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PALEOETHNOBOTANY OF THE GEORGIA PIEDMONT: FOUR LAMAR PERIOD FARMSTEADS IN THE MIDDLE OCONEE UPLANDS

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PALEOETHNOBOTANY OF THE GEORGIA PIEDMONT:

FOUR LAMAR PERIOD FARMSTEADS IN THE

MIDDLE OCONEE UPLANDS

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ABSTRACT

The terminal Mississippian/protohistoric Lamar period represents a significant stage of social, political, and economic reorganization in the Piedmont region of the middle Oconee watershed in north central Georgia. It is during this period that the *Ocuté* chiefdom of the middle Oconee river valley both peaked and declined. A nucleated settlement system in the riverbottom was transformed into a pattern of small, dispersed, self-sufficient farmsteads, extending well into the contiguous uplands. An upward spiral in human population is intrinsically related to these events. Finally, the intrusion of the Spanish into the region permanently altered the lives of indigenous people through the introduction of exotic species, disease vectors, and most probably the disruption of the native political and social systems.

This paleoethnobotanical analysis of over 600 flotation and water-screened samples from upland sites documents the human ecology underpinning these events. The focus of this study is four upland homestead sites, however, a regional perspective dominates the project, which is rooted in the principles of ecological anthropology.

The models presented in this dissertation explore the process of human intrusion into and adaptation to the uplands. Three research problems explore (1)evolving regional and local subsistence patterns, (2) the stimulus for migration to the uplands, and (3) the rate of migration. In response to these questions, hypotheses are formulated from existing archaeobotanical, ethnohistoric, ethnological, ecological, and paleoclimatological data. Paleoethnobotanical data, supplemented by paleopathological evidence, energy yield experiments, and analysis of variance, are used to test these hypotheses.

This investigation reveals a diachronic shift in plant exploitation strategy, from a balanced mix of wild and cultivated taxa in the Iron Horse, to an overwhelming emphasis on maize and mast in the Bell phase (A.D. 1580-A.D. 1670). Dynamic responses to environmental stress include technological modification and crop diversification. It is maintained that subsistence innovation and modification of the landscape evolved along with social and political structures, and in no way reflect social, political, or technological revolution.

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This dissertation is dedicated to the memory of my father, William E. Bonhage, Sr., and to the memory of John G. Witthoft, my first archaeological mentor. It is also dedicated to my husband, Steven Freund, our son Robert, and the members of our extended family.

"...Once in a while you get shown the light in the strangest of places, if you look at it right..."

Robert Hunter

"Scarlet Begonias"

Chapter 1

INTRODUCTION

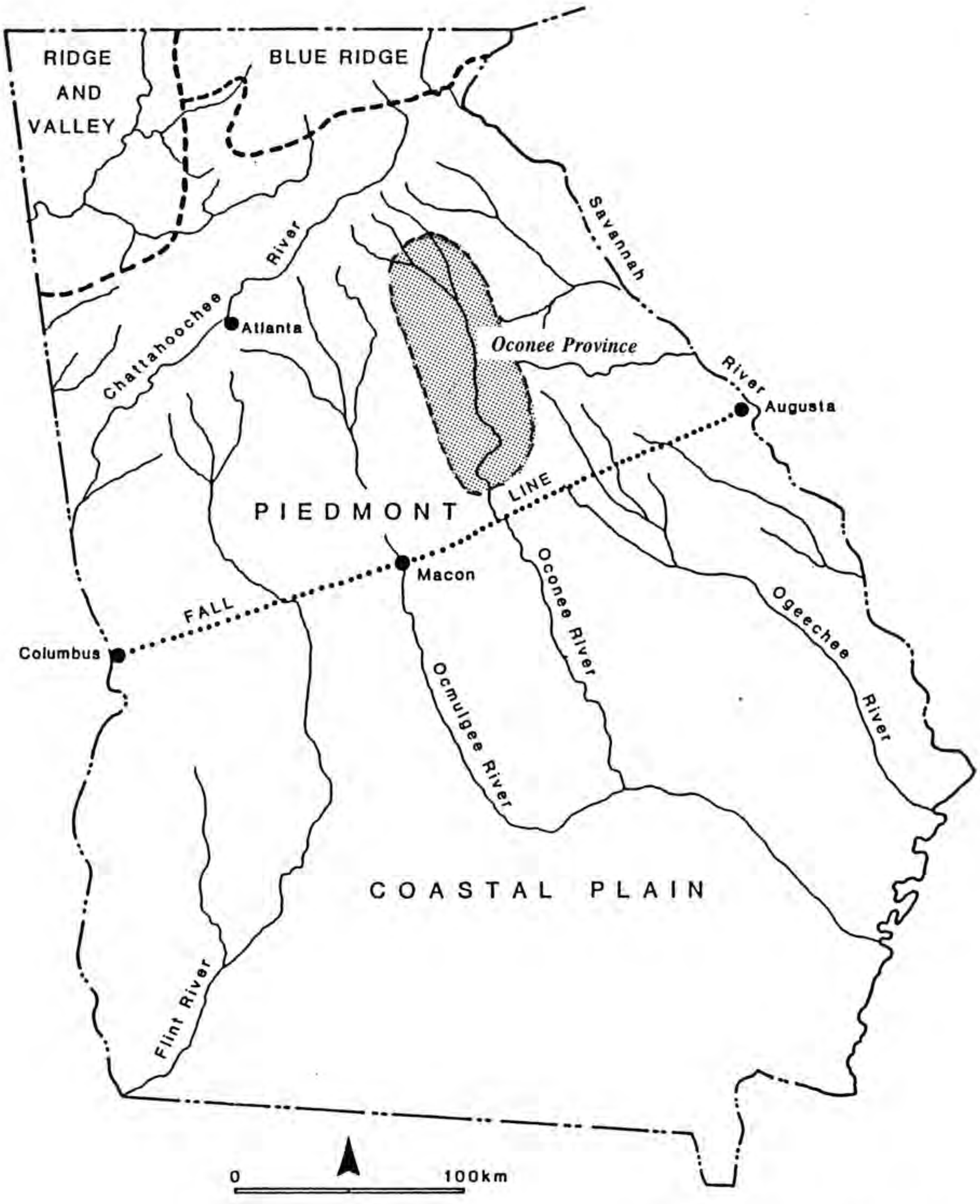
Although Mississippian settlements are typically associated with riverine environments, over 300 "homestead" sites are known in the Piedmont uplands of the Oconee watershed in north central Georgia. Some archaeologists argue that the total of sites within the Oconee archaeological district, extending from Athens to Milledgeville, may exceed 10,000 (Kowalewski and Hatch 1991; Hatch et al 1991). Most of these sites range from 0.3 to 0.6 ha in size, and date to the last two phases of the Lamar period, namely Dyar and Bell (A.D. 1520-1660), according to ceramic or radiocarbon evaluations (Kowalewski and Hatch 1991) (See Table 1). It is during this interval that dramatic regional demographic growth has been postulated (Hally and Rudolph 1986a; Smith 1986, 1987).

During the Lamar period, the Oconee region is presumed to have been politically circumscribed (Smith and Kowalewski 1980; Hally and Rudolph 1986b). Relying on archaeological and ethnohistoric data, Smith and Kowalewski (1980) delineate territorial boundaries of a distinct socio-political territory, the "Oconee Province," dating to the fifteenth and sixteenth centuries (See Figure 1 and Figure 2). This territory included a chiefdom, known to the Spanish as *Ocuté* (Hudson et al 1984). The Wallace Reservoir lies at the center of this archaeological region, and partially submerged within its waters is the Dyar site (9GE4) (Smith 1981). This single mound site is central to four multiple

Table 1: The Lamar period phases are divided into four temporal phases based on the diagnostic ceramic traits summarized below.

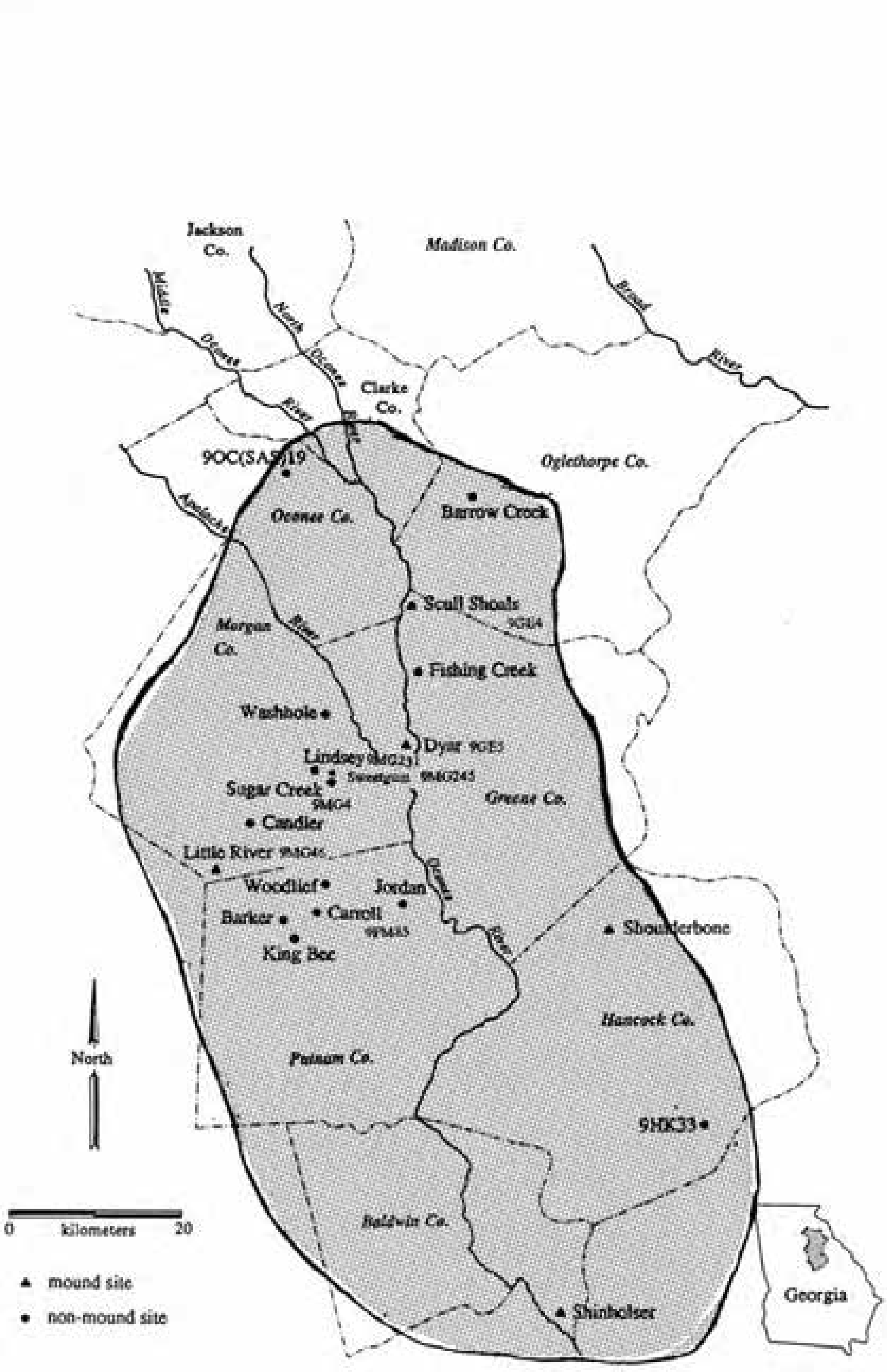
Phase	Approximate Calendar Date	Principal Distinguishing Ceramic Attributes
Bell	A.D. 1580 - 1670	widest rim folds (pinched); fine, multiple-lined incising added; <1% stamping (except Wolfskin); T-rims
Dyar	A.D. 1520 - 1580	wide rim folds (pinched); bold, multiple-line incising, stamping present, frequency varies
Iron Horse	A.D. 1450 - 1520	medium width rime folds (pinched); 2-4 bold-incised lines; stamping present; Morgan Incised (?)
Duvall	A.D. 1375 - 1450	narrow rim folds (cane punctate); no bold-incised; Morgan Incised; stamping

(Adapted from Kowalewski and Williams [1989] and Williams and Shapiro [1990]).



(Hally and Rudolph 1986)

Figure 1: Physiographic regions of Georgia.



(Adapted from Kowalewski and Hatch 1991)

Figure 2: The "Oconee Province," including the upland sites under investigation.

mound sites, two of which are located within the wide expanses of the Oconee flood plain. Scull Shoals (9HK1), just south of Athens in the Oconee National Forest, is the northernmost mound town of the province, and Schinholser (9BL1), south of Milledgeville is the southernmost (Williams 1983). The eastern-most mound site and probable locus of the capital of *Ocute*, is Shoulderbone (9HK1), on Shoulderbone Creek (Shapiro and Williams 1984), and the western-most, Little River (9MG46). Each of the latter two sites is located on a small tributary of the Oconee, rather than in the river flood plain historically assumed to be typical of Lamar mound centers (Shapiro and Williams 1984).

Growing demand for limited arable land and for wild resources could precipitate adjustments in subsistence strategy as carrying capacity was tested (Jochim 1981). The resolution of these ecological imbalances in the Oconee region is one primary focus of this dissertation. Theories of human cultural ecology provide the framework for this paleoethnobotanical study.

Research Objectives

The changing subsistence pattern in the Oconee uplands over the course of the Lamar period can be explained in terms of human-induced habitat modification and an increased commitment to agriculture, prompted by population pressure. Environmental modification is directly linked to agricultural extensification and intensification. Archaeological evidence of increasing numbers of scattered farmsteads points to agricultural extensification coterminous with population dispersal across the landscape. This thesis explores these phenomena.

In the ensuing chapters, I develop a model of evolving plant exploitation patterns within a dynamic demographic and ecological environment, and I identify environmental feedback loops affecting subsistence choices.

Site Descriptions

This study focuses on four Lamar period upland sites in the Oconee River drainage. Sugar Creek (9MG4), Sweetgum (9MG245), Lindsey (9MG231), and Carroll (9PM85) are small, non-riverine homestead sites. The former three are within two km of each other. According to ceramic analysis, together they represent three of the four phases of the late Mississippian and protohistoric Lamar period - - namely the Iron Horse, Dyar, and Bell (see Table 1). Like many Lamar farmsteads these sites are correlated with patches of soil suited to maize agriculture. Although four excavations is a small sample size, especially considering the large number of Lamar period sites in the Oconee uplands, I believe that it is adequate for several reasons.

The site sample includes two components each from the Dyar and Bell phases. In every way archaeologically determinable, the sites in each pair are closely parallel. Minimal paleoethnobotanical or archaeobotanical research has been conducted elsewhere in the Oconee uplands, the existing Lamar period botanical assemblages from the middle

Oconee region support the typical nature of the assemblages recovered from the project sites (Manning 1982; Blanton 1984, 1985; Gardner 1985; Williams and Shapiro 1990; Williams 1982a).

Regional Settlement Patterns

Political and Demographic Considerations

The Mississippian tradition emerges *circa* A.D. 800, in the central and lower Mississippi Valley regions, and by A.D. 1000 surfaces throughout the Midwest and Southeast, and persists into the early historic period of the sixteenth century. It is unlikely that the Mississippian tradition diffused from a central point of origin. Rather it is the product of local evolutionary trajectories (Griffen 1985). This culture period is characterized by simple and complex chiefdoms, maize-based economies, long-distance exchange, distinctive ceramic forms and styles, and is popularly recognized by flat-topped mounds. A diverse assemblage of unique symbols and sumptuary goods, often known as the "Southeastern Ceremonial complex," varies over space and time, but is strictly correlated to the Mississippian period and tradition. Marine shell gorgets, flint knives, chunkee stones, and embossed copper sheets, among other specialty items, are included in this complex (Waring and Holder 1945).

While Mississippian settlement patterns varied considerably over both time and space, there are enough similarities in settlement distributions and types to make some general observations. Settlements within individual Mississippian systems can be differentiated on the basis of size and function. Most systems have one or more sites featuring mounds. These sites served as administrative centers and were home to the chief and his retainers. The size of the non-elite population living at such centers seems to have varied from one system to another (Scarry 1986). Many systems are alleged to have possessed a hierarchy of settlements, recognized archaeologically by the size and number of their mounds (Steponaitis 1978; Scarry 1990), but this concept is now under debate (Smith 1978a,b; Milner 1990).

The residence pattern of non-elite members of society is just beginning to emerge. While nucleated settlements are often associated with the Mississippian period, hamlets and dispersed settlements were observed by the De Soto entourage (Biedma 1968 [1544]; Elvas 1933, 1968 [1557]; Garcilaso 1980 [1605]; Scarry 1986). This latter pattern minimizes effort, travel, and work in an agricultural society (Allan 1965). Intensive garden plots require heavy and frequent inputs of labor and even small distances can impose significant travel costs. Furthermore competition for land leads farmers to settle near their plots to defend their gardens. Farmers save energy and time while simultaneously increasing security by dispersing residences among gardens (Jochim 1981; Richards 1985). Throughout the Southeast, this configuration of mound towns, hamlets, and dispersed farmsteads is fairly common during the late Mississippian period (Kowlewski and Hatch 1991:14; Emerson 1992). A pattern of dispersed farmsteads is routine among modern horticultural peoples (Richards 1985). Current research in the middle Oconee region of Georgia (Kowlewski and Hatch 1991:13-14) and in the Florida panhandle (Scarry and Smith 1989; Scarry 1990:238) reveals that more than half of the Mississippian populations lived in independent farmstead households, less than a hectare in size, occupied by a single family. There is evidence, however, that during periods of political instability, these dispersed settlements were abandoned in favor of nucleated settlements.

Thus, the dispersed settlement system may be a consequence of the lifting of adverse political or other boundary conditions during the Lamar period, allowing greater production and reproduction (Hally and Rudolph 1986b; Kowalewski and Hatch 1991). Nucleated settlements are often associated with evidence of warfare or other conflict (Smith 1986; Milner et al 1990), while the dispersed pattern may either indicate a weakening of chiefly power or a general lack of dissension. Alternatively, or additionally, the dispersed configuration may reflect an overall population increase in late Mississippian times with agricultural intensification and extensification, ensuing from acute local competition for land (Jochim 1981).

Unlike similar areas enduring European contact, the Oconee region experienced what may have been strong population growth for decades following the DeSoto visit of 1540 (Hudson et al. 1985; Kowalewski and Hatch 1991). During protohistoric times, upland Lamar settlements tended to be dispersed, rather than nucleated (Kowalewski and

Hatch 1991). This expansion of settlement and population might have its roots in pre-Iron Horse emigration (Smith and Kowalewski 1980; Smith 1987), however natural increase, or a combination of these two forces is equally consistent with the archaeological evidence of population growth (Kowalewski and Hatch 1991). Ultimately the Oconee population experienced the demographic collapse which befell all native peoples, but not until the turn of the seventeenth century.[1]

Ecological Considerations

The Oconee region provides an interesting contrast to other Mississippian settlement systems in its heavy permanent occupation of the non-riverine uplands. During the late Lamar period, human occupation appears to have been tightly constrained to a 23 km radius around each major town, spilling into the uplands (Kowalewski and Hatch 1991; Hally 1993). Survey sections demonstrate that upland sites within a 10 kmeradius of the mound towns can occur at densities approximately 80% of that of the river bottoms. Between 10 and 23 km away from the mound centers the rate of settlement drops by about 50%. This measure of 23 km is noteworthy because evidence to support a typical 23 km midpoint between mound towns has been independently discovered elsewhere in Georgia (Kowalewski and Hatch 1991; Hally 1993). One

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[1] For a complete summary and discussion of Lamar period archaeological findings in the Oconee watershed, and the political realignments thought to have been instrumental in their formation, see Kowalewski and Hatch 1991.

hypothesis is that this distance represents the radius of a chiefly domain (Hally 1993). A "population explosion" within such a politically circumscribed area would theoretically trigger ecological and social stresses.

It has been argued that the Mississippian subsistence systems were adapted to floodplain environments - dependent on both their annually renewed soils and concentrated biotic resources (Smith 1978a, 1978b; Scarry 1986:18). This conclusion is related to the fact that Mississippian systems universally involved a switch from garden plot to field agriculture ultimately emphasizing maize (Scarry 1986; Keegan and Butler 1987; Woods 1987). Those few systems that appear to have fully integrated the uplands into their resource base were established in regions with similar, but not identical, access to fertile soils and abundant fauna in bottomland and upland zones (Shapiro 1983; Scarry 1986). The importance of riverine floodplain soils cannot be ignored, but it is possible that their importance is presently overemphasized (Anderson 1986a). Equally good soils may be found both along upland streams and in the rich humus abundant in upland forests. Although the latter was not annually renewed, a fallow system could permit vegetative decay to restore fertility. Proximity to land and water transportation routes may be of greater importance than soil characteristics in the strategic location of Mississippian settlements (Brain 1978; Smith and Kowalewski 1980, 1981; Scarry 1986). Moisture and temperature also play a role in any subsistence pattern, but these abiotic factors are not the foci of present models.

The suitability of upland soils for maize agriculture and the distribution of tillable patches may in part explain the Oconee settlement pattern (Anderson 1986). Just as there is no single Mississippian settlement configuration, subsistence systems also developed locally, varying within and between Mississippian societies (Hally and Rudolph 1986b; Scarry 1986). Most researchers agree that domesticated plants played a major role in Mississippian diet; but there is considerable divergence of opinion about the degree of dependence on agricultural products, the role of wild resources in the diet, and the nature of procurement strategies geared to the collection of wild resources (Scarry 1986). However, by the late Lamar when the Spaniards trekked through the Oconee region, corn was clearly the dominant cultigen (Elvas 1933, 1968 [1557]; Garcilaso 1980 [1605]). If the uplands were attractive to horticulturalists, why did horticulturalists not exploit the upland on a large scale sooner? The answers may lay in both ecological and economic theory.

Theoretical Orientation

Ecological Anthropology

Ecological anthropology is a problem-oriented discipline focusing on relationships, and consequently, its explanations of structure or function are dynamic and stress processes. All ecological relationships must be regarded as webs, rather than linear progressions with simple causes and effects (Netting 1977). Human ecology possesses a further complicating element in the existence of functional alternatives to specific behavior, or in institutions deriving from human choice and abilities (Jochim 1981). The recognition of these elements separates ecological anthropology from theories of economic determinism. Traditional ecology generally focuses on identifying patterning or correlations between events, and only rarely can the specific nature of causation be determined (Jochim 1981). The case of the Lamar period Oconee uplands may be one of these exceptions.

Optimization Theory

A number of economic models have been employed by archaeologists in the interpretation of prehistoric subsistence patterns. They are used to predict diet breadth, resource mix, exploitation patterns, and site distributions, given certain options and constraints (Winterhalder 1981; Winterhalder and Smith 1981; Hawkes and O'Connell 1982; Scarry 1986; Keegan and Butler 1987; Winterhalder 1987). The majority of these paradigms contain elements of ecological theory but are rooted in the cost/benefit models of microeconomic theory. Relevant economic models include optimal foraging (Winterhalder 1981), cost/benefit analysis (Earle 1980), input/output analysis (Lee 1969), and similar optimization models (e.g., MacArthur and Pianka 1966; Reidhead 1980, among others). These models are based on the principles that people tend to behave rationally, and that rationality is reflected in their allocation of scarce means (e.g., time or energy) among competing ends (Scarry 1986; Keegan and Butler 1987; Nassaney

1987). Continuing to the ultimate conclusion, maximization of energetic efficiency enhances the fitness of individuals, placing them at a selective advantage (Smith 1979).

Optimization models tend to be myopic, assuming that people will choose from the limited set of options on which the model focuses, rather than selecting from a more comprehensive menu which might consider cultural factors and alternatives (Smith 1979; Keegan 1987). Keegan (1987) notes that optimization models may be useful for the calculation of instantaneous time-allocation decisions, but they fail to address the broader questions of total currency demand or the impact of changes in the means of production. Nevertheless, if used as a predictive and interpretive tool, rather than a formula, optimization theory can be valuable.

Optimal Foraging Theory

Optimal foraging theory is a set of hypotheses and models, based on the general rule that people tend to exploit resources which provide the greatest return of energy per unit of energy expended, using any given technology. Its proponents have identified several components of foraging behavior that can be used to develop predictions about diet breadth, technological change, and other decision categories (Winterhalder 1981; Smith 1979; Stephens and Krebs 1986; Gremillion 1989a). Behavioral components of food acquisition relevant to predicting the optimal diet include time and energy costs of location, pursuit, capture, processing, as well as opportunity cost (Earle 1980; Winterhalder 1981; 1987). While this theoretical approach was first applied to animal behavior (MacArthur and Pianka 1966; Schoener 1971; Pyke et al. 1977), and later adapted to the study of hunter-gatherer cultures (Jochim 1976; Winterhalder 1981, 1987; Bettinger 1982; Hawkes et al. 1982), it is equally applicable to the evaluation of horticultural, agricultural, and mixed subsistence systems (Gremillion 1989a).

Optimal foraging theory asserts that foods in a given catchment zone are, consciously or unconsciously, ranked according to their energetic return upon encounter. Those with the highest rank will be favored, and appear as common dietary components. Foragers harvest only those species which raise or maintain their caloric return for total effort. As the demand for food increases due to anthropogenic or other natural forces, diet breadth expands in rank order. Those foods which are ranked lowest may never be exploited, regardless of abundance, or they will be utilized only in times of extreme food shortage.

It should be noted that optimal foraging theory does not strictly allow for the fact that a plant or animal might be included in the diet for variety, medicine, nutrients, ritual, pleasure, or other non-economic reasons. Some low-ranked species may be harvested for non-dietary reasons, with the residue being incidently consumed. One might argue that the "costs" of these resources are subsidized by their primary resource function, but this approach is rarely taken by predictive models.

Optimal foraging models are valuable not as rules, but as structured forms of inquiry. The expectation of optimal results is always more heuristic than realistic (Winterhalder 1987). Optimization principles, in conjunction with a broader ecological model, represent a useful paradigm for the interpretation of changing subsistence patterns in the Oconee region. This utility holds regardless of the biases inherent in the paleoethnobotanical evidence due to differential preservation. The general principles of optimization, as exemplified in optimal foraging theory, are the basis of the model proposed in this dissertation.

Carrying Capacity vs Diminishing Returns

An important corollary to the principle of optimization is the concept of carrying capacity. Carrying capacity, in relation to humans, is the upper limit of population that can be maintained in a given catchment zone, employing a particular technology (Allan 1949). In nature each group of organisms can increase at any density below its own carrying capacity and must conversely decrease at any value above it (Pianka 1988). Populations are limited by non-renewable resources, such as suitable habitation sites, but generally maintain a balanced equilibrium relative to the productive capacity of renewable resources, such as flora and fauna (Ricklefs 1979). "Overpopulation" is a relative term and in the case of humans there can be several levels of carrying capacity in a given area, depending on subsistence technology and temporal frame of reference (Jochim 1981). Rare in nature, the reaching of carrying capacity is characterized by a demographic decline.

It has been argued that carrying capacity is indeterminate for humans due to both practical and conceptual reasons (Dewar 1984). It is difficult to catalog and measure the amount of all potential human food in a habitat, and it is difficult to identify the critical limiting food resources in a habitat. Habitat resources in general and food abundance in particular are not constant over time but vary both cyclically and sporadically. An additional consideration is the fact that the density-dependent factor that most strictly limits the human population is not necessarily connected to habitat or food abundance per se. Regardless of these constraints, the carrying capacity paradigm is still considered to be useful in ecological anthropology (Beckerman and Crutchfield 1996).

In most cases, human technological modification is triggered by diminishing returns, rather than itself representing the realization of carrying capacity. In economics, the point of diminishing returns is that point at which the acquisition of each additional unit of value (e.g., kilocalories) incurs incrementally higher costs (e.g., time, kilocalories). This condition can be ameliorated by economic extensification, intensification, or both (Keegan and Butler 1987). Alternatively, demand may be suppressed by lowering the socially acceptable "standards of living," or consumption levels, reducing levels of political tribute, or similar actions. Only in the rare case when human population falls as a result of declining productivity, is it said that the population has exceeded its carrying capacity.

Humans may alter carrying capacity through technology or even through behavior, and many instances of culture change have been viewed as responses to the problems of approaching carrying capacity (Jochim 1981). Agricultural intensification and vegetative resource management through controlled burning, planting of multiple fields, adoption of more productive cultigens, protection or tending of wild species, along with habitat manipulation, can all increase carrying capacity. Behavior modification, such as the dispersal of the population across the landscape, or the regular accession of secondary resources, may do likewise. This relationship between human behavior and carrying capacity must be recognized, and is particularly relevant in the case of the late prehistoric Oconee culture.

Application to the Oconee Region

Over the course of the Lamar period in the Oconee region, faunal exploitation shifts from the hunting of restricted numbers of highly productive game species to the harvesting of a broad spectrum of wild taxa (Boyko n.d.). This pattern is exactly what would be anticipated under conditions of population pressure relative to resource supply. During the same period plant exploitation shifts as well, but in the opposite direction. The critical link between human behavior and carrying capacity must be invoked to explain this phenomena, as people modify their behavior at the point of diminishing returns.

As discussed earlier, during the late Lamar period the Oconee region was subject to both severe population pressure and culturally or politically imposed circumscription. If level of demand were the sole determinant of plant utilization, as population increased we would predict a shift from the targeting of a limited number of highly favored wild taxa, to the utilization of an extensive range including less productive species. But such is not the case. Human population increase was parallelled by a decline in the number and diversity of economically useful wild genera; in contrast, the variety of cultigens and their commensals increased. Wild taxa that were highly productive and easily manipulated were continually harvested. The human "intruders" into the uplands were agriculturalists and their conscious creation of habitat for cultivated species simultaneously extended the niche of some useful wild plants (Ford 1977). In short shifting patterns of the exploitation of wild and cultivated species are intrinsically linked. Although changed in composition and proportion over time, both wild and cultivated varieties were included in the diet throughout the Lamar period (Bonhage-Freund 1992).

Four previously established findings dominate the design of this study. First, a tremendous population increase occurred during the Lamar period in the Oconee uplands (Kowalewski and Hatch 1991). Second, it is likely that this region corresponded to the boundaries of a chiefdom (Smith and Kowalewski 1981). Third, throughout the Lamar period the upland population pursued a mixed economy (Bonhage-Freund 1990). Horticulture was practiced, habitats were manipulated, and wild foods comprised a significant proportion of the diet. Fourth, an unusually high number of farmsteads were located in non-riverine upland locations, compared to other known Mississippian settlement systems (Kowalewski and Hatch 1991). From these premises emerge three clear research problems to be discussed in chapter 2.

Research Implications

While this research is essential to the interpretation of Lamar Period settlement and subsistence patterns in the Oconee region, it is equally relevant to regional studies and to general Mississippian archaeology. Currently the adaptive pattern of the Mississippian period in the Piedmont is very poorly documented, and there is a need for information on the economic basis of regional Mississippian systems (Hally and Rudolph 1986b; Scarry 1986). From a paleoethnobotanical standpoint, little is known about variability in Mississippian subsistence strategies, the role of wild plants in Mississippian subsistence or the feedback loops relating foraging with agricultural intensification (Scarry 1986; Ford 1977). Faunal resources, while not the focus of this dissertation, play a significant role in the subsistence system. This facet of resource exploitation in the Lamar period Oconee uplands is presently under investigation and will be incorporated into this analysis where necessary (Boyko 1991; n.d.).

Chapter 2

MODELS OF HUMAN ECOLOGY IN THE OCONEE UPLANDS

Introduction

The decision to exploit the upland ecosystem intensively may have been based either on economic or socio-political forces. Internal or external pressures, such as warfare, epidemics, or political parameters all influence technology and settlement patterns. The models presented here explore the process of human intrusion into and adaptation to the upland landscape. It is my belief that socio-political and demographic factors influenced the timing and intensity of migration to the uplands.

Once the population was situated in the uplands, anthropogenic forces affected wild plant availability by the modification of habitat accompanying the deliberate cultivation and encouragement of native and introduced flora. Both wild and domesticated plants, along with native fauna, were integrated into a highly complex and flexible subsistence system. These concepts are incorporated in and tested by the following models.

Models of Human Ecology In the Oconee Uplands

Research Problem One: Evolving Subsistence Patterns

Mississippian subsistence is frequently associated with maize (*Zea mays*) agriculture. However, several additional important species were cultivated, encouraged, protected, or harvested from the wild. According to the principles of optimization, discussed in Chapter 1, people focus on the production and harvesting of those cultigens and wild foods which maximize energetic return (Braudel 1981:161; Keegan and Butler 1987:122; Muller 1987:266ff). Should the population reach the point of diminishing returns, it must stop growing, change technology, or add second line foods to the diet. For example, if the availability of fertile soil declines, soil enriching crops (Minnis 1985) or cultivars with lower demands might be grown, or an increased emphasis might be placed on wild flora and fauna. In extreme cases, indiscriminate harvesting of wild foods may occur.

Sometime during the Duvall and Iron Horse phases of the Lamar period, a major cultural adjustment occurred in the central Oconee drainage; ultimately resulting in widespread and permanent settlement of the uplands, as an "upland adaptation" based on localized resources evolved. Characterization of this subsistence system, its relationship and similarity to the bottomland adaptation, and its unique attributes, is an integral element of this dissertation. Ecosystems are dynamic and temporal change in the upland adaptation is anticipated. In this investigation the Iron Horse assemblage serves as the base-line for gauging variations in the upland landscape and diet.

Several internal and external pressures on upland carrying capacity have been identified, and will be discussed further in Chapter 3. Rapid population growth in the Dyar and early Bell phases (Kowalewski and Hatch 1991; Pluckhahn 1994), and at least one prolonged drought during each phase of the Lamar period (Stahle and Cleaveland 1992, 1994; Anderson et al. 1995) are significant ecological stressors. Other potential strains, such as pestilence or epidemic, are yet unknown.

In the early sixteenth century Spaniards introduced exotic species, including watermelon (*Citrullus vulgaris*) and peaches (*Prunus persica*) to Southeastern coastal peoples (Sheldon 1978; Blake 1981; Gremillion 1989a; Ruhl 1990). These imports spread to the interior along traditional trade routes, via hand-to-hand exchange (Strachey 1849 [1612]; Gremillion 1989a), and are found in late Lamar sites in the Oconee region. Beans (*Phaseolus vulgaris*) and squash (*Cucurbita* spp.), rare in archaeobotanical samples through the late Lamar period in the Georgia Piedmont, increased in abundance over time. The first research problem contemplates subsistence change over time by testing the following two hypotheses.

Hypothesis One: No Change

Hypothesis one, which serves as the null hypothesis, proposes that the Lamar population of the Oconee uplands never approached carrying capacity, maintaining a static adaptation throughout the Lamar period. Implicit in this premise is the notion that the people practiced sustainable resource exploitation. If this is true, the proportion of wild plant foods relative to domesticates would have remained essentially constant over time, and the breadth and mix of exploited species will remain fairly uniform, barring a shift in taste or technology. A similar constancy should be observed for animal resources. The mix of habitats, or local ecological niches, from which prey were derived, would have remained fairly constant under these circumstances with settlement patterns relative to resources remaining constant. Skeletal evidence would depict a relatively healthy and adequately nourished population prior to the immediate cause of death. As explained above, change is measured against the Iron Horse assemblage.

