Analysis of Plant Remains from the McCoy Bridge sites (31MA684 and 31MA774):

prepared by:
Amber M. VanDerwarker
Matthew Biwer
Mallory Melton
Jenna Santy

Report Submitted to TCR Environmental Corporation

Table of Contents

Tables at end of document in sequential order:

Appendices provided in separate MS Excel files:

Introduction

Archaeological plant and animal assemblages represent only a small fraction of what was originally used and deposited by humans in open-air settings. Natural and cultural factors can significantly modify organic remains, resulting in recovered assemblages that differ dramatically from the original deposits. As archaeologists, we examine collections that have undergone a series of processes—from the original selection of plants and animals by humans, to food preparation, cooking, discard, animal and insect scavenging, burial, decay, and weathering, to the recovery of food residues by archaeologists. Using standard methodological procedures for sampling, quantification, and analysis allows us to make sense of our assemblages in spite of the deleterious effects of these processes. Here we report on the identification and analysis of the archaeobotanical assemblage from the two adjacent Cherokee residential sites that were excavated as part of the McCoy Bridge Project, both of which are located in Macon County, North Carolina: 31MA684 (Middle Qualla period) and 31MA774 (Late Qualla period).

Recovery and Preservation Bias

The circumstances under which plants preserve best archaeologically involve extreme conditions (e.g., exceptionally wet, dry, or cold environments) that prohibit decomposition of organic matter (Miksicek 1987). Plants can also preserve through exposure to fire, which can transform plant material from organic matter into carbon (Miksicek 1987). The likelihood that a plant will become carbonized varies according to the type of plant, how it is prepared and used, and whether it has a dense or fragile structure (Scarry 1986). Plants that are eaten whole are less likely to produce discarded portions that may find their way into a fire. Plants that require the removal of inedible portions (e.g., hickory nutshell, corn cobs) are more likely to find their way into a fire, and thus into the archaeological record. Inedible plant parts represent intentional discard that is often burned as fuel. Moreover, because inedible portions tend to be dense and fibrous, they are more likely to survive the process of carbonization than the edible parts (e.g., hickory nutshell vs. nutmeats). Physical characteristics are also important for determining whether or not a plant will survive a fire. Thick, dense nutshells are more likely to survive a fire than smaller, more fragile grass seeds. Food preparation activities also affect potential plant carbonization. The simple process of cooking provides the opportunity for carbonization through cooking accidents. Foods that are conventionally eaten raw, however, are less likely to be deposited in fires than cooked foods. Some plants that find their way into the archaeological record in carbonized form were not eaten at all. Wood fuel is the most obvious example. Other non-food plants that become carbonized are incidental inclusions, such as seeds blown by wind dispersal (Miksicek 1987; Minnis 1981; Scarry 1986). Indeed, most secondary invaders are weedy species with lots of seeds (e.g., cheno/am plants) (Minnis 1981).

While we cannot ever hope to know the absolute quantities or importance of different plants in any past subsistence economy, the preservation and recovery biases discussed above do not prohibit quantitative analyses of archaeobotanical assemblages. The most commonly used plant resources in any subsistence economy are more likely to be subject to activities that result in carbonization (e.g., through fuel use and accidental burning) and ultimately, deposition (Scarry 1986; Yarnell 1982). Thus, we can quantitatively examine the relative importance of commonly-used plant resources through time and across space.

Methods of Quantification

Quantitative methods in archaeobotany have developed significantly over the past several decades, and as a result, have been a subject of much critical discussion (Hastorf and

Popper 1988). The most common methods for recording and quantifying plant remains are counts and weights. Because of problems with comparability between different types of plant taxa, however, raw (or absolute) counts and weights are not appropriate comparative measures (Scarry 1986). For example, denser taxa yield higher weights than more fragile taxa, and some taxa yield higher seed counts than others (e.g., grasses versus fruits) (Scarry 1986). Thus, using absolute counts or weights to summarize plant data is highly problematic. Most archaeobotanists agree that absolute counts are inadequate for assessing past people-plant interactions in that they do not control for biases related to preservation and sampling error (Kandane 1988; Miller 1988; Popper 1988; Scarry 1986). Absolute counts and weights are simply raw, unstandardized data.

One way to avoid the problems of absolute counts/weights is through the use of ubiquity measures (Godwin 1956; Hubbard 1975, 1976, 1980; Popper 1988, Willcox 1974). This type of analysis is essentially a presence/absence analysis that sidesteps the problems of counts and weights by measuring the frequency of occurrence instead of abundance. In other words, ubiquity analysis measures the number of samples in which a taxon was identified, as opposed to the number of specimens represented by that taxon. The researcher first records the presence of a specific taxon in each sample, and then computes the percentage of all samples in which the taxon is present (Popper 1988). For example, if acorn shell is present in four out of ten samples, then its ubiquity value is 40%. Thus, each taxon is evaluated independently (Hubbard 1980). Because different types of plants are disposed of differently, direct comparisons of ubiquity values between taxa are problematic (Hubbard 1980:53). For example, a 70% ubiquity value for hickory nutshell would not be equivalent to a 70% ubiquity value for beans as these categories have different preservation opportunities—hickory nutshell represents a processing by-product often used as fuel, while beans represent edible portions.

As with any quantitative measure, ubiquity analysis has its disadvantages. A sufficient number of samples is necessary to provide meaningful results as using too few samples creates a high likelihood of sampling error. Hubbard (1976:60) suggests a minimum of 10 samples. Moreover, although ubiquity analysis may mitigate for preservation biases, it is not immune to them (Hubbard 1980:53; Scarry 1986:193). Most importantly, because ubiquity deals with occurrence frequency and not abundance, it can potentially obscure patterns where occurrence frequency does not change but abundance does (Scarry 1986). As Scarry (1986:193) notes: "the frequency with which a resource is used may remain constant, while the quantity used varies." For example, a family may consistently eat corn on a daily basis, but the quantity they consume may vary from day to day. Despite these weaknesses, ubiquity analysis is a good starting point and can provide meaningful results when used alongside other measures.

While ubiquity measures may sidestep the problems inherent in absolute counts, they do not provide a means for calculating relative abundances of different plant taxa. Using comparative ratios is one way of determining the relative abundances of different plants. Essentially, calculating a ratio is a means of standardizing raw measures. In other words, we can deal with the problems of absolute counts and weights by standardizing them in terms of some constant variable (Miller 1988; Scarry 1986). The density measure standardizes data in terms of soil volume—the absolute count or weight of carbonized plant material (for individual taxa or for larger collapsed categories, e.g., corn kernels or corn) is divided by total soil volume for each sample or context. Density measures calculate the abundance of plants per liter of soil, and it is generally assumed that larger volumes of soil will yield more plant remains. However, differences in the context and manner of deposition between soil samples structure the relationship between soil volume and the size of the plant assemblage. For example, a 10 L soil sample from an intact house floor would probably yield a smaller sample of carbonized plant remains than a 10 L soil sample from a refuse midden, because people tend to keep their houses cleaner than their trash dumps. Thus, density measures are useful in determing feature function.

