric. Fossils observed consist of *Rotalids* (a family of small, single-celled marine foraminifera). Abundant fine sand was present as a secondary inclusion. Given these inclusions it would be easy to misidentify these materials as originating from the Hillsborough River Quarry Cluster (Upchurch et al. 1982:139-140).

The second atypical sample came from S-40 (Figure 11, left); a prehistoric quarry site characterized by abundant Ocala Limestone material. Several large nodules of this material were present at this location and were collected by the author. Though each nodule contained much high quality, fine-grained material, it is typically interspersed within a poorly silicified chert matrix. It is typically dark brown in color, lustrous, and has a splotchy, brecciated appearance. No diagnostic fossils were observed though a moderate amount of fine sand was present in the poorly silicified areas. There are similarities between this specimen and Hillsborough River Baybottom (Type 5) chert and Caladesi Quarry Cluster chert as described by Goodyear et al. (1983). Material bearing a strong resemblance to this has been observed by the author from a prehistoric context near Micanopy (Austin 2001). If nothing else, the preceding examples demonstrate the need to develop an appreciation for the amount of variability within quarry clusters rather than assuming that they are characterized exclusively by one type of material. Variation exists and the failure to recognize it can and will lead to misidentification and misinterpretation.

In addition to the two chert samples, several locations within the Gainesville, Ocala, and Lake Panasoffkee quarry clusters are known to have produced nodules of silicified coral. Silicified coral, because of its lack of diagnostic fossil content, cannot be attributed with any certainty to a particular source area though it is generally associated with both the Suwannee Limestone and Tampa member of the Hawthorn Group. No coral sources were noted in the Gainesville, Ocala, or Lake Panasoffkee quarry clusters by Upchurch et al. (1982). Several locations where coral has been found were brought to the author's attention by Claude Van Order. Mr. Van Order (personal communication, 2000) provided me with samples and location information for several coral sources. These include localities near Center Hill and Coleman in Sumter County, south of Summerfield in southern Marion County, and near Micanopy in Alachua County. Another source of coral was discovered during an archaeological survey near the town of Alachua in Alachua County (Stokes et al. 2001). With the exception of the source near Alachua, none of these coral outcrops appear to have been extensively exploited prehistorically and in fact, only a small amount of material suitable for the production of stone tools was present.

The presence of these atypical chert and coral deposits support Estabrook's (2005) contention that greater variation exists within quarry clusters and underscores the need to account for this variation. It does not undermine the utility of the quarry cluster approach, the general criteria used to assign samples to these clusters, or reduce the significance of the dominant types. By and large the central peninsular outcrops of Ocala Limestone chert are characterized by Orbitoids and have a grainstone or packstone fabric. It is, however, a cautionary tale for those who use lithic sourcing to draw conclusions about prehistoric mobility, settlement, and exchange. Accounting for variability within quarry clusters is yet another issue in desperate need of attention and tackling it will be another step forward for provenance studies.

Spatial Distribution

Upchurch et al. (1982) proposed the boundaries of their quarry clusters based to a significant degree on the extent of the limestone formations containing chert and a limited number of samples. Here, the distribution of chert sampled and analyzed is used to redraw the quarry cluster boundaries. Based on differences in the size and abundance of Orbitoid foraminifera presented above, the boundaries for the Gainesville, Ocala, and the Lake Panasofkee (East and West) quarry clusters have been revised (Figure 12) and are more similar to those proposed by Upchurch et al. (1982) and effectively reverse changes made by Austin (1997).

The boundaries of the Gainesville Quarry Cluster extend from an area sorth of the Alachua-Marion County line to just south of Alachua, and west from the area around Newnan's Lake to the Newberry area in western Alachua County and Williston in eastern Levy County. The extent of this quarry cluster is similar to that illustrated by Upchurch et al. (1982) though here its eastern edge has been shifted to the west and a portion of northwest Marion County and northeast Levy County have been included in this quarry cluster.