Hypothesis Two: Modification of Subsistence Strategy

Hypothesis two advances the proposition that the Lamar population of the Oconee uplands did reach the point of diminishing returns in the exploitation of its plant resource base. Wild plant foods requiring increasing increments of human labor in their exploitation, would have characterized the plant assemblage, and diet breadth should expand over time. An alternative scenario is equally possible. Agricultural intensification, or other technological change, would increase the carrying capacity and compensate for diminishing wild floral resources. In either case a temporary increase in harvesting of first-line animal foods is anticipated until they, too, were overexploited. Ultimately faunal exploitation patterns would have mirrored those of the flora.

The mix of wild versus cultivated plants is expected to shift as production costs of one versus the other changes due to human activity, and the relative importance of one habitat as a source of resources, versus another, is expected to have changed. Technological modification, such as agricultural extensification, intensification, or diversification might be anticipated as varieties of cultigens were added to or deleted from the diet. Adjustments in the mix of crops would indicate attempts either to increase productivity through inter-cropping (Minnis 1985), or to exploit species having lower environmental demands, regardless of production costs. Most of these attempts to boost agricultural productivity require additional increments of human energy compared to a subsistence program which is more evenly balanced between plentiful wild resources and prime cultigens.

Settlement patterns might either remain constant or change under this hypothesis. Stress indicators, such as Harris lines, or hypoplasia might be observed in the skeletal population if there was any substantial period of nutritional deficiency.

Research Problem Two: Stimulus for Migration to Uplands

Hypothesis One: Diminishing Returns in Bottomlands

In this case, the first and null hypothesis is that permanent upland settlements were indicative solely of severely diminished returns on subsistence efforts in the bottomlands, related to a population increase. According to this assumption, upland resources were generally inferior to those of the bottomlands; and the overall cost/benefit ratio of upland subsistence was much higher in the uplands. People, thus, avoided colonizing the higher grounds until the costs of riverine subsistence surpassed those of the uplands.

Under these conditions the earliest permanent upland settlements should reflect a high energy cost diet compared to the bottomlands. This proposition is substantially based on the assumption of lower agricultural productive capacity outside the river floodplain. Under this scenario, upland assemblages should emphasize not only cultigens, but also wild species that require relatively laborious harvesting techniques, much tending, or extensive processing. Such findings would indicate that although year round survival was possible in the uplands, the resources of that zone were, on average, inferior to those of the riverine zone.

Before permanent upland colonization was undertaken, riverine communities sites should have shown a prolonged and increasing dependence on second-line plant and animal resources that require significant inputs of human energy in harvesting and or processing. These circumstances would suggest a reluctance to relocate to an area viewed as holding even less potential. As upland colonization increased, economic pressure on bottomland resources should have been reduced and a concurrent shift in bottomland subsistence and settlement patterns is predicted. Use of secondary resources should have declined in the bottomlands, and the number of bottomland sites should have diminished as farmsteads relocate.

Hypothesis Two: Uplands Offer Attractive Alternative to the Bottomlands

Hypothesis two proposes that if permanent upland colonization were an elective choice, the energetic costs of subsistence in that zone were lower than or equal to those of the river bottom (Styles 1981). In this case, evidence of substantial agricultural activity in the uplands is predicted. The selective harvesting of first-line wild plant foods, particularly those that are complementary to cultigens, is expected in the earliest upland sites. Skeletal remains should be robust, with no evidence of Harris lines or other indicators of nutritional stress. Caries may be observed since they are associated with a diet high in maize. These observations would represent an upland terrain sustaining ample wild resources and also capable of supporting agriculture - conditions of which the Lamar people would be cognizant.

Hypothesis Three: Relaxation of Political Circumscription

As mentioned in Chapter 1, it is posited that during the Lamar period the Oconee region was subject to both severe population pressure and culturally or politically imposed circumscription. The existence of strategically located mound towns in the bottomlands of the Oconee and its major tributaries (Smith and Kowalewski 1980) is testimony to a powerful and complex chiefdom through the Dyar phase (Williams 1982a; Hally and Rudolphh 1986b; Hally 1993, 1996). This archaeological evidence is corroborated by ethnohistoric evidence (Bourne 1904; Garcilaso 1988 [1605]).

Nucleated settlements generally signify a state of readiness for conflict, and, indeed, the *cacique* of *Ocute* was known to be in conflict with the paramount of *Cofitachequi* during DeSoto's explorations (Anderson 1990; Rangel 1993). The dispersal of homesteads and their adjacent fields across the landscape, is a much more energetically efficient settlement pattern, and is to be expected in times of peace (Richards 1985). Nevertheless, powerful leaders may curtail the dispersal of the population in order to prevent defection to rivals. The demise of a chief is often accompanied by denucleation of the populace. This spread may occur gradually or abruptly.

It is known that, during the late Lamar period, the *Ocute* chiefdom began to devolve (Pluckhahn 1994) and by the Bell phase, mound building had ceased (Williams 1982a; Hally and Rudolph 1986b; Hally 1996). Coextensively, small dispersed settlements dominated the upland landscapes (Kowalewski and Hatch 1990; Pluckhahn 1994).

To test whether this new settlement pattern derives from relaxation of political controls and/or cessation of armed conflict, one can again consider diet breadth and quality, as in the test of Hypothesis One. If bottomland diet prior to colonization of the uplands chronically yielded lower energy returns than were achieved in the early upland farmsteads, political circumscription, precluding previous migration, is indicated. All else being equal, nutritional stress in the valley should either have diminished, or at least ceased to decline further, with the initial wave of upland colonization. Diet quality can be evaluated by assessing the numbers of edible taxa and types of taxa appearing in bottomland versus upland assemblages, and evaluating the energetic return and nutritional composition. This evidence alone is not sufficient to support hypothesis three, as it is the same evidence used to support hypothesis one. However, if improved energetic return is noted in the bottomlands in conjunction with a permanent shift to dispersed farmsteads, the case is more convincing. Nucleated settlements signal strong political control and or imminent warfare (Anderson 1990). In times of peace, farmers prefer to live among their fields, to minimize transportation costs and maximize security (Richards 1985). Other personal, practical, or culture-specific incentives for migration should also be considered.

Hypothesis Four: Temperature and Climate

Hypothesis Four submits that the cooling effects of the "Little Ice Age" can at least partially account for migration to the uplands. This proposition is based on the fact that lower ambient temperature reduces crop yields, requiring agricultural extensification to achieve adequate crop yields. Another climatic consideration is that marginally warmer temperatures at higher elevations may have favored agricultural productivity in all time periods. In addition, the potential for less frost may have marginally extended the growing season in the uplands.

To confirm a causal role of climate in upland migration, the following conditions must be met. First, cooler temperatures, which would depress agriculture, and in particular would adversely affect tropical cultigens, must appear prior to upland settlement. If climate played no role in upland colonization, no distinct weather pattern should be observed. Second, the uplands must be, on average, warmer than the lowlands to the extent that productivity will be positively affected. Third, uplands should experience a longer growing season than the bottomlands.

Hypothesis Five: Epidemic Disease

Hypothesis Five submits that a sudden increase in the upland population of the Oconee region represents an attempt to escape epidemic diseases. Although this hypothesis holds merit given ethnohistoric reports, a detailed investigation of this problem is currently beyond the scope of either my dissertation or the existing Lamar data base. The question can, however, be addressed indirectly using data derived from the small skeletal population and paleoethnobotanical evidence.

A pattern of abandonment of towns accompanied by population dispersal, in response to epidemic disease, was observed ethnohistorically in the southeastern chiefdom of *Cofachiqui* (*Cofitachequi*) (Garcilaso 1988 [1605]:298). This chiefdom has been identified archaeologically as located in the Santee-Wateree region of South Carolina, within the Piedmont physiographic province. There the DeSoto entourage observed unusually high numbers of fresh corpses in the charnel houses. The Spanish were informed by Indian leaders that a recent epidemic had induced fearful inhabitants to flee "to the forests without sowing their fields" and that the leaders had been unable to induce them to "...to (return) to their homes and towns..." (Garcilaso 1988 [1605]:298).

If population increased in the Oconee uplands due to epidemic disease, then the following pattern may be discerned. First, there should be clear archaeological correlates of epidemic disease in the bottomland sites, beginning as early as the Dyar phase when the Spanish first passed through the region. This evidence would include an abnormally high number of graves, many of which contain two or more bodies. The physical remains should exhibit no evidence of violent death. Individuals from all age, sex, and socio-economic groups would be represented.

Second, a marked reduction in the number and sizes of bottomland sites over time would occur in synchronization with a dramatic increase in the number of upland sites. Whether or not the burial configurations of the upland sites in the same time period resembled those of the bottomland would be dependent on how successful the people were in escaping the plagues.

Third, sites which show evidence of fatal epidemics might have low numbers of domesticated crops represented in the botanical sample, due to a shortage of people to cultivate or harvest them (Garcilaso 1988 [1605]:298). If the villages were abandoned in the middle of the growing season, at least some upland Dyar phase sites would have solely or primarily wild food remains. Since a plague might have occurred after the harvest, or forced foraging would presumedly have occurred for only one year, this manifestation would be difficult to detect archaeologically.

A lack of substantial paleopathological and archaeological analysis hinders the resolution of Hypothesis Five, although the postulate warrants attention. It is possible that the Oconee region actually represented a temporary "haven" from epidemics as there is evidence of major population in-migration in the late Lamar period. Ultimately the Oconee region experienced demographic decline some time after A.D. 1600.

Research Problem Three: Rate of Migration

The third research problem is to determine if the increased population and settlement density observed in the Oconee Region was a gradual, internal development, or the consequence of sudden migration. This question will be evaluated by testing the following hypotheses. Although demographic trends cannot be fully assessed by paleoethnobotanical analysis, these data provide an independent source of confirmation of population levels.

Hypothesis One: Stable Upland Occupation

The null hypothesis holds that there was no change in upland population and site density after the initial colonization. In this case, a settlement-subsistence pattern was established in the Iron Horse phase and thereafter maintained.

Hypothesis Two: Gradual Upland Colonization

The second hypothesis holds that a steady expansion of Oconee population brought about the gradual occupation of the Oconee uplands. In this case, a gradual shift in diet breadth is anticipated, as population pressure gradually pressed against resources.

Hypothesis Three: Rapid Upland Occupation

The third hypothesis is that upland occupation was rapid and sweeping. In this case, sharply altered diet breadth is anticipated, along with a rapid increase in open field and cultigen taxa as agricultural fields were cut from woodlands.

Conclusion

These research problems and the hypotheses derived from them afford a framework for the exploration of human adaptation in the central Oconee region during the Lamar period. The paleoethnobotanical data base is the primary focus; however, other related lines of evidence are employed as appropriate.

Chapter 3

CONTEXT OF PALEOETHNOBOTANICAL ANALYSIS I: NATURAL HISTORY, HUMAN ECOLOGY, AND ARCHAEOLOGY

Chapter 3 delineates the sites investigated in this project, placing them within the context of regional archaeological settlement patterns. Previous archaeobotanical studies are considered separately in Chapter 4. Chapter 5 recounts the ethnohistoric background framing Lamar period subsistence. This fifth chapter also provides ethnographic analogies useful to interpretation of the project data, and evaluates the energetic return of some important plant food taxa of the middle Oconee region.

Human Ecology

Human disturbance is one of the most powerful modifiers of plant communities. As the point of diminishing returns is reached in a given locality, environmental modification typically intensifies as a consequence of subsistence activities (Hudson 1976; Martin 1978). By altering the environment, humans are able to adapt to a wide variety of environmental situations without evolutionary modification of their own physiology (Fish and Hally 1983).

The late Lamar of the middle and upper Oconee river region is thought to have been a period of peak occupation by native Americans (Smith and Kowalewski 1981;

Ledbetter and O'Steen 1986; Rudolph 1986; Smith 1987; Kowalewski and Hatch 1991). Furthermore, warfare in neighboring river drainages may have restricted access to resources outside the Oconee region, thereby exacerbating stress on the environment by limiting potentially habitable territory (Anderson et al 1986; Rangel 1993).

Although environmental modification during the late Lamar period was no doubt extensive, it was not random. It has been observed that even within highly circumscribed territory humans carefully select procurement and habitation sites that best satisfy their particular wants and needs (Thomas 1983). The same behavior is evident in patterns of manipulation and exploitation of the biotic community. The theme of human activity as one component of any given ecosystem is central to the thesis presented in this document. In this project, correlations between institutional forms, demography and subsistence technologies within the upland setting of the Oconee watershed are compared to those of the riverine environment.

The Sites

This project focuses on four upland sites in the middle Oconee River drainage of north central Georgia. Sugar Creek (9MG4), Carroll (9PM85), Sweetgum (9PMG245), and Lindsey (9MG231) are all small homestead sites within close proximity to each other (Figure 2). According to ceramic analysis these sites represent three of the four separate phases of the late Mississippian and protohistoric Lamar period. Intrusion into the

Oconee region by the DeSoto and DeLuna expeditions in the mid-sixteenth century, was followed by the termination of the Late Mississippian period in the early to mid-seventeenth century. Lamar is the only recognized culture in the Georgia Piedmont during that period. Although the Lamar sequence is defined primarily on the basis of pottery (see Table 1), several other cultural features such as house and burial forms are also widely held to be diagnostic (Hally and Rudolph 1986a). The Sugar Creek site has been recognized as containing two components, Iron Horse and Bell; the Dyar and Sweetgum sites each represent the Dyar phase, and the presence of European trade goods and exotic plants, establish a Bell phase occupation at Lindsey (Hatch 1992).

Regional Overview

All four sites lie within the lower Piedmont physiographic province, with Sweetgum, Lindsey and Sugar Creek located within Morgan county, Georgia, and Carroll in adjacent Putnam county. They are all situated in the uplands surrounding what is now Lake Oconee, or the Wallace Reservoir. Lake Oconee is a hydroelectric facility covering approximately 19,000 acres along the Oconee and Apalachee Rivers in Greene, Hancock, Morgan, and Putnam counties, Georgia (Fish and Hally 1983). Mitigation undertaken in conjunction with this facility's construction has extended our knowledge of the Lamar period in this region.

Physiography

The Piedmont is a strongly dissected highland area that slopes gently toward the coastal plain of the southeastern region of the state. Stream valleys are typically broad and shallow throughout the Piedmont, with the interfluvial divides consisting of rounded hills with gentle side slopes and relief in the range of twenty to thirty m (Hally and Rudolph 1986b). The landscape ranges from almost level uplands to relatively steep slopes along major river valleys; isolated hills are rare (Hally and Rudolph 1986b). The Flint, Ocmulgee and Oconee rivers all arise near the southern border of the Upper Piedmont, the Chattahoochee and Savannah rivers also cross this region, and the Ogeechee river forms in the Lower Piedmont having only a small drainage basin above the Fall line (Hally and Rudolph 1986b) (See Figure 1).

At the southern end of the Lake Oconee basin the Oconee River crosses a belt of resistant rock, the Siloam Granite formation. Here the valley is narrow and the river channel is filled with shoals and islands. Upstream, the river follows a meandering course across a broad alluvial flood plain. Overall the river ranges between 30 and 60 m in diameter (Rudolph 1986).

Uplands of the Oconee region consist of relatively even hill, ridge, and plateau crests, believed to be remnants of an uplifted and dissected Jurassic and Lower Cretaceous peneplain that cuts across both igneous and metamorphic rocks. Models of the current land surface reveal approximately 46 m of relative relief, ranging from 168 - 213 m near the Wallace Reservoir (Brook 1981). A typical ridge is about 700 m wide, with only about a 50 m wide area of relatively flat ground across the crest, and sides sloping about 12.5% to a creek below (Kowalewski and Williams 1989).

The river valleys of the Piedmont contain a variety of habitats that were important to the region's Mississippian inhabitants, including alluvial bottomlands and nearby terraces. These lands provide moist, fertile, easily tilled soil in juxtaposition to forest resources. Although intermittent rocky shoals punctuate all Piedmont streams, and support a host of riverine species, but the distribution of these shoals is inconsistent. Along the middle Oconee, the most extensive shoals are juxtaposed to the most restricted bottomland, while the broadest alluvial bottoms lack shoals (Rudolph 1986).

Although no comprehensive study has been undertaken, remnants of ancient river terraces have been identified along the Oconee River Valley above the fall line, and elsewhere along Piedmont valleys. There are clear links between the distribution of archaeological sites and the locations of relict river channels. Brook (1981) describes many such examples in the Oconee region. Terrace remnants are most common where tributary streams enter the Oconee River.

Many archaeologists feel that abandoned river channels were attractive locations for aboriginal settlement because they provided a varied environment for food collection. Nevertheless, Brook (1981) argues that this explanation is insufficient to explain site distribution in the northern sector of the Oconee Reservoir. He notes that the age distribution of sites near old channels suggests that many were initially located on the banks of active stream channels and were subsequently abandoned and relocated with respect to the new river channel. This pattern implies that active streams, rather than backwater environments, were the focus of Oconee subsistence. Spanish explorers noted that,

> "...The land of *Ocute* is more strong and fertile than the rest, the forest more open; and it has very good fields *along the margins of the rivers* (emphasis mine)..." (Elvas 1968 [1557]:200).

Soils

The soils of the uplands are derived primarily from pre-Cambrian (600 million years B.P.) aged rocks. Today many Piedmont soils are extremely weathered, leached, naturally acidic, and manifest low natural fertility (Whittington 1986:355). Most of the upland soils are derived from decomposing organic matter, so these soils require long periods of fallow to regain fertility. In general, Piedmont soils are highly variable with respect to productive capacity, with loams confined to narrow stretches along streams and rivers (Pollock 1988). It is unknown how extensive creekside bottomlands were in prehistoric times. However, soils suited to corn agriculture were limited (Pollack 1988; Kowalewski and Williams 1989). Pollack (1988) argues that in late Lamar times this set of conditions would have resulted in small dispersed populations, focusing on patches of productive soils.

While modern soil profiles in the uplands are useful to site interpretation, they do not completely reflect the character of pre-contact agricultural potential. In the first half of the nineteenth century, Euro-American deforestation promoted soil erosion and gullying. The severity of this problem is well illustrated by conditions recorded near Milledgeville, Georgia, where a nearly three m deep fissure formed following forest clearing. Over a twenty year period this crack eroded into a chasm, "measuring no less than 55 feet in depth, 300 yards in length, and varying in width from 20 to 180 feet..." (Lyell 1855:28). Throughout the Southeast, ravines necessitating bridges for passage were considered to be "...attendant to the clearing away of wood" (Lyell 1855:30). The Oconee river was turbid with upland soils in the mid-nineteenth century (Cooper in Lyell 1855:256), at which time widespread cotton farming exacerbated soil depletion (Trimble 1969).

Implications for Protohistoric Agriculture

Traditional views of the superiority of floodplain soils for pre-industrial agriculture may be somewhat outdated (Baden 1995). Once cleared, some upland soils, lacking fine silts and clay commonly deposited in floodplain soils, may actually be easier to work. Protohistoric reports of widely dispersed fields in the Southeast imply that the notion that Mississippian peoples relied almost exclusively on floodplain soils is more myth than reality (Swanton 1969; Anderson 1986a). Kowaleski and Hatch (1991:13) calculate that the productive capacity of upland soils compares favorably to that of the flood plain. Citing Payne (1965:34) they demonstrate that even forgoing fertilizer, insecticides, and employing only rudimentary tillage, the anticipated average annual yield of fairly level upland soils in Morgan county is 17.6 bushels per acre, compared to 17.7 bushels per acre in alluvial soils. Steeper slopes in the upland average 7.1 bushels per acre. Upland soils with slopes no greater than 6% comprise 58% of the county's productive soils, compared to the alluvial soil's 14%. In other words, even discounting slopes and cyclical soil depletion, the uplands possessed considerable agricultural potential (Kowalewski and Hatch 1991). Comparable soils elsewhere in North American could be productively farmed for at least ten to twelve years (Thwaites 1896-1901 [1601-1791]:15:153; Hurt 1987), or possibly longer (Sagard 1939:92-93).

Adequate moisture is critical when corn first germinates, but thereafter, the timing of water availability is more flexible and over-watering, a greater danger in the flood plains, is more likely to be fatal to sprouts and young plants than drought (Scarry 1986). While some creekside soils of the upland region may have been renewed by flooding, the majority would have been dependent on the painstaking renewal of vegetative decay, perhaps enhanced by anthropogenic burning of ground cover (Hudson 1976). This factor lessens the value of upland soils, but does not negate it. Anderson (1986a) asserts that the superiority of floodplain soils is questionable, and notes that upland soils share many of their attributes.

Slope of the land and its exposure to the sun influence the temperature and moisture content of the soil at the microclimatic level. Soils on steep slopes are well drained, often to the point of creating moisture stress, particularly in southern exposures (Rickleffs 1979:42). Extrapolating from this observation, it is reasonable to assume that gentler and north-facing slopes would be less xeric, but still realize the warming effects of the sun, grading toward a more mesic environment on northern and eastern slopes. Plant communities on shady and sunny sides of mountains and valleys frequently differ in accordance with the temperature and moisture regimes of each exposure (Rickleffs 1979:42). Planting on slopes, of course, induces erosion, but considering the undulating landscape, erosion could not be completely avoided. Native agricultural techniques, described later, minimized soil loss by avoiding bare ground and maintaining root structures throughout the earth.

Climate

Temperature

Modern Piedmont summers are characteristically long and hot; winters are mild, but highly variable (Smith 1981a, 1994). The mean number of frost-free days is 255. Annual rainfall is abundant, averaging 111 to 134 cm (44-53 inches), and more or less evenly distributed throughout the year (Smith 1981a, 1994; Hally and Rudolph 1986b; Whittington 1986:355). Snowfall in the Southern Piedmont averages less than 10 cm (4 inches) annually, presenting little stress to either flora or fauna (Whittington 1986:355). These conditions are generally favorable for agriculture (Hally and Rudolph 1986b). Unfortunately, the doctrine of uniformitarianism cannot be invoked.

It is known that sometime between A.D. 1200 and 1500, the Neoboreal event, or "Little Ice Age," brought cooler temperatures to North America, which persisted until after A.D. 1750 (Bernabo 1981; King 1993). While experts cannot agree on the boundaries of this period of renewed glacial activity, nor its effects on microclimate (Muller 1986; Bradley and Jones 1992), it is likely to have had some effect on the Oconee region. Another complication is the fact that the effects of this cooling trend on regions that approach subtropical or tropical conditions is not well understood (Bradley and Jones 1992). One certainty is that the Neoboreal was not a steady state and that warmer intervals did occur within this cold period (Muller 1986; Bradley and Jones 1992). Given the parameters for the beginning of the "Little Ice Age," it is likely that it encompassed the Lamar period, from at least the Iron Horse phase onward.

Given the somewhat cooler average temperatures that were likely during the Neoboreal, even a small variation in the number of frost-free days may have impacted agriculture. The uplands have the advantage that cool air drains into the river bottoms, reducing frost in areas of higher topography (King 1993:252). This phenomenon would extend the growing season on both ends. While most varieties of corn grown by Lamar people could most likely be raised successfully, even with a reduced growing season, the number of frost-free days becomes significant if double-cropping is attempted.

Precipitation

Dendrochronological and dendroclimatological studies pinpoint fluctuations in mean annual rainfall in South Carolina and Georgia for the region lying between and adjacent to the Coastal Plain in South Carolina, and Ebenezer Creek, Georgia (Stahle and Cleaveland 1994; Anderson et al 1995). This territory lies about 200 km east of the sites now under consideration. Because the Southeast has been determined to represent a single "drought region" (Karl and Koscielny 1983), these mean annual rainfall estimates are used to approximate moisture conditions in the sites under current consideration.

Dendroclimatic studies reveal that the Lamar period was characterized by extended periods of generally adequate or better rainfall, punctuated by prolonged intervals of drought (Stahle and Cleaveland 1994; Anderson et al. 1995). The Duvall phase enjoyed adequate or better rainfall from A.D. 1377 until A.D. 1407. This trend was shattered by a protracted dry spell, spanning from A.D. 1407 through the Iron Horse phase in A.D. 1476. Within this 70 year interval it is estimated that weather-related shortfalls of agricultural stores would have occurred during 21 individual years (Anderson 1994). However, for most of this stretch, years of slightly low precipitation were counter-balanced within a year or two, and severe shortages were most likely circumvented by maintenance of food reserves (Anderson 1994). Within these seven arid decades, the most devastating moisture deficit occurred during the Iron Horse phase, when nearly continuous drought persisted for seven years, A.D. 1469 - A.D. 1476. Except for approximately 10 scattered years of shortfall, the next 83 years featured favorable rainfall until A.D. 1559 in the Dyar phase. A ten year drought ensued, the longest of the century, with only one year of "normal" rainfall (A.D.1565), and chronic, severe food shortages (Anderson 1994). The Dyar phase closed with a decade of above average precipitation (A.D. 1570's). Two more years of bountiful rain initiated the Bell phase (A.D. 1580-A.D. 1582), but a relapse into drought lasted until the turn of the century, with a more "normal" cycle returning circa A.D. 1596.

Relationships between climate, crop yields, and socio-political conditions have been widely studied (Anderson 1990; 1994; Anderson et al.1995). However, care must be taken in modeling relationships between climate and culture (Anderson et al. 1995). For example, climate may be an aggravating, rather than causal, factor in culture change, with demographic, technological, or other conditions or combinations of conditions representing the prime stimulus or stimuli for culture change (Anderson 1981). By its nature, human ecology demands the consideration of a complex web of stimuli and responses. Nevertheless, these paleoclimatic data represent a powerful interpretive tool in the modeling of human ecology in the southeastern United States.

Character of the Forest

As previously noted, the middle Oconee region lies within the Piedmont physiographic province. Descriptions of the forest and its composition vary mainly in the estimation of minor components. Braun (1950) classifies the Oconee region within the bounds of the Oak-Pine Forest, and others include it in the Oak-Hickory association (Weaver and Clements 1938; Oosting 1942) or the oak-hickory-pine climax type (Kuchler 1964; Whittington 1986:355). The dominant trees of prehistoric Eastern Piedmont forests were hardwoods including oak (*Quercus* spp.) and hickory (*Carya* spp.), but the short-leaf pine and a mixture of lesser hardwoods, such as sassafras (*Sassafras albidum*), poplar/cottonwood (*Populus* spp.), hackberry (*Celtis* spp.), sycamore (*Platanus occidentalis* L.), sweetgum (*Liquidambar styraciflus* L.), and persimmon (*Diospyros* *virginiana*) were also reasonably abundant, particularly in areas of windfall or gaps (De Vorsey 1971; Nicholson and Monk 1974; Plummer 1975; Sheldon 1983; Delcourt 1987). Limited sixteenth century observations by Spanish explorers support these descriptions (Bourne 1904; Biedma 1968 [1544]; Garcilaso 1988 [1605]; Rangel 1993). These narratives are supplemented by the descriptions of seventeenth and eighteenth century naturalists (Beverley 1947 [1705]; Adair 1968 [1775]; Bartram 1955 [1792]; Du Pratz 1972 [1774]).

Original forests of the Piedmont are characterized by Nelson (1957) according to soil coloration. He correlates "red" soils, characteristic of 35-40% of the Piedmont at the time of Euro-American settlement, with hardwood forests featuring little or no pine. However, Government Land Office (GLO) records dated 1805-1832 (Plummer 1975:6-7) display a mean of 20.55% pine (*Pinus* spp.) in Morgan county forests, and *Fidalgo de Elvas* noted stands of "tall pines" (Elvas 1933, 1968 [1557]). Of special interest is the dominance of oak (*Quercus* spp.) at 53.9% over hickory (*Carya* spp.), a mere 9.4%, considering the inverse character of archaeological nut remains, later discussed in detail. Among the oaks, post oak (*Q. stellata*) - 17.75%, red oak (*Quercus rubra*) - 12.7%, and black oak (*Quercus velutina*) - 11.3%, dominate. White oak (*Quercus alba*) comprises only 8.35% of the forest. Chestnut (*Castanea dentata*) - 3.21%, beech (*Fagus grandifolia*) -0.31%, walnut (*Juglans* spp.) - 0.13%, and chinquapin (*Castanea pumila*) - 0.02%, ranked last among the mast-producers.

Producers of fleshy fruits are scarce in GLO records (Plummer 1975). Cherry (*Prunus* spp.) - 0.05%, hawthorn (*Crataegus* spp.) - 0.01%, and persimmon (*Diospyros* *virginiana*) - 0.3% are represented in small amounts, while black gum (*Nyssa sylvatica*) and red mulberry (*Morus rubra*) are absent. A total of 34 hardwood taxa and two pines are enumerated. No other softwoods are noted. These records are not meant to be exhaustive inventories, and certain species are differentially tallied or ignored. However, a broad picture can be legitimately derived from these data. (See King [1978] for cautions regarding interpretation of GLO records.) Plummer (1975:8-9) notes that more post oak and less pine occurred on those soils having higher clay content. The Cecil soils of Morgan county, coupled with a slightly more mesic environment than Carroll, Haralson, or Meriwether counties, supported a true oak-pine-hickory forest. In interpreting the data I assume that these forest floristics extend to the adjacent Putnam county. Payne (1976) submits that the native forests of Putnam counties consisted primarily of pine and oak in the uplands, and sweetgum, poplar, and water-tolerant oaks in low ground.

Two forest types are found in the bottomland. The first, occupying well-drained floodplains and terraces, shares only four species with the uplands, namely, white oak, post oak, southern shagbark hickory (*Carya carolinae-septentrionalis*), and loblolly pine (*Pinus taeda*). In addition, willow oak (*Q. phellos*), sweetgum (*Liquidambar styraciflus*), swamp red oak (*Q. Varpagodaefolia*), shagbark hickory (*C. ovata*), overcup oak (*Q. lyrata*), red maple (*Acer rubrum*), hard maple (*A. floridanum*), hackberry (*Celtis occidentalis*), and American elm (*Ulmus americana*) can be found. The oaks and sweetgum account for nearly 66% of this forest (Wharton 1978; Joseph and Cantley 1990:11).

The second bottomland forest habitat in the Piedmont is the swamp forest, occurring in poorly drained areas which may retain standing water for much of the year. A variety of water-tolerant oaks, hickory (especially *C. cordiformis*, *C. aquatica*) and sweetgum are the primary canopy species in this forest type (Wharton 1978; Joseph and Cantley:11).

Role of Fire

Contrary to popular belief, little, if any, virgin forest remained in the Southeast when Europeans first arrived (Maxwell 1910; Day 1953; Swanton 1969; Hudson 1976; McCabe and McCabe 1984:20; Chapman et al. 1982; Delcourt 1987). Natives burned the forest cover far out of proportion to their numbers. They repeatedly charred large portions of the forest to create grazing lands and browse, artificially stimulating the number of deer. Aboriginal people also employed fire to concentrate game in hunting, while simultaneously modifying the understory. Low intensity ground or surface fire was used to reduce competition to mast producers, clear away leaf litter for ease in collecting nuts, facilitate travel, and create fire-free zones of open woods around habitations, simultaneously preventing ambush (Hudson 1976; Cronon 1983; Pyne 1983; Wagner 1996). Occasional "open" forests observed by the Spanish are testimony to this practice (Elvas 1933, 1968 [1557]:200). Fire was used to manipulate both wild plants and cultivars. It was used to regulate succession in old fields, improve yields of useful plants, and stimulate woody shoots (Hudson 1976; Cronon 1983; Pyne 1983; Wagner

1996). Native people incinerated their agricultural fields in late winter in preparation for spring planting, destroying deliberately weakened trees, returning nutrients to the soil, and creating a black blanket of ash to retain soil warmth (Strachey 1849 [1612]; Wagner 1996).

As a consequence of all this burning, the early Piedmont forest cover was broken by large expanses of grassland replete with scattered giant oaks and large herds of deer (Whittington 1984:357). The open fields and second growth forests observed by Bartram (1955 [1792]), as by-products of both agriculture and controlled burning, epitomize the impact of human activity (McCabe and McCabe 1984:19-20). Occasional stands of pure pine reflect the frequent burning (Elvas 1933, 1968 [1557]; Day 1953; Hudson 1976; Delcourt et al. 1981; Chapman et al. 1982; Sheldon 1983; Delcourt 1987). These conclusions are drawn from modern studies of natural forest succession and, if correct, imply that aboriginal people in the Piedmont habitually and consciously exerted intense pressure on the environment (Oosting 1942; Nicholson and Monk 1974; Golden 1979; Christensen and Peet 1981; Boserup 1982; Harnett and Krofta 1989; Dickson 1991).

Previous Archaeological Work

Wallace Reservoir Mitigation

The most comprehensive archaeological study in the Oconee Region is a mitigation project undertaken in conjunction with the construction of Lake Oconee (Fish and Hally 1983). See Gresham (1987) for an overview of this salvage operation. In the survey phase of the Wallace Reservoir project over 800 Lamar period sites were mapped. The concentration of sites in proximity to the Oconee River may reflect sampling bias, as the bottomlands were the primary focus of this investigation. The relatively small upland area appended to the Wallace survey revealed unexpected and dramatically high numbers of sites, mostly dating to the late sixteenth and early seventeenth centuries. Overall, 74% of the Lake Oconee area was surveyed. The absolute number of sites doubled during the Lamar period, and in terms of number of sites per 100 year period, the number increased by 800% (Gresham 1980). The majority of shell middens and shoal-related sites date almost exclusively to the late Lamar period (Rudolph and Blanton 1980:29; Rudolph 1986:8).

Pollack (1988) relates placement of Lamar sites in the bottomlands to specific soil types in the Lake Oconee vicinity. He observes that during the Dyar phase, non-riverine settlement occurred only on relatively extensive patches of soils of moderate fertility.

In the Bell phase, bottomland sites were typically located on smaller parcels of agricultural soil than those of the Dyar phase, yet these farmsteads were principally positioned on the most highly fertile soils outside the actual floodplain. He concludes that during the Dyar phase occupants employed a strategy of extensive horticulture, compared to intensive farming in the Bell phase. Alternatively, this pattern could represent agricultural extensification using an infield-outfield system.

Regional Settlement Patterns

By A.D. 1200 mound centers spaced about 80 km apart and approximately equal in size existed in the Savannah River region. In the Middle Savannah River, mound building ceased and site frequency was close to zero by A.D. 1450 (Anderson 1986b; 1994). Contemporaneously, in the middle Oconee and middle Chattahoochee river regions, the number of both mound and non-mound sites significantly increased (Rudolph and Blanton 1980; Rudolph 1986; Hally and Rudolph 1986a). The Wallace survey data clearly illustrate this trend. Within the survey area 54 floodplain and four upland sites dated to the early Lamar period, while in the late Lamar these figures jumped to 200 and 13 respectively (Rudolph and Blanton 1980). This dramatic increase in site number encompassed locations on shoals of the Oconee River, along secondary and tertiary streams, and well into the uplands (Rudolph and Blanton 1980). It is likely that the decline in both mound building and population in the middle Savannah River drainage subsequent to the Rembert phase[1] was related to the concurrent growth and expansion of chiefdoms in the middle Oconee and the Wateree River valleys (Hally and Rudolph 1986a).

As discussed in Chapter 1, Smith and Kowalewski (1980), using archaeological and ethnohistoric data, delineated the Wallace Reservoir as lying within the boundaries of the Ocuté province (Figure 2). Upland habitations clearly constituted an essential component of the settlement system. Dense concentrations of Lamar period sites existed within a roughly 10 km radius of mound centers, dropping by approximately one-half in a ring within 10 km to 23 km of mound centers. Beyond 23 km, upland sites virtually disappeared from the landscape (Hatch 1992).