Standardizing by soil volume, however, does not control for the range of non-plant related activities that contribute to the deposit from which the soil sample derives. In other words, the density measure does not consider plant remains in terms of plant-related activities, but rather in terms of all of the activities that are represented in the deposit. Thus, if the analyst is interested in determining the importance of a specific plant relative to the other plants in a sample or context, then density measures may be inadequate. Rather, standardizing by plant weight might be more appropriate (Scarry 1986). Unlike the density measure, standardizing by plant weight considers the contribution of a specific plant or category of plants solely in terms of plant-related activities. As a result, a plant weight ratio more accurately reflects spatial and temporal differences in plant use. As a quantitative category, plant weight is a sum of weights recorded for all carbonized plant specimens per sample or context. Thus, for each sample, there is a total weight of plant material—this figure is the denominator used to standardize the variable of interest.

Overall, ratios are useful quantitative tools that overcome some of the problems of absolute counts. It is important to understand, however, that ratios reveal only the relative importance of plants within varied depositional contexts, not the absolute dietary contribution of actual resources used in the past (Scarry 1986). For the purposes of the present analysis, we used both plant weight and soil volume to standardize the data – interestingly, both measures yielded similar patterning in the data. Thus, most of the data are presented as density measures.

Finally, the analysis presented below also uses diversity analysis (the Shannon-Weaver Index) to evaluate the richness and evenness of plant taxa in the assemblages from different temporal contexts. The Shannon-Weaver Index determines diversity based on count data, and diversity values for different assemblages are compared directly. In addition, the Shannon-Weaver diversity index (H′, see below) combines both richness and evenness into a single measure. The mathematical formula is as follows (Reitz and Wing 1999:105):

$$H' = -\sum_{i=1}^{s} (p_i)(\mathrm{Log}\ p_i)$$

where:

H' = the diversity index
p_i = the relative abundance of the i^{th} taxon in the sample (for the animal assemblages, this is calculated as NISP and MNI)
Log p_i = the logarithm of p_i (this is calculated to the base 10 for both assemblages)
s = the number of different taxa represented in the sample

When comparing the diversity among different samples, higher numeric values (for H′) indicate higher species diversity (Reitz and Wing 1999). Because the Shannon-Weaver index combines both richness and evenness, the diversity of one sample relative to another depends upon how richness and evenness co-vary. For example, if Assemblage A is richer than Assemblage B, but both are similarly even, then Assemblage A will yield a higher diversity value. In addition, if the categories in Assemblage C are more evenly distributed than the categories in Assemblage D, but both are similarly rich, then Assemblage C will yield a higher diversity value (Reitz and Wing 1999:105). While evenness (or equitability) is a component of the diversity index (H′), it can also be considered independently, as follows:

$V' = H'/\text{Log } s$

where:

V' = equitability
H' = the diversity index (as calculated above)
s = the number of different taxa represented in the sample

Equitability values (V') can range from 0 to 1, with a value of 1 indicating an even distribution of taxa, and lower values representing less even distributions (Reitz and Wing 1999:106)

Laboratory Procedures

A total of thirty-five flotation samples from both sites were sent to UCSB's Integrative Subsistence Lab for analysis. These samples represent approximately 25% subsample of the total flotation samples taken over the course of excavations. Twenty-two samples from 10 features come from the Middle Qualla site, and 13 samples from 11 features come from the Late Qualla site. Both the light and heavy fractions of these flotation samples were analyzed. Although the materials from the light and heavy fractions were processed and sorted separately, data from the two fractions were combined for analysis. According to standard practice, the light fractions were weighed and then sifted through 2.0 mm, 1.4 mm, and 0.7 mm standard geological sieves. Carbonized plant remains from both fractions were sorted in entirety down to the 2.0 mm sieve size with the aid of a stereoscopic microscope (10–40 X). Residue less than 2.0 mm in size was scanned for seeds, which were removed and counted; in addition, taxa encountered in the 1.4 mm sieve that were not identified from the 2.0 mm sieve were also removed, counted, and weighed. Corn cupules and acorn nutshell were also collected from the 1.4 mm sieve as these tend to fragment into smaller pieces and can be underrepresented in the 2.0 mm sieve.

Botanical materials were identified with reference to the paleoethnobotanical comparative collection at the University of California, Santa Barbara (UCSB) paleoethnobotany lab, various seed identification manuals (Martin and Barkley 1961; Delorit 1970), the USDA pictorial website (http://www.ars-grin.gov/npgs/images/sbml/), and Minnis (2003) which allowed us to identify the range of taxa native to the region. Taxonomic identification was not always possible—some plant specimens lacked diagnostic features altogether or were too highly fragmented. As a result, these specimens were classified as "unidentified" or "unidentified seed." In other cases, probable identifications were made—for example, if a specimen closely resembled a corn cupule, but a clear taxonomic distinction was not possible (e.g., the specimen was highly fragmented), then the specimen was identified as a probable corn cupule and recorded as "corn cupule cf.".

Once the plant specimens were sorted and identified, we recorded counts, weights (in grams), portion of plant (e.g., corn kernels versus cupules), and provenience information. Wood was weighed but not counted, and no wood identification was conducted. Generally, most of the seeds identified in the samples were too small to weigh, and thus only counts were recorded. Hickory nutshell and corn remains were identified only as fragments, and were both counted and weighed. Other than counts and weights, no other measurements were taken on any specimens. In some cases, taxon counts were estimated by their respective weights. For each light and heavy fraction that yielded more than 200 specimens of a single taxon, the absolute number was extrapolated from the weight of a sub-sample of 200 specimens with respect to the weight of all specimens of that taxonomic category in the light or heavy fraction sample. The equation is expressed as follows:

$$\frac{x}{b} = \frac{200}{a} \quad \rightarrow \quad ax = 200b \quad \rightarrow \quad x = \frac{200b}{a}$$

where *a* is the weight of the sub-sample of 200 corn kernels, and *b* is the weight of the entire sample of corn kernels; *x* is the variable to solve for.

In addition to sampling a portion of the flotation samples that were sent to UCSB, we also sub-sampled selected samples that were extremely large. These samples were weighed and then systematically split using a riffle splitter; some samples were split in half and others in quarters depending on the overall weight of the sample. Counts and weights from the selected subsample were extrapolated using the total sample weight.

Basic Results

This section presents the results of the identification of the carbonized plant remains from the both sites. Common names of plants and their corresponding taxonomic identifications are listed in Table 1. Table 2 presents raw counts and weights of all taxa summed by period (data summary by feature is listed in Appendix A and B); raw counts and weights are provided for each taxon. In addition to plant weight, wood weight and soil volume are also provided.