The Ocala Quarry Cluster stretches from just south of Orange Lake to southern Marion and northern Sumter county and from the just east of Silver Springs westward to S.R. 41 in

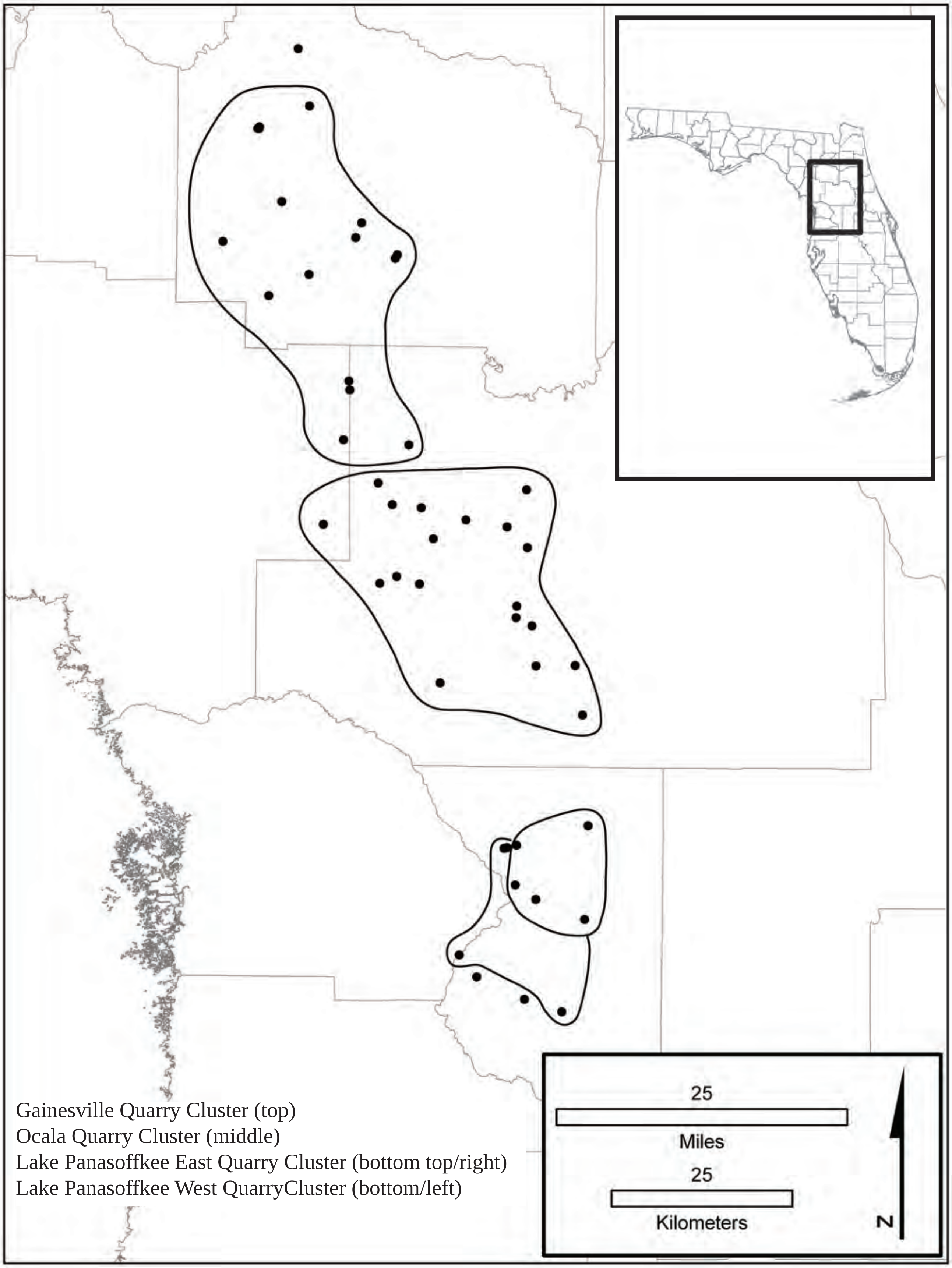

Figure 12. Revised boundaries for the Gainesville, Ocala, and Lake Panasoffkee East and Lake Panasoffkee West quarry clusters.