Oconee Uplands

Two additional small-scale surveys in the four counties surrounding the Wallace Reservoir disclosed 79 more Lamar period sites. Many of these are a considerable distance from the reservoir boundaries, with the majority situated in the uplands (Wood and Lee 1973; Wood 1976 in Fish and Hally 1983). Regional data indicate that Lamar site densities of upland tracts are nearly as great as those of the floodplain (Hatch 1992).

Numerous expanses of upland landscape have been intensively surveyed in conjunction with Georgia Power Company's cultural resource management program, the United States Forest Service, and the University of Georgia Department of Anthropology.

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[1]Rembert is the terminal Mississippian phase in the Savannah River basin.

Typically these surveys concentrated on clear-cuts; that is, areas of at least 500 acres stripped of vegetation. Finch's survey of an upland area in Greene County, Georgia, presents additional evidence of a population explosion in the Oconee region during the Late Mississippian period (Elliot 1981).

Every patch of ground suitable for agriculture that has been examined in the Oconee region has yielded Lamar, and in particular late Lamar, sites (Hatch, personal communication, 1989). This discovery negates the previous assumption that Mississippian sites were found mainly in the floodplains of major rivers and their primary tributaries. As noted above, late Mississippian-protohistoric upland sites are located in the rolling Piedmont terrain, as far as 20-25 km away from these major drainages (Elliot 1981; Blanton 1984).

Surface evidence indicates that the typical upland site is small, usually within the 2500 - 10000 m^2 (Hatch, personal communication, 1990). Site dimensions, coupled with archaebotanical evidence of agriculture (discussed in chapter 4), suggests that these were small farmsteads. Kowalewski and Hatch (1991) propose that this dramatic expansion of settlement in the upper Oconee rivershed during the late sixteenth century was comprised of dispersed homesteads. Their density ranged from six to seven sites per km^2, over an area of 3750 km^2 (Kowlewski and Hatch 1991). This range is based on a summary of data from all 13 non-riverine, later Lamar sites that have been excavated, from all the intensive surveys of non-riverine, cleared land (totalling 3500 ha), and from extensive surveys of forested land. Blanton's (1984) survey work for Georgia Power Company near Sparta, Georgia, also reveals multiple upland sites dating to the late

Mississippian period. He found the most intensive occupation to be in the Dyar phase with fewer sites in both the earlier Duvall and later Bell phases. Later subsurface work on a portion of this property (9HK64) included paleoethnobotanical analysis described in Chapter 4 (Gardner 1985).

Recent surveys of the Upper Oconee and Upper Broad River valleys and adjacent uplands in Jackson and Madison counties disclose important settlement data (Pluckhahn 1994). This area is geographically peripheral to the "Oconee Province" (Smith and Kowalewski 1980). A single Duvall phase component on a site in southern Jackson county represents the early Lamar Period there. This scarcity implies that this recently surveyed area was unoccupied and little utilized during much of the Lamar period. Data from Jackson and Madison counties indicate that about A.D. 1550 the upper Oconee Valley at large witnessed a population increase similar to that of the middle Oconee region. The fact that Dyar and Bell phase ceramics appear in the headwaters region without antecedents supports the theory that they are intrusive, and that Late Lamar settlements reflect a migration into the area (Pluckhahn 1994).

Pluckhahn (1994) suggests that as population increased in the former Oconee province, the people migrated into the remaining wilderness. He further proposes that this migration occurred during the process of "de-evolution" of the chiefdom, as regional settlement patterns reflect a decentralization of society in general. Locally and regionally dispersed communities replaced nucleated settlements as social and political controls declined. There is additional ceramic evidence of migrations from the upper Savannah river region. A related alternate explanation is that, following Spanish intrusion, the line between chiefdoms of the Oconee and upper Savannah blurred allowing people from either or both polities to move into the former buffer zone (Pluckhahn 1994)

Other Non-Riverine Sites

A variety of Mississippian-protohistoric archaeological excavations has been conducted in the Oconee region beyond the river valley. Ridge top sites include 9HK64, located five miles southwest of Sparta (Blanton 1985), 9GE1081, a flat knoll top hamlet, overlooking Fishing Creek in Greene County north of the Wallace Reservoir (DePratter and Kowalewski 1983); King Bee, a Dyar phase habitation on a ridge plateau above Little Glady Creek in the Oconee National Forest, north Putnam County (Elliott and Boyko 1985); and Raccoon Ridge (9MG271), a small Bell phase site in Morgan county (Worth 1995). Two additional Lamar sites were studied in the Oconee National Forest in Greene County, a "Boulder Cache," (9GE1083) facing Sandy Creek, possibly a ceremonial site (Ledbetter and Wynn, n.d.); and a small (50 x 80 m) habitation site with two occupations of the Duvall and Dyar phases (Ledbetter and Wynn, n.d.). Between 1987 and 1990 Pennsylvania State University conducted excavations of upland homestead sites temporally spanning the Lamar period at Lindsey (Bell phase), Sugar Creek (Iron Horse and Bell phases), Carroll (Dyar phase), and Sweetgum (9MG245).

The late Mississippian non-riverine sites that have been scientifically excavated to date are all small (less than one hectare), and of them only Lindsey (9MG231), Sugar Creek (9MG4), Carroll (9PM85), and Sweetgum (9MG245) have been systematically studied as entire sites (Kowalewski and Hatch 1991). The excavations at Racoon Ridge (9MG271) are still in progress (Worth 1996). The thoroughness of subsurface investigation at the remaining locations varies from the excavation of 2 m^2 to almost 564 m^2. Most of these sites were located on ridge tops between 20 and 40 m in vertical elevation above the nearest stream, with the remainder on low rises or terraces adjacent to streams. Soil analyses at all but one indicate their location on prime agricultural soil types (Kowalewski and Hatch 1991). A relatively low number of archaeobotanical studies have emerged from these middle and upper Oconee region sites. (See Chapter 4.)

Conclusion

Chapter 3 paints the physical backdrop for the interpretation of archaeological and archaeobotanical data of the middle Oconee region of the Georgia piedmont. It also sketches the earlier archaeological work of the region, summarizing current thought on the design and basis of Lamar period settlement patterns. Subsequent chapters expand on these topics.

Chapter 4

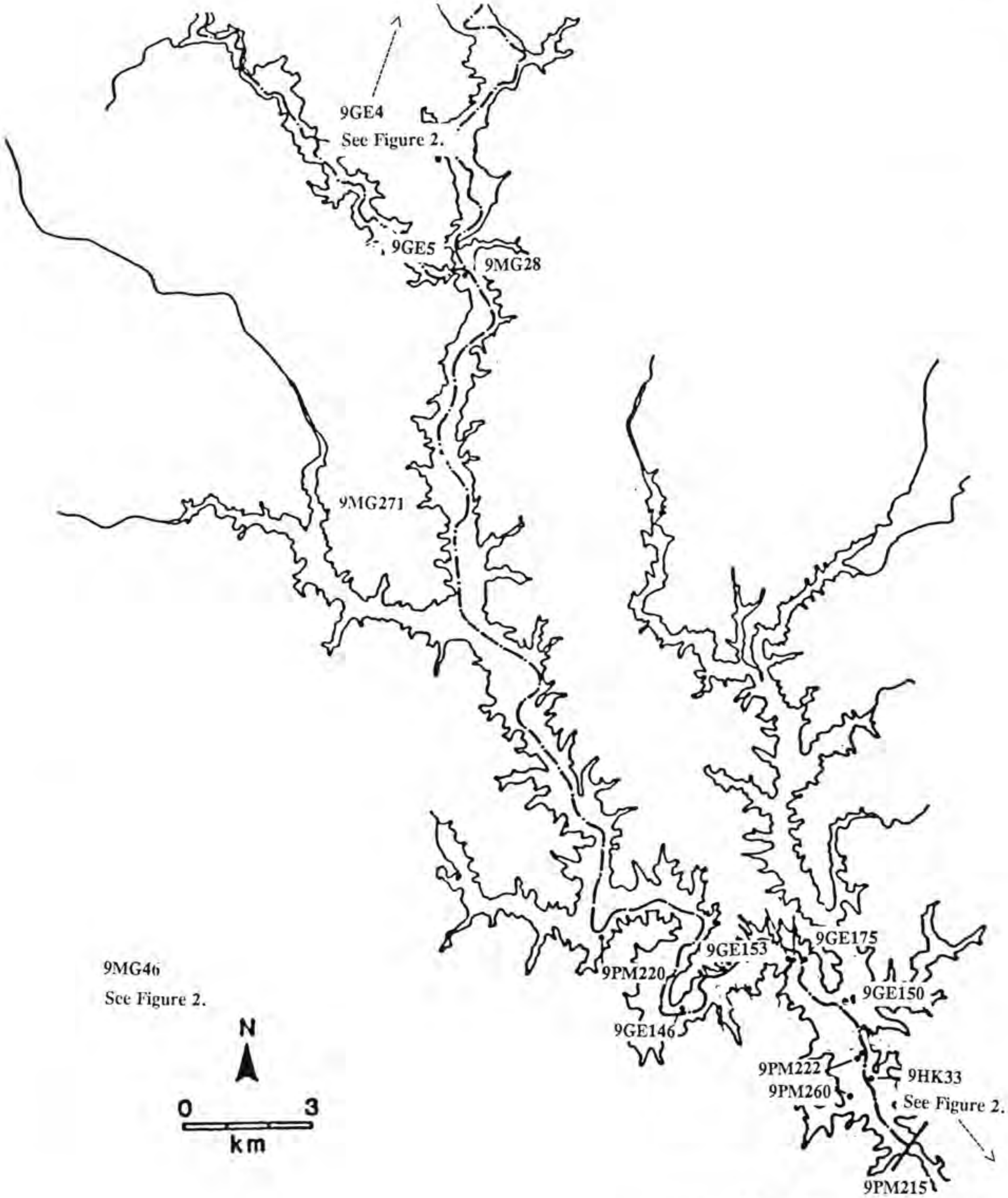
CONTEXT OF PALEOETHNOBOTANICAL ANALYSIS II: PREVIOUS LATE PREHISTORIC ARCHAEOBOTANY OF THE GEORGIA PIEDMONT

Introduction

Limited archaeobotanical research has been conducted in either the immediate Oconee region, or the Georgia Piedmont in general. The amount and quality of this research varies. In some cases no samples were taken; in others, samples were water-screened. In those cases where flotation samples were processed, an assortment of sampling strategies was employed. Due to these circumstances, quantitative evaluation of regional data is infeasible; however, qualitative evidence can provide insight to Mississippian /protohistoric ecology and subsistence.

Wallace Reservoir Project

Of the sites selected for "intensive investigation" within the Wallace Reservoir Archaeological Project (see Fish and Hally 1983), a total of 12 contained Lamar Period components. (See Figure 3). Ten of these lay in the Oconee River bottomlands, including floodplain and islands. I examined both published reports and original site files



(Adapted from Fish and Hally 1983)

Figure 3: Lamar period sites in the middle Oconee region for which archaeobotanical data is available.

of these Lamar sites, including laboratory reports. In the case of the Joe Bell site (9MG28) many of the original records were not available, but I did examine some unprocessed soil samples. The macrobotanical assemblage of the Joe Bell site has been previously reported (Williams 1982a).

Protocol for water-screening samples from the Wallace Reservoir project called for routine defloculation of the sample with Calgon and rinsing through a french fry basket under a faucet. (See, for example, Williams 1977-1979:41) to recover the largest fragments of wood, nut, and corn cob charcoal. Flotation samples were processed in plastic tubs, employing defloculant as needed. The light fraction was decanted into fine screen of unspecified size, and the heavy fraction was screened through window screen (Williams 1977-79). Assuming a sufficiently fine-mesh screen, this procedure would capture the full range of macrofossils. Selected samples were submitted for archaeobotanical analysis, but these samples did not represent every site.

Of the Wallace project sites selected for intensive investigation, and identified as containing Lamar components, four represented the Duvall phase (9GE4 [Williams 1984], 9GE153 [Hally 1977-1978; Smith 1981; Shapiro 1981b], 9GE175 [Hally and Fish 1978-1979; Shapiro 1981a], 9PM222 [Hally and Fish 1978-1979]), one the Iron Horse (9GE5 [Hally 1978-1979; Smith 1981a, 1994]), six the Dyar (9GE4 [Williams 1984], 9GE5 [Hally 1978-1979; Smith 1981a, 1994], 9PM260 [Hally 1977-1979; Manning 1982], 9PM215 [Hally and Fish 1978-1979], 9PM220 [Hally 1977-1979], 9MG46 [Shapiro and Williams 1984; Williams and Shapiro 1985]), seven the Bell (9GE4 [Williams 1984], 9GE150 [Hally 1977-1981; Smith 1981b], 9MG28 [Williams 1977-

1979, 1982], 9PM215 [Hally and Fish 1978-1979], 9PM220 [Hally 1977-1979], 9PM260 [Hally 1977-1979; Manning 1982]), and one Dyar/Bell (9GE150 [Hally 1977-1981; M. Smith 1981b]). Table 2 and Table 3 summarize the available information on location, function, faunal assemblage and processing of macrobotanical samples for each of these sites.

Archaeobotany of the Bottomlands

For most Oconee bottomland sites, counts and or weights of taxa are recorded, with little or no further interpretation. A summary of the taxa represented at all riverine sites is found in Table 4. A discussion of the sites and paleobotanical interpretation of the data follows.

Each of the major late prehistoric phases is represented by at least one habitation site. A village associated with Dyar mound (9GE5) (Smith 1994) contains a Duvall phase component, as does a village associated with Scull Shoals mound (9GE4) (Williams 1984). However, the only macrofossil reported for the latter was oak acorns. A smaller village at the Joe Bell site (9MG28) includes both Duvall and Bell phase occupations (Williams 1977-79, 1982). The Iron Horse and Dyar phases are represented at Dyar mound village. The major occupation of the Joe Bell site is a Bell phase village. In addition to habitation sites, several extractive sites adjacent to shoals also exist. These are shown in Table 2.

Table 2: Lamar components in the Wallace Reservoir bottomlands which were subjected to archaeobotanical analysis.

Phase	Site/Cit./ID#	Location	Function	Process & Fauna
Duvall, IH, Dyar, Bell	9GE4 (14) H1	non-shoals, floodplain	mound center	Duvall: D, T, R, SM
Iron Horse (mixed with paleo-Indian)	9GE153 (1;7b;11) S1	shoals, floodplain	extractive	screened; D (limbs);B, R, SM; 88% A, Tl
Duvall, Iron Horse, Bell (trace)	9GE175 (5;7) S2	shoals, floodplain	extractive	fine screen; A, D, B, SM, dog
Duvall?, Iron Horse?, Dyar?	9PM222 (5) S3	shoals, island	extractive	flot, dryscreen; invertebrates, trace:TL, SM, BD
Duvall, Iron Horse & Dyar	9GE5 (3;9;10) H2	non-shoals, floodplain	mound center w/ village	flot,waterscreen 60% D; R, T, B, SM, F, A, 17% Tl
Dyar	9PM215 (5) S4	shoals, terrace	extractive	
Dyar (late)	9PM220 (2;6) M1	non-shoals, river bank	shell midden	flot; SF
Dyar	9MG46 (8;15) H3	terrace overlooking creek	mound center - 5 hectares	
Duvall, Bell	9MG28 (12;13) H4	non-shoals, floodplain	habitation - village	Duvall: SM, B, 88% F, SF, R; Bell: mammal (D=65%), B, F, Tl, A, L
Lamar	9GE146 (4) S5	shoals, terrace	extractive	

Key
D=deer; T=turkey; R=raccoon; B=bear; SM=small mammals; BD =Birds; SF=shellfish; F=fish; Tl=turtles; A=other aquatic resources; R= other reptiles; L=insect larvae; underlined species dominate
H=habitation site (village or mound village) S=shoal site M=midden

Citations

1 Hally 1977-78
2 Hally 1977-79
3 Hally 1978-79
4 Hally & Fish 1977-78
5 Hally & Fish 1978-79
6 Rudolph & Hally 1982
7a Shapiro 1981a 7b 1981b
8 Shapiro & Williams 1984
9 M.Smith 1981a
10 M.Smith 1994
11 M.Smith et al 1981
12 Williams 1977-79
13 Williams 1982
14 Williams 1984
15 Williams & Shapiro 1985

Table 3: Lamar components in the Wallace Reservoir uplands.

Phase	Site/ID#	Location	Function	Process & Fauna
Dyar & Bell (also Archaic and Woodland)	9PM260 (Hally 1977-79; Manning 1982) R1	upland (ridge top overlook-ing Oconee River, 24 M below)	extractive rockshelter - hunting, hickory nut production	water or fine screen Dyar: D, R, SM, F, T. Bell: D, R, SM, F, Tl
Bell (mixed with middle and late Archaic	9GE150 (Hally 1977-81; Smith 1981b) R2	upland; proximate to Lawrence shoals at confluence of Richmond Creek & Oconee River	extractive rockshelter- "overnight" camp for hunting	water screen & dry screen SF-M, F-M
Dyar & Bell	9HK33 (Blanton 1985; Gardner 1985) F1	uplands	farmstead	flotation
Iron Horse (also Vining)	9MG271 (Worth 1995, personal communi-cation; 1996) F6	uplands; ridge top	farmstead	hand excavated D, T, A

Key
D=deer; T=turkey; R=racoon; B=bear; SM=small mammals; BD=Birds; SF=shellfish; F=fish; Tl=turtles; A=other aquatic resources; R= other reptiles; L=insect larvae.
F=farmstead R=rockshelter

Table 4: Floral taxa identified in Lamar components of Wallace Reservoir bottomland sites. Site identification numbers correspond to those of Table 2.

Taxon	Duvall	Duvall / IH	Iron Hrse	Dyar	Bell	Lamar
Cultigens						
Common Bean (*Phasaeolus vulgaris*)	H2		H2			
Corn (cob) (*Zea mays*)	H2, H4-*Min*	S2	H2	H2	H4	
Corn (kern) (*Z. mays*)	S3-*T*, H2	S2	S1-*T*, H2	H2	H4	
Marshelder (*Iva annua*)					H4	
Maygrass (*Phalaris caroliniana*)						
Peach (*Prunus persica*)					H4	
Open Field						
Chickweed (*Stellaria* spp.)		S2				
Grasses (*Gramineae*)	S3			M1		
Knotweed (*Polygonum* spp.)					H4	
Maypop (*Passiflora incarnata*)	H4	S2	H2	H2, M1		
Partridge Pea (*Chamaecrista* spp.)				M1		
Smartweed (*Polygonum* spp.)	H2-*Min*					
Spurge (*Euphorbia* spp.)	S3 H2-*Min*				H4	
Old Field						
Grape (*Vitis* spp.)	H2-*Min*		H2	M1		
Hackberry (*Celtis* spp.)					H4	
Persimmon (*Diospyros virginiana*)	H2-*M*	S2				
Poke (*Phytolacca americana*)	S3	S2	H2	M1		
Sumac (*Rhus spp.)*		S2				

(cont. on next page)

Table 4 (cont.)

Taxon	Duvall	Duvall / IH	Iron Hrse	Dyar	Bell	Lamar
Open Woods						
American Hornbeam (*Carpinus caroliniana*)				M1		
Arrow-wood (*Viburnum* spp.)						
Beans - unspecfied (*Phasaeolus* spp.)	H2-*Min*		H2			
Bedstraw (*Galium* spp.)	S3	S2				
Cherry Family (*Prunus* spp.)	H2-*Min*			S4		
Holly (*Ilex* spp.)	S3					
Tulip Tree *Liriodendron tulipfera*)						
Wild Bean (*Phasaeolus* spp.)					H4	
Forest/Nuts						
Black Walnut *Juglans nigra*)	H2-*Min*		H2		H4	
Hickory (*Carya* spp.)	S3 H2	S2	S1-*T*, H2	H2, M1	H4	S5
Oak Acorn (*Quercus* spp.)	H1, H2, H3, S4		H2-*D*	H2-*D*, M1	H4	
Pine Seeds (*Pinus* spp.)			H2			
Wetlands						
Cane (*Arundinaria* spp.)			H2			

(cont. on next page)

Table 4 (cont.)

	Duvall	Duvall / IH	Iron Hrse	Dyar	Bell	Lamar
Wood Types						
Chestnut (*Castanea americana)*		S1				
Hickory (*Carya* spp.)	H2					
Oak (*Quercus* spp.)	H2					
Pine (*Pinus* spp.)	H2	S2	S1-*D*; H2	S4		S5
Hardwood (unspecified)	H2			H2		

(Hally 1977-78, 1977-79, 1978-79; Hally & Fish 1977-78, 1978-79; Rudolph & Hally 1982; Shapiro 1981; Shapiro & Williams 1984; M. Smith 1981a, 1994; M. Smith et al. 1981; Williams 1977-79, 1982, 1984; Williams & Shapiro 1985)

Key:
H=habitation site (village or mound S-shoal M=Midden
D=dominant in category *Min*=minor amount *T=Trace*

Site Identifications:

H1=9GE4	S1=9GE153	M1=9PM220
H2=9GE5	S2=9GE175	
H3=9MG46	S3=9PM222	
H4=9MG28	S4=9PM215	
	S5=9GE146	

Paleoethnobotanical Interpretation

Agriculture

The macrobotanical assemblages of bottomland habitation sites, represented in Table 4, confirm the practice of agriculture throughout the Lamar period. Beginning in the Duvall phase and continuing through Bell, both corn cobs (and/or cupules) and kernels are recovered from the village area of both the Dyar (Smith 1994) and the Joe Bell sites (Williams 1982a). The cobs are particularly significant at the village at Dyar, as they demonstrate that mound towns were not solely dependent on tribute for their own subsistence, assuming that corn is typically shelled for transport. A few common beans (*Phaseolus vulgaris*) are also seen in the Dyar village assemblage in the Duvall and Iron Horse components. While beans drop out during the Dyar phase, domesticated marshelder is seen in the Bell phase at 9MG28. Maypop (*Passiflora incarnata*), a fruit-bearing vine that is commensal with agricultural crops, is ubiquitous except in the Bell component of 9MG28, providing additional evidence of agriculture prior to the Bell phase. During the Bell phase, peach (*Prunus Persica*), an "exotic" introduced by the Spanish, is seen for the first time at 9MG28 (Williams 1982a).

The majority of shoal sites located in the course of Wallace Reservoir mitigation date to the late Lamar period, particularly to the late Dyar phase (Rudolph and Blanton 1980:29). While rich in faunal material, these sites typically lack substantial macrobotanical remains. Small amounts of corn, usually kernels, were recovered. A shell midden (9PM220) contained no field crops, but did include maypop. The lack of agricultural products at these sites is not surprising. In the boudin valley (defined in Rudolph 1986) system of the Oconee river, shoals are never adjacent to sizable tracts of tillable soils, and biotic assemblages of shoal or midden sites emphasize aquatic species. In the case of the Iron Horse phase occupation at 9GE153, other provisions were clearly transported, rather than procured locally. Deer limb bones, representing relatively easily transported hind and forequarters, dominated the 12% of the faunal assemblage comprised of mammal bones (Shapiro 1981a). Several authors (Romans 1775; Bourne 1904; Swanton 1911,1969) cite parched corn, often ground, as the main food for travelers. Corn kernels are rarer than cob fragments in archaeological contexts, and are usually preserved only as a result of cooking accidents. If the corn was prepared elsewhere, the fact that it is found at all is remarkable. It is likely that people focused on aquatic species during their stay at these extractive sites, utilizing other foods for variety or in an emergency.

The Duvall phase occupants of the Joe Bell site heavily exploited the aquatic resources of the Oconee. They were highly selective, focusing on fish, with only minor labor-intensive harvesting of turtles, mollusks, and snakes, and no frog or salamander remains were found. Mammals comprised only 5.8% of the bone of the single Duvall phase feature, and rabbit remains represented 57.8% of the Duvall mammal assemblage. This pattern is in contrast to the Bell phase faunal assemblage where mammals constituted 56.8% of the identified species, with deer and rabbit dominating. An eclectic congregate of mollusks, fish, amphibians, birds, and even boiled mud-dauber nests makes up the difference (Williams 1982a), implying that greater effort was required to procure animal protein in the late Lamar, compared to the incipient Lamar period. In contrast to the Duvall village at 9MG28, mammals, especially deer are well represented at the Duvall phase mound centers, 9GE4 and 9GE5, eclipsing aquatic resources.

Nuts

As is indicated in Table 4, the single most important wild plant food category for the Lamar period is nuts, which are derived from climax forest species. Table 4 shows that black walnut (*Juglans nigra*), hickory (*Carya* spp.), and oak acorns (*Quercus* spp.) were used throughout the Lamar period at habitation sites. The single exception is the Dyar phase, where black walnut is lacking. Of further interest is the fact that acorns dominate the nut assemblage in the bottomlands. Acorns are more abundant in the river bottoms than hickory, but require more energy to utilize. In addition, they are less nutritious than hickory (Gardner 1992), assuming that the hickory is merely crushed and added to stews. The energetic return of nuts and other wild foods is evaluated in chapter 5.

On the other hand, if hickory is rendered into oil, the net energy produced may be less than for a similar quantity of acorns (Table 9). One must also consider search and transport costs. In long-occupied sites, the former would be negligible. However, since the majority of hickory grows in the more xeric upland forests, the cost of acorn production is proportionally reduced. Hickory harvested locally would most likely be added to the cooking pot, while that which was transported would be rendered into oil (or "milk").

Also of note is the presence of pine seeds during the Iron Horse phase. Pine seeds or pine cone fragments were found in multiple contexts. Unlike the large, edible seeds of western pines, *e.g.*, piñyōn (*Pinus edulis*), these Eastern varieties are most likely artifacts of firewood collection or incidental inclusions reflecting the local environment, rather than a potential food source.

Wood

A limited amount of wood species identification was performed on these samples as part of the routine archaeobotanical analysis. Pine (*Pinus* spp.) was the only universal genus. Oak (*Quercus* spp.) was noted at one habitation and one shoal site, while chestnut (*Castanea americana*) and hickory (*Carya* spp.) were recognized at one site each. The ubiquity of pine in the area is not surprising as the climax forest type has been classified as oak-hickory-pine (Kuchler 1964). Oak and hickory are definitely climax species in this forest type, but pine is often considered to be a sub-climax species, indicative of human or natural disturbance (Quarterman and Keever 1962). In neighboring South Carolina, pine/conifer, oak, and hickory are the three dominant types of wood found in 24 archaeological sites spanning the early archaic through Mississippian time periods and representing both coastal plain and Piedmont contexts (Wagner 1995). These data imply that the charcoal assemblage of the Oconee bottomlands is fairly typical for the late prehistoric/protohistoric time period. It also suggests a high amount of human disturbance to the landscape.

Habitat Indicators

Open field species are pioneering plants that invade open land within the first several years of disturbance. Old fields are at least three to five years old and harbor brambles[1], bushes, small trees, and other slower-growing or later invading taxa (Oosting 1942, 1956; Whittington 1984:356). Old field species are frequently found in "edge zones," or areas of ecotone between disturbed or open land and woods or forest. Woods is a term used informally by Strausbaugh and Core (1977) to describe the area transitional between the old field and mature forest, and features species of varying light requirements. This area of ecotone is more rich in species than the climax forest, and features both canopy and understory species, including herbaceous plants. The floor may be tangled or open, but the latter condition usually reflects human intervention or natural fire (Hudson 1976; Pyne 1983). While the term "woods" is not officially recognized in ecological literature, I use the term to differentiate taxa which are more likely to be found in more open forested areas, from those typical of the deep climax forest.

Table 4 indicates that habitation and extractive sites exhibit similar, constant, low (one to three taxa) levels of seeds representative of each of these three habitats for the

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[1]A bramble is any one of a number of related shrubs of the rose family, as the raspberry, dewberry, blackberry, etc: they are usually prickly (Guralnik and Friend 1966).

majority of the Lamar period. The regular flooding of the bottomlands may maintain consistent populations of open field species, while old field species and the woods habitat may be sustained along the borders of habitation sites. The Dyar phase shell midden (9PM220) featured a surprising abundance of partridge pea (*Chamaecrista* sp.), which though edible, is "expensive" in terms of harvesting and processing costs. It may have grown wild on the midden, have been eaten as a "novelty," or consumed out of necessity.

The Bell phase is particularly deficient in old field species, featuring only hackberry, which would be labor-intensive to collect for food. In turn, the Bell phase is the only occupation to access wild foods from the woods. Because spring flooding reduces or eliminates the need for fallowing, a lack of old field species may signal the extensification of existing villages. Surprisingly for a riverine setting, cane is the only wetland species recovered from any site, and it is found only in one Iron Horse habitation. It was probably a construction material, or possibly used as tinder or to create smoke.

Archaeobotany of the Uplands

Beyond the paleoethnobotanical analysis of the four sites in my own study, relatively little archaeobotanical research has been conducted in the Oconee uplands (See Figure 3. Gardner's (1985) analysis of a Dyar-Bell farmstead (9HK33) is a notable exception (Blanton 1984, 1985), and the multiple component Racoon Ridge site (9MG271) is currently under investigation. In addition, two rockshelter sites overlooking the Oconee river were studied as part of the intensive investigation component of the Wallace Reservoir project (Fish and Hally 1983). These were 9PM260 (Hally 1977-79; Manning 1982), and 9GE150 (Hally 1977-81; Smith 1981b). The archaeobotanical record of the uplands is summarized in Table 5.

Farmsteads

9HK33

Water flotation in a barrel was used to extract a "small sample of carbonized plant remains" from 9HK33 (formerly GP-HK-08), a small contact-period homestead in Hancock County, Georgia (Gardner 1985). Water was agitated with a shower head, over-flowing into bridal veil (1 mm mesh) which captured the light fraction. Though this netting is larger than optimal, at least some small seeds are present in the samples (Gardner 1985). A total of 142 l were floated from fifteen samples, representing three Dyar phase and one Bell phase proveniences, and one unclassified corn cob pit.

A total of eight food plants were observed, which together imply that the site was occupied on a year-round basis. Late summer/early fall produce includes maypop, maygrass (*Phalaris caroliniana*), goosefoot, squash, and maize in the Dyar phase, with

Table 5: Floral taxa identified at the middle Oconee upland sites. Site identification numbers correspond to those of Table 3.

Taxon	Iron Horse	Dyar	Dyar / Bell	Bell
Cultigens				
Common Bean (*Phaseolus vulgaris*)				
Corn (*Zea mays*) (cob)	F6	F1		F1
Corn (kern)	F6			F1
Goosefoot (*Chenopodium berlandieri*)		F1		
Maygrass (*Phalaris* sp.)		F1		
Peach (*Prunus persica*)			R1-*D*	F1
Squash (*Cucurbita* sp.)		F1		
Open Field				
Grasses (*Graminae*)			R1	
Maypop (*Passiflora incarnata*) (*Passiflora incarnata*)		F1	R1	F1
Old Field				
Grape (*Vitis* spp.)	F6			
Hackberry (*Celtis* spp.)			R2	
Persimmon (*Disopyros virginiana*)	F6			F1
Poke (*Phytolacca americana*)				R1
Woods				
Arrow-wood (*Viburnum* spp.)			R2	
Beans- c.f. *polystachyus*	F6			
Tulip Tree (*Liriodendron tulipifera*)			R2	
Forest/Nuts				
Black Walnut (*Juglans nigra*)			R2	
Hickory (*Carya* spp.)		F1	R1-*D*,R2	F1
Oak Acorn (*Quercus* spp.)		F1	R1	F1
Wood Types				
Cedar (*Juniperus* spp.)			R1	
Elm (*Ulmus* spp.)			R1	
Oak (*Quercus* spp.)			R1	
Pine (*Pinus* spp.)			R1-*D*,R2	

(Hally 1977-79, 1977-81; M. Smith 1981b; Manning 1982; Gardner 1985)
Key: F=farmstead R= rockshelter *D*=dominant in category

Site identifications: F1=9HK33 F6=9MG271 R1=9PM260 R2=9GE150 only corn and peach in the Bell phase. The cultigens would have been planted in early spring. Hickory nuts, and acorns comprised the late fall harvest in both components, with persimmon added in the Bell phase (Gardner 1985). Nuts and corn provide indirect evidence of winter occupation. They are bulky and would most likely be stored and consumed close to the point of harvest.

Two starchy seeds, goosefoot and maygrass, were possible domesticates. It could not be determined if these plants were cultivated or merely collected at this site. Ten of the 13 starchy seeds found were in the early Dyar phase Feature 54, and none in the Bell phase feature 11 (Gardner 1985). Three confirmed domesticates were present in the samples: maize, squash, and peach. The dominant cultigen was maize, which occurred in 60% of the samples. Maize was represented by few kernels, but numerous cupules, although no complete cobs were preserved, as is often the case after flotation. Based on cupule measurements, 50% of the cupules were from eight-row cobs, 37% from ten-row cobs, 10% from twelve-row cobs, and 3% (one cupule) from a presumedly abnormal six-row cob. The mean row number of the sample was 9.1. In addition, two cupules that derive from sixteen-row cobs were noted in the non-flotation material from feature 71. Most of these measurements appear to be within the range of variation expected of Eastern Complex corn, also known as Eastern Eight-Row, Maize de Ocho, and Northern Flint. This is the most common corn of the Mississippian period in the East. The single relatively intact kernel recovered from the samples was broad and relatively shallow (7.4 mm x 5.2 mm), also suggesting Eastern Complex corn. The sixteen row cobs may have been Southern Dent corn, introduced to temperate North America by the Spanish. This variety is only rarely recovered archaeologically in the South (Gardner 1985).

Crop diversification is evident at 9HK33 (Table 5) where domesticated goosefoot, maygrass, corn, squash, and peaches are all identified in the Dyar phase component. In the Bell phase, however, corn and peach are the only domesticates. This paucity of crops is probably related to the fact that only a single Bell phase pit was excavated at this site. In fact, an abundance of maypop seeds, commensal to horticultural genera, indirectly signals increased agricultural field production. Twenty maypop seeds were found in the Bell component of 9HK33, compared to eight in the Dyar (Gardner 1985). This finding is even more significant when it is considered that all Bell phase macrobotanical remains were recovered from a single pit.

Mast was relatively abundant, with hickory nut shell dominating this assemblage, occurring in 67% of the samples. Acorn appeared in 27% of the samples but was most abundant in the Bell phase feature 11, from which the solitary peach stone was also recovered. In addition, feature 11 yielded 20 of the 28 maypop seeds and the single persimmon seed (Blanton 1984; Gardner 1984).

Inedible macrofossils included wood and stem fragments and chinaberry (Melia azedarch) stones. The last suggests contamination of the site by materials from a later component. Chinaberry is a post-1787 introduction, native to Asia, and probably reflects admixture with the plow zone (Gardner 1984). This taxon is not included in table 5.

9MG271

Racoon Ridge (9MG271) is a multiple component site in Morgan county where Archaic, Woodland, Vining and Lamar components are recognized (Worth 1996). The incipient Mississippian Vining phase occupation (*ca.* A.D. 800-1200) (Worth 1996), lying beyond the scope of this dissertation, is clearly distinguishable from the Iron Horse component; only the latter phase is considered here. A small Lamar farmstead, so far containing only a single rectangular structure, has been radiocarbon dated to A.D. 1490 $\pm$ 40 and OCR dated to A.D. 1520 $\pm$ 15, confirming the ceramic assignment of the component to the Iron Horse phase (Worth 1995, personal communication). The small bell-shaped pit from which these macrofossils were recovered was filled in a single episode.