As mentioned above, a total of 35 flotation samples were sent to UCSB for analysis, representing a total of 443 liters of soil with a total plant weight of 551 grams. Combined, these samples yielded 32 plant taxa (identified to the genus level), including corn, a variety of nuts and fruits, and numerous small seeds (Tables 1, 2).

In addition to corn (*Zea mays*), other cultigens identified in the McCoy Bridge samples include bean (*Phaseolus* sp.), bottle gourd (*Lagenaria siceraria*), knotweed (Polygonum sp.), goosefoot (Chenopodium sp.), and little barley (Hordeum pusillum). Corn and beans are often discussed together as they commonly represent partner crops. Although they did not co-evolve as part of the same domestication process, corn and beans have a long tradition of inter-cropping and successional cropping in the New World (Lentz 2000). Inter-cropping is beneficial in that corn stalks support the bean vines throughout plant growth (Smartt 1988:149). Moreover, inter-cropping also reduces the risk of pest and disease outbreaks than in pure stands (Smartt 1988:149). Corn and beans are also complementary in terms of nutritional value; corn is deficient in essential amino acids lysine and isoleucine, which beans have in abundance (Bodwell 1987:264; Giller 2001:140). Thus, in addition to the benefits of cropping corn and beans together, there are also benefits to eating corn and beans together. Bottle gourd fruit, seeds, oil and leaves are edible and the gourds are easy to grow. The rinds can also be hollowed out for storage of water and other substances. Unlike corn and beans which were planted in small holes made with digging sticks, knotweed, goosefoot, and little barley were typically broadcast by hand. Their low abundances in comparison to corn make it likely that these cultigens were planted in home gardens instead of prepared fields. Like chenopod and knotweed, little barley is a grain seed and a good source of carbohydrates; grain seeds were probably parched and could be ground down to a meal and baked into bread or incorporated into stew.

Nutshell recovered from the McCoy Bridge flotation samples includes acorn (*Quercus* sp.), thick-shelled hickory (*Carya* spp.), black walnut (*Juglans nigra*), hazelnut (*Corylus* sp.), and pecan (*Carya illinoensis*), the latter which represents a thin-shelled hickory. Acorn was the most abundant nut recovered, followed by hickory and black walnut. It is worth mentioning, however that virtually all of the acorn remains (both shells and nutmeats) were recovered from a single feature (Feature 351) that dates to the Middle

Qualla period. The extent of acorn processing depends upon whether the nuts derive from white or red oak trees. Nuts from the red oak are high in tannin and are extremely bitter as a result. White oaks, however, yield sweeter nuts; the nutmeats from these acorns can be used for cooking immediately after extraction from the shell (Scarry 2003). The tannin present in the bitter acorns, however, requires an additional processing step. Leaching the tannin from acorns can be accomplished either by soaking them in water, or parching and then boiling them with an alkaline substance such as wood ash. Once processed, acorns were generally ground into a fine meal, which could then be used to make gruel, bake bread, or thicken stews. Less often, acorns were boiled and the oil extracted (Swanton 1944:260, 277).

While the nutmeats of walnuts and pecans can be easily extracted from the shell, thick-shelled hickory nuts require more extensive processing before they are rendered palatable (Petruso and Wickens 1984). The hickory kernels are so tightly enmeshed in the interior shell that picking the nutshells from the cracked shell casing is a time-consuming task. Instead, hickory nuts were generally pounded into pieces and boiled to extract the oil (Ulmer and Beck 1951). The process of boiling the pounded hickory nuts separates the pieces of shell, which sink to the bottom of the pot, from the oil, which rises to the top as the nutmeats dissolve and can be skimmed off or decanted. This oil or milk would then be used as an added ingredient in soups and stews, as a condiment for vegetables, or as a general sauce or beverage (Scarry 2003; Talalay et al. 1984). The hazelnut identified in the assemblage probably represents the American hazelnut (*Corylus americana*). Unlike the other nuts which come from trees, hazels are shrubs; they prefer open and anthropogenic habitats, and form dense thickets (Scarry 2003). While the nuts begin to ripen in the late summer, they do not fall to the ground until October/November, at which time they are quickly consumed by animals (Scarry 2003). These factors would have resulted in low collection rates for this type of nut (Scarry 2003; Talalay et al. 1984). Hazelnuts are high in fat and were probably processed for the nutmeats themselves, as opposed to the oil they produce (Scarry 2003).

Fruit taxa recovered from the samples are represented by wild species, with the exception of several peach pits (*Prunus persica*) from Late Qualla features. Wild species of fruit include grape (*Vitis* sp.), persimmon (*Diospyros virginiana*), blackberry/raspberry (*Rubus* sp.), plum/cherry (*Prunus* sp.), groundcherry (*Physalis* sp.), maypop (*Passiflora incarnata*). It is worth noting that uncarbonized seeds of maypop, blackberry/raspberry, and groundcherry were found in abundance in multiple features from both time periods. Evidently, the sites represented fallow agricultural fields and were covered with these plants prior to being cleared for excavation. Thus, it is possible that the carbonized seeds of these species are also modern in nature, having been carbonized through previous episodes of burning fallow fields to prepare them for planting. Both the carbonized and uncarbonized seeds (of maypop, groundcherry, and blackberry/raspberry) were recovered at varying levels within features, suggesting a significant amount of bioturbation mixing up modern and ancient plant materials. It should be noted that only the carbonized seeds are included in the analysis and the tables presented in this report.

A variety of seeds that produce edible seeds and greens was also identified in the assemblage. These include carpetweed (*Mollugo* sp.), pokeweed (*Phytolacca americana*), purslane (*Portulaca* sp.), smartweed (*Polygonum* sp.), spurge (*Euphorbia* sp.), and tickclover (*Desmodium* sp.). Other seeds that may have been exploited purposefully or may simply represent incidental inclusions in the assemblage include arrowhead (*Sagittaria* sp.), bearsfoot (*Polymnia uvedalia*), bedstraw (*Galium* sp.), bulrush, copperleaf, filaree (*Erodium* sp.), oxalis, partridge pea, possible yellow stargrass, and was myrtle. In addition to edible greens, bedstraw also may have been consumed as a tea and the weedy legume may have been used as food (Hedrick 1972; Peterson 1977). Clover seeds (Trifolium sp.) may indicate that clover leaves were being consumed. Carpetweed is a weed seed and was probably not consumed. Filaree greens and flowers are edible (http://www.arthurleej.com/a-filaree.html), and wax myrtle leaves can be dried and used for seasoning; their berries are edible but bitter (http://hubpages.com/hub/Common-Edible-Wild-Plants---Part-I).