western Marion County. This configuration again is similar to Upchurch et al.'s (1982) Ocala Quarry Cluster except for the loss of some area in northwest Marion County and northeastern Levy County mentioned earlier. A further modification made as a result of this work is the separation of the southern end of the Ocala Quarry Cluster and the northern end of the Lake Panasoffkee Quarry Cluster. Both Upchurch et al. (1982) and Austin (1997) show the Ocala and Lake Panasoffkee sources as being contiguous. A break in the distribution of outcrops between these two sources is the basis for this division. Additional sampling at the southern end of the Ocala and the northern end of the Lake Panasoffkee quarry clusters may eventually lead to further revisions to these boundaries.

Lake Panasoffkee Quarry Cluster chert is distributed across an area in northern Sumter County in the vicinity of the town of Wildwood south to Bushnell and from the Withlacoohee River at the Sumter-Citrus County line east to around U.S. 301. The East/West division of the Lake Panasoffkee Quarry Cluster roughly corresponds to the eastern and western sides of I-75. Compared to both Upchurch et al. (1982) and Austin, (1997) the Lake Panasoffkee Quarry Cluster has been reduced as a result of this research. The northern boundary has been retracted toward the south and the western extent has been shifted eastward. The most significant modification (discussed above), is the separation of this quarry cluster into eastern and western sub-clusters.

A revised map reflecting the changes made to the extent of the quarry clusters considered in this research as well as those not considered is presented in Figure 13. The Lower Suwannee Quarry Cluster is quite large in both Upchurch et al.'s (1982) and Austin's (1997) representations, especially the latter (see Figures 3 and 4). Based on reconnaissance in the vicinity of the Lower Suwannee Quarry Cluster during this research and the failure to locate any additional sources of chert suitable for the production of stone tools in this area, I recommend that this quarry cluster be reduced in size and encompass the source at Fanning Springs and the surrounding environment. The modified representation of the Lower Suwannee Quarry Cluster can be seen in Figure 13. Changes to the extent of the Santa Fe Quarry Cluster also have been made. Both Upchurch et al. (1982) and Austin (1997) show the Santa Fe Quarry Cluster in contact with the Lower Suwannee Quarry Cluster. As a result of the reduced area of the Lower Suwannee Quarry Cluster, the Santa Fe Quarry Cluster is here considered not to be contiguous with it. Additional sampling is needed in order to more accurately characterize the extent of this quarry cluster. Provisionally, the Santa Fe Quarry Cluster can be considered to extend from an area just south of High Springs and the Santa Fe River north into southern Columbia County around O'Leno State Park, and east from near the confluence of the Ichetucknee and Santa Fe rivers up to, but no further than, the border of Columbia and Union counties. Having presented the fossil size and abundance criteria for distinguishing among the quarry clusters characterized by Ocala Limestone chert, its application to an archaeological assemblage is in order to demonstrate its usefulness.

Archaeological Application

My own interest in interaction and exchange among the Middle to Late Archaic Mount Taylor peoples of the St. Johns River Valley (SJRV) stimulated this research (Endonino 2003). The absence of naturally occurring lithic raw material suitable for making chipped stone tools in the SJRV rules out the possibility of local procurement. The production of lithic tools and the byproducts of their manufacture in this region must, therefore, have come from somewhere else. Given the proximity of the Gainesville, Ocala, and Lake Panasoffkee quarry clusters to the St. Johns River, I anticipated that much of the material found in the SJRV would be from these sources. When applied to an archaeological assemblage, the criteria for discerning between the Gainesville, Ocala, and Lake Panasoffkee quarry clusters outlined earlier successfully facilitated the attribution of lithic tools and debitage to each of these sources with greater confidence. A successful application of these criteria is demonstrated below through a comparison of the results of two sourcing efforts on the same assemblage: the first of these following criteria for the identification of Ocala Limestone chert outlined by Upchurch et al. (1982) and the second using the revised criteria presented in this paper.