A complete analysis of the macrobotanical remains is planned, but thus far only a brief visual appraisal of hand-excavated specimens has been completed, revealing maize kernels, whole corn cobs, grape and persimmon seeds (Worth 1995, personal communication; Raymer 1996; personal communication). In addition, what appears to be either *Phaseolus polystachyus*, or unusually small examples of *Phaseolus vulgaris* (common bean) is represented (Mozingo 1996, personal communication). Substantial amounts of charred turtle shell dominate the faunal assemblage. The small amount of bone observed appears to be primarily deer. A single, one-foot diameter pit was filled with fluffy gray ash and a single species of mussel shell (Worth 1995, personal communication).

While this is a small sample, it does indicate that a mixed economy was practiced during the Iron Horse phase at Raccoon Ridge. Agriculture is indicated by the substantial evidence of corn and possible bean cultivars. Persimmon, grape, and probably wild bean, demonstrate that wild species were collected from the edges of fields from old, probably fallowed fields, and possibly from woods. Terrestrial and aquatic animal species were hunted and collected. In short, while agriculture was practiced, a several habitats were exploited to supplement the diet.

Rockshelters

The first of the two rockshelters, 9PM260, contains Middle and Late Archaic, Woodland, Dyar, and Bell components, but only the last two are considered here (Hally 1977-79; Manning 1982). The site is comprised of the shelter itself and the immediate vicinity. Wood, hickory shell, and peach stones are abundant, with trace amounts of acorn shells and seeds, pokeweed, maypop, and grass seeds. Although most of the seeds were uncharred, the arid state of the cave, coupled with depositional conditions, strongly suggests that these remains were aboriginal in origin. Wood was charred, with pine and cedar clearly dominating the assemblage.

Hickory dominates the mast assemblage, comprising 98% of the nutshell (52.7 g versus 1.15 g acorn) within and north of the shelter. In addition, a probable nutting stone was detected in the boulder formation (Manning 1982). These conditions support the hypothesis that this was a center for hickory "butter" production, and was occupied, at least in part, during the November harvest period (Manning 1982). Since nut shell is ubiquitous throughout the site, it is not possible to assign nut processing to either Woodland or Lamar components with certainty (Manning 1982).

Pokeweed, maypop, and peach remains indicate possible occupation in late summer as well, although both maypop and peach can both be stored with minimal processing. Pokeweed and maypop are so infrequent that they may represent animal dispersal. Pokeweed would be anticipated in the plant community on the edge of a clearing that would exist around this zone of human activity. It is less likely, but possible, that maypop would occur naturally in the open ground surrounding the shelter.

These data, along with the limited size and location of the site on a ridge top, suggest that it was occupied for relatively brief periods of time by small groups of people for specific and limited purposes. An abundance of Mississippian triangular points and the absence of diagnostic Woodland projectiles implies that the premises served as a deer-hunting camp in Lamar times. It is possible that deer and nut harvesting activities occurred concurrently, or that such activities were conducted at intervals throughout fall and winter (Manning 1982).

9GE150 is a second rock shelter overlooking the Oconee. It is interpreted as an "overnight" camp shelter, utilized during Middle Archaic, Late Archaic, Bell, and modern (twentieth century) periods (Hally 1977-81; Smith 1981b). As in the case of 9PM260, most of the macrobotanical remains were uncharred, but thought to be aboriginal in origin. In contrast to other plant remains, the majority of wood was charred. Hickory shell was the most common plant residue. In contrast to 9PM260, the shell fragments were relatively large, a contraindication of hickory milk production (Hally 1981). Larger particles are more typical of hickory crushed and added to the cooking pot, while the by-product of oil production is somewhat pulverized. Trace amounts of black walnut were also discovered and probably represent casual use, rather than being the focus of the site's occupation. If such was the case, fall site use is indicated.

The few seeds recovered also indicate seasonality. A single black haw (*Viburnum* sp.) hints at an autumn stay. A small concentration of maypop seeds attest to late summer occupation, while a tulip tree (*Liriodendron tulipfera*) seed indicates early to late summer through fall usage. A single aster family (*Asteraceae*) seed could originate in any season but winter. Of these, only the black haw and maypop are likely to have been directly introduced to the cave by humans. All of these seeds might occur naturally in the open fields and woods habitats surrounding a periodically disturbed site.

A minimal amount of wood identification was performed on the rock shelter samples. Pine was represented at both rock shelters, and red cedar, chestnut, and oak were all identified at 9PM260. Red cedar is indicative of somewhat xeric conditions, and might be expected on upland slopes. In the Piedmont, pine is most often associated with second growth forests, as the seedlings are not shade-tolerant, yet grow quickly in full sun. These two species might be anticipated in open areas surrounding the rock shelters. Conditions that enhance the reproductive process of pine are also created by controlled burning, which might be used to enhance nut production near 9PM260 (Wagner 1996).

Oak is common in the Oconee uplands, but chestnut is very rare in this region, although it can survive here. It is possible that a tree was transplanted beyond its normal range.

Paleoethnobotanical Interpretation from Previously Excavated Oconee Area Sites

Economic System

The close proximity of the two upland rock shelters to the bottomland, and their clearly extractive functions leads me to believe that they are associated more closely with the riverine settlements than those of the uplands. The upland farmsteads, 9HK33 and 9MG271, enjoyed proximity to important specific faunal and mast resources that were limited in the bottomlands, namely deer and hickory. To reduce transportation costs, the rendering of nut oils by permanent upland residents would be conducted near the farmstead, rather than at remote seasonal camps. Nevertheless, nut collection at remote seasonal camps cannot be ruled out, based on this evidence.

Agriculture

Only one of the three upland sites, Racoon Ridge (9MG271), is dated prior to the Dyar phase. Thorough floral analysis of material from this site has not yet been undertaken, so observations are cursory at best. Available evidence points to an emphasis on maize agriculture, supplemented by a suite of wild animal and plant foods representative of several habitats. Faunal analysis points to selectivity, with deer, turtle, and mollusks being harvested almost exclusively. Although nuts and maypop are conspicuous in their absence, the Iron Horse upland floral assemblage at Racoon Ridge closely resembles that of the bottomland site in every other aspect. Systematic archaeobotanical research has not yet begun for this site, and a more thorough analysis will undoubtedly achieve a more representative assemblage.

The remaining sites date to the Dyar or Bell phase. In contrast to the strict dependence on corn in bottomland habitation sites, the single upland farmstead is typified by a highly diversified crop strategy during the Dyar phase, including corn, goosefoot, maygrass, squash, and perhaps maypop. This assemblage is sharply condensed to corn and peaches in the Bell phase uplands, and to corn and marshelder in the bottomlands. Beans are conspicuously absent in all but the earliest riverine sites.

Agricultural diversification, seen in the Dyar phase, would allow people to exploit even marginal soil, moisture, light, and nutrient conditions. The tendency to settle on moderate quality soils in the Dyar phase may have inspired this strategy (Pollack 1988). Less productive genera such as marshelder, would not supplant maize; but rather would grow in soils not suitable for corn. Adverse weather, disease, and predators differentially affect individual species, and thus diversification would enhance absolute crop yields. Intercropping of corn, squash, and perhaps maypop, would increase the yields of all three.

The apparent shift in subsistence strategy during the Bell phase to a less diverse cultigen base may represent nothing more than a sampling artifact, particularly in the uplands. The Dyar occupation at 9HK33 was far longer than the Bell, and all Bell plant remains there are derived primarily from a single feature (Blanton 1985; Gardner 1985). While no confirmed cultigens were recovered at either rock shelter, this condition is anticipated for the same reasons that cultigens were scarce or absent at shoal sites (see discussion above). These were extractive centers, and the foods being harvested there would provide basic subsistence for the brief duration of the site's occupation. Peach stones in a variety of sites reflect direct or indirect contact with the Spanish during the Bell phase. As discussed above, there is indirect evidence from the proliferation of maypop at 9HK33 that agricultural intensification was characteristic of the Bell phase (Gardner 1985).

Nuts

Nuts played a prominent role in the Oconee region diet from at least Woodland times. Acorns dominate the bottomland nut assemblage from Duvall through Dyar phases. Acorns are supplemented with black walnut, and hickory in the Iron Horse phase. The breadth of nut harvesting may signal population pressure, as black walnut involves even higher capture and processing costs than acorns (Table 9). Acorn shell tends to preserve poorly compared to either hickory or walnut. Therefore, its abundance in the bottomland sites in particularly noteworthy.

While not conclusive, evidence of intensive hickory processing at 9PM260 implies that bulky hickory nuts were reduced to their essential component for easier transport or more compact storage during the Dyar and/or Bell phases (Manning 1982). Consequently, in the bottomlands where water-tolerant oaks are the dominant mast producer and hickory is comparatively rare (Payne 1976), acorn seeds and shell dominate the nut assemblage. Shagbark (*C. ovata*) and southern shagbark (*C. carolinae-septentrionalis*) are the most common hickory types in the middle Oconee bottomlands, but bitternut (*C. cordiformis*) and water hickory (*C. aquatica*) are also significant (Wharton 1978). Of these the latter two have somewhat small but sweet kernels, while the latter two species are bitter (Radford et al. 1968; Strausbaugh and Core 1977). Since hickory suitable for oil production is scarce in the lowlands, it would be counter-productive to render it there. The comparatively meager locally harvested hickory crop would most likely be added to stews. Any hickory oil imported from the uplands would leave no archaeological evidence in the riverine habitation sites. In short, overall hickory use in the bottomlands may have been greater than the archaeological record indicates. However, this observation does not fully explain the disproportionate exploitation of acorns in the bottomlands versus the uplands. Post (*Quercus stellata*) oak and other easily prepared white oaks (*Quercus* spp.) comprise approximately 25% of the upland forests, with other oaks constituting nearly another 28%. Hickory represents a mere 10% of the canopy (Plummer 1975).

The Dyar phase sees a proliferation of sites in the uplands, which persists through the Bell phase (Kowalewski and Hatch 1991). Hickory clearly dominates the upland nut assemblage. In the upland farmstead 9HK33, hickory occurs in 67% of the samples versus acorns in 27%, nearly the inverse of their representation in the forest. Hickory is the single most common plant in all Dyar and Bell phase rockshelters, but some acorn is present, and black walnut appears in the Bell phase. As discussed above, wild foods other than hickory were most likely used only on an encounter basis at the rock shelters. It is the farmstead assemblages by which upland nut use can be monitored.

Beyond preservation issues, the use of hickory is less labor intensive than acorn, if it is used directly, rather than reduced to oil (Table 9). While in shorter supply than acorns, if hickory were sufficiently abundant to satisfy dietary requirements, this fact would explain the seeming preference for hickory over the more abundant acorns in the uplands.

Habitat Indicators

Both upland and bottomland habitation sites contain a consistent low level of open and old field habitat indicators. Maypop, which is associated with agricultural fields, is the only consistent evidence of open fields. Persimmon and grape, which are often spared on the edges of agricultural fields, dominate the old field taxa.

This pattern complements the agricultural and ethnohistoric evidence of the protohistoric uplands. During the Dyar phase, the wide variety of cultigens is indicative of agricultural intensification. The paucity of open field species and old field species other than those specifically associated with agriculture indicates possible agricultural extensification. Upland population increased dramatically during Dyar (Kowalewski and Hatch 1990). Agricultural land was at a premium and old fields might be cleared for cultivation. Agricultural fields were kept free of plants that were not economically useful (Strachey 1849 [1612]:115), limiting the potential for the preservation of open field taxa.

No wetland taxa were recovered at any upland site, and open woods species were seen only at one rock shelter (9GE150) and one Iron Horse farmstead. The latter indicates that these sites had been established long enough to attain an advanced stage of secondary ecological succession on their borders.

Archaeobotany of the Georgia Piedmont Beyond the Oconee Watershed

A limited number of late prehistoric and protohistoric sites have been excavated elsewhere in the Georgia Piedmont (Hally and Rudolph 1986b). An even smaller subset of these has generated archaeobotanical data. In order to create a more substantial comparative data base, this section discusses the macrobotanical assemblages from Piedmont sites in western Georgia. These sites are enumerated in Table 6.

Dog River Valley

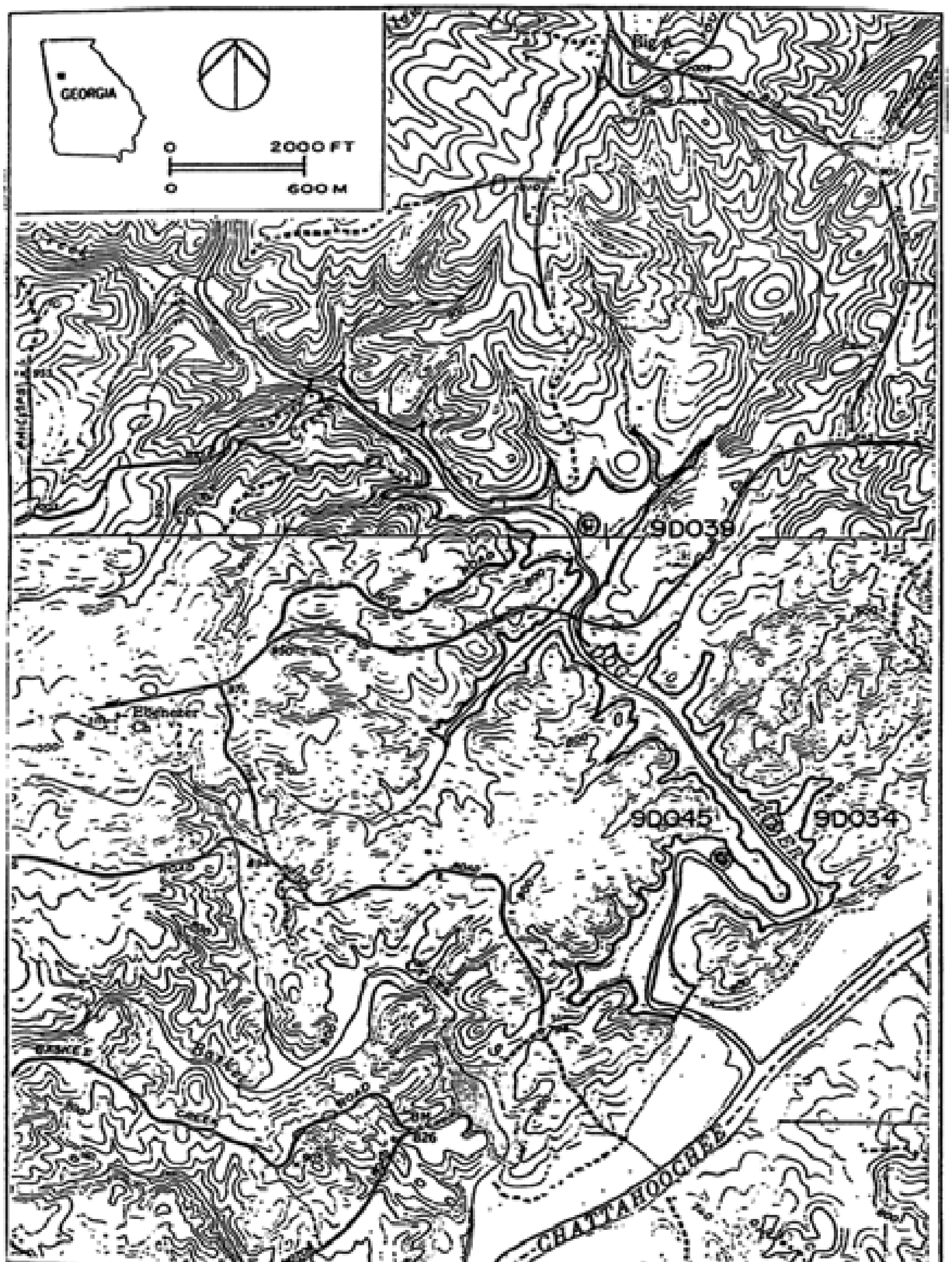
Geomorphology and Vegetation

Three of the four Western Piedmont sites under consideration are located within the bounds of the Dog River Reservoir (Figure 4; Poplin 1990). The geomorphology of the Dog River valley differs from that of the Oçonee. Here a steep-sided valley with a narrow alluvial flood plain nevertheless contains well-defined alluvial land forms including levee ridges, abandoned channels, point bars, and alluvial fans. Backswamp areas are common. Rocky shoals are present where the toe slopes of Piedmont ridges intersect the stream channels (Poplin 1990).

Late prehistoric and protohistoric upland and bottomland forest compositions for the areas under discussion approximate those described for the Oconee watershed. In late prehistoric times tulip tree (*Liriodendron tulipfera*), Shumard oak (*Quercus Shumardii*), willow oak (*Q. phellos*), live oak (*Q. virginiana*), and bay magnolias (*Magnolia* spp.) featured prominently in the bottomland forests, while the upland canopy was dominated by Virginia pine (*Pinus* virginiana) and scarlet oak (*Q. coccinea*) (Wharton 1978). Several varieties of hickories (*Carya* spp.) were probably present in the local forests, particularly in the uplands (Wharton 1978).

Table 6: Late prehistoric sites in the western Georgia Piedmont.

Time Frame	Site	Location	Function	Process & Fauna
ca. A.D. 1545-1614 contemporary to Dyar/Bell	9DO34 F2 (Poplin 1990)	Dog River; relict levee ridge - extending into otherwise lowland	Farmstead	flotation & hand excavation
ca. AD. 1552-1622 contemporary to Dyar/Bell	9DO39 F3 (Poplin 1990)	Dog River; relict levee terrace	Farmstead	flotation & hand excavation
A.D. 1587-1617 contemporary to Bell	9DO45 F4 (Poplin 1990)	Dog River; relict levee terrace	Farmstead	flotation & hand excavation
"mid to late sixteenth century" contemporary to Dyar/Bell (Joseph & Cantley 1990: 125).	9HE76 F5 (Joseph & Cantley 1990)	Middle Chatta-hoochee River, upland tract extending into generally lower area; 198 M above floodplain	Farmstead	flotation



(Poplin 1990)

Figure 4: Dog River sites.

Site Descriptions

Two of the late prehistoric farmstead sites in the western Piedmont, 9DO39 and 9DO45, are situated on relict levee terraces along the Dog River, a tributary of the Chattahoochee, in Douglas County (Poplin 1990). A single upland ridge-top site, 9DO34, is located on a finger of high ground extending into otherwise low land. Both 9DO34 and 9DO39 span the Dyar and Bell phase; 9DO45 dates only to Bell (Poplin 1990).

An 8 m diameter round house, complete with central hearth, is the most prominent feature of site 9DO34. Lines of charcoal and daub help to define the structure. Samples of charred roof timbers and *in situ* structural posts are included within the substantial macrobotanical samples recovered at this site (Poplin 1990)

The second Dog River farmstead, 9DO39, is located on a small bluff overlooking a bend in the river. An unusually well preserved Dyar/Bell phase round house dominates this site. Accidental fire forced the abandonment of this structure, and consequently, features, rafters, wall posts, household goods, personal items, and stores were intact, and in presumedly original positions. The floral assemblage included a woven baskets containing corn cobs, and food processing tools including nutting stones, *manos*, and *metates*.

Two round houses were identified at the final Dog River site, 9DO45. The first was similar to those of 9DO34 and 9DO39. The second was smaller, about 6 m in diameter, and featured a bowl-shaped floor and an entryway sloping from the central hearth. In contrast to the other houses already described, the only daub noted was in association with the hearth and internal partitions (Poplin 1990).

The botanical assemblages of the three Dog River sites were secured through both hand excavation and water flotation. The assessments are summarized in Table 7.

Agriculture

All the Dog River sites emphasize maize agriculture, with cob, kernels, and processing equipment being recovered in various contexts. Corn is supplemented by common bean, and cucurbits (squash and gourd) at the Dyar/Bell levee terrace site, 9DO39, completing the "three sisters," while its upland counterpart, 9DO34, lacks only squash from this trio. Maypop, which is associated with agriculture in the protohistoric southeast (Gremillion 1989b), was found only in the bottomland sites, 9DO39 and 9DO45. Like 9HK33 in the middle Oconee uplands (Gardner 1985), corn and maypop were the only indication of agriculture at the Bell phase farmstead, 9DO45 (Gremillion 1990).

Nuts and Forest Seeds

Hickory shell dominated the nut remains at all three sites, while acorns were noted in only the two earlier sites, (9DO34 and 9DO39). Black walnut remains are noted at both 9DO39 and 9DO45. A nutting stone at 9DO39 attests to the dietary significance of mast. Pine seeds, probably associated with firewood collection, are noted only at the

Table 7: Taxa recovered from other late prehistoric Georgia Piedmont sites. Site identification numbers correspond to those of Table 6.

Taxon (Latin binomials- Table 5)	= Dyar / Bell	= Bell	Taxon	= Dyar / Bell	= Bell	Taxon	= Dyar / Bell	= Bell
Ag. Crops			Old Field			Forest/ Nuts		
Bean	F3		Bramble	F5		Black Walnut	F2 F3 F5	F4
Corn (cob,cup)	F2 F3 F5	F4	Grape	F2 F3 F5		Oak Acorn	F2 F3 F5	
Corn (kernel)	F2 F3 F5	F4-*T*	Persim-mon	F3 F5		Pine	F5 cone	F4 seed
Gourd	F3		Sumac	F3		Walnut Family	F5	
Squash	F3							
Open Fields			Woods			Wetlands		
Goosefoot	F5		"Beans"	F3	F4	Blk Gum	F2	
Grasses	F2 F5	F4	Bed-straw	F3	F4	Sedge	F3	
Knotweed	F3		Stick-tight	F3				
Maypop	F3	F4	StJohn's Wort	F3				
Morning Glory	F3	F4	Tulip Tree	F3				
Purslane	F5							
Ragweed	F3	F4						
Senna	F2							
Spurge	F3							

(Gremillion 1990; Joseph and Cantley 1990; Poplin 1990; Raymer 1990)

Key
F2=9DO34 F3=9DO39 F4=9DO45 F5=9HE76 *T*=trace amount

N.B. All sites represent farmsteads.

Bell phase 9DO45.

This limited sample points to more selectivity in nut species exploited during the Bell phase site than in the mixed Dyar/Bell phase sites. More easily processed but comparatively scarce hickory nuts supplant acorns in the Bell phase. Although black walnuts are found in both time periods, they never appear in great amounts (Gremillion 1990).

Habitat Indicators

Each of the two bottomland sites, 9DO39 and 9DO45, yielded four or five open field taxa, including maypop, while the upland Dyar/Bell phase site, 9DO34, featured only two. At least half of the bottomland open field species hold economic potential (knotweed, morning glory), while this was true of neither of the upland open field taxa. Open field taxa are anticipated when fields are cleared for agriculture.

Old field indicators (i.e., bramble, grape, persimmon, sumac [*Rhus* sp.]) were moderate in the Dyar/Bell the bottomlands (9DO39), scarce in the contemporary upland site (9DO34), and absent in the later Bell phase bottomland site (9DO45). Open woods taxa (unspecified[2] beans, bedstraw [*Gallium* sp.], beggar's lice or stick-tight [*Desmodium* sp.], Saint John's wort[*Hypericum* sp.], tulip tree [*Liriodendron tulipfera*]) were moderately abundant in the Dyar/Bell terrace site, 9DO39, but absent at the upland ridge site, 9DO34. Only unspecified beans and bedstraw are derived from this habitat at the

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[2]The term "unspecified" is used to denote any taxon for which a genus cannot be, or has not been, assigned.

riverine Bell phase site, 9DO45. Unspecified beans are placed in the "wild" category only because common bean (*Phaseolus vulgaris*) would most likely be recognized and reported by species. The two earlier sites, 9DO34 and 9DO39, each contained one wetland taxa, while none were found in the Bell phase site. Black gum (*Nyssa sylvatica)*, found at the upland site (9DO35), is edible.

Synthesis

These data point to a society dependent on maize and wild nuts, complemented by minor crops and wild foods collected from a range of habitats. The earlier two sites, 9DO34 and 9DO39, feature a variety of crops, while during the Bell phase at 9DO45, only corn is cultivated. Notably absent from these sites is peach, which had already been introduced to the eastern seaboard, and even the interior, by this time (Scarry 1985; Hatch *et al.* 1991). Open field taxa, which typify agricultural assemblages, are more common in the bottomlands, regardless of time period. This association probably has more to do with the scouring effects of spring flooding than degree of commitment to agriculture. An abundance of the relatively rare open woods taxa at the Dyar/Bell 9DO39 site, in contrast to the other two sites, may be explained by the richness of the data base for that site. Differential preservation is also the most likely explanation for contrasts between 9DO39 and the other two sites in regard to old field and wetland species.

Wild or domesticated beans and mast are included in the diet. Acorns, which are high in carbohydrates, are abundant in the bottomlands but conspicuously absent from the Bell phase site, 9DO45, perhaps signalling that the site's inhabitants lived well below carrying capacity. Hickory is more easily processed and provides a better nutritional complement to corn than acorns, but has higher collection costs (Table 9). On the other hand, black walnut, which is extremely costly to process, is present at all three Dog River sites (Raymer 1990). The lack of acorns at 9DO34 may be related to depositional or preservational factors. It is clear that nuts and corn comprised the basis of subsistence at these sites.

Taken together, the assemblages from these sites indicate probable year-round site occupation (Gremillion 1990). As mentioned above, no species produces seed in January or February, but one can deduce from the presence of storable foods and permanent architecture signify that these occupations were permanent.

In considering these data it must be cautioned that 9DO39, due to the circumstances of its preservation, provides a more complete subsistence record the other two sites. With this fact in mind, the assemblages of the three sites are remarkably similar. Any differences seem to be more dependent on chronology or differential preservation than on elevation.

Chatahoochee River Uplands

As part of the West Point Lake mitigation project (Joseph and Cantley 1990) an upland farmstead, 9HE76, dating to the Dyar/Bell phase was investigated. The site lies along an upland tract, 198 m above the river, extending into a generally lower area of flood plain, along the middle Chattahoochee River in Heard county (Figure 5).

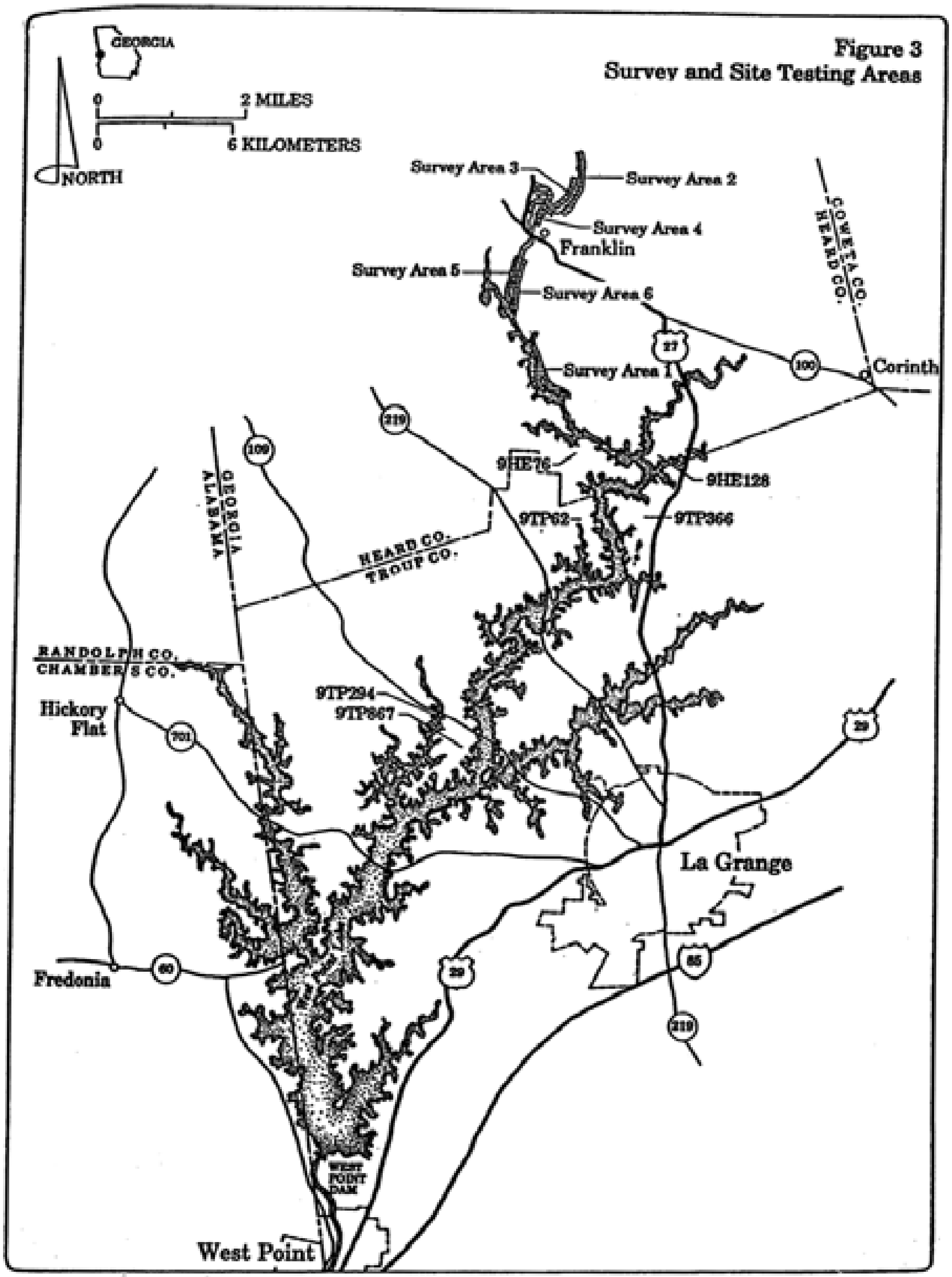
Agriculture and Habitat Indicators

Corn cobs and kernels present the only direct evidence for agriculture at this site. Even maypop is lacking. However, wild goosefoot and purslane, two of the three open field taxa, commonly invade agricultural fields. Furthermore, they are edible species which are deliberately tended or tolerated by some historic native people.

Possible evidence of fallowing of fields, or at least of long-term site occupation, is found in the presence of bramble, grape, and persimmon. All seeds, other than corn kernels, were found in trace or minor amounts (Raymer 1990:141) and so these interpretations are made with caution.

Nuts

Although clearly identified hickory shell was dominated by black walnut, over half of the specimens relegated to the "walnut family" (*Juglandaceae*) category are thought to be hickory. In this case, hickory again dominates the nut assemblage. Acorn is found in only minor amounts. Pine cone scales are half as abundant as acorn, however it is highly unlikely that pine seeds were consumed. No open woods or wetland habitats were represented.



(Joseph and Cantley 1990)

Figure 5: Chattahoochee river sites.

Ubiquity and abundance studies point to corn as the dietary staple at this site. Collectively, nuts were ubiquitous, but much less abundant that at other Mississippian sites (Raymer in Joseph and Cantley 1990:143). Black walnut, usually relatively rare, was present in every sample. The meager amount of hickory shell is also atypically small.

Synthesis

Sites within and beyond the Oconee drainage suggest a Piedmont-wide mixed farming-foraging-hunting subsistence strategy throughout the Lamar period, involving cultigens, starchy seeds, nuts, and fleshy fruits, as well as a host of fauna. Maize and locally abundant nuts were the dietary staples. This subsistence pattern affirms the observations of early European travelers (Kalm 1772; Bartram 1853 [1789], 1955 [1792]; Strachey 1849 [1612]; Josselyn 1865 [1674]; Beverley 1947 [1705]; Biedma 1968 [1544]; Elvas 1933, 1968 [1557]; Swanton 1969; Hudson 1976). Beyond these commonalities, individual communities demonstrate flexibility in their interactions with local ecosystems, supplementing the staples with locally abundant fleshy fruits, seeds, roots, and other flora, as well as animal protein ranging from insect larvae (Williams 1982a) to deer. It is likely that anthropogenic modification accounts for some resource availability. For example, clearing of forests for agricultural fields invites successional species, while controlled fallowing of fields, using periodic low-level burning, promotes the growth of other taxa. These same horticultural activities influence faunal availability.

As population and habitation site densities increased in a given area, it is probable that catchment zones of individual settlements inversely diminished. Concurrently, agricultural intensification, rising dependence on mast, and broadening of the wild food base are anticipated.

In the Oconee region this peak of population occurs in the Dyar and Bell phases (Kowalewski and Hatch 1991). In fact, a slight amount of diversification of the agricultural crop assemblage is seen only in one Dyar phase upland site (9HK33) in the Oconee watershed. In the Oconee bottomlands, corn and beans are the only cultigens until the Bell phase, when marshelder and peaches appear, but beans drop out of the assemblage. Maypop, commensal to agricultural fields, is nearly ubiquitous in the Oconee region during all time periods. Old field taxa, indicating either the fallowing of fields or long-term occupation of the site, are always present in the valley and uplands, except in Dyar phase upland sites. In the western Piedmont there is a variety of open field species in Dyar/Bell, equally consistent with agricultural land clearing or flood disturbance, but maypop is less common than in the Oconee region. Half of these open field varieties are edible species and may reflect the floral equivalent of "garden hunting" (Linares de Sapir 1976).

It is in the Dyar phase that Oconee uplands are "invaded" by humans, relieving pressure in the valleys, and allowing the subsistence strategy there to remain largely unchanged for a time, although adjustments to shifting fauna begin in the Dyar phase.

During the Dyar phase, the Oconee uplands immediately show signs of disturbance compared to the Iron Horse phase. Old field taxa disappear, and crops with varying growing requirements proliferate. Immediate agricultural intensification is implied by the 250% increase in maypop noted by Gardner (1985) between the Dyar and Bell phases. By the Bell phase, the bottomland resources are again pressed, as seen in the lack of old field species, presence of low-ranked black walnut, and possible crop diversification in the form of marshelder and wild bean.

In the Bell phase, peaches are seen throughout the middle Oconee region, but not in the Western Piedmont. Since this fruit is known to have originated with the coastal Spanish missions, and been spread through hand-to-hand trade, it is likely that peaches had not yet diffused into that region by early historic times.

Overall, the harvesting of wild foods excluding nuts declined slightly over time in the Oconee region. However, indications of edible wild plants productive of fleshy fruits, greens, tubers, and beans were all present in the Western Piedmont assemblages contemporary with the Dyar and Bell phases, in opposition to a decline in the variety of cultigens. Taken together, the assemblages of these Piedmont sites signal a Piedmont-wide economy incorporating products of every stage of the field-fallow cycle, in addition to forest and wetland resources. Maize and nuts persist as the single major crop and wild food, respectively. Other cultivated and wild plants fluctuate in abundance.

A larger array of nuts is heavily exploited in both the Oconee and Dog River valleys, compared to uplands, through the Dyar phase. In the Oconee region, in contrast to a hickory focus in the uplands, bottomland nut use is based on acorns, which have greater abundance but lower energetic returns. Labor-intensive black walnuts appear in the Oconee valley assemblage in Duvall and Iron Horse and reappear in Bell. The temporary absence of black walnut from the riverine assemblage may be correlated with migrations to the uplands. This same "broadly cast net" is seen through Dyar and Bell in the Western Piedmont, with a strikingly large black walnut contribution to the Chattahoochee diet (Raymer in Joseph and Cantley 1990). In the Oconee uplands hickory is more ubiquitous than corn, but both hickory and acorns are more abundant in Bell phase contexts than Dyar (Blanton 1985), hinting at a growing dependence on mast.