A general assessment of seasonality for these plants indicates the harvesting and collection of resources from March through November (Tables 3, 4). Regardless to temporary or permanent occupation, most plants do not bloom in the winter months, between December and March, which make plant seasonality data difficult to assess length of occupation without other complementary datasets. A perusal of the seasonality table, however, reveals that most plants are ripe and ready for collection between May and October. Clearly, there is a bounty of wild plant foods that can be collected fresh throughout the spring, summer, and fall months. Many of these can be stored for later use in the winter.

Quantitative Analysis

The quantitative analysis presented here focuses on a comparison between the Middle and Late Qualla period occupations of the McCoy Bridge sites. We present various summary measures, including ubiquity (Tables 5-7), diversity (Table 8), and relative abundances (Tables 9 and 10). In addition we present a density comparison of abundance plant types, including corn, hickory, and walnut, using box plots. A comparison of taxonomic ranking by ubiquity values (see Table 7) demonstrates broad similarities between the Middle and Late Qualla occupations with respect to which plants were regularly used. Hickory and corn are the top two most commonly used plants. Hickory was identified in 100% of features for both time period; maize increases from 80% to 100% ubiquity from Middle to Late Qualla times. In addition, acorn, walnut, and maypop all occur in the top 5 ranked plants from both periods. The only difference in the rankings by ubiquity is the appearance of bottle gourd in the top ranked plants of the Late Qualla occupation, as it does not rank highly in the Middle Qualla assemblage.

Diversity was calculated using the Shannon-Weaver index, which provides a separate index for diversity (H′) and equitability (V′, aka evenness). We calculated diversity values for the Middle Qualla assemblage twice, both including and excluding the acorns from Feature 351. Regardless of the acorns, it is clear that both diversity and equitability values increase from the Middle to Late Qualla occupations, indicating an expansion of diet breadth, in terms of the inclusion of more plants in the diet as well as a less skewed exploitation of these plants.

We calculated relative abundances of plant remains based on three measures: percentages of total counts, densities, and standardized counts. Data were aggregated by broad category (e.g., cultigens, fruits, nuts, etc), and measures were calculated twice, both including and excluding the acorns from Feature 351 (see Tables 9-10). A perusal of Tables 9 and 10 reveal an increase in non-native cultigens (corn), edible greens/seeds, and large-seeded fruits; the increase in the latter is attributable to the introduction of the peach. If we exclude the acorns from Feature 351, then nuts also appear to increase in abundance in Late Qualla samples. Given these increases among multiple categories of plants, we consider some taxa more closely: corn, hickory, and walnut.

Box plots allow us to determine if two distributions of data are statistically different at the 0.05 level (see also Cleveland 1994; McGill et al. 1978; Scarry and Steponaitis 1997; Wilkinson et al. 1992). Box plots summarize distributions of data using several key features. The median value of the distribution is marked by the line at the center of the box. The edges of the box, or hinges, represent the 25th and 75th percentiles of the distribution—the approximate middle 50% of the data fall between the hinges (Cleveland 1994:139). Vertical lines, or whiskers, extend outward from the box and represent the tails of the distribution. Box plots also designate outliers—these are unusually large or small data values that "portray behavior in the extreme tails of the distribution" (Cleveland 1994:140). Outliers are depicted as asterisks and far outliers as open circles. Box plots can also be notched, which converts the box shape to an hourglass shape – the notches in the hourglass shape represent the 95% confidence intervals for the distribution. If any the notched areas on any two plots do not overlap, then the two distributions can be said to differ significantly. The box plots presented here use density data (calculate per sample), and thus we must focus on taxa that occur at high ubiquity rates and have high abundances.

We begin by considering the corn data, as an aggregate of all corn parts (kernels and cupules) and separately for kernels and cupules (Figure 1). Based on the box plots presented in Figure 1, it is clear that corn statistically increases in abundance from Middle to Late Qualla times. This increase, however, is accounted for only by the cupules, not the kernels. Given that cupules are a by-product of shelling kernels from the cob, this increase in cupules represents an increase in the initial processing of corn at the habitation site, not an increase in cooking or consumption. If corn was being cooked and consumed in greater abundance in the Late Qualla period, then we would also expect a corresponding increase in corn kernels as well. It is possible that this increase in cupules reflects a shift in agricultural strategy between the Middle and Late Qualla periods. We explain this shift in agricultural strategy through reference to Killion's infield/outfield model of agriculture intensity in relation to residential site structure. As part of his model, Killion argues that the organization of residential space is closely correlated with the type of field-cropping strategy employed by the residents (Killion 1990:200). According to Killion's model, we can expect that people would have stored and processed corn at the residential site when infields were cultivated. Conversely, if outfields were cultivated intensively, then we can expect that people would have stored and shelled their corn in the fields, away from the residence. As Killion has demonstrated ethnographically, where people choose to shell their corn depends on how close their fields are to their residence. Given this argument, the increase in cupules between the Middle to Late Qualla periods may indicate that people increasingly cultivated more infields relative to outfields through time. We discuss the implications of the agricultural shift below.

Figures 2 and 3 present box plots for hickory and walnut, respectively. The increase in nuts evident from the abundance data presented in Table 10 makes it clear that this change is attributable to a statistical increase in hickory nuts, not walnut. In summary, we can characterize the Middle to Late Qualla transition at McCoy Bridge by increases in the collection of hickories and wild edible greens/seeds, an expansion of diet breadth, the addition of peaches to the diet, and an agricultural shift towards the cultivation of more infields relative to outfields.