The assemblage considered comes from 8VO53, the Lake Monroe Outlet Midden (LMOM), located on the western shore of Lake Monroe north of its juncture with the St. Johns River (Figure 14). A series of standard radiometric and AMS dates place this site's occupation between 4040-3090 B.C. (two sigma calibration) with most of the dates falling between 3660 B.C. and 3340 B.C. (ACI 2001:9-1). A lithic reduction area spatially segregated from the midden deposits produced an impressive assemblage of bifaces, microliths, flake tools, and debitage; arguably the largest Mount Taylor period lithic assemblage excavated to date. Both analyses of this assemblage were performed on materials from the midden and the lithic workshop.

Previous work by Archaeological Consultants, Inc. (ACI 2001:5-6) determined that at least five different quarry clusters are represented in the assemblage. Much of the material is believed to be chert from Ocala Limestone sources, and the Ocala Quarry Cluster in particular, as it is indicated as being the nearest source of chert to the project area. Other sources identified include the Peace River, Upper Withlacoochee, Brooksville, and Hillsborough River quarry clusters. However, source identifications are not indicated for debitage, microliths, or other tools and were only separated according to raw material type (chert vs. coral). Some of the bifaces were attributed to specific source areas "when possible" (ACI 2001:2-5). The inconsistent attribution of tools and the apparent lack of attributions for other tools and debitage make direct comparisons of sourcing efforts impossible. Likely the statement that Ocala Quarry Cluster materials account for the majority of the chert from this assemblage is based on impressions formed through observation during sorting and analysis. The attribution of a significant portion of the chert in the assemblage to the Ocala Quarry Cluster, without applying well-defined criteria, masks a great deal of variability in the sources present in the overall assemblage, especially