This pattern of nut exploitation implies that carrying capacity was approached in the Oconee river valley prior to the advancement of population into the uplands, as even that are difficult to process were regularly harvested in the bottomlands. The Western Piedmont bottomlands and uplands exhibited no such dichotomy. The sites contemporary to the Dyar and Bell phases each exploited all available nut species, while the Bell phase equivalent site, 9DO45, focused only on hickory and black walnut.

In addition to a nearly indiscriminate harvesting of nuts, the character of western Piedmont Dyar/Bell phase agriculture differed from the Oconee region. The focus in the Western Piedmont was the "three sisters" of corn, beans, and squash, to the total exclusion of Eastern tradition crops. Peaches had not yet reached the area. Finally, wild edible taxa are more broadly represented in the Western Piedmont at the Dyar/Bell phase sites than in the Oconee region. In the Bell phase, however, the 9DO45 edible assemblage is abbreviated to corn, maypop, wild beans, black walnuts, and hickory.

While these data are insufficient to explain this phenomena in the Western Piedmont, it is clear that conditions there differ from those of the Oconee drainage.

Chapter 5

CONTEXT OF PALEOETHNOBOTANICAL ANALYSIS III: ETHNOHISTORY, ENERGY YIELDS OF RESOURCES, AND ETHNOGRAPHIC ANALOGY

Format of Chapter

Chapter five provides the historical framework for paleoethnobotanical interpretation in the Oconee region, and also reviews relevant experimental research, and ethnographic reports.

Ethnohistory

The task of the paleoethnobotanist is to delineate what plants and correlated categories of human behavior are represented in the archaeological record, and to make reasoned inferences regarding economic activities that leave no physical evidence. Some human activities, such as the practice of on-site horticulture, can be implied from macrobotanical remains, but others cannot. For example, information on who performed subsistence tasks, specific methods of food processing, the cultural uses of plants and their place in the ethos, is invisible. Spanish, French, and English explorers or their biographers left somewhat biased and limited primary accounts of native American subsistence in the Southeast during the early contact period (Strachey 1849 [1612]; Bartram 1853 [1789], 1955 [1792]; Biedma 1968 [1544]; Elvas 1933, 1968 [1557]; Du Pratz 1972 [1774]; Garcilaso 1988 [1605]). These historical observations are presented, along with notations on the ecological consequences of European exploration. Historical accounts of early contact period agricultural practices in the Southeast are summarized (Strachey 1849 [1612]; Bartram 1853 [1789], 1955 [1792]; Swanton 1969; Hudson 1976; Dobyns 1983). While protohistoric accounts and ethnographic analogy may fill in the gaps, they do not provide conclusive evidence for all categories of prehistoric behavior involving plant use.

Cultural Focus

This chapter centers on accounts of Native Americans most closely related, culturally and geographically, to the people of the Sugar Creek, Carroll, Sweetgum, and Lindsey sites. In particular the Creek, Chickasaw, and Choctaw are cited, but so are other southeastern groups; the Cherokee, Powhaton, and Natchez are also characterized. Unfortunately, Europeans rarely ventured beyond the bottomlands, and descriptions of riverine settlement and subsistence practices cannot be assumed to have been identical to those of the upland regions. While protohistoric accounts and ethnographic analogy may fill in the gaps, they do not provide conclusive evidence for all categories of prehistoric behavior. Furthermore, the majority of these accounts are based on early historic coastal Algonquians cultures, rather than those of the protohistoric Piedmont groups (Gremillion 1989a). Nevertheless, these historical accounts are valuable interpretive tools for deciphering the aggregate protohistoric archaeological record. In this section ethnohistoric accounts of subsistence technology and practices that apply to plant usage are examined.

Mississippian Chiefdoms

As introduced in Chapter 1, archaeological and historical evidence indicates that during the period from the eleventh through mid-seventeenth centuries, the middle Oconee drainage in north central Georgia comprised the territory of politically integrated chiefly societies (Smith and Kowalewski 1980, 1981; Hally and Rudolph 1986b; Smith 1986; Kowalewski and Hatch 1991). Unlike similar areas enduring European contact, the Oconee region experienced what may have been strong population growth for decades following the DeSoto visit of A.D. 1540 (Hudson, Smith, and DePratter 1984; Kowalewski and Hatch 1991). During protohistoric times, upland Lamar settlements tended to be dispersed, rather than nucleated (Kowlewski and Hatch 1991). This expansion of settlement and population might well be the consequence of emigration (Smith and Kowalewski 1980; Smith 1987), however, natural increase, or a combination of these two forces is equally consistent with the archaeological data (Kowalewski and Hatch 1991). Ultimately the Oconee population experienced the demographic collapse that befell all native peoples, but not until the turn of the seventeenth century.[1] The character and strength of the chiefly system at any given point in time affected the size and distribution of settlements. The interaction of politics and demography will be shown to have ecological consequences.

Subsistence

Corn

First-hand accounts of protohistoric Oconee subsistence are found in the De Soto chronicles (Bourne 1904; Elvas 1933, 1968 [1557]; Garcilaso 1986 [1605]). The domestication of maize (*Zea mays*) is universally noted in Spanish narratives, with special mention of parched, powdered maize being the staple food of both European and native travelers throughout the Southeast (Bourne 1904; Swanton 1911, 1969; Romans 1775). Historic Natchez cooked at least forty-two named dishes using corn (Swanton 1911; Hudson 1976). Its exploitation throughout the Southeast spanned its green and milky stage in early summer (Strachey 1849 [1612]:115; Swanton 1969) through the

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[1] For a complete summary and discussion of Lamar period archaeological findings in the Oconee watershed, and the political realignments thought to have been instrumental in their formation, see Kowalewski and Hatch 1991.

mature stage. Dried corn was often processed in wood-ash lye, which reduces some of the essential amino acids, but dramatically increases niacin (Katz *et* al. 1974). Due to the manifest dependence on corn, this process presumably reduced the incidence of pellagra (Hudson 1976; Geller 1985). Many other dishes combining corn with sundry ingredients such as fish, meat, nuts, beans, berries, seeds, and wild sweet potatoes (Ipoema sp.) beans are recorded (Adair 1968 [1775]; Swanton 1969:354; Hudson 1976). These preparations typically enhanced the nutritional value of the maize (Geller 1985). Beans were particularly important as they are rich in lysine, which is lacking in corn (Hudson 1976).

Maize also served non-dietary functions, as the following examples illustrate. Young corn was beaten to a pulp and used as a substitute for deer brains in dressing skins. The juice of green corn was used to erase tattoo marks. Corncobs were burned to make smoke in tanning skins and also rubbed over the outside of pots before they were fired (Swanton 1969). Corn also was central to many rituals (Swanton 1969).

Varieties of Corn

In the vicinity of James Town, Virginia, corn contemporary to the Bell phase was described as follows.

> "...the forme of yt is of a man's tooth, somewhat thicker... the stalks will grow a man's height, or rather more from the ground, and every stalk commonly beareth two eares, some three, many but one, and some none. Every ear groweth with a great hose or pill about yt and above yt; the stalke being greene hath a sweet juyce in yt, somewhat like a sugar-cane..." (Strachey 1849 [1612]:115-116).

By early historic times several varieties of maize were raised in the Southeast. Dumont and Du Pratz (translated in Swanton 1911) described the types of corn grown by the early historic Natchez. Ears were said to be:

> "...as big as the fist some of which bear as many as 300 grains, and more arranged horizontally on the ear and as large as peas...a single maize stalk is able to produce from seven to eight ears and ...grows from a single seed (DuPratz in Swanton 1911:74).

Two main types of maize were described: a very round grain, flint or hominy corn; and flour or dent corn, which was ground into flour. The former was round, hard, glossy, and white, yellow, red, or blue, the latter was flatter than flint corn, and its grain is distinguished by a groove extending for its entire length. In Louisiana the red and blue grains were more frequently found in the highland areas than in the lowlands (Du Pratz in Swanton 1911:74), however, this distribution does not necessarily apply elsewhere. In addition to these varieties was a grain known as "little maize," which resembled popcorn, so named because it is smaller than the others. It grew very quickly and was observed to be the first crop to be sown by settlers "in order to have something to live on very soon" (Swanton 1911:74; Du Pratz 1972 [1774]). It was double cropped in the same field in the same year and is said to have the advantage of "flattering the taste much more than the large kind" (Swanton 1911:74; Du Pratz 1972 [1774]). In seventeenth century Virginia, triple cropping of corn was observed (Maxwell 1910:82). These two examples on opposite ends of the Southeast suggest that double cropping was not uncommon in the warm southern region. Although the recorded episodes of multiple uses of a field in a given growing season have all centered on corn, there is no reason why other crops, such as eastern tradition cultigens, could not have been included in this cycle.

Corn and Culture

Just before entering the *Ocuté* region, De Soto passed through *Toalli*. There the importance of maize was reflected in both architecture and tribute customs. Records indicate that each Indian family had two houses, a round, oven-like winter house, and a more open summer house. Next to the latter was a kitchen where (maize) bread was baked. Maize was stored in a *barbacoa* near the kitchen. The barbacoa was a single-room wooden house, having a cane floor, and raised on four posts. "Principal men" would have several of these structures, and part of the tribute paid to them was in the form of maize (Elvas 1933, 1968 [1557]). Among the historic Creek and Cherokee, when families harvested their corn crop, a portion was set aside as a contribution to the public granary, known to the Europeans as the "King's Crib." Families whose private stores fell short, travelers, or neighboring towns could all be aided with these provisions at the chief's discretion (Bartram 1853 [1789]).

Maize was prominent in the ceremonial cycle of all Southeastern Indians. Most notable is the "Feast of the First Fruits," also referred to as the "busk," or "Green Corn Dance." This ceremony of purification and renewal was timed with the ripening of the corn crop (Bartram 1853 [1789]). The central role of corn in the ritual complex would ensure its redistribution, the dispersal of germ plasm, and the maintenance of particular strains (Ford 1990, 1994).

The Spanish often commented on the richness of the soil in the Southeast, as well as the abundance of corn, beans and pumpkins (Bourne 1904; Biedma 1968 [1544]; Elvas 1933, 1968 [1557]). Each town or village was surrounded by fields. To De Soto's men this bounty explained the custom of throwing out the old grain to make room for the new within the context of the ceremonial cycle (Elvas 1933, 1968 [1557]). Hudson (1969), rebuts that the harvest was seldom sufficient to last to the next harvest, nor was it expected to do so.

Additional Cultigens

While maize was obviously the most important domesticate, it was not the sole southeastern cultivar. Other lesser domesticates included beans, pumpkins, and squashes (*Cucurbita* sp.) (Strachey 1849 [1612]:116,119), and the "eastern tradition" (Gremillion 1989), sunflower (*Helianthus annuus* var. *macrocarpa*) (Hariot 1893 [1588]; Swanton 1969; Hudson 1976). Bottle gourd, (*Lagenaria siceraria*) was raised primarily as a raw material for the production of household and ceremonial items, although its seeds were edible. Other representatives of the eastern tradition varied in importance over space and time. These crops include sumpweed or marshelder (*Iva annua* var. *macrocarpa*), goosefoot (*Chenopodium berlandieri*), pigweed (*Amaranthus* spp.), knotweed (*Polygonum spp.*), giant ragweed (*Ambrosia artemisiifolia*), and canary grass (*Phalaris* sp.) (Strachey 1849 [1612]; Hedrick 1919; Du Pratz 1972 [1774]).

There were at least two kinds of domesticated native beans, and in addition "wild peas" (beans) were collected. According to Swanton (1969) these domesticates were probably marsh peas (*Lathyrus myrtifolius* or *Lathyrus venosus*). The wild beans were said to resemble the *fagioli* of Italy (Strachey 1849 [1612]:119) and have been identified as a species of *Phaseolus* (Clayton in Strachey 1849 [1612]). De Soto found "small beans" of unidentified species in the granaries, along with corn (Elvas 1933, 1968 [1557]). Josselyn (1865 [1674]:423) reported that Indians grew kidney beans, "some much bigger than others." Romans (1775:84) observed that 18th century Choctaw cultivated, "...a greater number of different *Phaseolus* and *Dolichos [hyacinth bean]* than any I have ever seen elsewhere..."

Beans were usually cooked in combination with corn, meat, or grease. Sometimes softened beans were pounded in a mortar into lumps of "bread" (Hariot 1893 [1588]; Swanton 1969). The synergistic combination of corn with beans of all types results in a protein of high biological value. It is adequate for all, but the more protein-sensitive members of the population, such as lactating mothers and recently weaned children (Altschul 1962; Kaplan 1965).

Peaches (*Prunus persica*) were introduced by the Spaniards and quickly became a favorite aboriginal food. While Strachey (1849 [1612]) fails to enumerate peaches in early seventeenth century Virginia, one hundred years later Virginian Indians alleged to the English that they were a native species (Beverley 1720 in Hedrick 1919; Bartram in Kalm 1772; Swanton 1969). The fruits were dried like native plums, grapes, and persimmons, although the practice of preserving by dehydration may have been a later development (Swanton 1969; Hudson 1976). Watermelon is another European introduction which spread quickly throughout the Southeast and is associated with the *Ocute* province by 1597 (Blake 1981).

Agricultural Practices

Strachey (1849 [1612]:115) describes the procedure used by native Americans in Virginia, and presumedly elsewhere in the Southeast for clearing of forests for agriculture. He reports, that

> ...(they) "bruised the barke of those trees which they will take awaie neere the roote, then do they scorsh the rootes with fier, that they grow no more. The next yeare, with a crooked piece of wood, they beat up those trees by the rootes, and in these mowldes they plant their corne: the manner is thus, they make a hole in the earth with a stick, and into yt be put three or five graine of wheat, and one or three of beans: ther hole they make four or five feet one from another, for one corne being close together, one stalk woud choak ells the growth of another and render both unprofitable...Their women and children do contynually keepe the ground with weeding..."

Others have also described this same process in 17th and 18th century Virginia (Smith 1907; Beverley 1947 [1705]). This procedure is similar to that described in the Gulf region (Adair 1968 [1775]). Maxwell (1910:79 ff) adds that while small trees were removed easily, larger ones might take ten years to fall. People cultivated the ground around them, harvesting the gradual fall of limbs and trunks. Much of the work was reported to be performed by women.

This regime was not a swidden, "slash and burn", or "shifting cultivation" system, in the classic sense. In tropical climates fields are cleared as often as every year, regaining fertility in approximately 4 to 20 years (Boserup 1965). Tracts of cleared forests in the eastern woodlands maintain fertility for much longer periods of time, but in some areas have been documented to require 35 to 50 year fallow (Heidenreich 1971). The use of the terms "slash and burn" or "shifting" cultivation in reference to the Oconee Lamar culture refers to the latter long-fallow system of the eastern deciduous forests.

Agricultural field work is said to have been accomplished using "a common hoe" and "a small hatchet," (Adair 1968 [1775]:406), and sometimes "a crooked peece of wood" to pull up the dead saplings (Strachey 1849 [1612]:115; Smith 1907:96). Natchez digging sticks were described as "made like a capital L" out of hickory. During subsequent years of planting in the same field, Natchez burned the dried corn stalks in place to prepare for planting (Du Pratz in Swanton 1911). This practice was also observed among 17th century Pascagoula (Pénicaut in Swanton 1969). None of these horticultural tools are likely to appear in the archaeological record due to their organic composition.

Indian fields surrounded their houses (Spelman in Smith 1884). Fields and "truck patches" were widely scattered. In early seventeenth century Virginia, farmsteads were scattered among fields and gardens on patches ranging from 20 to 400 acres (Maxwell 1910:80). Eighteenth-century Chickasaw practiced an infield-outfield agricultural system. Each home had a small field "pretty close to it," and large, open fields on "...the best of their land here and there..." (Adair 1968 [1775]:406-407).

Chickasaw planted corn in straight rows of closely set hills, placing five to six grains per hole, two holes per hill. Rows were placed approximately three feet apart with pumpkins, watermelons, "marsh-mallows," sunflowers, and a variety of beans and peas between the rows. The legumes were recognized as enhancing crop yields. They generally "...let the weeds outgrow the corn.." Pascagoula, however, weeded their crops several times during the growing season (Pénicaut in Swanton 1969). Scaffolds were raised near Chickasaw crops, where old women took vigil to guard against human and non-human predators (Adair 1968 [1775]:406-408).

Corn, beans, and squash were recognized by the Indians as highly compatible crops, and Spanish, French, and English report that they were grown together throughout the East (Bourne 1904; Hedrick 1950; Hasenstaab 1994). All three thrive in a moist environment with a moderately high temperature, yet decline with over-watering, and each can tolerate the acidic soils that predominate in the Southeast. Corn removes nitrogen from the soil, while beans replace trace amounts of it. Beans and corn play complementary roles in the diet. Virginia Indians were observed planting beans and corn together in hills (Josselyn 1865 [1674]:423).

Wild Foods

Wild plant foods, particularly nuts, played a critical nutritional role in the Mississippian diet (Smith 1981; Blanton 1984). The De Soto *entrada* reported that some "towns" seemed to be deliberately located near fields of nut and fruit trees (Elvas 1933, 1968 [1557]), while others report that single trees, or even groves of trees, were planted near Indian agricultural fields (Bartram 1955 [1792]; Dobyns 1983). Wild harvested fruits include plums (*Prunus americana*), persimmons (*Diospyros virginiana*), grapes

(*Vitis* sp.), mulberries (*Morus rubra*), and strawberries (*Fragaria* spp.). Plums and persimmons were dried into a sort of "fruit leather," called "bread" by the Europeans and used as food over the winter (Hedrick 1950; Swanton 1969).

Nuts

Use of hickory nuts (*Carya* sp.), black walnuts (*Juglans nigra*), acorns (*Quercus* sp.), chestnuts (*Castanea dentata*), and chinquapins (*C. pumila*) have all been documented both historically and archaeologically (Strachey 1849 [1612]:128-129; Swanton 1969; Hudson 1976; Haecker 1977; Hally 1977-79, 1978-79; Hally 1977-81; Williams 1977-79; Hally and Smith 1978-79; Rudolph and Hally 1982; Manning 1982; Williams 1982a; Munson 1988; Gremillion 1990; Raymer 1990; Gardner 1992; Smith 1994). However, chestnuts were rare in the middle Oconee region. Black walnuts, hickory nuts, and acorns provide lipids and protein. Hickory is superior to both maize and acorns as a source of nine of the ten essential amino acids. Acorns contributed substantial carbohydrates to the diet, but overall were far less nutritious than hickory (Gardner 1992). It should be noted that the "walnuts" frequently cited by early explorers were more likely to have been hickory nuts, as the Spanish use those terms interchangeably, and hickory was more widely available. The Powhatan of Virginia stored *monohominy*, or black walnut, in gourds, and used it to anoint their bodies, while *powcohicora*, or hickory milk, served as food (Strachey 1849 [1612]:128-129). It is likely that *monohominy* was actually rendered from butternut, rather than walnut.

Processing of Nuts

The best documented use of nuts was the production of "oyle," "butter" or "mylke" from hickory, butternut and possibly, black walnuts (Strachey 1849 [1612]: 128-129; Swanton 1969; Erichsen-Brown 1979; Gardner 1992). One hundred pounds of hickory nuts (about 1000 nuts, at about 8 g per nut, in the case of the shagbark variety [Haecker 1977]) were needed to produce about one gallon of oil (Hudson 1976). Essentially, the nuts were broken between stones, smoke-dried, pulverized in a mortar, and boiled in water. The shells sank and the liquid became milky with oil. This "butter" could be long-stored and was used to flavor many foods. There is archaeological evidence that the by-products were dried and used for fuel. It is likely that the labor-intensive nut-cracking was accomplished mainly by children, who were also instrumental in the collection of this resource (Ford 1979). This assignment reduces the overall production cost because children require fewer calories than adults to perform the same labor. The manufacture of hickory butter implies that this nut was at least periodically abundant.

Alternatively, hickory nuts were crushed and added directly to broths (Strachey 1849 [1612]:129; Swanton 1969; Gardner 1992). The nutmeats thickened the broth and the oil floated, flavoring the stew. Munson (1988) has demonstrated that this process of adding hickory directly to the cooking pot is highly efficient in terms of human energetic return, and nutrient conservation.

In the Southeast hickory, chestnuts, and walnuts were also smoked and dried on reed mats elevated over fire (Hariot 1893 [1588]:29). Hickory, in particular, was an important supplement to lean game and dried corn during the winter when other high quality foods were scarce (Gardner 1992). Smoked nuts were soaked until soft and eaten as is, or pounded into loaves of "bread" (Hariot 1893 [1588]; Swanton 1969:364).

Acorns usually required more extensive processing than other nuts due to their high tannin content. Some acorns were edible after merely being parched, but most required boiling in water to remove the bitter and poisonous tannic acid. The boiled acorns were then pounded into a pulp which was dried into a meal and used in much the same way as hominy meal. Acorns were sometimes boiled like potatoes (Swanton 1969); Watt and Merrill 1975). Historic Choctaws relied heavily on acorn meal when the corn crop was poor. This practice may indicate the importance of acorns in the diet prior to the cultivation of corn (Hudson 1976).

Fleshy Fruits

Wild fleshy fruits provided variety and valuable nutrients in the diet, and were eaten fresh, dried, or smoked (Geller 1985). Persimmons were considered to be the "most useful" fruit and were frequently mentioned by the De Soto chroniclers, who called them *amexias* (Swanton 1969). Du Pratz (in Swanton 1969) attributed a lack of diarrhea and dysentery to the use of dried persimmon. Persimmon "bread" was made by scraping the fruit in open sieves to separate the flesh from the skin and seeds, and forming the pulp into long thin loaves, dried either in the sun or smoked over a grill. Swanton (1969) reports that the Creeks prepared a similar cake from maypop (*Passifora incarnata*), although it is difficult to imagine how this preparation could be accomplished.

This fruit, the size and shape of a hen's egg, is filled with small, hard seeds, each enclosed in a thin, liquid-filled bladder.

Maypops are ubiquitous in the archaeological record of the Southeast from Archaic times onward. They are particularly numerous from Late Woodland times on, probably because they are a pioneering plant that quickly invades agricultural fields. Such colonizing species can be maintained by continued disturbance of the soil (De Wet and Harlan 1975). There is persuasive evidence that maypops were deliberately planted, or at least encouraged (Gremillion 1989). The Gentleman of Elvas described a plant which may have been maypops,

> "... There is everywhere in the country...another plant, to be seen in the fields, bearing a fruit like strawberry, near to the ground, and is very agreeable." (Elvas 1968 [1557]:202).

Strachey is more specific.

> "...Here is fruit the naturals called a *mapacock*. This groweth generally low and creepeth in a manner amongst the corne...yt is the bignes of a queen apple, and hath manin azuarine or blew kernells like a pomegranet and yt bloometh of most sweet and delicate flower, and yt is a good summer cooling fruit and in every field where the Indian plant ther corne be cart-loads of them..."(Strachey 1849 [1612]:119).

In Virginia, Indians harvested mulberries, huckleberries (*Gaylussacia* sp.), raspberries (*Rubus* sp.), gooseberries (*Ribes* sp.), and cherries (*Prunus* sp.) (Strachey 1849 [1612]:117-119; Beverley 1705 in Swanton 1969). Mulberries in Ichisi (central Georgia) were said to be larger and more delicious than those of Spain and were prized by the Spaniards (Bourne 1904). Plums, grapes and crab apples (*Malus* sp.) were also eaten (Bourne 1904; Elvas 1933, 1968 [1557]). Hawthorn (*Cretaegus* sp.) tea was an anti-spasmodic sedative (Sheldon 1983). Fox grapes (*Vitis vulpinus)*, "as full and luscious a grape as in the villages between Paris and Amiens," were reported to have grown near James Town, Virginia. These were "full clusters of grapes" on vines which "climb the tops of the highest tree (Strachey 1849 [1612]:119).

Roots and Tubers

Roots were another important category of food. Swamp potato (*Sagittaria* L. spp.), which grows in swamps and shallow waters, is most easily collected from fall to spring. In historic times this root was baked in a Dutch oven or in the ashes of a fire, then put into a mortar and made into meal or powder. This was used like hominy meal, especially during winter famines. Wild sweet potato, or morning glory (*Ipoema pandurata* L.) has a large tap root that can weigh as much as fifteen to thirty pounds; it was eaten raw or boiled with meat or fish. Groundnuts, or Indian potatoes (*Apios tuberosa*) are about the size of walnuts and were boiled (Hudson 1976). In North Carolina roots of Angelica (*Ligusticum canadense*) were documented to be boiled with meat (Swanton 1969). A starchy red powder was prepared from the roots of *greenbriar (Smilax* spp.). Added to boiling water, this product jelled, creating a favorite food for babies and old people. Greenbriar powder and juice were both used in making breads (Swanton 1969; Hudson 1976).

Vegetables and Potherbs

The southeastern Indians did not ordinarily eat uncooked vegetables, with the possible exceptions of wild onion (*Allium cernuum* Roth), and wild garlic (*Allium canadense* L.). These were among the very few greens available from late fall to early spring (Hudson 1976). Rangel reported that bunches of young onions were eaten boiled and raw with corn cakes (Bourne 1904). Nevertheless, Indians in Virginia were said to avoid onions (Strachey 1849 [1612]:120).

Woods and fields provided habitat for a great variety of herbaceous plants, including violets (*Viola* spp.), purslane (*Portulaca oleracea* L.), sorrel (*Rumex* spp.), roses (*Rosa* spp.), and onions. Cooked vegetables included dayflower (*Commelina erecta*), cabbage palm, (*Sabal palmetto*), and cane (*Arundinaria* spp.) among others,(Sheldon 1983).

Beverages

There is little historical documentation of southeastern Indian beverages, but modern Choctaw and Cherokee prepare drinks that may have ancient origins. The roots and bark of sassafras (*Sassafras albidium*) are used to make tea, but this plant is also used to thicken soup and as medicine. The Cherokee make a tea from the dried leaves, twigs, and young buds of spicebush (*Lindera benzoin* [L.] Blume). Cherokee prepare a hot drink by softening maypops in boiling water, squeezing, then straining the juice. Pods of honey locust (*Gleditsia triacanthos* L.) are similarly prepared as a hot or cold beverage. Southerners made a honey locust beer that may have been introduced to them by the local Indians (Hudson 1976). Hudson (1976) does not think the Indians fermented the brew.

Miscellaneous Seeds

The Spanish frequently mentioned stored foods, particularly those set aside for winter. Repeatedly mentioned were maize, beans, walnuts, and dried persimmon (Elvas 1933, 1968 [1557]). Many seeds collected by the Indians could have been stored for winter use. Cockspur grass (*Echinochloa Beau* V.) produces abundant seed from midsummer to fall; it can be parched and ground into a meal (Hudson 1976). In some areas summer and fall ripening lotus seeds were made into a bread along with corn flour (Swanton 1969; Hudson 1976). Two species of cane, switch cane (*Arundinaria tecta* [Walt.] Muhl) and giant cane (*Arundinaria gigantea* [Walt.] Muhl), produce edible seed, on an irregular schedule. *A. gigantea* flowers only once in twenty years (Fernald and Kinsey 1943: 53 in Haecker 1977) and at best switch cane seeds would be available every three years (Hudson 1976; Erichsen-Brown 1979). Nevertheless, during periods of synchronized flowering, cane would represent a substantial resource. Wild goosefoot (*Chenopodium* spp.) was a reliable, prolific producer of extremely small and nutritious seeds that can be ground into meal. As a bonus its young leaves can be eaten like spinach. These wild types of goosefoot are not to be confused with *Chenopodium berlandieri*, a Woodland through Mississippian period domesticate (Smith 1992).

Non-Dietary Uses of Plants

Plants, too numerous to catalogue here, were used medicinally. These are enumerated by other authors (Moerman 1986). Swanton (1969) amply demonstrates that plants were critical, sustainable sources of raw materials in the Southeast. Flora provided materials for construction, firewood, cordage, basketry, canoes, weapons, hunting equipment, textiles, and household implements, among others. They also furnished means of personal enjoyment and adornment, and items of ceremonial importance such as substances for smoking, incense, ingredients for ritual drinks (e.g., "the black drink"), dyes, beads, drums, etc.

Energy Yields

In order to apply optimization theory to the upland subsistence adaptation, it is necessary to ascertain the net energy yields of key cultivars and wild resources. Some of this information has been determined by other researchers using search costs or cultivation, harvesting and processing costs in their calculations (Baker 1980; Munson 1984; Beckerman 1986; Gardner 1992). In addition, I have conducted experiments on the collection and processing of a limited number of lesser wild plant foods. Taken together, these studies are useful in filling in the gaps of the archaeological record. That is, they may be useful in explaining the presence or absence of particular taxa, reconstructing details of plant processing and disposal, systems of horticulture, etc.

This approach must be used cautiously. Even the most remote cultures are affected by modern technology and the allegedly "traditional" techniques upon which most experimental archaeology is based, may derive from post-contact innovation. Furthermore, simulations can only approximate the work of a native. Prehistoric people were familiar with their own catchment zone, and were experienced in harvesting and processing its wild resources. Furthermore, the modern landscape may substantially differ from its aboriginal condition (Wagner 1996).

The following section reviews the expected energy available from major classes of foodstuffs utilized in the Lamar period. Refer to Table 8 for a summary of data used in my field studies. Calculations and reports of net energy yields for the enumerated resources are reported in Table 9. In Table 9, net kcal per work-hour is calculated by first determining the gross caloric value of foods collected during a timed episode (gross kcal harvested and gathered), the total time in minutes required to harvest, transport, and process, less the costs in human energy associated with the collection and processing of these provisions (kcal cost). The resulting energy yield per timed episode (net kcal) is extrapolated to produce an estimate of the net energy yield anticipated in exploiting a particular species (net kcal per work-hour).

Table 8: Time in minutes and (energy) in kcal used to calculate energy yields.

Taxon/Unit	1	2	3	4	5	6	7	8	9	10
Corn/m^2	2 (16.8)	2 (7.2)	4 (26.4)	1 (4.6)	10 (30)	5 (15)	-	-	-	5 (30)
Goosefoot/ m^2	2 (16.8)	neg	-	1 (4.6)	7 (21)	5 (15)	4 (24)	4 (24)	-	2 (16.8)
Maypops/4 (147 g)	-	-	-	1 (4.6)	2 (6)	5 (15)	-	-	-	1 (6)
Black raspberry - fresh/340 g	-	-	-	16 (73.6)	3 (9)	5 (15)	-	-	1.5 (5)	-
Black raspberry - dried/85 g (340 g fresh)	-	-	-	16 (73.6)	3 (9)	5 (15)	-	-	neg	3 (9)
Blackberry - early /551 g	-	-	-	85 (391)	3 (9)	5 (15)	-	-	2 (6)	-
Blackberry - peak /3260 g	-	-	-	105 (483)	3 (9)	5 (15)	-	-	10 (30)	-
Blackberry - dried, peak/42 g (255 g fresh)		-	-	1 (4.6)	2 (6)	5 (15)	-	-	neg	3 (9)
Elderberry /679 g	-	-	-	15 (69)	2 (6)	5 (15)	-	-	-	-

Key
1=cutting trees with stone axe (Baker 1980)
2=planting (Baker 1980)
3=weeding (Baker 1980)
4=harvesting (Baker 1980; Seeman and Wilson 1984; Bonhage-Freund, dissertation research)
5=gathering, including husking or bundling (Baker 1980; Bonhage-Freund, dissertation research)
6=transporting (Baker 1980)
7=removing perianth (Seeman and Wilson 1984)
8=winnowing (Seeman and Wilson 1984)
9=cleaning (Bonhage-Freund, dissertation research)
10=preparation (Baker 1980; Bonhage-Freund, dissertation research)

Table 9: Net energy yield (total kcal) of selected species.

Taxon/Unit	Gross Kcal/ Time harvesting & gathering (minutes)	Total Costs (Kcal) /Total processing time (minutes), including harvesting & gathering	Net Kcal/ Total processing time	Net Kcal Work-hour	Citation
Corn/m^2	820/11	130/29	690/29	1533	1,2
Goosefoot/m^2 (optimal)	815/8	145/30	670/30	1340	1,8
Goosefoot/m^2(peak)				1040	1,8
Maypops/0.4 kg				200	3
Maypops/0.4 kg				360	3,4
Maypops/4 (147 g)	132/3	32/9	100/9	666	5
Blk Raspberry/340 g	248/19	103/26	145/26	335	5
Blk Raspberry/85 g (dried-from 349 g fresh)	248/19	112/29	136/29	281	5
Blackberry/551 g (early)	320/88	421/95	-101/95	-64	5
Blackberry/3260 g (peak)	1885/108	537/123	1348/123	658	5
Blackberry/42 g (peak;dried-from 255 g fresh)	150/3	38/11	112/11	611	5
Blackberry				972	3
Elderberry/679 g	489/17	90/22	399/22	1088	5
Elderberry				2813	3
Shagbark Hickory/ 5 kg				211 - 3492	6
Mockernut Hickory/ 2.8 kg				152 - 3642	6
Bitternut Hickory/ 2.5 kg				132 - 3300	6
Black Walnut/ 5.2-9.5 kg				621	6
Butternut/ 7.7-9.7 kg				247	6
Hazelnut 0.31 - 0.91 kg				592	6
Oak Acorn 3.2-14.3 kg				288 - 3504	7

1=Baker 1980 2=Wilson 1987 3=Beckerman 1986 4=Watt & Merrell 1975
5=Bonhage-Freund 6=Talalay et al. 1984 7=Petruso & Wickens 1984
8=Seeman & Wilson 1984

Agricultural Grains, Pseudo-grains, and Oily-seed Crops

Corn (*Zea mays*) dominated the late prehistoric grain and pseudo-grain[2] crops in the middle Oconee region. Secondary to maize were goosefoot (*Chenopodium berlandieri*), sumpweed (*Iva annua* var. *macrocarpa*), and sunflower *(Helianthus annuus var. macrocarpus)*. Of the these, goosefoot is thought to have been most important, based on observations described elsewhere (Lopinot 1992).

Corn

Baker (1980:221) calculates the caloric yield per m^2 of *Zea mays* to be 820.35 kilocalories under aboriginal conditions. This is the gross yield and does not consider the time or energy costs of producing and processing corn (Baker 1980:218). Baker does, however, provide estimated caloric costs associated with various general agricultural tasks (1980:218). In Table 8 I assess the total time and energy requirements associated with the production of corn, among other genera. These figures are based on Baker's (1980:218) activity cost estimates and Wilson's (1987 [1917]) narrative description of Hidatsa agriculture. In these computations I ignore certain variable costs such as guarding crops, parching meal, processing corn in alkali, and so forth. Based on my calculations, maize production, under ordinary circumstances, yields about 1533

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[2]Pseudograins are seed-bearing plants which are similar to cereal grasses in that they produce abundant, small seeds on terminal infloresences.

kcal per work-hour. No allowance is made for predation losses under the assumption that this waste would be partially compensated by meat captured due to the "baiting effect" of maize fields (Muller 1986).

Goosefoot

Goosefoot has lower moisture and nutrient requirements than corn and may have served as a buffer against low maize yields. It contains over twice the protein of maize (Smith 1992:179), and is relatively high in fat and food energy (Seeman and Wilson 1984 [1917]). The sowing and tending of goosefoot is less labor-intensive than that of corn, and the level of seed loss during reaping, and harvesting and processing costs, is not nearly as high as has previously been assumed (Lopinot 1992). It has been estimated that maize production must yield in excess of 1000 kg./ha before it would represent an attractive alternative to *Chenopodium berlandieri* in terms of harvest yield alone (Smith 1992:180). Furthermore, stomach content analysis of terrestrial vertebrates indicate that predator pressures are significantly less on goosefoot than on maize (Martin et al. 1961).