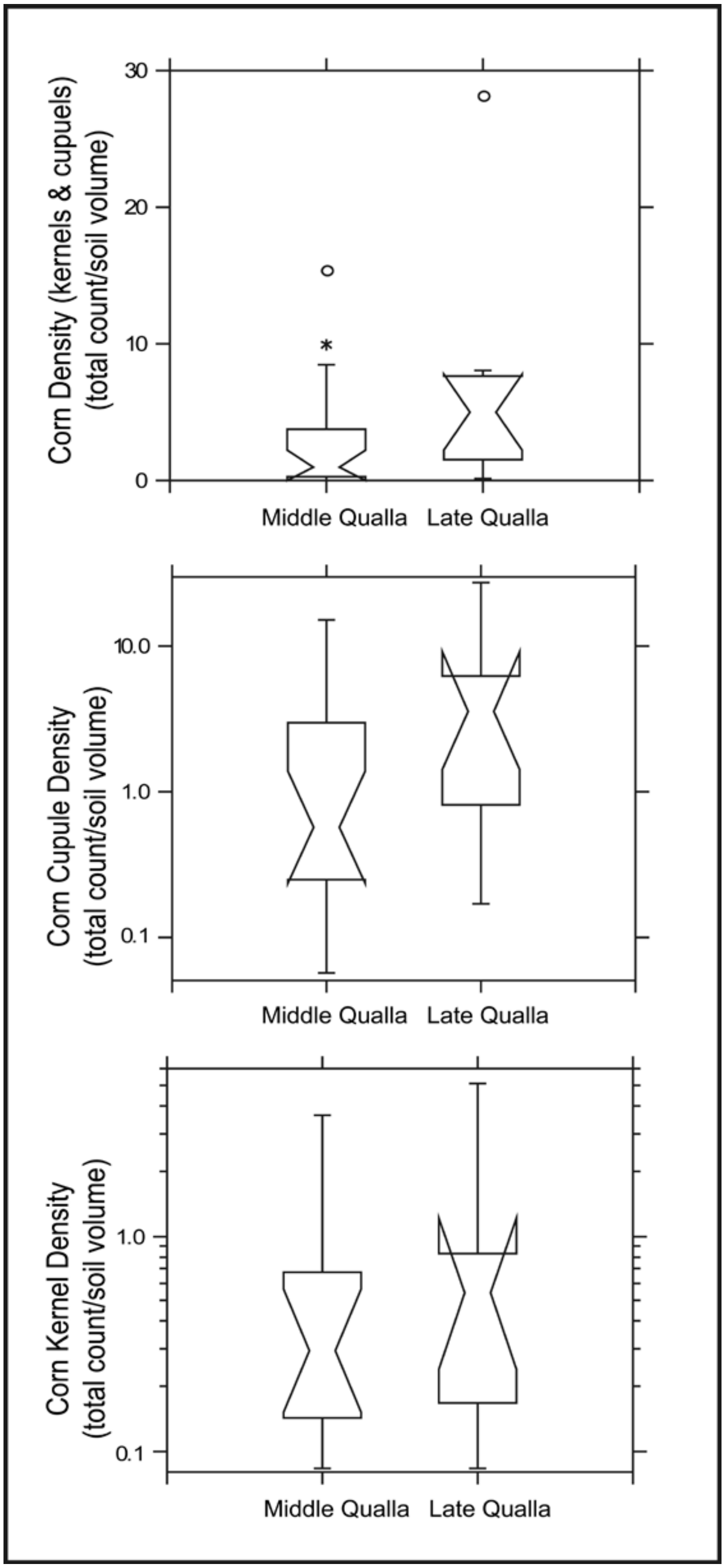

Figure 1.Box plots of corn densities by period.

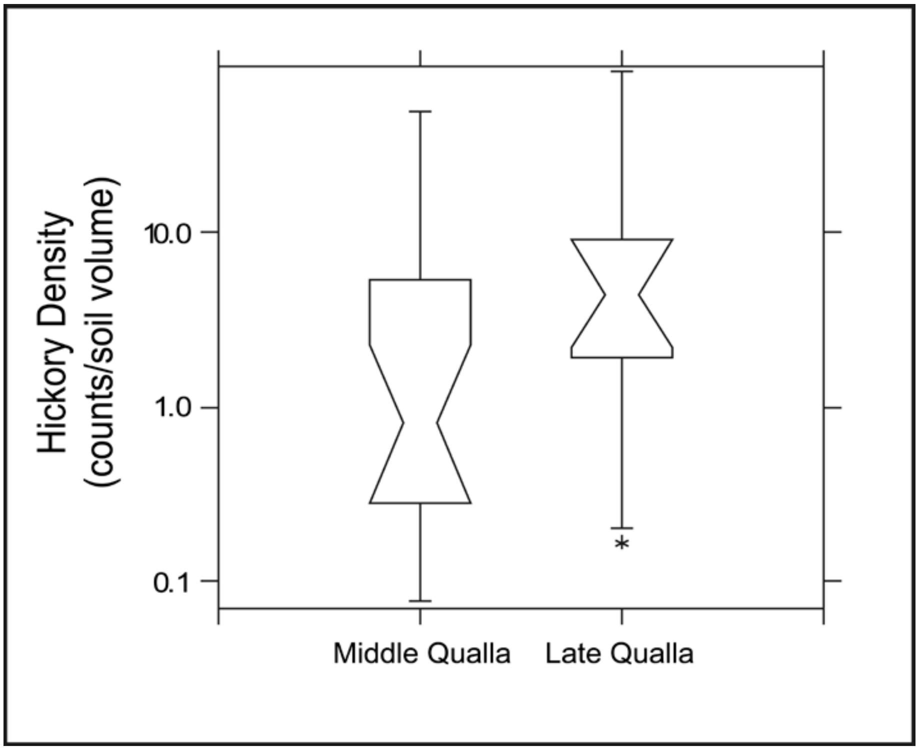

Figure 2. Box plot of hickory shell densities by period.

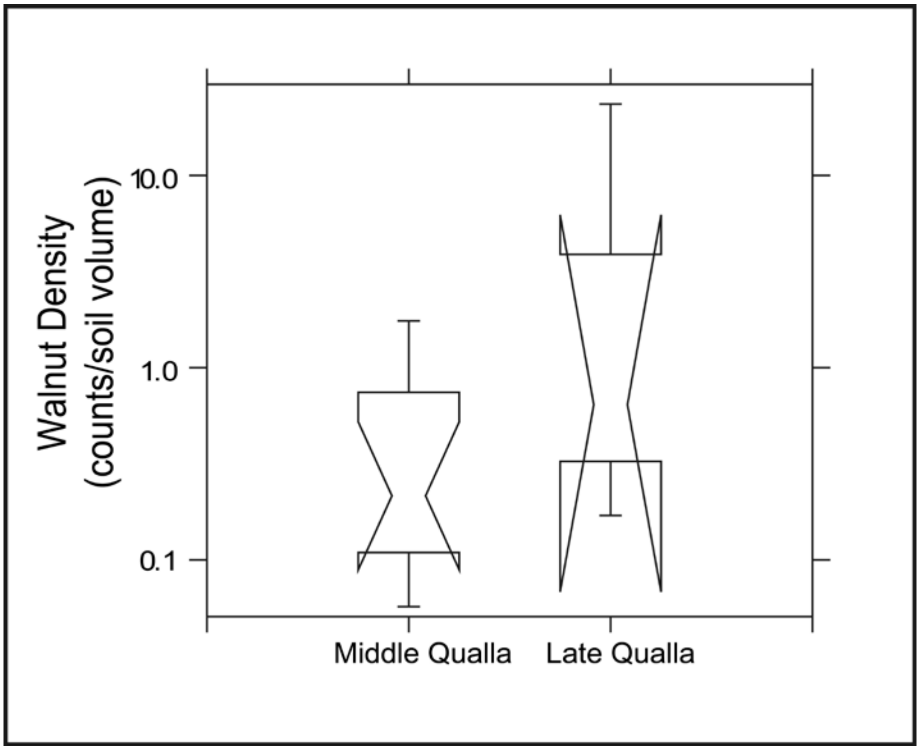

Figure 3. Box plot of walnut shell densities by period.