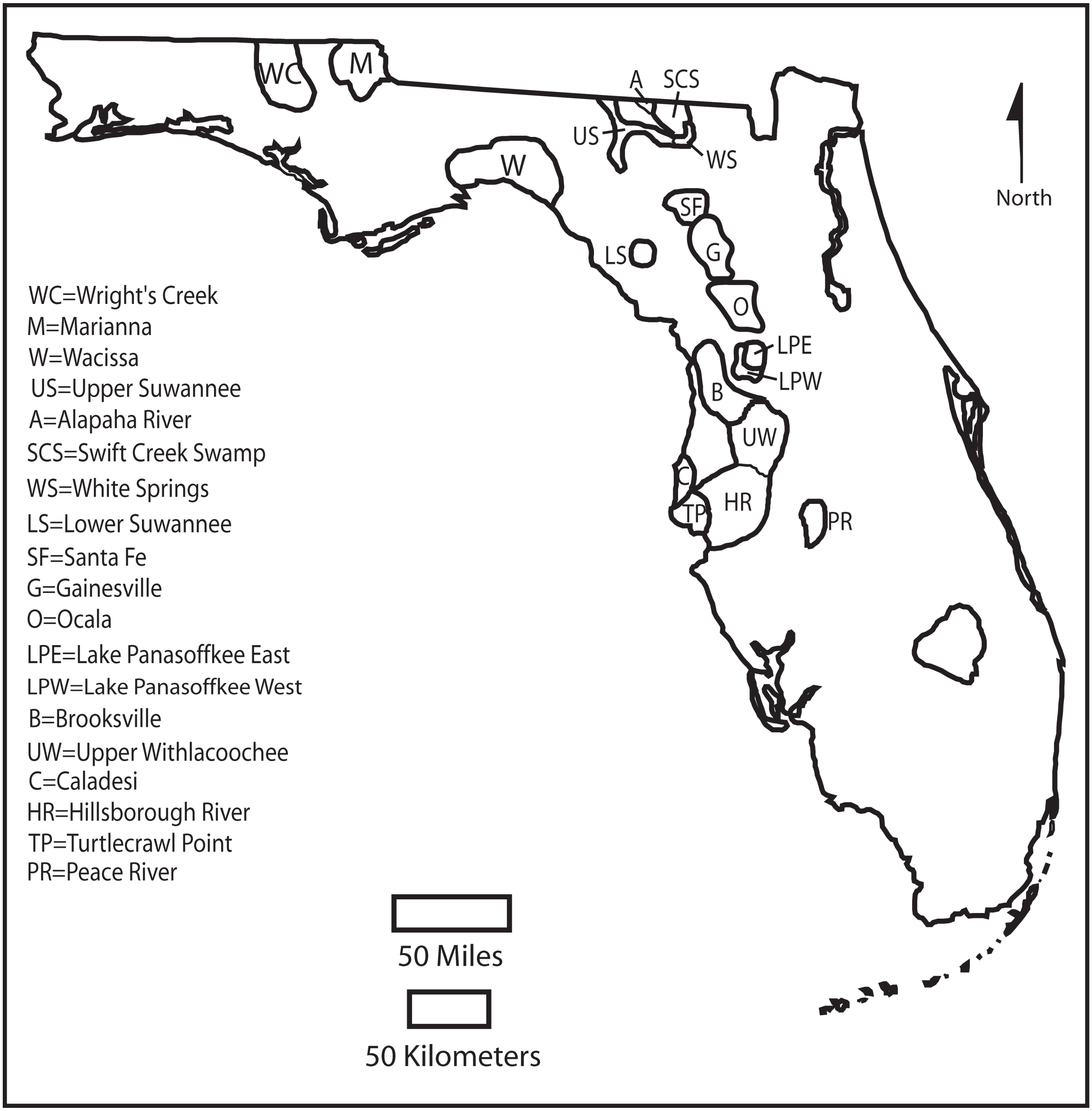

Figure 13. Quarry clusters reflecting changes based on this research.

considering that more than one quarry cluster characterized by Ocala Limestone chert are just as close if not closer than the Ocala Quarry Cluster.

A sample of the LMOM assemblage consisting of 1583 lithic artifacts was identified to source by the author (Endonino 2003). Tools came from all excavated proveniences at the site but only debitage from Test Units A (3x3-m) and C (4x4-m) within the midden deposits were analyzed. Test Unit B (4x4-m), placed at the location of the lithic workshop and located away from the midden, produced an abundance of debitage and microlithic tools as well as haftable bifaces and biface fragments. Debitage from this location has not yet been analyzed in detail, but during preliminary sorting it was observed that somewhat less than half of the material was chert, and of that, most appeared to be derived either from Suwannee or Ocala Limestone sources; this is in accord with the findings presented below. Among the artifacts analyzed are 36 haftable bifaces and biface fragments, 266 “other” tools including a number of flake tools and microliths, and 1281 pieces of debitage.

The frequency and percent of each source area identified is presented in Table 4. Twelve distinctive source areas