Experiments by others demonstrate that yields of wild goosefoot of the species *Chenopodium missouriense*, are comparable to those of domesticated varieties (Seeman and Wilson 1984). These researchers use *C. missouriense* to estimate the caloric potential of *C. berlandieri*. They find that at its productive peak, the harvesting, screening and processing of domesticated goosefoot grosses 304 g of seed per work-hour, for a net yield of approximately 1040 kcal. Identical trials, during two week periods bracketing the productive peak, yielded similar results. The mean gross output for the two week periods on either side of this peak was 284 g per work-hour, for a net return of roughly 970 kcal (Seeman and Wilson 1984:309). In essence, this finding indicates that domesticated goosefoot may be harvested for an extended period of at least six weeks with only negligible reduction in yield. These estimates, while somewhat lower than my own calculations (based on Baker [1980]), are still comparable. (See Table 9).

Baker (1980:221) determines that a one m^2 patch of *Chenopodium album* growing in ideal soil conditions yields 814.86 kcal, or 99% that of the same acreage planted in corn. Domesticated goosefoot should yield at least as much. Cultivated goosefoot would be broadcast (Lopinot 1992), saving 3.6 kcal per minute of planting with a digging stick, and would probably not be weeded (Lopinot 1992), saving an additional 6.6 kcal per minute of human energy. However, Baker fails to discount preparation time in his figures, and overlooks certain other costs which I have estimated from Seeman and Wilson (1984). Based on a combination of Baker's and my own calculations, goosefoot yields 1340 kcal per work-hour. This estimate is consistent with Lopinot's observations that the net energy yield of goosefoot is comparable to maize. Noting that beyond their productive capacity, the nutritional value of chenopods is greater than that of corn, Lopinot (1992) alleges that the dominance of corn must be explained on an alternate basis.

In fact, the actual net energy yield of goosefoot is probably closer to the somewhat lower calculations of Seeman and Wilson (1984). They conducted actual field studies under controlled, but not necessarily optimal, conditions. The taxon they harvested is also more similar to the domesticated variety of goosefoot than is the *C. album* processed in the Baker (1980) field test. In either analysis, the return of goosefoot, harvested at its peak, is at least 2/3 that of maize, and there is a good chance that the actual return is higher.

It has been demonstrated that domesticated chenopods are theoretically capable of producing yields comparable to those of nonhybrid corn; however, with intensive cultivation, corn yields can be increased more than those of any of the starchy seeds (Scarry 1993:89). This difference may explain, in part, the Mississippian emphasis on corn. Another downside to a dependence on starchy seeds is their storage requirements. They require storage containers, whereas maize could be stored on the cob, in containers, granaries, racks, etc., or even hung from rafters. Lopinot hypothesizes that evolving social and ceremonial structures may play a role in the preeminence of corn. In addition, maize would have required less commitment of time and energy to harvest than domesticated goosefoot during the critical fall period of intensive hunting and nut collection (Smith 1992). Regardless of these factors, the energetic potential of domesticated goosefoot provides sufficient incentive to ensure its retention in the agricultural suite.

Sunflower and Sumpweed

Sunflower (*Helianthus annuus)* and sumpweed, or marshelder (*Iva annu*a var. *macrocarpa),* are low maintenance crops that never equaled the rank of either corn or goosefoot in the late prehistoric diet of the Oconee region. These seeds were primarily sources of oil (Yarnell 1978). Sumpweed, in particular, has a considerable tolerance for soil diversity, but prefers disturbed, open habitats (Yarnell 1978). Marshelder was ingested without removing the seed coat (Jones 1936:151), thus reducing processing costs.

Beans

Common bean (*Phaseolus vulgaris*) appears in Duvall and Iron Horse phases in riverine Piedmont sites studied by other researchers. The only positive identification of this taxon in an upland context, prior to the Penn State project, was at the Dog River site, 9DO34, which is contemporary with the Bell phase. The apparently minor role of domesticated beans appears to be widespread in eastern North America until the post-contact period (Wetterstrom 1986:17; Gremillion 1989a).

Wild Fleshy Fruits

Maypops

Maypops (*Passiflora incarnata*) are the most common open field taxon in the Oconee upland assemblages. Beckerman (1986), observing their scarcity in modern times, found these colonizers to have high collection costs (2.5 work-hours per kg). There is evidence, however, that maypops were far more plentiful in late prehistoric fields, and were either encouraged or deliberately planted (Strachey 1849 [1612]:119; Gremillion 1989b). Beckerman (1986:601) disallows collection costs in calculating a caloric return of 200 kcal per hour (0.4 kg of fruit). He bases this figure on an estimate of 50 kcal per 100 g of fresh fruit. The USDA, however, indicates that 100 g of passion fruit yields 90 kcal (Watt and Merrill 1975). Applying this figure would almost double the caloric yield to 360 kcal per 0.4 kg.

Four ripe maypops, averaging 36.76 g, were collected in the Oconee area for me by Thomas Gresham of Southeastern Archaeological Services. These were opened at intervals over a period of seven months. They maintained a juicy pulp for over a month at room temperature. After seven months, the seeds were still edible, but bland, and encased in dried, deflated bladders. According to my calculations, summarized in Tables 8 and 9, the net caloric return on these fruits is about 666 kcal per work-hour. I assume synchronous ripening of fruits in this estimate. Asynchronous maturity would significantly reduce yields. The extremely small number of fruits harvested in this episode renders these figures unreliable. However, considering the dominance of maypop seeds in southeastern assemblages, I feel that the actual net yields leaned toward the higher estimate. Considering the storage potential of this crop, and ignoring modern standards of palatability, maypops may have been stored for winter use, as well as enjoyed in their more nutritious and favorable fresh state.

Brambles

Brambles, including raspberries and blackberries, added variety and vitamins to the diet at very little cost, if taken in season and eaten fresh. However, picking out of season may generate negative net energy yields (-64 kcal per work-hour). In three timed episodes I picked raspberries and blackberries during minimal and optimal periods of availability. Berries were placed and carried in a flat woven basket. For realism, my two year old son accompanied me on two of these expeditions and his tending is included in the harvesting costs. In the case of fresh fruits, the only "processing" I employed was the removal of inedible debris. Taken at their peak, fresh blackberries returned 658 kcal per work-hour, and dried fruit yielded 611 kcal per work-hour. Black raspberries were less productive at 335 kcal per work-hour in mid season. Beckerman (1986) calculates a net yield of 972 kcal per hour for blackberries. In aboriginal times, smoke-drying for storage was routine when harvests surpassed immediate needs. While this process adds to preparation time, I employed only sun drying in my trials.

Elderberries

Beckerman (1986) estimates a gross collection rate of 5 kg per hour of elderberry clusters, with an effective net yield of 2813 kcal per hour. My extrapolations, while somewhat lower, still indicate a substantial yield. During a fifteen minute period, I manually snapped fruit-laden cymes into a flat, woven basket, accumulating 679 g of edible fruit, for a net return of 1088 kcal per hour. These fruits would have been another attractive, though transient, resource.

Nuts

From Archaic times, nuts represented an important food resource in eastern North America (Caldwell 1958; Lopinot 1984). Oaks are the most common tree in the Georgia

Piedmont, with hickory ranking a distant second. Acorn production is among the most variable of nut yields. Conservative estimates of annual production per tree are as follows, chestnut oaks (*Q. prinus.*) 0.45-34 kg (Zawacki and Hausfater 1969; Goodrum *et al 1971)*, white oaks (*Q. alba*) 0.05-4.4 kg, black oaks (*Q.velutina*) 0.05-3.9 (Goodrum *et al*. 1971). Studies of hickory production show a typical production range of 1 - 3 kg during mast-bearing years (Zawacki and Hasufater 1969; Talalay et al. 1984). Some open grown shagbark hickories produce as much as 8.2 kg (Nixon *et al*. 1968). Compilations of black walnut production under natural conditions range from 1.9 to 15 kg per tree per annum, depending on canopy and other conditions Zarger 1946; Talalay *et al*. 1984). Butternut trees in closed canopy situations averaged from 0.5 to 5.5 kg, with some trees not producing for over four years at a time (Talalay *et al*. 1984). Most nut-bearing trees do not consistently yield large crops, nor do they necessarily produce every year. Within a grove, trees tend to have synchronized production cycles (Scarry 1986:104). The fluctuations in yield are to some extent predictable (Gardner 1992). Different patches of trees, species of the same genus, and genera of trees may each have unique periodicity. By exploiting several different species of nuts of a given genus, fluctuations may be evened-out.

Hickory nuts are superior to both corn and acorns as a source of nine of the ten essential amino acids. They are also high in fat and calories. Acorns are a better source of carbohydrate than hickory, but provide less protein than maize; in particular, lower amounts of seven essential amino acids. All things being equal, hickory nuts are nutritionally superior to other nuts. They also have the highest overall predictability (Gardner 1992).

Talalay *et al*. (1984) experimented with various methods of extracting nutmeats from their shells. While the full range of yields is reported here, one can assume that Mississippian peoples would achieve close to the maximum efficiency, due to their own experimentation and experience. Energetic costs included in these evaluations are collection, hulling, and extraction. Hickory processing experiments focused on nutmeat utilization. The lower energy returns reported in Table 9 result from the unlikely hand-picking of nutmeats from shells. The higher energy yields result from crushing and winnowing or from separating shell from nutmeat in liquid (Talalay *et al*. 1984). Production of hickory oil would be somewhat more costly, in terms of time and energy, than the opportunistic addition of crushed nuts to a stew. Decanting costs must be added in oil production, and storage costs would also be higher. Rendering of oil would be most advantageous when there was a need to transport nuts over a great distance. By reducing the bulky hickory to its essential component, one could transport a great number of calories in a reduced package. On the downside, most of the protein and other nutrients are lost when only the oil is consumed.

Shagbark hickory yields a range of 211 to 3492 kcal per hour (Talalay *et al*. 1984). Mockernut hickory produces 152 to 3642 kcal per hour, Bitternut hickory ranges from 132 to 3300 kcal per hour (Talalay *et al*. 1984). Black walnut nets 621 kcal per hour, while butternut furnishes only 247 (Talalay *et al*. 1984). Hazelnut provides 592 kcal per hour (Talalay *et al*. 1984). In this test, butternut was extracted by cracking and picking. However, historic Cherokee normally crushed and boiled butternut to obtain oil (Witthoft 1993, personal communication). This latter method produces higher yields. These tests failed to consider that much of the nut harvest was probably performed by children, whose expenditures of energy per hour would be less than that of a typical adult (Ford 1976). This fact would enhance net caloric yields.

Experiments in acorn processing were less thorough (Petruso and Wickens 1984). Although kilocalories produced per hour of collection and shelling were calculated, parching, leaching, and other necessary processing were not considered in the production costs. Again, these calculations were based on the energy expenditure of adults. The typical energy potential of different genera of oak acorns per hour of collecting and shelling are as follows: black oak - 1204, red oak - 998, bur oak - 3503, white oak - 288, and chestnut oak - 347 (Petruso and Wickens 1984). Yet to be subtracted from these yields are the energetic costs of parching, and excepting only chestnut oaks and some white oaks, leaching. The more tannin-rich oaks, such as red oaks, require proportionately more processing than the less bitter oaks, such as white oaks.

Another consideration in evaluating mast potential is the typical interval between crops and between good yields. Hickories and black walnut produce annual yields, while black, red, and pin oaks have a biennial cycle. Most varieties of nut trees bear good crops every two to three years, but red oak requires as many as three, and white oak from four to ten years between substantial outputs (King 1976b: Table B.3).

Opening the forest canopy is one way to increase nut production. Not only do individual trees with greater exposure to sun produce more mast, but squirrel habitat is limited by reducing the size of the canopy (Wagner 1996). Poor producers, or trees which were not economically useful, may have been ring-girdled, but those remaining nut-bearing trees would more than make up for their loss in enhanced production. Forests were regularly burned to create "park-like" conditions, and this management in part may have been to open the canopy for maximum nut yield (Hudson 1976; Pyne 1983; Silver 1990; Wagner 1996). Technically these costs should be factored into the net caloric yield of nuts. Black walnut trees were deliberately planted along edges of some fields, or left standing in cleared fields, providing a convenient source of nuts (Bartram 1955 [1792]; Dobyns 1983). Butternut was sometimes planted in groves near rivers (Witthoft 1993, personal communication). These practices also reduced transportation cost and would have slightly improved energetic return.

Considering availability, nutritional profiles, and net energetic return both acorns and hickories provide attractive resources for Piedmont populations. Hickory is the most nutritious and least costly, but in shorter supply than acorns. Each of these two nut types was dominant in the archaeobotanical record under some circumstances during the later prehistoric - protohistoric period. Despite the annual variation in yields, these resources were a staple, second only to maize, throughout the Lamar period.

Ethnographic Analogies: Modern Native Horticultural Systems

Ethnohistoric descriptions of early native agricultural practices have been summarized above. In this section I present several examples of agrarian systems used by modern Indians employing traditional methods. Ideally, Southeastern cultures would have been highlighted, but in-depth descriptions of native Southeastern subsistence, comparable to those presented here, do not exist. While the three societies discussed here span the map of North America, they are remarkably similar in their subsistence strategies. The economic system of all three native groups focuses on maize production, but minor crops and wild plants and animals are integral to each. All of these cultures participate in mainstream economies to some extent, and yet their ancestral subsistence traits are useful in interpreting prehistoric and protohistoric lifeways.

Hidatsa

At the turn of the century, many Hidatsa families in North Dakota clung to traditional lifestyles. While time and circumstances had forced some modification of the economic system, memories of the old ways were still alive. Maize agriculture was central to this life. All ethnographic information in this section is derived from Wilson (1987 [1917]).

Horticultural fields were located parallel to the river in the bottomlands on either side of the village. Each family was free to clear and plant any unused tract. Square to rectangular garden plots were cleared only in the river valleys due, in part, to the largely impenetrable nature of the prairie sod. Ideally, plots were located in a fairly open area devoid of large trees, although this criterion was no longer so important with the availability of metal axes. In field placement people were cognizant of microclimates that might affect their crops.

In late summer or in autumn, a husband helped his wives and unmarried daughters fell smaller trees in the womens' fields. A single tree along the edge of the field might be spared to provide shade. Suitable timber was reclaimed for firewood, with the remainder left to dry until spring, when it was strategically burned, along with brush. It took four days to incinerate a 75 x 100 yard field. The emic perspective is that this process "softened the soil and left it loose and mellow for planting". Ideally, families would have at least two fields, one on each side of the village. These plots might be planted with different types of corn, or one might be used while the other lay fallow (Wilson 1987 [1917]:13-15, 114-115).

Family gardens were separated by four foot wide strips of bare earth, but, with permission of the adjoining neighbor, one family might raise a border of a single crop in the area of demarcation. Any crop, *except* corn, might comprise this living fence. After two or three years, depending on how rapidly productivity fell, a field would be left fallow for two years (Wilson 1987 [1917]:114-115). Gardens were also fallowed for at least two years following their female owner's death. The richness of the bottomland precluded more extensive or frequent field abandonment.

Using straight digging sticks, with the bottom cut at an angle, women planted corn in rows of hills about four feet apart, avoiding stumps. This placement was calculated to produce acceptable yields even in the case of sub-normal rain, but precluded the possibility of a "bumper crop." Over the course of the growing season women slowly cleared out roots and small stumps, but large tree stumps were left to rot. Once this task was completed, fields were gradually enlarged along the edges. Crops were hoed and weeded twice in the growing season, with uprooted young weeds being left in place to rot. Platforms, or "watcher's stages," were constructed adjacent to the fields where preadolescent females and young adult women guarded the crops from humans and animals.

Beans, squash, and sunflower were also grown in hills. Several varieties of sunflowers were placed eight or nine paces apart around the border of the plot. Wild sunflowers were also tolerated, and were considered to be a second crop, of high quality oily seeds (Wilson 1987 [1917]:16-19). Broad, single ranks of squash and gourds bordered groupings of seven alternating rows of corn and beans. Agricultural tasks were undertaken in response to ecological, as opposed to temporal, cues. For example, a second planting of corn was made "when June berries were ripe" (Wilson 1987 [1917]:37).

Small "tobacco gardens" were maintained by old men for their personal use. They were located at some distance from the corn gardens, because tobacco was thought to have negative effects on an adjacent maize crop.

Garden crops were supplemented by wild game, traditionally bison, and wild plants. For example, "ground beans" and "wild potatoes" were collected in the fall. Communal orchards lay adjacent to the village (Wilson 1987 [1917]).

Teenek

The Teenek (Huastec) Indians of Veracruz and San Luis Potosí in northeastern Mexico are a Mayan-speaking (Teenek) people who have retained a rich cultural tradition, according to Alcorn (1984), the source of all ethnographic material in this section. Their highly complex economic system involves the exploitation of a variety of vegetation zones and communities, most of which are actively "managed." Their territory lies within two physiographic provinces, the Sierra Madre Oriental, and the Northeastern Coastal plain, and is naturally rich in plant, animal, and riverine resources. However, these resources alone are insufficient to support the human population.

The *Teenek* have developed a system of shifting cultivation, based on the proliferation and exploitation of successional plants. Agricultural patches over scattered over space and time to minimize crop losses to predator populations. Their moist tropical environment differs in some respects from that of the southeastern United States, and yet many of their subsistence practices resemble those of protohistoric eastern natives. Agricultural sites are prepared by slashing the standing vegetation and then burning the debris to fertilize the soil. The burning also destroys many weed seeds, insects, and disease microorganisms. The intercropping of multi-level cultigens with diverse root structures, mimicking the forest configuration, shades the ground and protects the soil. Uprooted weeds are left in the field as mulch.

Agricultural plots are small, limiting soil erosion and creating habitat for successional species, including small game and animals which prey on crop predators (Linares de Sapir 1976). This practice of dispersing agricultural plots also ensures the continued presence of seed sources for successional and climax species. Finally, risk of total failure is limited by minimizing the percentage of crop exposed to adverse conditions in any given plot.

The forest is a mosaic of natural and anthropogenic vegetation zones, all of which play a role in the Teenek economic system. Teenek maintain highly diverse dooryard gardens, consisting of protected or spared useful plants. These seemingly "wild" areas of plant growth include ornamental, edible, medicinal, utilitarian, ritual, and even "useless" plants. Some may have been originally transplanted or otherwise "managed."

The *Teenek* are dependent on a milpa system of maize cultivation. The Milpa is a field inter-cropped with corn, beans, and squash. It is primary among a variety of anthropogenically manipulated ecosystems maintained on any given family plot. Milpa is cleared from bush fallow fields, that is, an expanse covered with eight to fifteen years of successional regrowth. Particular soil, exposure, and topographical requirements must also be met. A milpa, as such, can be productive for two to three years, after which it has been carefully transformed into a semi-wild garden. Milpa may be prepared and planted in any month except January, so fields are in different stages of maturity at any given time. After the initial burning, secondary crops such as amaranth or sesame are broadcast into the ashes. Milpa is deeply embedded in socio-cultural trappings, involving a ceremonial complex.

Following initial preparations, corn is planted, accompanied by appropriate ceremonialism. Yellow, white, blue, or red corn seeds are carefully selected, based on the farmer's personal preferences. These are planted in separate plots if the farmer wishes to preserve the purity of his seed stock. A farmer and some hired hands line up and proceed abreast across the field. Digging sticks are used to punch and refill holes, each of which is planted with five corn kernels. After the corn is sown, the proprietor himself distributes bush or pole bean seeds between the maize. Sometimes beans and maize seeds are mixed and planted concurrently. Unwanted vegetation is slashed back periodically during the growing period of maize. Some plants not considered harmful to corn are allowed to grow and are themselves exploited.

After the harvest, crop plants are mulched into the soil, and managed successional and agricultural crops are planted or allowed to grow among the standing stalks. Each successive corn planting is inter-cropped with a changing suite of spared, encouraged, and cultivated plants, until the regenerated field is a multi-storied tangle of economically useful plants. These "old" fields are known as *k'aalumlab*, and several are concurrently maintained by every family, each such plot having a unique, but controlled composition.

Semi-wild areas, or *Te'lom*, containing elements of primary and secondary forest composition and introduced species, are likewise maintained. Today these areas produce commercial crops, such as coffee beans, in addition to raw materials for household needs, semi-wild food and medicinal plants, and "orchards" of fruits.

A variety of plots devoted to commercial crops has been developed and abandoned over Teenek history, in response to external markets. All of them have been managed through swidden techniques similar to those described. To some extent, all vegetation zones surrounding the community are managed through destruction, sparing, encouragement, and planting. In the past, diets included more root crops, but these species have declined in importance since wage labor has become available. Today 65 of the recognized food resources of the Teenek are cultigens, the remaining 141 food plants are "managed." Of these resources only 32 are Old World plants.

In summary, the Teenek economic system, while based on maize husbandry, is much more complex than field agriculture. It is an integrated system of plant and ecosystem management designed to foster diversity of economically useful plants, which reflects sensitivity to and extensive knowledge of the local ecology. The emphasis on species heterogeneity, and the dispersal of productive plots across the landscape reduces risks and promotes higher yields, all with the least labor investment (Alcorn 1984:393). Since milpas may be planted at almost any time, production can be closely monitored. Management decisions, while made at the household level, relate also to considerations of neighbors, kin networks, and local and regional politics.

Tewa

Picuris Pueblo, located in the *Sangre de Cristo* mountains of northern New Mexico, is home to a population of Tiwa-speaking people. Summers are short, and the annual precipitation is about 15 inches (Ford 1977; Brown 1979). The short growing season limits the crops that can be grown, and highly variable localized weather conditions and insect pests may result in the occasional loss of crops. Indians participate in a complex system of ceremonialism and social interaction at local and regional levels.

Kinship ties link Picuris Pueblo with distant communities, creating both obligations and resources for individuals and their families (Ford 1991). Tewa ceremonialism, like that of other pueblo peoples, is centered on corn (Ford 1994). Rituals provide opportunities for redistribution of food, dispersal of maize germ plasm, and the nurturing of particular strains of maize (Ford 1990, 1994).

Pueblo lands are owned in common. If a family wishes to farm a tract, it must be cleared and remain fallow for a year. Today it would be plowed, and fertilizer added before planting. Traditional gardens are maintained by some members of the Picuris community. I was priveledged to visit the home of Pat and Margaret Martinez. The Martinez family garden is located proximate to the family dwelling. Widely dispersed hills of corn, planted four or five inches deep, dominate the field. Wide planting is said to produce bigger ears (Martinez, personal communication 1991). Water control and drought resistant strains of corn are two essential elements of southwestern agriculture. With help, Mr. Martinez floods his fields once or twice each growing season by diverting water from a stream through an irrigation ditch. Cows and pigs are allowed to forage in the fields after the fall harvest, providing fertilizer for crops. This practice was, of course, a post-Hispanic modification of the agricultural system. Today fields in the community are fenced with cedar and barbed wire. In the past, each family planted several fields widely dispersed across the 260 acres of irrigated, communally owned territory (Brown 1979). Each field would accommodate but one color of corn - white, blue, red, yellow, or black. Although people consume any shape or color of corn, Pueblo rituals require "perfect" ears of a solid color. A single cross-pollinated grain of a second color renders the ear unsuitable for ceremonial purposes (Ford 1994). This strong motivation influenced the planting of scattered fields. An obvious bonus of this practice is the reduction of risk to an entire crop succumbing to a localized disaster such as a blight, hail, or predators. In addition to corn, squash and "horse beans" are planted in the field.

A roughly ten or twelve foot band of tolerated plants surrounds the horticultural field. Here a community of chenopods (goosefoot) and amaranth (pigweed) thrives, along with wild sunflower and "bugseed." The goosefoot and pigweed are casually sown by farmers during cultivation of their gardens. Chenopods and amaranth rob water from the corn in the main field, and so are uprooted and tossed to the border. There they thrive with no further attention and are harvested as eaten as "Indian spinach."[3] Certain wild plants, such as purslane (*Portulaca* spp.) are permitted to grow between rows of corn. They do not require much water, they shade the ground, and they are themselves harvested as a bonus crop. Chokecherry and wild plum trees are also transplanted to the field border, where they grow unattended until the harvest. Other plants have been transplanted from a distance and carefully nurtured in demarcated spaces near the family residence. These encouraged species add variety and nutrients to the diet (Wetterstrom 1986), serve as pharmaceuticals (Ford 1976), and furnish ritual components (Ford 1991).

A few additional wild plants still play a role in *Picuris* pueblo subsistence. *Piñon*

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[3]This wild *Chenopodium* spp. differs from the domesticated varieties which are grown today in meso-America, or which were raised as part of the "Eastern Tradition." The wild types are harvested mainly for greens, while the domesticated varieties are usually double-harvested, first for greens and later for their large, grain-like seeds. Both wild and domesticated types have similar growing requirements.

nuts are especially favored. The cost of harvesting and processing these nuts is reduced by raiding packrat caches. Firewood is still used for heating and cooking. Particular types of fuel are selected and aged with the end use in mind. For example, *piñon* pine is preferred for cooking. Families who farm to the extent of the Martinez household are few in number, and purchased foods are used by all families to some extent. Nevertheless, traditional foods and subsistence technology are still highly regarded by all members of the pueblo.

Synthesis

* These three ethnographic accounts of horticulture share common themes. Each group engages in some type of maize-based agriculture involving the initial clearing of forests. The Teenek practice a full-blown, meticulously orchestrated swidden system, at once simplifying the ecosystem in maize husbandry, and diversifying it through managed successional growth. Anthropogenic manipulation of the landscape is central to all three economies. The landscape is a mosaic of fields in different stages of fallow, and each family maintain at least two active fields in any given growing season. The Hidatsa, whose fields are renewed by flooding, typically engage in only short fallow. They also are the exception to the rule of dispersing fields across the landscape into non-riverine areas. Members of each culture, however, maintains at least one field or garden in immediate proximity to their homestead, creating an infield-outfield system of crop

management. Each of these cultures features small nucleated settlements, but at the regional level, these small communities and their surrounding fields are dispersed across the landscape.

No aspect of subsistence is left to chance. Field placement, crop mixtures and spacing, seed selection, horticultural activities, and selection of particular firewood for each job are carefully considered, based on experience and local conditions. Seasonal activities are attuned to natural phenomena, rather than the calendar. Tradition and ceremonialism govern many agricultural practices, with practical consequences. Kinship ties are critical to the completion of work and distribution of produce.

Each of these agricultural systems emphasizes intercropping. Main fields are bordered by, or even interspersed with a variety of encouraged, tolerated, or protected wild taxa. Some of these may be deliberately transplanted to a desired location. Generally, economically useful trees are spared, or if small, may be transplanted to the edge of permanent fields. Only the Tewa depend on animal or chemical fertilizers. Soils are enriched through the burning or mulching of spent crops, discarded weeds, and other organic debris.

Each of these subsistence strategies is to some degree based on wild as well as cultivated species. The term "wild" is used loosely because few species completely escape anthropogenic forces in traditional cultures. Native peoples recognize that some of their crops have "wild" relatives, and may encourage or avoid cross-pollination, as deemed advantageous.

The Hidatsa, Teenek, and Tewa all offer insights to the interpretation of the paleoethnobotanical record of the central Oconee region. In conjunction with ethnohistoric accounts they represent an even more powerful tool, reenforcing the longevity of customs observed by Euro-American explorers, and adding detail where the archaeological record is deficient.

Chapter 6

FIELD AND LABORATORY METHODS

Introduction

This chapter describes the field and laboratory methods employed in the recovery and analysis of archaeological remains from the Lindsey (9MG231), Sugar Creek (9MG4), Carroll (9PM85), and Sweetgum (9MG245) sites. These sites were excavated by James W. Hatch under the auspices of the Pennsylvania State University as archaeological field schools between 1987 and 1990. Each site presents unique circumstances for sample collection and processing. This chapter describes and evaluates field and laboratory sampling strategies, processing of samples, and techniques for macrofossil identification. Macrobotanical specimens included in this study were recovered primarily through manual water flotation; however, *in situ* excavation, water screening, and machine assisted flotation were also employed.

Field Methods

At all four sites, workers collected flotation samples in doubled heavy-duty plastic garbage bags or cloth bags, which were labeled inside and out with provenience data and Master Sample Number (MSN). Data recorded for each sample includes provenience, size of sample measured in liters or percentage of volume, name of excavator, date of excavation, and number of bags of unprocessed fill. In the field, larger features were divided into halves or quadrants for sampling, and each division was assigned a separate MSN. Some features were further partitioned by stratum or level.

A range of one to four samples from each feature or postmold level was subjected to flotation, with the remainder of the fill being water-screened or dry-screened, depending on conditions at the site. The postmold samples varied in volume from one liter to the entire post contents. Postmold samples were generally floated, water-screened, or dry-screened, as noted below.

Due to limited access to water at the Carroll site (9PM85), only features were subjected to flotation; however, 100% of their contents was processed. The fill of 15 postmolds was water-screened through standard 1/16 inch window screen, while the balance of postmold samples were dry-screened through 1/4 inch mesh. No samples were taken from feature 18. Plow zone samples from the Carroll site were the only controls taken from any site in this study, and they were never floated. These plow zone samples would most likely reflect modern seed rain rather than prehistoric "background."

The Sweetgum site (9MG245), suffered a similar scarcity of water, and consequently, only feature samples were floated in the field. A minimum of 10 l and a maximum of 100% of each feature, other than burials, was floated. In addition, 14 postmolds were subjected to machine-assisted flotation in the laboratory. Of the remaining 208 postmolds, two l[1] fill from each were dry-screened through 1/8 inch screen. At least 30 postmolds were mapped but not sampled. Samples collected from burials, as well as midden samples and those associated with special artifacts designated by "field numbers," were water-screened.

In excavations at Sugar Creek, 100% of feature fill and at least 50% of postmold fill was retained. A total of 29 features were floated, one was water-screened, and one was hand excavated. Another 17 features were not sampled, in part because many of these were discovered in closing down the site. Fill from a total of 98 postmolds was floated.

One half of each feature was floated at Lindsey, while the remainder was dry-screened through 1/4 inch mesh, except feature 4 where 1/8 inch screen was used. A one liter sample of each Lindsey postmold was floated, and the remainder was water-screened through 1/4 inch mesh. Excluded from the above description are four features which were recognized too late in the season to be sampled.

At each site samples were normally stored for up to several weeks before processing, but were not completely dried. No presoaking or deflocculation was undertaken prior to flotation. Damp soil breaks apart more easily than either wet or waterlogged soil, and dry charcoal floats better than wet (see Pearsall 1989: 50, 86 for discussion). One school of thought holds that soil should be completely dried before

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[1]or 100%, whichever was greater

flotation. It is equally true that presoaked and deflocculated soil yields water-logged charcoal (Pearsall 1989:50). While the ideal procedure has perhaps not been determined, the compromise system used at these sites proved adequate for the high clay content soils of the Oconee uplands.

At each of these sites, a variety of undergraduate and graduate students floated samples in a creek, lake, or wading pool, using the two-person tub method described by Pearsall (1989:39-47). A square galvanized steel flotation tub, modified with 1/16 inch window screen bottom, was used as the water reservoir. Standard kitchen strainers, with mesh ranging from 1.0 to 2.0 mm, were employed to skim the light fraction. Occasionally the matrix was gently massaged by hand in the flotation tub to dissolve the concentrated clay. While this approach is not generally recommended because some macrofossils are inevitably damaged, fewer than 5% of the total samples, from all four sites combined, needed to be refloated or partially water-screened in the laboratory to break down the remaining clay peds. Furthermore, there was no striking difference in the macrofossil assemblages of these samples versus any other manual flotation sample in this study. In the few cases of samples that were refloated in the laboratory, hydrogen peroxide (3% H_2O_2) was used to disperse the clay. The process of refloating usually further fragmented the wood charcoal, and may have been more destructive than "massaging." Every time a sample is wet and dried the macrofossils suffer some damage (Pearsall 1989:87); nevertheless by reprocessing the heavy fraction it was possible to obtain nearly complete floral recovery.

In the field, both light and heavy fractions were dried on newspaper in the shade for several hours prior to transport to a warm warehouse for thorough drying. Specimens were placed in 1.5 mm thick "zipper" type plastic bags containing identifying tags, and packed in heavy corrugated boxes.

Laboratory Procedures

In the laboratory, samples were differentially analyzed on the basis of their field processing. Initial studies of floated, dry-screened, and water-screened samples revealed that only flotation samples recovered the full range and quantity of macrofossils. Large seeds were rarely observed in water-screened samples, and small seeds were absent, while dry-screened specimens primarily consisted of hickory nutshell and excessively fragmented wood charcoal. Water-screened or dry-screened samples frequently yielded fewer than 10 macrobotanical fragments, although some yielded many grams of such material. After these initial investigations only flotation samples were fully sorted and analyzed, except as noted below. In the majority of cases, water-screened and dry-screened samples were scanned for the presence of identifiable floral macrofossils, and samples of wood were identified as outlined later.

Sampling Strategies

Early in this research it was observed that macrobotanical remains were differentially abundant in particular contexts at all four sites. Ranking from highest to lowest in macrobotanical content were large features other than burials, smaller features, round-house wall postmolds, all other postmolds and finally, burials. An effort was made to examine as many specimens as possible and still complete this project in a timely manner; consequently, wherever a high degree of redundancy was anticipated, sampling was employed. Nevertheless, since this is the first paleoethnobotanical study for the Oconee uplands, I tended to over-sample.

Where large features were excavated in sections, at least one flotation sample was completely sorted from each stratum and level. In the case of extremely large features where multiple samples were taken, some additional floated and water-screened samples were studied for comparison. All features and round-house wall postmolds for which flotation samples were available were studied. The remaining postmolds were arbitrarily sampled according to context. Presumed structural posts were deliberately chosen, particularly those which appeared to be rich in macrobotanical remains. Additional postmolds were selected by excavation unit, using a random number generator. At least 20% (or a minimum of one), of the remaining posts in each excavation unit was sorted. Floated samples were given preference over water or dry-screened specimens, the latter being studied only as a last resort. Specific details of sample selection and deviations from these procedures for the individual sites follow.

Artifacts and organic remains recovered from the Carroll site (9PM85) are federal property, as the site lies within the bounds of the Oconee National Forest. As such they were surrendered to the Forest Service in Gainesville, Georgia, after analysis. Because future access would be cumbersome, I evaluated all field samples, regardless of the method of field processing.

All flotation samples from the Sweetgum site (9MG245) were inspected. As recounted above, these samples included 14 posts and most features. Because dry-screened postmolds represented the majority of samples from this site, I was obliged to work with them as well. I attempted to mitigate the low quality of dry-screened samples by examining a full 85% of them. I also analyzed the water-screened burial and midden samples. Samples associated with special artifacts that were assigned field numbers were not examined.

Sugar Creek (9MG4) is a dual component site where fairly well defined, but slightly overlapping, Iron Horse and Bell phase living areas were delineated. All floated features were studied with the single exception of Feature 2, which was located in an outlying unit. For each occupation period at Sugar Creek, a round "winter" house was identified, as well as at least one rectangular structure. All floated material from wall posts from the circular buildings were sorted. The posts of rectangular structures were more densely placed than those of the round houses. They did not generally contain much non-wood charcoal, and had a high degree of redundancy. Therefore, they were less rigorously investigated. In the field, few or no flotation samples were saved from structures five or six respectively, nor any from the northwest wall of structure three.