Conclusions

In a recent publication synthesizing the extant published data on Qualla-period Cherokee plant remains, VanDerwarker and colleagues (2013) argue that Cherokee foragers and farmers responded to the increasing risks of contact (death, disease, raiding, warfare, etc.) by expanding diet breadth and focusing on foods that have greater short-term rewards (e.g., wild foods). The data from McCoy Bridge fit this pattern in some ways (increases in fruits, hickories, diversity), but not in others (lack of decline in corn), suggesting that there were multiple ways to alter the diet in response to how the specifics of culture contact played out in different locales. The shift in agricultural strategies at McCoy Bridge nevertheless fit well into VanDerwarker and colleagues' (2013) model of risk aversion through future discounting. Given the uncertainty of long-term site residence in the region and the increasing problem of village raiding and crop destruction (e.g., field burning) by northern native groups during the Late Qualla period, it is no wonder that the McCoy Bridge residents shifted the bulk of their agricultural fields closer to home where they could be better monitored and protected. Nevertheless, increases in wild foods suggest that uncertainty over long-term investments in food production was a looming concern during an era of cultural and biological disruption.

References Cited

Bodwell, C. E.
1987 Nutritional Implications of Cereals, Legumes, and Their Products. In *Cereals and Legumes in the Food Supply*, ed. by J. Dupont and E. M. Osman, pp. 259–276. Iowa State University Press, Ames.

Cleveland, William S.
1994 *The Elements of Graphing Data*. AT&T Bell Laboratories, Murray Hill, New Jersey.

Delorit, R. J.
1970 *Illustrated Taxonomy Manual of Weed Seeds*. Wisconsin State University, River Falls.

Giller, Ken E.
2001 *Nitrogen Fixation in Tropical Cropping Systems*. CABI Publishing, New York.

Godwin, H.
1956 *The History of British Flora*. Cambridge University Press, Cambridge.

Hastorf, Christine A., and Virginia S. Popper (editors)
1988 *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*. The University of Chicago Press, Chicago and London.

Hedrick, U.P.
1972 *Sturtevant's Edible Plants of the World*. Dover Publications, New York.

Hubbard, R.N.L.B
1975 Assessing the botanical component of human paleoeconomies. Bulletin of the Institute of Archaeology 12:197–205.

1976 On the strength of the evidence for prehistoric crop processing activities. *Journal of Archaeological Science* 3:257–265.

1980 Development of Agriculture in Europe and the Near East: Evidence from Quantitative Studies. *Economic Botany* 34:51–67.

Kandane, Joseph B.
1988 Possible Statistical Contributions to Paleoethnobotany. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, ed. by

C. H. Hastorf and V. S. Popper, pp. 206–214. The University of Chicago Press, Chicago and London.

Killion, Thomas W.
1990 Cultivation intensity and residential structure: an ethnoarchaeological examination of peasant agriculture in the Sierra de los Tuxtlas, Veracruz, Mexico. *Latin American Antiquity* 1: 191–215.

Lentz, David L.
2000 Anthropocentric Food Webs in the Precolumbian Americas. In *Imperfect Balance: Landscape Transformations in the Precolumbian Americas*, ed. by D. L. Lentz, pp. 89–120. Columbia University Press, New York.

Martin, A. C., and W. D. Barkley
1961 *Seed Identification Manual*. University of California Press, Berkeley.

McGill, Robert, John W. Tukey, and Wayne A. Larsen
1978 Variations of box plots. *The American Statistician* 32:12–16.

Miksicek, Charles H.
1987 Formation Processes of the Archaeobotanical Record. In *Advances in Archaeological Method and Theory*, Vol. 10, ed. by M. Schiffer, pp. 211–247. Academic Press, New York.

Miller, Naomi F.
1988 Ratios in Paleoethnobotanical Analysis. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, ed. by C. H. Hastorf and V. S. Popper, pp. 72–85. The University of Chicago Press, Chicago and London.

Minnis, Paul E.
1981 Seeds in Archaeological Sites: Sources and Some Interpretive Problems. *American Antiquity* 46(1):143–152.

Minnis, Paul E. (editor)
2003 *People and Plants in Eastern North America*. Smithsonian Books, Washington and London.

Peterson, Lee Allen
1977 *A Field Guide to edible wild plants of Eastern and Central North America*. Houghton Mifflin Company, Boston.

Petruso, Karl M., and Jere M. Wickens
1984 The Acorn in Aboriginal Subsistence in eastern North America: A Report on Miscellaneous Experiments. In *Experiments and Observations on Aboriginal Wild Plant Food Utilization in Eastern North America*, edited by P. Munson, 360-378. Indiana Historical Society, Indiana.

Popper, Virginia S.
1988 Selecting Quantitative Measures in Paleoethnobotany. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, ed. by C. H. Hastorf and V. S. Popper, pp. 53–71. The University of Chicago Press, Chicago and London.

Reitz, Elizabeth J., and Elizabeth S. Wing
1999 *Zooarchaeology*. Cambridge University Press, Cambridge, U. K.

Scarry, C. Margaret
2003 Patterns of wild plant utilization in the prehistoric Eastern Woodlands. In *People and Plants in the ancient eastern North America*, ed. by P. J. Minnis, pp. 50-104. Smithsonian Institution Press, Washington D.C.

1986 Change in Plant Procurement and Production during the Emergence of the Moundville Chiefdom. Unpublished Ph.D. dissertation, Department of Anthropology, University of Michigan, Ann Arbor.`

Scarry, C. Margaret, and Vincas P. Steponaitis
1997 Between Farmstead and Center: The Natural and Social Landscape of Moundville. In *People, Plants, and Landscapes: Studies in Paleoethnobotany*, ed. by K. J. Gremillion, pp. 107–122. The University of Alabama Press, Tuscaloosa.

Smartt, J.
1988 Morphological, Physiological, and Biochemical Changes in *Phaseolus* Beans under Domestication. In *Genetic Resources of Phaseolus Beans*, ed. by P. Gepts, pp. 143–162. Kluwer Academic Publishers, Boston.

Swanton, John R.
1944 The Indians of the Southeastern United States. Bureau of American Ethnology Bulletin 137. Government Printing Office, Washington.

Talalay, Laurie, Donald R. Keller, and Patrick J. Munson
1984 Hickory Nuts, Walnuts, Butternuts, and Hazelnuts: Observations and Experiments Relevant to Their Aboriginal Exploitation in Eastern North America. In *Experiments and Observations on Aboriginal Wild Plant Utilization in Eastern North America*, edited by P. J. Munson, pp. 338-359. Indiana Historical Society, Indianapolis.

Ulmer, Mary and Samuel E. Beck
1951 *Cherokee Cooklore*: *Preparing Cherokee Foods*. Museum of the Cherokee Indian, Cherokee.