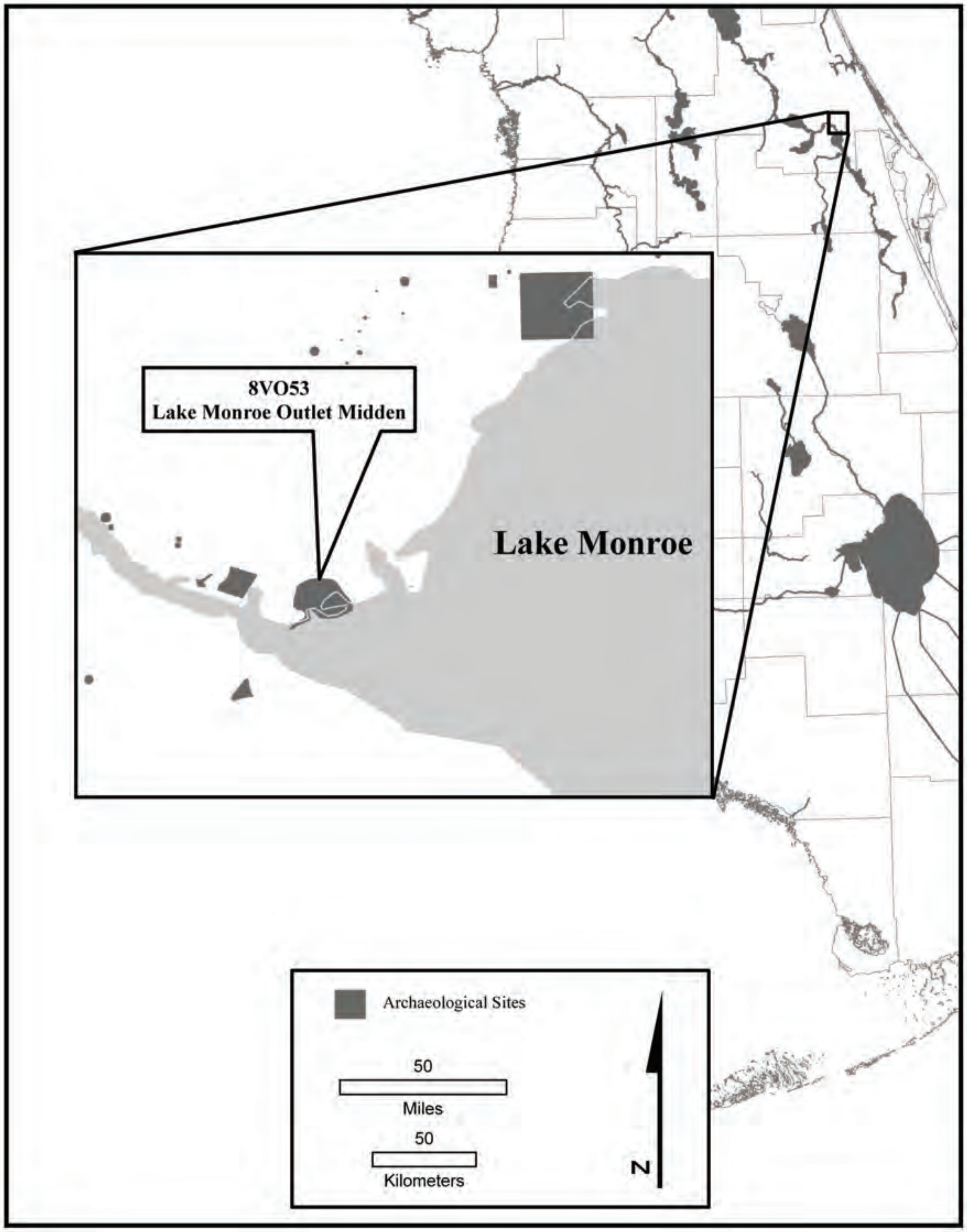

Figure 14. Location of 8VO53, the Lake Monroe Outlet Midden.