After arbitrarily investigating those posts from structures three and four which visually appeared to be most promising, several additional samples were pulled blindly from the boxes of postmold samples and sorted. Next, posts which lay adjacent in the ground to those which were fully studied, were scanned as described in the next section. Only four posts from structure five were sampled in the field, and all of these were evaluated. Other postmold samples were chosen as delineated above. Ultimately, all floated posts from rectangular structures were examined to some extent. In all, 79 post samples were completely sorted, and seven were scanned, for a total of 88% of the postmold flotation samples.

At of the Lindsey (9MG231) site all 25 features were examined. Because four features had originally been identified as postmolds, only one liter flotation samples were processed from them. No complete sample was available for any quadrangle of Feature 4, stratum two, level two of the Lindsey site, so the most nearly complete sample was examined in its entirety. Material from all round-house postmolds were fully sorted, and additional postmolds were studied as previously described.

Sample Sorting

Prior to my access to the flotation samples, the majority had been inspected and partially sorted by students, either without magnification, or using a free-standing magnifier designed for needlework. Most of the bone and shell had been extracted, along with stone debitage, daub, and some floral macrofossils. These macrobotanical specimens were subsequently provided to me and in most cases, so was the matrix from which they had been extracted. Despite this presorting, I treated each sample as if it were being examined for the first time, and conformed to the following procedures. In the case of six samples, a laboratory assistant undertook this work under my direct supervision.

If either the heavy or light fraction of the cleaned sample filled more than one gallon size zipper bag, the entire specimen was evenly divided in half[2] using a riffle box. Very large samples, up to several 33 gallon garbage bags of heavy fractions in volume, were further divided. One portion was completely sorted, while the remainder was scanned for corn and seeds, which were extracted and recorded separately. In a few cases only the seeds of additional taxa were removed, but all seeds were counted. Nut shell and wood were noted but not removed. In the cases where certain samples were only scanned without thorough sorting, a small wood sample was removed for taxa identification.

The fraction to be sorted was slowly poured into the uppermost of a series of nested geological sieves and gently agitated. This segregated the sample into even-sized particles for ease of examination and to ensure maximum seed recovery (Pearsall 1989). The mesh sizes of the sieves were 4.00 mm, 2.38 mm, 2.00 mm, 1.70 mm, 0.85 mm, 0.50 mm, 0.25 mm, and occasionally 12.4 mm when unusually large particles were

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[2]Occasionally a floated sample filling from two gallon bags to multiple 33 gallon bags was further subdivided, employing the same methodology.

present (Aikens 1981). Using a Wild M3Z dissecting microscope fractions above 2 mm were completely separated into constituent parts. Minerals and most uncarbonized organic matter were set aside and not weighed or counted. Fractions less than 2 mm were visually scanned but only carbonized seeds and identifiable portions of plants or seeds, other than wood or hickory, were removed. In the case of pre-sorted samples, wood and nut charcoal were resifted through a 2 mm screen and only those remaining in the sieve were used in the statistical analyses. None of the presorted samples were split.

After sorting the samples, an attempt was made to identify all macrobotanical remains to the lowest possible taxon, usually at least the genus level. This task was possible in the majority of cases. Taxa were identified, counted, weighed and recorded by MSN. Wood was sampled and analyzed separately as described below.

All charred macrobotanical remains were assumed to be of archaeological significance. Partially mineralized, pliable seeds lacking an embryo were also considered to be of prehistoric origin. All mineralized seeds considered to be archaeologically significant were of genera which normally possess very hard seed coats and which have undergone dramatic color transformations during mineralization, and are likely to resist decomposition for long periods of time. For example, *Passiflora incarnata* (maypop) is often mineralized. In their viable form maypop seeds are hard, shiny and black, while mineralized they are soft, dull, and orange or orange-white. Often, charred and mineralized seeds of the same species were found in the same sample. Pockets of deeply buried seeds of species not typically stored by rodents have been considered by some to be archaeological deposits (Keepax 1977:226-227). Occasionally mineralized seeds of more than one species were found together in the same provenience. The effects of including these mineralized specimens will be discussed in chapter 6.

The inclusion of uncarbonized seeds in the assemblage is controversial. Kaplan and Maina (1977) maintain that buried, uncarbonized seeds may remain intact for long periods of time. This proposition is challenged convincingly by Lopinot and Brussell (1982). Keepax (1977) recommends rejecting all uncharred seeds to avoid the complex issue of modern contamination. At the same time he cites at least four conditions by which uncharred seeds might be determined to be prehistoric in origin.

Some mineralized wood, found together with charred wood and of the same species composition, was also included in the sample. Inclusion occurred only in the case of postmolds, and only if specimens were found which were charred on one end and mineralized on the other. This condition was uncommon, but did occur rarely. It is very feasible for rotted wood to remain intact for the up to five and one-half centuries we are considering (Baldwin, personal communication, 1990).

Taxon Identification Techniques

Identification of taxa was made by comparison to modern charred and uncharred reference collections, positively identified archaeological specimens, and standard reference volumes (Delorit 1970; Martin and Barkeley 1973; Schopmeyer 1974; Montgomery 1977). Selected specimens were verified by Frances B. King of the Center for Cultural Resources Research, Department of Anthropology, University of Pittsburgh. Lawrence Kaplan of the Biology Department at the University of Massachusetts-Boston, confirmed the abundance of *Phaseolus polystachyus* (wild bean). Domesticated goosefoot (*Chenopodium berlandieri*) was verified through electron microscopy. (See appendices A and B).

Taxon determination focused on morphological characteristics of the specimens, including size, texture, specialized structures (e.g. bud scars), and overall shape. Internal structures (e.g. the seed of sunflower minus the achene), distinctive embryos (corn), or other unique characteristics were also considered.

The identification process was heavily dependent on the manipulation of modern specimens by crushing, peeling, dissecting, and charring to detect distinctive characteristics not noted in standard references. The known availability of these genera in the Oconee region, either ethnohistorically or in modern times, was also considered. Alternatively, the potential of a given variety to survive in this region under protohistoric conditions was appraised. In some cases it was possible to identify the specimens only to the family level, but in a few cases characteristics were so distinct that a species could be designated.

Special Cases

Domesticates

Genera that consist of both domesticated and wild taxa required special attention. Domestication is the final stage of plant food production, and the changes leading to true domestication are cumulative. While domesticated plants cannot survive without human assistance, the criterion for distinguishing between wild and domesticated varieties vary by species (Ford 1985:6; King 1987).

In the cases of sunflower (*Helianthus annuus*) and sumpweed (*Iva annua*) overall seed size is indicative of domestication. A large endosperm produces more energy for a developing seedling, but negatively affects the total number of seeds a plant is capable of producing. In natural populations a balance is reached between seed size and seed number (King 1987). The large achenes preferred by humans are at a disadvantage in the wild under less than ideal environmental conditions. Measurement of the achene is universally used as the determinant of domestication of both sunflower and sumpweed. Measurement was done with the aid of an ocular micrometer. Sunflower achenes within the range of 6.3-20+ x 3.2-12+mm (Yarnell 1978) and sumpweed achenes within the range of 5.0-5.4 x 3.2-3.7mm (Asch and Asch 1978) were assigned to the domesticate taxon.

The case of goosefoot (*Chenopodium spp.*) is more complex. In nature, dormancy is an essential adaptation for wild cereals because it insures germination only under the right combination of conditions (King 1987). In goosefoot, the thick seed coat (testa) of wild populations, which represses germination, is negatively selected by humans. A thinner testa and proportionately larger endosperm are the hallmarks of domesticated goosefoot. Humans assume the role of inducing germination by planting under optimal conditions. While seed coat texture, size and form of seed may play a role in differentiating wild type seeds from domesticates, the only certain way to determine the domesticated or wild status of *Chenopodium spp*. is to measure the thickness of the testa. Thicknesses of 7.0 to 21.0 microns with a mean of 16 have been reported for domesticated varieties (Smith 1992:147; Gremillion 1993b), while wild types typically measure between 40 and 52 microns, with some examples of *C. gigantospermum* as thick as 69 microns (Smith 1992:147).

Using a Jeol brand scanning electron microscope (SEM) model JSM5400, coupled with a Gamma-tech brand integrated microanalyzer for imaging and X-ray (IMAX) software package at a SUNPARC workstation, I evaluated the *Chenopodium* recovered from the project sites. Two samples from Lindsey included *Chenopodium* seeds. One contained only four seeds, but the other produced over 300. Sugar Creek yielded only four *Chenopodium* seeds and the other sites other sites produced none. Due to funding limitations, all of the seeds from small samples were examined, but only 18 seeds were chosen for analysis from the substantial Lindsey sample. The criteria for selecting the Lindsey specimens were that the seeds must be whole, but the testa must be broken in several places in order to increase the likliness that their thickness could be measured. Most of these specimens were distended during charring, in a manner analogous to a puffed breakfast cereal, facilitating sample selection. The first 18 seeds meeting these criteria were examined, but in the end, not all of them produced clean edges at right angles needed for good seed coat measurements.

I mounted individual seeds on a stub (metal holder) using a conductive adhesive, grounded with colloidal silver and coated with gold-palladium in a sputter-coater. Next they were scanned under a SEM, with an image being produced by the IMAX. IMAX software calculated the thickness of the seed coat. Results and illustrations are in Appendices A and B.

Wood Charcoal

Wood charcoal is the dominant macrofossil in every feature and postmold excepting only the nutshell feature at the Carroll site and the corn cob feature at the Sugar Creek site. Since wood fragments literally number in the hundreds of thousands in these sites combined, sampling was necessary.

Minnis and Ford (1977:82) propose that 20 pieces of charcoal from each provenience constitute a sample size that will adequately reflect the total frequencies of charcoal within a sample. However, the charcoal recovered by flotation from features and postmolds in the southeastern United States is vastly different from samples recovered at Chimney Rock and the other southwestern sites that were analyzed by Minnis and Ford (1977). Southeastern wood charcoal fragments are typically much smaller, most measuring between 2.0 and 4.0 mm, or smaller, and being derived from a much richer and more diverse habitat than that of the mesa regions. I evaluated wood charcoal fragments in groups of 10, evaluating a minimum of two groups from each feature or postmold having an adequate quality and quantity of wood charcoal. Extrapolating on the Minnis and Ford precept, this process continued until I encountered two consecutive lots beyond the initial assemblage of 10 wood fragments, which contributed no new taxa to the sample. For postmolds I required only that a single group of 10 charcoal fragments beyond the initial set contribute no new taxa to the list of identified genera before quitting the sample. This procedure was observed because in postmold samples the full range of taxa was typically observed within the first group of 10 fragments evaluated. Presumedly this finding follows from the fact that most wood in a postmold is derived from a single log. If by following this strategy I nearly exhausted the supply of charcoal for a given sample, or if the sample comprised fewer than 25 fragments, I generally attempted to classify all the wood charcoal for that batch.

In evaluating wood taxa in features, all charcoal greater than 2 mm in size was spread on a numbered 1 mm grid. A random number was generated on a calculator, and the charcoal fragment covering, or closest to, the appropriate block was evaluated. This process was intended to ensure that all size classes would be given equal consideration.

Dry-screened and water-screened samples were handled differently because they were typically all recovered from the same (2 mm) fraction. In these cases, groups of 10 were chosen by order of encounter during sorting.

Unless no others were available, I chose not to evaluate any wood specimens less than 2mm in size. Smaller specimens are unlikely to possess all the structural features needed for a reasonable identification. In fact, most fragments above 2.0 mm could only be identified to the genus, and many could only be classified as ring porous, diffuse porous, hard, or soft wood. The last is limited, yet useful, information.

Wood taxa were identified by comparison with charred and natural transverse, tangential, and radial thin sections of modern wood, although the transverse view was emphasized due to magnification limitations, size of the specimens, and time constraints. As needed, dichotomous keys were employed (Panshin and de Zeeuw 1980). Since these keys are geared toward fresh wood they were of limited use, but by employing both the microscopic and macroscopic keys, following multiple paths, and with frequent reference to the comparative collection, a genus could generally be determined.

Factors Influencing Analysis

The kitchen sieves used to collect the light fractions featured mesh ranging from 1.0 to 2.0 mm, which is too large to capture the smallest seeds that might reasonably be anticipated in the assemblage. Typical examples of such seeds are tobacco (*Nicotiana tabacum L.*), 0.5 mm, amaranth, (*Amaranthus sp.*), 0.6 - 1.4 mm, and several species of goosefoot (*Chenopodium*), which range from 0.7 to 1.5 mm. Nevertheless, one would anticipate that if such seeds were present, at least a few would be captured in matted rootlets. This proved to be true. Consequently, in the case of these small seeds, I emphasize ubiquity rather than absolute counts in the final analysis.

In many cases, flotation samples were not measured prior to flotation, nor were they standardized in any way. This lack was compensated for in the laboratory by calculating the volume of the features or posts from field records, and using ratios or macrobotanical units per liter as the currency of comparison.

Conclusion

Although there is currently no "standard procedure" for archaeobotanical analysis, the protocol delineated here is widely accepted (Scarry 1986; Johannessen 1986; Pearsall 1989). A discussion of qualitative and statistical methods appear in Chapter 7.

Chapter 7

ANALYTICAL METHODS

Introduction

Chapter 6 provides a commentary on both the recovery of botanical samples in the field and my own sampling strategies in the laboratory. Chapter 7 considers the interpretive methods employed in my research and describes the categories into which taxa have been grouped for analysis. Included in this chapter is a discussion of the statistical implications of occurrence, ubiquity, and density indices, comparison ratios, and proportions, as well as techniques involved in wood analysis. Finally, I address proven interpretive methods adopted by other paleoethnobotanists, but not employed by me in the present study.

Analytical Categories

In the course of this analysis the data were combined, and recombined, in a variety of spatial and temporal contexts with intent to discern patterns of differential distribution of taxa. Such patterning is an important indicator of the degree of homogeneity in the paleoethnobotanical record, and also highlights irregularities which must be addressed in the interpretation of these data. Spatial-functional, ecological, and temporal configurations are emphasized.

Provenience

Phase and Site

Clustering data by phase and site is a necessary first step in any temporally-based study. As was discussed in Chapter 1, three phases of the Lamar period are represented in this analysis of upland paleoethnobotany, namely the Iron Horse (A.D. 1450 - A.D. 1520), Dyar (A.D. 1520 - A.D. 1580). and Bell (A.D. 1580 - A.D. 1670) (Williams and Shapiro 1990). The earliest of these phases, Iron Horse, has been established at only one of the study sites, namely Sugar Creek (9MG4), while each of the other phases is featured at two sites apiece. Carroll (9PM85) and Sweetgum (9MG245) date to the Dyar phase, while a second component at Sugar Creek, and the single component Lindsey site (9MG231) represent the Bell phase.

The first known permanent upland sites date to the incipient Mississippian Vining phase (Worth 1996). However, Iron Horse, and the earlier Duvall phase, settlements were established during the vanguard of *serious* upland colonization and are, overall, more scarce than Dyar or Bell phase farmsteads. Sugar Creek is rich and complex in feature and postmold configurations, the majority of which date to the Iron Horse phase. Abundant archaeological charcoal and a profusion of pottery sherds in clear context permit confident phase assignments to most individual proveniences. Although it would have been preferable to have included at least one additional Iron Horse site in the study, Sugar Creek is sufficiently rich to be revealing, and optimistically, representative of the phase. In addition, the assemblage of the Iron Horse phase of Sugar Creek compares favorably with the as yet fragmentary evidence from Racoon Ridge (Worth 1995, personal communication; Table 3).

Of particular importance is the juxtaposition of Iron Horse and Bell phase components at Sugar Creek. This circumstance provides a rare opportunity for intrasite-intratemporal comparison. This opportunity is significant for several reasons. Due to site-specific vagaries of deposition, preservation, resource availability, etc., even the best controlled intersite comparisons entail potential errors. While not completely eliminated, these potential inaccuracies are greatly reduced by directly contrasting two time intervals at the same site. Although some base-line conditions and local resources may have changed during the 60 year interim between these phases, adjustments can be made more readily for intra-site dissimilarities than for the incongruity of contemporary sites that vary in both space and time.

Intrasite Function

Categorization is a way of minimizing "noise" from the archaeological record, and allows for a systematic appraisal of the site and its contents. Postmolds and features provided the most obvious evidence of human occupation at each of these sites, although Sweetgum (9MG245) also contained a midden. Due to the effects of historic plowing of farms, no intact house floors or hearths were detected. Overall, postmolds were the most common subsurface disturbance.

Each site contained at least one major feature, which, from its size and contents, is assumed to be a trash pit. One theory is that these were originally a borrow pit from which daub was extracted in the construction of a round house (described below) (Dickens 1985; Hatch 1995:148). These large features mark one end of a continuum of native excavations that range down to the size of small posts. The smaller features were differentiated from posts by their shapes and locations. Following Polhemus (1987) and others (Dickens 1985; Schroedl 1986), features were categorized primarily by form, profile, relative depth, and contents. Most burials were not floated and so are notably absent from the botanical study. The overlapping of structure patterns, and lack of clear activity areas at these sites, precluded detailed archaeobotanical analysis by feature function at this time. Such a program should be undertaken in the future.

It must be noted that phases and sites contained vastly different numbers of post molds and features. These, in turn, underwent differential processing during discrete field seasons at individual sites. These facts must be considered in evaluating the plant macrofossils. Disposal patterns may result in the differential deposition of particular plant remains in unique contexts. If a site is deficient in a particular class of proveniences, the paleoethnobotanical data may be skewed. With these ideas in mind, it is noted that the Iron Horse phase of Sugar Creek, Sweetgum, and Lindsey sites are represented by a full spectrum of provenience types. In contrast, the Carroll excavations included no floated postmolds, and the Bell phase of Sugar Creek maintained only one large feature, and one small corn cob-filled feature, but was rich in floated postmolds.

Grouping by Processing Method

Sediment samples at these sites were processed by standard "Apple Creek" style flotation, machine assisted flotation, water-screening, or dry-screening (See Pearsall 1989, Chapter 2 for a description of these methods). Occasionally a large macrofossil, such as a corn cob, was be individually excavated by hand. $Carbon_{14}$ samples, ranging in size from less than 0.01 l to 0.54 l, were extracted from many flotation samples in the field, including the 71 samples that were ultimately examined. Fifty-eight of the 71 carbon specimens were available for analysis. These 58 were floated, weighed, sorted, and the resulting assemblages were tallied along with those of the corresponding flotation samples. These 58 pairs of samples represent approximately 8% of all proveniences from all four sites. The 13 missing samples represent only 2.4% of all proveniences.

The 13 flotation samples for which the radiocarbon samples were unavailable were excluded from the ratio analyses, because ratios are mainly based on wood and nut charcoal, the two major components of carbon samples. Conversely, all flotation samples were included in other non-charcoal-based appraisals of the assemblages, as the C_{14} samples were found to exert a negligible effect on taxon counts.

Due to the less complete macrobotanical recovery of other processing methods (see Pearsall 1989, Chapter 2), most of my analyses are based solely on flotation samples, along with their corresponding hand excavated specimens and C_{14} samples. In the small number of samples where a C_{14} sample was taken, but was not available for macrobotanical analysis, the sample was not considered. Exceptions were made only for the occurrence index, ubiquity analysis, and for wood analysis, where all proveniences are considered.

Grouping by Habitat

An ecosystem is an assemblage of living and nonliving components in an environment, together with their interrelations. As a unit of study, it may be defined broadly or narrowly, according to how the research problem is defined by the investigator (Moran 1982:328). A habitat is a place where a plant or animal lives. It is often characterized by either dominant plant forms or physical characteristics, for example, "grasslands" (Moran 1982:331). Thus, habitats are the building blocks of ecosystems. In this inquiry the upland region is considered to be a single ecosystem comprised of a variety of habitats, which vary in number and proportion over time.

Human impact on the Oconee upland ecosystem is evaluated by clustering the taxa by habitat and tracking the dominance of these taxa over time. I assume that an increase or decrease in a class of taxa reflects interaction of that plant community with the human population. The habitats defined here are intended to be only rough approximations of major plant associations. These divisions, which will be defined below, include "agricultural field," "open field," "old field," "woods/thicket[1]," "wetlands," and "forest/nuts," and all taxa identified in this research and presented in the dissertation are classified by habitat in Appendix C. In order to generate sufficient data to allow meaningful interpretations, the localized area of ecotone, commonly referred to as "edge zone," was eliminated as a category. Although most plants growing in such locales can also exist in one of two sets of environmental conditions (for example, old field or open woods/thicket), I have arbitrarily "assigned" taxa to the category where they are most likely to appear. Without taking this step, most wild species from these assemblages would be assigned to the "edge zone," and discrete patterns would be masked.

For this same reason I have ignored numerous microhabitats that may be found within each major division. Factors such as soil characteristics, bedrock, slope, light availability, shelter, and moisture requirements within each of the major environmental zone affect plant survival, even to the point of allowing plants to grow in unusual macrohabitats. My data set is too broad to undertake such a fine-scaled study. The following is a discussion of the major habitat classifications on which my analysis is founded.

In the category, "agricultural field" I include only recognized cultigens, including *Chenopodium berlandieri* sp. (goosefoot), *Helianthus annuus* (sunflower), *Iva annua* (sumpweed), *Phaseolus vulgaris* (common bean), *Zea mays* (corn), and *Prunus persica*

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[1] This is designated as "woods" in tables and figures.

(peach). The latter is included in the category of "agricultural field," although it was grew along borders of settlements and in old fields as well as along the edge of fields. Despite its weedy nature (Gremillion 1989a), the peach is recognized as a domesticate.

"Open field," includes any pioneering species, or species likely to appear within the first one to five years of clearing a piece of land. This class includes some taxa which persist in old fields, and others which may be found on any disturbed ground, including agricultural fields. Regardless of how common a plant may be in agricultural fields, or how economically useful it may be, if the taxon is not a recognized cultigen, it is relegated to the "open field" division. The prime example of a plant which is so common in agricultural fields that it may have been "encouraged" to grow there is maypop (*Passiflora incarnata*). Nevertheless, it is assigned to the "open field." Other examples of "open field" taxa include wild varieties of goosefoot (*Chenopodium* sp.), ground cherry (*Physalis* sp.), and various genera of grasses.

The "old field" category is reserved for species which become established in sizable forest gaps, edges of woods or thickets, and in open fields that have been abandoned for five or more years, and some of which typically dominate the patch during the second two decades of abandonment (Oosting 1942; Nicholson and Monk 1974). Elderberry (Sambucus sp.), brambles (*Rubus* spp.), and persimmon *(Diospyros virginiana*) are among the more common examples of "old field" taxa. Honey locust *(Gleditsia triacanthos)* and black walnut (*Juglans nigra*) are also included in this group based on Bartram's (1955 [1792]:57) and Battle's (1922) specific comments indicating their prevalence in "ancient cultivated fields,"[2] associated with "old Indian settlements." Black walnuts are also considered separately in an analysis of mast.

"Open woods/thickets," indicated on the tables as "Woods," is the most broadly defined of the habitats. It includes species which grow on moist, dry, or rocky soils. The common denominator is that the plants assigned to this division grow in the tangled, highly mixed zone of trees, shrubs, and undergrowth that lies between the typical area of ecotone and the mature forest canopy. "Open woods/thickets" may arise on the borders of forest, along waterways, or proximate to gaps in the forest. Like the area of ecotone it is a transitional plant association which, barring further disturbance, is ultimately overtaken by climax forest. Examples of genera included in this category are tulip tree (*Liriodendron tulipfera*), indian cucumber (*Medeola virginiana*), and wild bean (*Phaseolus polystachyus*[3]).

The "forest" classification is reserved for those taxa found primarily in the canopy of the mature oak-pine-hickory forest. Oaks (*Quercus* spp.), hickories, (*Carya* spp.), and beech, (*Fagus* sp.) dominate this division because pine (*Pinus* sp.) seeds or cone fragments are rare. However, in the wood charcoal analysis, pine eclipses all other species in most samples.

The final category is "wetlands." For my purposes, this category is restricted to those taxa that actually grow in water, swamp, or permanently moist ground. Cane

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[2] Bartram (1955:57) notes that, "Though these are natives of the forest, yet they thrive better, and are more fruitful, in cultivated plantations, and the fruit is of great estimation with the present generation of Indians..."

[3] This taxon is frequently cited, in error, as *Phaseolus polystachios* (L. Kaplan, personal communication 1994).

(*Arundinaria gigantea* or *A. tecta*) is included, although it can also survive in well-watered areas at some distance from actual standing water. Sweet flag (*Acorus calamus*), black gum (*Nyssa sylvatica* var. *biflora*), duck potato *(Saggitaria sp.)*, and water pepper (*Polygonum hydropiper*) are the other members of this group.

It is important to recognize that the diversity of taxa represented in the archaeological record does not necessarily reflect the number of economically useful plants. Neither does the tallying of species equate with either a true measure of diversity, the size of a given habitat, or the intensity of its prehistoric exploitation.

Analytical Techniques

Just as there is no "standard procedure" for processing paleobotanical materials in the field or laboratory, there is no prescribed method of quantitative analysis. One theme common to all archaeobotanical studies is that, due to the differential preservation of macrofossils, multiple measures must be undertaken. Each of the procedures described below focuses on a different aspect of the macrobotanical assemblage. By exploiting one particular facet of the data, each technique reveals a single view of the overall image of plant exploitation at these four sites. By examining the figures from different perspectives, trends of plant exploitation and environmental manipulation can be detected. The dilemma of differential preservation is, to some extent, mitigated by using multiple techniques to evaluate the data.

Taxon Occurrence

In this method, a straightforward list of all catalogued genera is created. A taxon is included on the list if it is identified at least once. Each provenience receives a score of plus (+) or minus (-) for each botanical entry. Absence is defined by presence elsewhere. All taxa are weighted equally.

The mere presence of a taxon in good archaeological context provides valuable information. Given a sufficiently large inventory, many habitats within the catchment zone can be reconstructed. These ecological zones, in turn, give clues as to the amount of human disturbance in the site vicinity, as well as to the span of time over which this disturbance occurred. Research shows that the upland region was dominated by mature oak-pine-hickory forests prior to human colonization (Braun 1950), but other ecological zones are equally anticipated in the uplands. Human modification created clearings, which were either artificially maintained, or reverted to forest following a natural cycle of succession. Finally, the array of plant species contained in features and postmolds indicates during what seasons people inhabited these sites.

In this analysis taxon occurrence is based on all available analyzed samples, including those that were floated, water-screened, and dry-screened. Water-screening and dry-screening are generally redundant to flotation. However, in one sample at the Carroll site (9PM85), a single non-duplicated taxon was recovered from water-screening.

Ubiquity Analysis

Ubiquity analysis goes one step beyond the Taxon Occurrence listing. This method measures the percentage of site proveniences in which each taxon occurs (popper 1988). Each unique post, feature, or midden is regarded as one provenience, regardless of how many samples of its contents were examined. Due to the incomplete recovery typical of samples processed by other methods, only flotation samples are included in the ubiquity analysis. To include dry-screened or water-screened samples would skew the measure in favor of large seeds, such as persimmon or peach, or nuts, and wood, because small and medium size seeds, and corn kernels, cupules, and cob fragments are rarely recovered by any method other than flotation.

In this procedure, a taxon is counted as present, regardless of whether it was seen in the complete sorting of a sample or merely in the scanning of the portion which was not fully sorted, as discussed in Chapter 6. What is important is the fact that it is present in the provenience. In this approach all taxa of wood are combined under the label of "wood." A more detailed analysis of wood is presented elsewhere.

Since taxa are scored on presence, regardless of their counts or weights, ubiquity analysis partially compensates for differential preservation (Popper 1988). Ubiquity analysis is based on two premises. First, those taxa which were more prevalent at the site at the time of its occupation will be present in more archaeological proveniences. Second, each provenience is independent. Accordingly, if a taxon preserves poorly, and yet was ubiquitous at the time of deposition, it is still possible that at least a single seed will survive in multiple contexts, even though the species' gross count or weight will be insignificant (Yarnell 1982; Johannessen 1984).

Ubiquity analysis does not provide absolute measures of taxon magnitude, but it is a reliable measure of relative significance. An important characteristic of this technique is that the score of one taxon does not affect the score of another, and thus the tallies of different taxa can be evaluated independently (Popper 1988). A disadvantage of ubiquity analysis is that it can be affected by disposal patterns. For example, if a taxon is more likely to appear in features than postmolds for any reason, and trash pits are larger, but fewer in number in one time period versus another, the ubiquity score of this taxon will be lower in the period with fewer trash disposal areas. If the ubiquity scores of one or more taxa depart from the trends revealed by other methods of inquiry, variations in disposal patterns should be considered.

In my analysis, ubiquity is presented for major groupings of taxa by phase, by each site as a whole, and also by classes of proveniences within each site. Grouping by phase and site provides for a reconstruction of the prevalence of habitat exploitation patterns. It also aids in the reconstruction of catchment characteristics. Analysis by provenience within the site helps to establish activity areas and disposal patterns, if differential deposition is observed.

Density Ratio

The "Density Ratio" is a calculation of counts or weights of a taxon per liter of sediment floated. By using the total amount of sediment in the sorted sample as the common denominator, macrofossils from samples of varying sizes can be compared on an equal basis. As I describe below, mean counts are used as a measure of the abundance of taxa at each site in some cases, and weight measured in grams in others.

In this assay I use counts for seeds, grass and cane stems fragments, and tuber fragments. Most archaeobotanists use counts for seeds only. However, Scarry (1986), among others (Lennstrom and Hastorf 1995), sometimes finds it useful to use counts for all taxa. She uses counts exclusively because her numbers of wood and nutshell are comparable to her seed counts. That is, they are in very small quantities. To use counts exclusively under such conditions is logical because using a single measure makes taxa of all types more readily comparable. At the sites in my study, wood and nutshell may be hundreds, or even thousands, of times more plentiful by count than seeds. To base their density on enumeration, or conversely, to base seed density on weights, would be ineffective. All seeds would appear to be less than insignificant in direct comparisons to nuts or wood.

I am adhering to a compromise approach. In my samples tuber fragments, as well as grass and cane stems, appear in comparable numbers and weights to seeds. I am, therefore, using count per liter of flotation as the unit of analysis for these plant parts. In tables and figures the term "seed" is used generically to encompass all of these classes of macrofossils that occur in relatively small numbers. Nut shell and wood are evaluated separately, using grams per liter of flotation. All taxa of wood are subsumed under a single category.

Corn kernels, which are actually seeds, are measured by counts. Cob fragments, however, are more comparable in number and weight to nut shell than to seeds in the samples under current investigation, and are consequently measured by weight in this analysis. Cob is more frequently preserved than corn kernels at the project sites, and it is also a by-product of food production, much like nutshell. Assessing corn kernel and cob density using two different measures has the advantage of providing an independent check on the importance of maize at a site or within a phase.

As described in Chapter 6, some flotation samples were merely scanned and not fully sorted. In those cases, seeds were removed from the sediment, but wood, corn, and nut shell were merely noted. Due to these facts, the volume of soil used to normalize wood and nut shells differs slightly from that used to normalize "seeds." That is, the number of g of wood, nutshell, or corn per liter can only be determined by dividing the appropriate figure by the actual number of liters from which the taxa were extracted, rather than the total number of liters sorted and scanned from the site.

In the course of this project, two features were encountered which each contained an overwhelming abundance of a single taxon. Sugar Creek (9MG4) contained a single pit filled with corn cobs (Feature 33). Carroll (9PM85) presented a single anomalous Feature (10), which was dominated by charred nut shell. Given the implications of adding these data to the numerical calculations, Feature 33 was excluded from density appraisals, as was the nut shell content of Feature 10.

Density is another gauge of the relative importance of taxa within a site, and with caution, between sites and phases. The usual problems of differential preservation come into play. These impediments become magnified when dealing with two or more sites because of potentially different depositional and environmental conditions. As stated at the beginning of this section, intersite comparisons are more valid if multiple analytical strategies are employed. It is likewise imperative that units of comparison between sites be as closely matched as possible.

Additional Wood Analysis

As mentioned throughout the text, wood remains were subjected to special analysis. One purpose of this separate treatment of wood was to provide an independent measure of anthropogenic effects on the environment. A second objective was to discern patterns of selective resource exploitation.

Samples of wood were selected as described in Chapter 6. These were identified to genus, and rarely, but whenever possible, to species level. Due to the fact that most fragments of wood charcoal were 2 mm or less in any dimension, identifications beyond general categories of "pine," "hardwood," "ring porous," or "diffuse porous" were often impossible. The broad categories of "hardwood" and "pine" were the most reliable, and proved to be very useful.

Wood was analyzed by measuring the ratio

$$N_x : Q \tag{7.1}$$

N = count of taxon fragments

$_x$ = identification of taxon

Q = sum of identified taxa

and reporting this quotient as a percentage. An analysis of the dominant wood in each context and phase is presented. The utility of percentages will be discussed below.

Comparison Ratios

Ubiquity and density are actually two different examples of standardizing ratios. Paleoethnobotanists employ any number of ratios based on the variables and units of measure most pertinent to their research problems (Miller 1988). Comparison ratios focus attention on two mutually exclusive variables and can be used either to assess the effects of different preservation contexts, or to identify different use contexts. Wood charcoal is often used as the normalizing variable for sites where it is reasonably certain that charcoal represents ordinary household fuel, because fuel use has been shown to remain fairly constant over time at any given site, in proportion to the intensity of activities involving fire at that site (Asch and Asch 1975; Pearsall 1983). By comparing quantities of other taxa to wood charcoal, the use of the former may be relatively tracked over time. Asch *et al.* (1972) use nutshell as the norming variable, based on the premise that it was a regularly burned refuse product, found in proportion to nut use. In order to avoid the mixing of building materials and fuel, only the contents of features are used in these comparison ratios. Due to this fact, the ratios cannot be said to represent the full range of the plants used at the site, but only of those which appear in features. Nevertheless, they will provide one more piece of evidence to trace patterns of plant use over time. I employ the following comparison ratios to gauge the importance of various plant foods to the diet. In each Equation numbers 7.2 through 7.7, the numerator is the component being evaluated.

$$N_e : \quad W_w \tag{7.2}$$

N_e = total number of edible wild seeds

W_w = total weight of wood (g)

$$N_c : \quad W_w \tag{7.3}$$

N_c = total number of cultigen seeds

W_w = total weight of wood in (g)

The above two ratios venture to gauge the relative importance of wild and cultivated plant varieties over time. Wood is the norming variable.

The importance of nuts, and a second measure of the stature of corn, is estimated by individually comparing nut shell and corn cob to wood in the following ratios.

$$W_n : \quad W_w \tag{7.4}$$

W_n = total weight of nut shell (g)

W_w = total weight of wood in (g)

$$W_{zc}: \; W_w \tag{7.5}$$

W_{zc} = total weight of corn cob (*Zea mays*) in (g)

W_w = total weight of wood in (g)

Both nut shell and corn cob are by-products of food production, and as such are not used in calculating Equations 7.2 and 7.3. It is believed that as the amount of nuts and corn in the diet increased, so did the likelihood that these two types of refuse would be exploited as fuel, and thus be preserved. Even if this assumption should prove to be false, if all other factors remain equal, an increase or decrease of the amount of nuts or corn in the diet should be reflected in the quantities preserved. Therefore, a comparison of nut shell and corn cob to wood, a universally recognized fuel, provides some indication of the prevalence of these two classes during any given phase.