VanDerwarker, Amber, Jon B. Marcoux, and Kandace D. Hollenbach
2013 Farming and Foraging at the Crossroads: The Consequences of Cherokee and European Interaction through the late Eighteenth century. *American Antiquity* 78(1):68-88.

Wilkinson, Leland, MaryAnn Jill, Stacey Miceli, Gregory Birkenbeuel, and Erin Vang

1992 *Systat Graphics*. SYSTAT, Inc., Evanston, Illinois.

Willcox, G. H.

1974 A history of deforestation as indicated by charcoal analysis of four sites in Eastern Anatolia. *Anatolian Studies* 24:117–133.

Yarnell, Richard A.

1982 Problems of interpretation of archaeological plant remains of the eastern woodlands. *Southeastern Archaeology* 1(1):1–7.

Table 1. Common and taxonomic names of plants identified at the McCoy Bridge sites (31MA684 and 31MA774).

Plant Type/Groups	Common Name	Taxonomic Name
Cultigens	Bean	*Phaseolus* sp.
Cultigens	Bean cf.	*Phaseolus* sp. cf.
Cultigens	Bottle gourd rind	*Lagenaria siceraria*
Cultigens	Bottle gourd seed cf.	*Lagenaria siceraria* cf.
Cultigens	Common bean	*Phaseolus vulgaris*
Cultigens	Corn cupule	*Zea mays*
Cultigens	Corn cupule cf.	*Zea mays* cf.
Cultigens	Corn kernel	*Zea mays*
Cultigens	Corn kernel cf.	*Zea mays* cf.
Cultigens	Goosefoot	*Chenopodium* spp.
Cultigens	Knotweed	*Polygonum* sp.
Cultigens	Knotweed cf.	*Polygonum* sp. cf.
Cultigens	Little barley	*Hordeum pusillum*
Edible Greens/Seeds	Carpetweed	*Mollugo* sp.
Edible Greens/Seeds	Pokeweed	*Phytolacca americana*
Edible Greens/Seeds	Purslane	*Portulaca* sp.
Edible Greens/Seeds	Smartweed	*Polygonum* spp.
Edible Greens/Seeds	Spurge	*Euphorbia* spp.
Edible Greens/Seeds	Spurge family cf.	Euphorbiaceae cf.
Edible Greens/Seeds	Tick clover	*Desmodium* sp.
Edible Greens/Seeds	Tick clover cf.	*Desmodium* sp. cf.
Fruit	Blackberry/raspberry	*Rubus* spp.
Fruit	Grape	*Vitis* sp.
Fruit	Groundcherry	*Physalis* sp.
Fruit	Groundcherry cf.	*Physalis* sp. cf.
Fruit	Maypop	*Passiflora incarnata*
Fruit	Peach	*Prunus persica*
Fruit	Persimmon	*Diospyros virginiana*
Fruit	Plum/cherry	*Prunus* spp.
Miscellaneous	Arrowhead	*Sagittaria* sp.
Miscellaneous	Bean family	Fabaceae
Miscellaneous	Bean/persimmon	*Phaseolus/Diospryos*
Miscellaneous	Bearsfoot	*Poylmnia uvedalia*
Miscellaneous	Bedstraw	*Galium* sp.
Miscellaneous	Bulrush	*Scirpus* spp.
Miscellaneous	Copperleaf	*Acalypha* sp.
Miscellaneous	Copperleaf cf.	*Acalypha* sp. cf.
Miscellaneous	Filaree cf.	*Erodium* sp. cf.
Miscellaneous	Grass family	Poaceae

Miscellaneous	Oxalis	*Oxalis* sp.
Miscellaneous	Partridge pea	*Chameacrista* sp.
Miscellaneous	Pine pitch	*Pinus* spp.
Miscellaneous	Pine pitch cf.	*Pinus* spp. cf.
Miscellaneous	Stargrass cf.	*Hypoxis* sp. cf.
Miscellaneous	Wax myrtle	*Myrica* sp.
Nuts	Acorn meat	*Quercus* spp.
Nuts	Acorn meat cf.	*Quercus* spp. cf.
Nuts	Acorn nutshell	*Quercus* spp.
Nuts	Acorn nutshell cf.	*Quercus* spp. cf.
Nuts	Hazelnut	*Corylus* sp.
Nuts	Hickory	*Carya* spp.
Nuts	Hickory husk cf.	*Carya* spp.
Nuts	Pecan	*Carya illinoensis*
Nuts	Walnut	*Juglans nigra*
Nuts	Walnut cf.	*Juglans nigra* cf.
Nuts	Walnut Family	Juglandaceae
Unidentified	UID nutshell	
Unidentified	Unidentifiable	
Unidentified	Unidentified seed	
Unidentified	Unidentified seed	
Unidentified	Unidentified seed frag	

Table 2. Counts and weights of identified plants summed by period for the McCoy Bridge sites (31MA684 and 31MA774).

Period	MQ		LQ	
N of Samples	22		13	
N of Features	10		11	
Total Soil Volume (L)	294.5		148.5	
Total Plant Weight (g)	305.31		246.11	
Total Wood Weight (g)	186.62		200.18	
Common Name	Count	Weight	Count	Weight
Cultigens				
Bean	3	0.05		
Bean cf.	3	0.01	31	0.13
Bottle gourd rind	24	0.04	28	0.24
Bottle gourd seed cf.			5	0.03
Goosefoot	2	0.02	4	0.02
Common bean	1	0.03		
Corn cupule	640	4.10	985	7.24
Corn cupule cf.	19	0.10	23	0.03
Corn kernel	148	0.85	129	0.41
Corn kernel cf.	21	0.03		
Knotweed	1	--	4	--
Little barley	2	--		
Fruits				
Blackberry/raspberry			3	--
Grape	4	--	2	--
Maypop	5	--	53	--
Peach			8	--
Persimmon	2	--	1	--
Plum/cherry	1	--		
Edible Greens/Seeds				
Pokeweed			27	--
Purslane	22	--	1	--
Smartweed	4	--	309	--
Spurge	4	--		
Spurge family cf.	1	--		
Tick Clover			2	--
Tick Clover cf.	1	--		
Nuts				
Acorn nutshell	10688	39.86	11	--
Acorn nutshell cf.	2	0.02	1	--
Acorn meat	593	26.11		