were identified and of these, five are characterized by Ocala Limestone materials. Overall, Ocala Limestone materials account for a little over 30 percent of the assemblage. All of the quarry clusters characterized by Ocala Limestone chert considered in this paper were present: Gainesville, Ocala, Lake Panasoffkee East, and Lake Panasoffkee West. The Lake Panasoffkee chert, especially Lake Panasoffkee West, proved to have accounted for most of the chert present at the site. Chert from the Green Swamp and Rock Ridge areas within the Upper Withlacoochee River Quarry Cluster provided a fair amount of the lithic material, about seven percent of the site total. The Green Swamp/Rock Ridge localities are characterized by Ocala Limestone chert but their case is unique in that it also contains fossils diagnostic of the Suwannee Limestone and sand as a secondary inclusion (Upchurch et al. 1982:132). These characteristics in combination make this source area unique and readily identifiable. Other quarry clusters are represented as well. Hillsborough River Quarry Cluster material identified comes from two sub-areas: the Upper Hillsborough River and Cowhouse Creek. The presence of frequent gastropods, sometimes called "drills" or "aguers," are an indicator of origins in the upper reaches of the Hillsborough

Table 4. Quarry cluster determinations for Lake Monroe Outlet Midden (8VO53) lithic materials.

Material	Quarry Cluster	Bifaces		Other Tools		Debitage		Total	
		N	Pct.	N	Pct.	N	Pct.	N	Pct.
Chert	Gainesville	1	0.06	4	0.25	11	0.69	**16**	**1.00**
Chert	Ocala	6	0.38	12	0.76	38	2.40	**56**	**3.54**
Chert	Lake Panasoffkee East	3	0.20	7	0.44	104	6.57	**114**	**7.21**
Chert	Lake Panasoffkee West	7	0.44	69	4.36	161	10.17	**237**	**14.97**
Chert	Lake Panasoffkee Indeterminate	0	0.00	0	0.00	2	0.13	**2**	**0.13**
Chert	Ocala Limestone Indeterminate	2	0.13	8	0.51	52	3.28	**62**	**3.92**
Chert	Upper Withlacoochee River, GS/RR	0	0.00	19	1.20	92	5.81	**111**	**7.01**
Chert	Upper Withlacoochee River	0	0.00	10	0.63	69	4.36	**79**	**4.99**
Chert	Brooksville	1	0.06	5	0.32	39	2.46	**45**	**2.90**
Chert	Suwannee Limestone Indeterminate	0	0.00	0	0.00	3	0.20	**3**	**0.20**
Chert	Hillsborough River	1	0.06	3	0.20	8	0.51	**12**	**0.77**
Chert	Hillsborough River, CHC	0	0.00	0	0.00	2	0.13	**2**	**0.13**
Chert	Upper Hillsborough River	0	0.00	3	0.20	1	0.06	**4**	**0.26**
Chert	Caladesi	0	0.00	3	0.20	14	0.88	**17**	**1.08**
Chert	Indeterminate	1	0.06	0	0.00	19	1.20	**20**	**1.26**
Silicified Coral	Indeterminate	14	0.88	123	7.77	666	42.07	**803**	**50.72**
Total		**36**	**2.27**	**266**	**16.84**	**1281**	**80.92**	**1583**	**100**

GS/RR=Green Swamp/Rock Ridge locality within the Upper Withlacoochee River Quarry Cluster, CHC=Cow House Creek locality within the Hillsborough River Quarry Cluster.

River. Charophyte oogonia, the reproductive apparatus of a freshwater plant, are diagnostic of the Cowhouse Creek and Harney Flats areas in Hillsborough County (Upchurch et al. 1982:74). Caladesi Quarry Cluster chert is represented by a few of the "other tools" and debitage and these may have been the Peace River materials identified during the ACI (2001) analysis. The particular source within the Peace River Quarry Cluster they cite are characterized by fossils (*Sorites* spp.) and sand inclusions similar to those characteristic of the Caladesi materials. The findings presented here, as well as those of ACI (2001), are in agreement regarding the presence of Suwannee Limestone chert sources, namely the Upper Withlacoochee River (exclusive of the Green Swamp and Rock Ridge areas) and Brooksville quarry clusters.

These source identifications diverge from those of ACI (2001) in that more sources have been identified and, most importantly, materials attributable to the Gainesville, Ocala, and Lake Panasoffkee East and West quarry clusters were discernible using size and abundance criteria. Whereas the original analysis by ACI (2001) identified only a single quarry cluster characterized by Ocala Limestone chert, the Ocala Quarry Cluster following Upchurch et al. (1982), the revised criteria presented in this paper allowed for all four sources considered here as well as the related, though distinct, Green Swamp/Rock Ridge area within the Upper Withlacoochee River Quarry Cluster, to be discerned. The ability to more accurately source lithic artifacts from 8VO53, or any other assemblage, allows issues such as mobility, band range, and exchange to be addressed in a more precise and nuanced fashion. While a more thorough consideration of the mechanisms for bringing lithic raw materials into the SJRV is beyond the scope of this paper, the criteria developed here for discerning among Gainesville, Ocala, and Lake Panasoffkee East and West cherts have been shown to be applicable to archaeological problems.

Conclusions

These results are encouraging. There are real differences in the size and abundance of fossils in cherts from Upchurch et al.'s (1982) Gainesville, Ocala, and Lake Panasoffkee quarry clusters. These differences are observable, quantifiable, and can be used to differentiate between the clusters. Table 5 presents these revised criteria. Based on differences in the abundance and size of fossil content of the samples studied, alterations to the geographic extent of the Gainesville and Ocala quarry clusters also have been made and the Lake Panasoffkee Quarry Cluster has been divided into eastern and western clusters. Additional sampling will, as predicted by Upchurch et al. (1982) 25 years ago, likely result in additional changes and refinements. Future work should focus on collecting more samples from Ocala Limestone-derived cherts, especially at the northern end of the Gainesville Quarry Cluster, the southern end of the Ocala and northern end of the Lake Panasoffkee East and West quarry clusters, and within the Lake Panasoffkee East and West quarry clusters. Sampling within the Lower Suwannee Quarry Cluster in order to characterize and determine its extent is yet another important area for future work. Finally, efforts need to be made to search for "anomalies" within quarry clusters that might be mistaken for materials from other source areas.

In all, the results have been positive and I believe they will be useful to others interested in the provenance determination of cherts used by prehistoric groups. This paper has largely been methodological in its orientation and most of it has been of a geological nature with its relationship to archaeology only minimally developed. Hopefully the brief example of their application to an archaeological assemblage will demonstrate their usefulness. Knowing the sources of stone, their distribution, and being able to distinguish between them using empirical and quantifiable criteria is necessary for laying a solid foundation for provenance studies and gives further

Table 5. Revised diagnostic criteria for the Gainesville, Ocala, Lake Panasoffkee East and Lake Panasoffkee West quarry clusters.

Quarry Cluster	Host Rock Fabric	Diagnostic Criteria	Avg. Abund.*	Avg. Size*
Gainesville	packstone, grainstone	abundant Orbitoids, tend to be larger than other quarry clusters, Pectens frequent, fairly well-silicified, some quartz-lined voids	9.55	10.5
Ocala	packstone	small Orbitoids that are few in number, Pectens common, chert comes in homogenous and variably silicified masses	2.88	7.6
Lake Panasoffkee E.	grainstone, minor packstone	Orbitoids few in number and tend to be small, silicification is variable but tends to be less than Ocala or Panasoffkee W, scattered Pectens, quartz-lined cavities	2.20	6.1
Lake Panasoffkee W.	grainstone, minor packstone	abundant Orbitoids variable in size but not as large as Gainesville, scattered Pectens, quartz-lined cavities, better silicification that Panasoffkee East	9.20	7.6

* Per square centimeter.

strength to the to the conclusions arrived at by archaeologists using this method of inquiry.

Notes

1. Upchurch et al. (1982) define packstones a grain supported stone where the large grains are in contact and the pores between the grains are filled with mud. Grainstones are grain-supported rocks with minimal mud in the pore spaces resulting in a highly permeable and porous material.

Acknowledgements

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