Acorn meat cf.	1	0.02		
Hazelnut			10	0.05
Hickory	1852	28.22	1683	24.63
Hickory husk cf.			1	0.05
UID Nutmeat cf.	148	2.15	3	0.12
Pecan			89	0.44
UID nutshell	2	0.11		
Walnut	94	2.98		
Walnut cf.	4	0.04		
Walnut family	1	0.01		
Miscellaneous				
Arrowhead			2	--
Bean family			2	--
Bean/persimmon	1	--	16	--
Bearsfoot			6	--
Bedstraw			2	--
Bulrush			8	--
Carpetweed	2	--		
Copperleaf	1	--		
Copperleaf cf.			4	--
Filaree cf.			1	--
Grass family	1	--		
Oxalis	2	--	2	--
Pine pitch	20	0.12		
Pine pitch cf.	92	0.66	20	0.08
Stargrass cf.	1			
Wax myrtle	2			
Unidentified Specimens				
Unidentifiable	773	6.06	379	1.66
Unidentified seed	2	--	17	--
Unidentified seed frag			299	--

Table 3. Seasonality of plants identified from Middle Qualla Features at the McCoy Bridge site.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Oxalis			X	X	X	X	X	X	X	X		
Wax myrtle				X	X	X	X	X	X	X		
Purslane					X	X	X	X	X			
Bottle gourd					X	X	X	X	X			
Little barley					X	X	X					
Stargrass cf.					X	X						
Copperleaf						X	X	X	X	X		
Plum/cherry						X	X	X	X			
Carpetweed						X	X	X				
Bean							X	X	X	X		
Common bean							X	X	X	X		
Goosefoot							X	X	X	X	X	
Knotweed							X	X	X	X	X	
Maize							X	X	X			
Maypop							X	X	X	X		
Smartweed							X	X	X	X	X	
Spurge							X	X	X	X		
Tick clover cf.								X	X	X		
Grape								X	X	X		
Acorn									X	X	X	
Persimmon									X	X		
Hickory										X		
Walnut										X		

Table 4. Seasonality of plants identified from Late Qualla Features at the McCoy Bridge site.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Oxalis			X	X	X	X	X	X	X	X		
Filaree cf.				X	X	X						
Purslane					X	X	X	X	X			
Bottle gourd					X	X	X	X	X			
Bedstraw					X	X	X	X				
Pokeweed					X	X	X	X				
Blackberry/raspberry					X	X						
Arrowhead						X	X	X	X	X		
Peach						X	X					
Smartweed							X	X	X	X	X	
Bearsfoot							X	X	X			
Bulrush							X	X	X			
Goosefoot							X	X	X	X	X	
Hazelnut							X	X	X			
Knotweed							X	X	X	X	X	
Maize							X	X	X			
Maypop							X	X	X	X		
Grape								X	X	X		
Tick clover								X	X	X		
Pecan									X	X	X	
Acorn									X	X	X	
Persimmon									X	X		
Hickory										X		
Walnut										X		

Table 5. Ubiquity Analysis for plants from Middle Qualla features (in descending order by ubiquity value).

	Features Present	Total Features	Ubiquity Value (%)
Hickory	10	10	100
Maize	8	10	80
Acorn	6	10	60
Walnut	5	10	50
Maypop	4	10	40
Purslane	3	10	30
Bean	2	10	20
Bottle gourd	2	10	20
Grape	2	10	20
Persimmon	2	10	20
Smartweed	2	10	20
Spurge	2	10	20
Carpetweed	1	10	10
Common bean	1	10	10
Goosefoot	1	10	10
Knotweed cf.	1	10	10
Little barley	1	10	10
Oxalis	1	10	10
Pine pitch	1	10	10
Plum/cherry	1	10	10
Stargrass cf.	1	10	10
Tick clover cf.	1	10	10
Wax myrtle	1	10	10

Table 6. Ubiquity Analysis for plants from Late Qualla features (in descending order by ubiquity value).

	Features Present	Total Features	Ubiquity Value (%)
Hickory	11	11	100.0
Maize	11	11	100.0
Acorn	4	11	36.4
Bottle gourd	4	11	36.4
Maypop	3	11	27.3
Walnut	3	11	27.3
Bulrush	2	11	18.2
Copperleaf	2	11	18.2
Pecan	2	11	18.2
Pokeweed	2	11	18.2
Smartweed	2	11	18.2
Blackberry/raspberry	1	11	9.1
Oxalis	1	11	9.1
Arrowhead	1	11	9.1
Bearsfoot	1	11	9.1
Bedstraw	1	11	9.1
Filaree cf.	1	11	9.1
Goosefoot	1	11	9.1
Grape	1	11	9.1
Hazelnut	1	11	9.1
Knotweed	1	11	9.1
Peach	1	11	9.1
Persimmon	1	11	9.1
Purslane	1	11	9.1
Tick clover	1	11	9.1

Table 7. Top ranked plant resources in descending order by ubiquity value.

Ranking	Midde Qualla	Late Qualla
1	Hickory	Hickory/Corn
2	Corn	Acorn/Bottle gourd
3	Acorn	Maypop/Walnut
4	Walnut	
5	Maypop	

Table 8. Shannon-Weaver diversity (H’) and equitability (V’) values by period.

	Middle Qualla[1]	**Middle Qualla[2]**	**Late Qualla**
Diversity (H’)	0.684	0.947	1.518
Equitability (V’)	0.221	0.306	0.466

[1] includes all data from Middle Qualla flotation samples

[2] excludes acorn data from Feature 351

Table 9. Summary of data by plant group by raw counts, relative percentages, density, and standardized counts (includes all data from flotation contexts).

	Middle Qualla				Late Qualla			
Plant Type/Groups	count	percent	density	std count	count	percent	density	std count
Cultigens (native)	29	0.2	0.10	0.09	41	1.2	0.28	0.17
Cultigens (non-native)	835	5.8	2.84	2.73	1168	33.6	7.87	4.75
Edible Greens/Seeds	34	0.2	0.12	0.11	339	9.8	2.28	1.38
Fruit (large)	8	0.1	0.03	0.03	62	1.8	0.42	0.25
Fruit (small)	4	0.0	0.01	0.01	5	0.1	0.03	0.02
Miscellaneous	120	0.8	0.41	0.39	63	1.8	0.42	0.26
Nuts	13385	92.9	45.45	43.84	1798	51.7	12.11	7.31

Table 10. Summary of data by plant group by raw counts, relative percentages, density, and standardized counts (excludes the acorn data from Middle Qualla Feature 351).

	Middle Qualla				Late Qualla			
Plant Type/Groups	count	percent	density	std count	count	percent	density	std count
Cultigens (native)	29	0.9	0.10	0.13	41	1.2	0.28	0.17
Cultigens (non-native)	835	26.5	2.95	3.62	1168	33.6	7.87	4.75
Edible Greens/Seeds	34	1.1	0.12	0.15	339	9.8	2.28	1.38
Fruit (large)	8	0.3	0.03	0.03	62	1.8	0.42	0.25
Fruit (small)	4	0.1	0.01	0.02	5	0.1	0.03	0.02
Miscellaneous	120	3.8	0.42	0.52	63	1.8	0.42	0.26
Nuts	2120	67.3	7.48	9.19	1798	51.7	12.11	7.31