Other comparisons can be constructed to answer questions about specific problems under consideration. I use Equation 6 to probe the rate of corn production through time.

$$W_z: \; W_{zc} \tag{7.6}$$

W_z = total weight of corn kernels (*Zea mays*) in (g)

W_{zc} = total weight of corn cob (*Zea mays*) in (g)

A decrease in the kernel to cob ratio often indicates higher corn production. This change is due to the increased likelihood of cobs being used for fuel and thus being more apt to preserve than kernels (Lopinot 1992). All corn kernels and cobs recovered from floated proveniences are included in the calculation of this ratio. Only the anomalous Bell phase corn cob pit at Sugar Creek is excluded.

One must approach this ratio cautiously, however, as two other interpretations could account for the identical outcome. First, shelled maize may be entering a regional redistributional system, resulting in fewer kernels remaining at a site. Second, ceramic technology may be improving. The consequence of this later condition would be fewer vessels breaking during cooking, resulting in fewer opportunities for the charring of maize kernels.

Percentages and Proportions

The final statistical technique employed is the percentage, or proportion, a concept first introduced in the wood analysis section. Percentages and proportions are frequently employed to standardize sample contents, in order to facilitate the evaluation of relative importance among taxa (Miller 1988). Data from floated proveniences are included in this calculation.

Percentages can be used to detect the replacement of one category of material by another through time. They are also used to assess variability between samples due to circumstances of preservation (Miller 1988). I employ the following percentages to explore the emphasis on either wild seeds or cultigens in the diet.

$$N_x : Q \tag{7.7}$$

N = total number of seeds

X = class taxon

Q = sum of all seeds

Measures Not Employed

Depending on the research questions, data base, and unique characteristics of the samples, paleoethnobotanists rely on a range of analytical procedures. Rarely is it possible, or appropriate, to use every proven technique. For example, in his use of ratios to track agricultural intensification in the American Bottom, Lopinot (1992) used a comparison of starchy seeds: maize kernels with great success. In the present case, this calculation would be trivial due to the paucity of starchy seeds at any site other than Lindsey (9MG231).

Diversity Indices

A very popular measure of environmental richness among ecologists is the Diversity Index. There are several methods for measuring species diversity in a plant assemblage. A widely-known technique is the Shannon-Weaver Index (Shannon and Weaver 1949), which incorporates the total number of taxa in the assemblage and the relative abundance of each taxon to express the certainty of predicting the identity of a randomly selected plant remain (Yellen 1977; Popper 1988:66). If there are many taxa evenly distributed in the assemblage, the certainty of predicting the identity of the selected plant is low and the index indicates high diversity. If the taxa are few and unevenly distributed, the index indicates low diversity. The technique is prone to misinterpretation, however, as an assemblage with a few species and high evenness could have the same diversity as one with many species and low evenness. Furthermore, the Shannon-Weaver index (Shannon and Weaver 1949) requires high counts for each taxon. Counts under ten can lead to inaccurate results, and samples cannot be combined from different populations to achieve a count of ten without grave risk of error (Pearsall 1983). It is mainly the requirement of relatively abundant seed counts that precludes the use of diversity indices in this research project. While the results are not as precise as a legitimate diversity index, the ubiquity index does provide insight to species variance and relative abundance over time.

Ranking

Ranking is a technique which attempts to measure plant frequencies more precisely than ubiquity analysis by estimating and adjusting for noncultural sources of patterning. Ranking translates the absolute counts of data into an ordinal scale (Popper 1988). In this method, a ranking system is developed, e.g., a scale of 1 to 5, and for each taxon a scale of abundance is set which determines the frequency required to fall within each rank. To choose the criteria for determining a scale of abundance for each taxon, one selects the most important noncultural sources of patterning in the data for which one wants to control. The scale is set to neutralize the biases introduced by the sources of patterning (Popper 1988). This technique is limited by the quality of plant preservation at a given site, and by the subjective nature of the ranking system itself. Ranking is most suitable for evaluating the abundance of plant remains at a site that has consistently excellent preservation, as well as high counts of taxa in each sample. These conditions do not describe the Oconee upland sites. Hence, this procedure is not attempted.

Conclusion

In this chapter I have summarized the logic behind the categorization and manipulation of data undertaken in this study. I also describe the aims and methodology of techniques employed in scrutinizing the data base. In Chapter 8, I present the results of this inquiry.

Chapter 8

ANALYSIS OF DATA I: MACROFOSSILS EXCLUSIVE OF WOOD

Focus of Chapter

In this chapter I present and interpret the individual analyses of data which were described in Chapter 7 for all macrobotanical remains except wood charcoal. Wood charcoal is considered separately in Chapter 9. Inter-site and inter-temporal comparisons are constructed, as appropriate, based on each individual data set. In Chapter 10, significance of individual taxa, as well as of selected classes of taxa are evaluated. In Chapter 11, the data from Chapters 8, 9, and 10 are used to test the hypotheses proposed in Chapter 2. more highly integrated, employing a holistic approach.

In the course of this four-chapter inquiry I consider multiple issues including catchment zone composition and anthropogenic participation in the ecosystem. Seasonality of site occupation is appraised. In addition, the changing nature of agriculture in the upland culture is assessed. Variations in plant exploitation are examined in light of population pressure, technology, productive capacity of plants, regional rainfall, animal predation, and alternative food resources. Unless otherwise noted, all observations in these chapters refer solely to the four sites whose macrobotanicals were analyzed by me.

Placement in Space and Time

Taxon Occurrence

The list of taxa represented in Table 10 notes taxa by phase and site. This table is summarized graphically in Figures 6 and 7. Between the Iron Horse and Bell phases there is an increase in number of taxa in four out of six plant classes. These categories include agricultural fields, open fields, open woods/thickets and wetlands. The remaining two divisions, forest/nuts, and old fields, remain fairly constant, with a very slight decline during the Dyar phase. It is noted that the number of agricultural field taxa likewise declines during the Dyar phase and then recovers, spurting ahead in Bell. Genera which were presumably included in the diet are indicated by an asterisk in Table 10. It should, however, be noted that these trends are highly influenced by the Lindsey site assemblage. The diversity of plant types depicted in Figure 7, reflects a striking similarity between the numbers of taxa represented in the Iron Horse and Bell phase assemblages from Sugar Creek (9MG4). Other tests, such as density of the floral assemblage, ratios of different food types, among others, must be scrutinized to determine if the conclusions drawn from this increased diversity in the Bell phase are valid, or an artifact of the "Lindsey effect."

Table 10:Listing of taxa at the project sites.

Taxon (* edible)	Habitat	Iron Horse	Dyar C	Dyar SG	Bell L	Bell SC
******Cucurbita*** spp. (squash, gourds)**	**Ag. Fld**	+	+	+	+	+
******Chenopodium berlandieri*** (goosefoot)**	**Ag. Fld**	+	-	-	+	-
******Helianthus annuus*** (sunflower)**	**Ag. Fld**	+	-	+	+	+
******Iva annua*** var. ***macrocarpa*** (marshelder, sumpweed)**	**Ag. Fld**	+	-	-	+	+
******Phaseolus vulgaris*** (common bean)**	**Ag. Fld**	-	-	-	+	-
******Prunus persica*** (peach)**	**Ag. Fld**	-	-	-	+	+
******Zea mays*** (corn)**	**Ag. Fld**	+	+	+	+	+
Arundinaria **spp. (cane)**	**Wetlnds**	+	+	-	+	+
Acorus calamus **(sweetflag)**	**Wetlnds**	-	-	-	+	-
******Nyssa aquatica*** var. ***biflora*** (black gum)**	**Wetlnds**	+	+	+	-	+
Polygonum hydropiper **(water pepper, smartweed)**	**Wetlnds**	-	-	-	+	-
*** *c.f. Sagittaria*** spp. (duck potato)**	**Wetlnds**	-	+	+	-	-
******Carya*** spp. (hickory)**	**For/nts**	+	+	+	+	+
******Fagus*** spp. (beech nut)**	**For/nts**	+	-	-	-	+
******Juglans*** spp. (walnut family)**	**For/nts**	+	+	+	+	+
******Quercus*** spp. (oak -acorn)**	**For/nts**	+	+	+	+	+
?*Ampelopsis* spp. (pepper vine)**	**Old Fld**	+	+	-	-	+
******Celtis*** spp. (hackberry)**	**Old Fld**	-	-	-	-	+
******Diospyros virginiana*** (persimmon)**	**Old Fld**	+	+	-	+	+
******Gleditsia triacanthos*** (honey locust pod)**	**Old Fld**	+	-	+	-	+
******Juglans nigra*** (black walnut)**	**Old Fld**	+	-	-	-	+
******Malus*** sp. (crab apple)**	**Old Fld**	-	+	-	-	-
******Phytolacca americana*** (pokeweed - greens eaten prior to seed stage)**	**Old Fld**	+	-	+	-	+
?*Rosaceae* (rose family)**	**Old Fld**	-	-	-	-	+
******Rubus*** spp. (blackberry/raspberry)**	**Old Fld**	+	+	-	+	+

(cont. on next page)

Table 10 (cont.) Taxon (* edible)	Habitat	Iron Horse	Dyar C	Dyar SG	Bell L	Bell SC
******Sambuccus* **sp. (elderberry)**	Old Fld	+	-	-	-	-
******Vaccinium* **sp. (blueberry)**	Old Fld	+	-	-	-	-
******Vitis* **spp. or** *Vitaceae* **(grape)**	Old Fld	+	+	+	+	+
Acalypha **spp. (3-seeded mercury)**	Opn Fld	-	-	-	+	-
Asclepias **sp. (milkweed, butterfly weed)**	Opn Fld	-	+	-	-	-
Ambrosia artemisiifolia **(ragweed)**	Opn Fld	+	-	-	+	-
******Chenopodium* **sp. (goosefoot - greens eaten prior to seed stage)**	Opn Fld	-	-	-	+	-
Cirsium **sp. (thistle)**	Opn Fld	+	-	-	-	-
Convulvus **sp. (bindweed)**	Opn Fld	-	-	-	-	+
Delphinium **sp. (larkspur)**	Opn Fld	-	-	+	-	-
Desmanthus **sp. (bundleflower)**	Opn Fld	+	-	-	-	-
Digitaria **sp. (crabgrass)**	Opn Fld	-	-	-	+	-
Euphorbia **sp. (spurge)**	Opn Fld	-	-	-	+	-
Gramineae **(grass family) grass stems or internodes**	Opn Fld	+	-	-	+	+
Lespedeza **sp. (bushclover)**	Opn Fld	-	-	-	+	-
Lithospermum **sp. (gromwell)**	Opn Fld	+	-	-	-	+
******Passiflora incarnata* **(maypop)**	Opn Fld	+	+	+	+	+
******Physalis* **sp. (groundcherry)**	Opn Fld	-	-	-	+	-
Plantago lanceolata **(plantain)**	Opn Fld	-	+	-	-	-
******Polygonum* **spp. (knotweed)**	Opn Fld	+	+	+	+	+
******Portulaca oleracea* **(purslane)**	Opn Fld	-	+	-	-	-
Solanum rostratum **(nightshade)**	Opn Fld	-	+	-	-	-
Veronica **sp. (speedwell)**	Opn Fld	-	-	+	-	-
Vicia **sp. or** *Lathyrus* **sp. (vetch or vetchling)**	Opn Fld	-	+	-	-	-
Carpinus carolineana **(American Hornbeam)**	Woods	-	-	-	+	-
Cornus **sp. (dogwood)**	Woods	-	+	-	-	+

(cont. on next page)

Table 10 (cont.) Taxon (* edible)	Habitat	Iron Horse	Dyar C	Dyar SG	Bell L	Bell SC
Crataegus spp. (hawthorn)	Woods	+	-	-	+	-
Desmodium sp. (stick-tight)	Woods	+	+	-	+	-
Galium sp. (bedstraw)	Woods	+	+	-	+	+
Liriodendron tulipfera (tulip tree)	Woods	-	-	+	+	-
**Medeola virginiana* (Indian cucumber)	Woods	-	-	-	+	-
Ostrya virginiana (hop hornbeam)	Woods	-	-	+	+	-
Phaseolus polystachyus (wild bean)	Woods	+	+	+	+	+
Prunus spp. (cherry)	Woods	+	+	-	+	+
c.f. *Sorbus* spp. (mountain ash) or *Amelanchier* sp. (serviceberry)	Woods	-	-	-	+	-
**Viburnum* spp. (haw)	Woods	+	-	-	+	-
**Viola* sp. (violet)	Woods	-	-	-	-	+

Key
C=Carroll site ((PM85)
SG=Sweetgum site (9MG245)
L=Lindsey site (9MG231)
SC=Sugar Creek site (9MG4)
*=edible

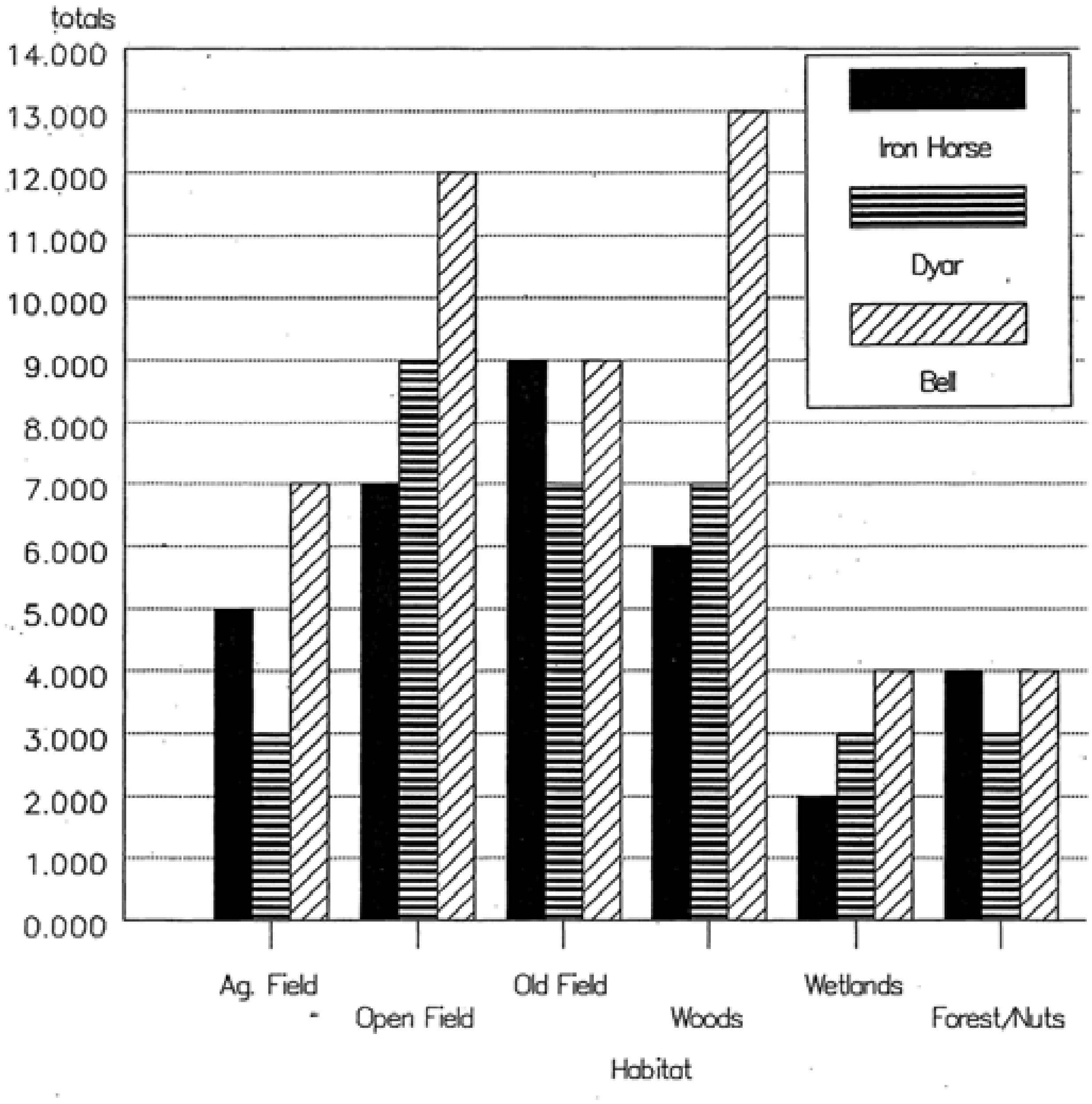

Figure 6: Taxa list (phase). (N=total number of taxa, Car=Carroll, SGm=Sweetgum, Lin=Lindsey, SC-Sugar Creek.)

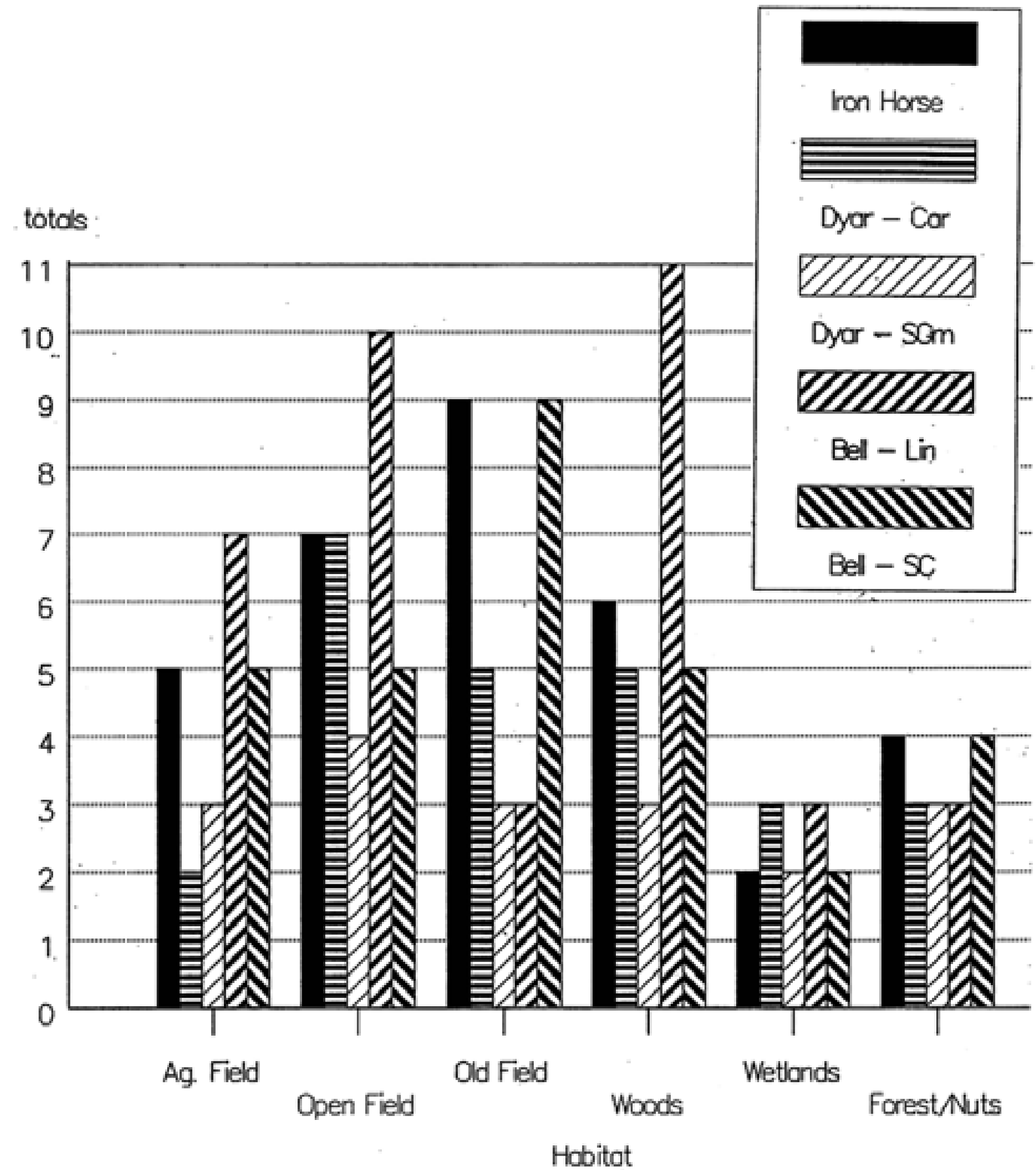

Figure 7: Taxa list (site). (N=total number of taxa, Car-Carroll, SGm=Sweetgum, Lin-Lindsey, SC=Sugar Creek).

Taken at face value, two phenomena are clearly evident in the phase level occurrence patterning (Figure 6) which shows escalation in numbers of species followed by an increasing emphasis on agriculture. Accelerating emphasis on agriculture in the Bell phase readily accounts for the lengthened plant tally, since newly disturbed land fosters heterogeneity of species, compared to a mature landscape. Although wild ungulate browsing effectively limits both numbers and varieties of plant taxa (Kay 1994), human depletion of the deer herd does not account for this proliferation of plant types. The relative stability of old field species (7 to 9 taxa per phase), which represent prime browse, leads to this conclusion. If a reduction in numbers of deer, for which there is some evidence in the Bell phase assemblage (Boyko n.d.), were strongly correlated with this proliferation of taxa, old field genera would show a marked increase between Iron Horse and Bell phases, which they do not.

While the overall diversity of plant macrofossils increases over time at the gross level at these sites, the number representing probable dietary components is fairly constant in most habitat divisions. The single categorical exception is found in the Bell phase, where augmentation of the agricultural assemblage with *Phaseolus vulgaris* (common bean), *Prunus persica* (peach), and the reinstatement of *Iva annua* var. macrocarpa (marshelder) and *Chenopodium berlandieri* (domesticated goosefoot), undoubtedly represents an increased investment in farming. This opinion is substantiated by a corresponding increase in all types of open field taxa, which normally co-vary with newly cleared or disturbed expanses.

Analysis of variance, presented in Appendix C, places nearly a 99% confidence level on the differences in plant taxon occurrence observed between phases which are attributable to either time period or to habitat, based on the occurrence list.

Data are further partitioned into the constituent sites from which they are derived in the site level occurrence analysis, Figure 7. This exercise not only highlights inter-site variation, but provides a check on conclusions formed at the phase level analysis. This site-level occurrence analysis discloses additional patterning. A complex system of corn-based agriculture, inter-cropped with minor cultigens and/or encouraged or protected wild species, is well-established at all sites in all phases.

Squash and corn, which were inter-cropped by early historic people, are found at every site. The broad leaves of the squash plant shade the soil, reducing evaporation of water. In addition, both the flesh and seeds of squash are edible. Common bean completes the agricultural trinity at the Lindsey site. The absence of common bean (*P. vulgaris*) at the other three sites is neither explained, nor unusual for late southeastern Mississippian sites. Beans were probably emphasized in the Bell phase as a supplementary protein source, more than a soil amendment, as their nitrification effects are minimal (Baden 1995). They also have less wastage than corn, squash, or sunflower. Sunflower *(Helianthus annuus)* is a significant dietary supplement, present at every site except Carroll. It is an oily-seed crop which was often ground into meal and, like marshelder, requires minimal care. As discussed below, there is some question as to the domesticated status of many of the sunflower specimens, but ethnographic analogy implies that wild sunflower seeds are equally indicative of agricultural fields (Wilson 1987 [1917]).

All plants that favor the open field habitat naturally thrive in agricultural fields. Maypop (*Passiflora incarnata*), in particular, is an encouraged commensal (Gremillion 1989b). Since most open fields in the Lamar uplands were either under cultivation or recently abandoned, it is logical to anticipate that the prevalence of open field genera will parallel that of agricultural fields. This is found to be true at both the phase and site levels of observation (Figures 6 and 7). The Carroll site is, again, the single anomaly. At that site, there is evidence of only two agricultural crops, yet the open field taxa count of seven equals that of the earlier Iron Horse phase component at the Sugar Creek site. While it is true that a more restricted suite of crops is represented in the Dyar phase samples, and particularly at Carroll, the high number of open field taxa at both Dyar sites (9PM85, 9MG245) suggest that agriculture was, nevertheless, nearly as extensive then as in the Iron Horse and Bell phases. This configuration may represent drought-induced crop failure, however. For example, 5 of the 7 open field taxa recovered from the Iron Horse phase would be considered "weeds," one a source of dye, and just one (maypop) is edible. A similar pattern is found in the Bell phase with 8 out of 12 species being probable "weeds," one (*Lithospermum* sp. - gromwell) a source of dye, and 4 edible. However, in the Dyar phase, most open field taxa (4 out of 7 at Carroll, 2 out of 4 at Sweetgum) are edible, with the remaining being either weeds or of medicinal value. These patterns suggest that wild open field species were of greater dietary importance during the Dyar phase than at any other time in the Lamar period. This

This possibility will be discussed in more detail in Chapter 9. Many pioneering species typically demand less moisture than exotic domesticates, thriving in the warm, open space generated by agricultural efforts.

The slight reduction in the number of old field species during the Dyar phase is more clearly seen at the site level (Figure 7) than in the phase composite (Figure 6) and is discussed below. There is also a slight increase in wetland taxa at Dyar phase Carroll (Figure 7). Wetland species are actually fairly constant across the sites, however. Two or three taxa are represented at each site and occupation. The same is true of nut trees, where oak acorns (*Quercus* spp.), hickory (*Carya* spp.), and black walnuts (*Juglans nigra*) are represented at all sites, with the addition of beechnut (*Fagus* spp.) at the two Sugar Creek occupations. Black walnut is also positively identified to the species only at the two occupations of the Sugar Creek site.

Analysis of variance, presented in Appendix D, indicates that the amount of variation between numbers of species noted from each habitat during each time period is significant at the 90% confidence level. The sum of variation between the numbers of species representing each of six habitats in the five different site-phases is significant to the 99% confidence level. These confidence intervals are adequate to insure that the occurrence lists are a valid source of data on species abundance during the late Lamar period.

Discussion

Chapter 3 recounts that the Iron Horse phase (A.D. 1450 - A.D. 1520) was for the most part, marked by low but adequate annual rainfall. However, there was probably a prolonged drought in the middle of the phase, from A.D. 1469 to A.D. 1476, judging from climatic conditions in the adjacent Savannah watershed (Anderson 1994). This pattern means that during the Iron Horse phase, years of low precipitation were typically soon counter-balanced. Communities could maintain sufficient agricultural surpluses to see them through shortfalls (Anderson 1994), except, perhaps during the probable period of prolonged drought. During the Iron Horse phase, Sugar Creek inhabitants husbanded squash, goosefoot, sunflower, marshelder, and corn (Zea mays). Although it is unknown exactly when the Sugar Creek site was occupied, perhaps the higher percentage of wild foods found in the assemblage reflect a need to supplement agricultural produce. Nevertheless, judging from the overall character and abundance of the macrobotanical and zooarchaeological assemblages, and the overall robusticity of the skeletal population, (See Appendix F) it is unlikely that 9MG4 was occupied during an extended drought.

Regional dendroclimatological data indicate that while adequate rainfall characterized the early and late Dyar phase, the 1560's brought the longest drought of the century (Anderson 1994). Again, the precise years of occupation at the Carroll and Sweetgum sites are unknown, yet a general decrease in the numbers of taxa representing most habitat categories is observed at these two individual sites (Figure 7). Four out of six habitats show a decline in representation at the Carroll site, and five out of six at the Sweetgum site. The main exception is a relative abundance of drought-tolerant, sun-loving pioneers at the Carroll site.

The array of plant taxa observed in each Lamar phase can be explained not only as a response to climatic influences, but also in terms of optimization of return for effort.

Throughout the Dyar phase, mounting upland population aggravated any resource insufficiencies, including the amount of arable land available to individual farmsteads. Consequently, allocation of field space to particular crops would have been more carefully considered than in previous times. Goosefoot drops out of the Dyar assemblage. Although goosefoot represents a more reliable harvest, its overall productivity is less certain. Under average conditions, corn yields an estimated 1533 kcal per work-hour, while domesticated goosefoot produces one-third less at 1040 kcal per work-hour (Table 10, page 118). Smith (1992:208) suggests that a corn field yielding 25% below its maximum potential would still equal the yield of a similar field planted in domesticated chenopods. In addition, incremental intensification of human labor increases corn yields disproportionately, in comparison to goosefoot. This disparate productive potential might render goosefoot inadequate as the staple given a restricted field size. However, Lopinot (1992):51) proposes that goosefoot approaches the output of non-hybrid corn, and lacks many of the nutritional and horticultural shortcomings of maize. In short, corn might be more risky, yet reduced maize production would still yield more kilocalories per ha than *Chenopodium berlandieri*, and perhaps other eastern tradition crops such as *Phalaris caroliniana*, *Hordeum pusillum*, and *Iva annua* var. *macrocarpa,* once net yields are calculated.

The watering of corn is most critical at two points in its growth cycle, namely, shortly after planting, and during tasselling (Scarry 1986; 1993). In periods of drought, the limited precipitation that does occur is most likely to coincide with these two periods. Corn that receives minimal rain during its early development generates longer roots to compensate. Thus, as the drought persisted, Dyar phase people might well have taken a calculated risk in limiting their plantings to only the most productive of staple species.

The increase in numbers of cultigens during the Bell phase may well reflect a return to crop diversification due to both meteorological and historical circumstances. Overall, seven recognized cultigens are featured in the Bell phase assemblage, compared to five in the Iron Horse phase and three in the Dyar phase. (See Table 10, Figures 6 and7). The dawning of the Bell phase in the late 16th century brought adequate rainfall (Anderson 1994) and the reappearance of a major local crop, goosefoot. Common bean reached the uplands in the Bell phase. The beans may have been deliberately employed to enhance the production of corn and squash in synergistic intercropping (Hastenstab 1994). Peaches reached the Oconee region through hand-to-hand trade (Gremillion 1989:212 ff), and may also have been introduced by either the DeSoto or the Pardo expedition. Peach trees reach maturity in as little as three years (Gremillion 1989: 214), and so their introduction to the uplands during the Bell phase is fairly secure. Nevertheless, the potential introduction of peaches during late Dyar cannot be completely ruled out if it is assumed that mature trees suffered curtailed or aborted production during drought, precluding their appearance in the archaeological record.

A slight reduction in the number of old field species during the Dyar phase intimates two non-exclusive scenarios. First, old fields were prematurely cleared for farmsteads by the burgeoning population. Second, a possible Dyar phase drought constrained fruit production. If, as assumed, fallowing was central to the overall late Mississippian subsistence system, early reclamation of fields reduced crop yields and curtailed the energetic return of farming. Simultaneously, the old field species which rounded out the diet were severely reduced in number. Under normal circumstances a balance of fields in all stages of fallow would be anticipated.

Many economically useful plants characteristic of old fields produce fleshy fruits. In times of moisture stress they produce fewer, smaller fruits, or even fail to produce at all for one or more seasons. Considering the rebound of such genera as persimmon during the better-watered Bell phase, it is unlikely that the fields were denuded during the Dyar phase. It is probable that slow-maturing old field species, such as persimmon, black walnut, and locust were selectively spared as the old fields around them were cleared for planting (Dobyns 1983). Such discriminate clearing would explain not only the lack of quickly rebounding shrubs such as blueberry, and elderberry, after the Iron Horse phase, but also the presence of the slower-maturing old field genera during the peak of human occupation, the Dyar phase.

Projections of gross caloric return on enumerated old field shrubs conservatively range from 335 to 1088 kcal per work-hour, gross, based on my own projections (Table 9), with a mean of 694 kcal per work-hour during production peaks. Such a return is considerable, and under ideal conditions it is expected that a field would be left fallow until trees encroached on these inexpensive resources. The fact that their disappearance from the archaeological record coincides with the peak of human occupation in the Oconee region supports the hypothesis of a shortened fallow. Agricultural crops have higher average energy yields than old field fruits, with the added advantage of extended storability, and many can be stored without significant processing.

Grapes, like old field tree fruits, are found in every occupation. In this study, grapes have been assigned to the old field category; however, they are more often found in the edge zone between field and forest, perhaps in greater abundance than any other edible species. This taxon yields an estimated 1368 kcal per work-hour, and can be dried and stored. It is likely that grapes and the related pepper-vine were cleared from old fields being prepared for agriculture but permitted to flourish along the borders.

It has been proposed that the large upland population of the middle to late Lamar period placed a strain on resources (Hatch et al 1989; Boyko 1988). While this pressure is evident in the faunal assemblage, it is not clear from the botanical inventory. During periods of nutritional stress, the diet is expected to broaden to incorporate an array of less energetically efficient resources. Although the occurrence list indicates increased diversity in the botanical assemblages over time, only the agricultural species appear to represent dietary components. The major exception was the relative abundance of edible, wild, open field taxa during the Dyar phase, signaling an unusual emphasis on collected foods at a time when evidence of cultigens is sparse.

The occurrence list reflects a steady dependence on nut species throughout the Lamar period. The fact that beechnuts were found in both components at Sugar Creek, and nowhere else, is indicative that these nuts represented a convenient local source, rather than a response to nutritional stress. The only potentially important plant food harvested from the woods habitat was wild bean (*Phaseolus polystachyus*). Its presence remained constant over time. There is some tenuous evidence that this genus was cultivated, or at least encouraged, again pointing to an emphasis on agriculture (Fritz

1986). The only economically useful plant added to the archaeological record from the woods habitat during the Bell phase was Indian cucumber (*Medeola virginiana*), which was insignificant.

An examination of wetland macrofossils reveals but a single potentially significant source of calories, duck potato (*Sagittaria* sp.), and this identification is only tentative. This tuber was exploited only during the Dyar phase, and was found at both Carroll and Sweetgum, suggesting that it was a low ranked resource, collected only in times of food scarcity. This finding, again, bolsters the Dyar phase drought speculation.

Throughout the Lamar period, all of the six habitats on which I focus were available for human exploitation. The fluctuations in patterns of exploitation are explained mainly in terms of moisture availability and historical circumstance. No taxon that appears in the archaeological record is typical solely of spring fruiting plants. Nevertheless, the presence of pokeweed and wild goosefoot, which are both used as pot herbs ("greens") in the spring, indicates a possible spring occupation. Crops such as corn and squash, which require a long growing season, provide indirect evidence of springtime occupation of the sites. People would need to prepare and plant the fields in early spring, particularly if double-cropping were attempted (Swanton 1969; DuPratz 1972 [1774]; Hudson 1976). Summer genera are well represented in agricultural, open and old field categories. Nuts attest to a fall occupation, and persimmon confers evidence of occupation through at least early frost. There are no "winter crops," but the presence of storable foods such as corn and nuts allows for a winter occupation.

Summary

The occurrence list depicts a year-round occupation of the uplands, which is further substantiated by archaeological evidence described in chapter 3 (See Tables 5 and 7. People engaged in a mixed economy, centered around maize agriculture, and incorporating a variety of secondary crops, as well as wild foods from numerous local habitats. During the Iron Horse phase, old field resources were more prominent in the diet than at any other phase of the Lamar period. The Dyar phase was most likely a period of nutritional stress, while the Bell phase was one of agricultural intensification. These last observations are supported by paleopathological analyses summarized in Appendix F. The possibility has not been excluded that agricultural products were entering a regional redistribution system regulated by a chiefly hierarchy during the Dyar phase; however, no direct evidence has been found to support this prospect.

Density Ratio

Figure 8 illustrates the average density of botanical remains recovered from each site per liter of floated soil matrix. From this graph it is apparent that the Sweetgum assemblage depressing the average Dyar phase occurrence value. This same figure illustrates an uncharacteristically light macrobotanical recovery at the Sweetgum site, despite the fact that over 600 liters of sediment were floated, only about 41% that of the

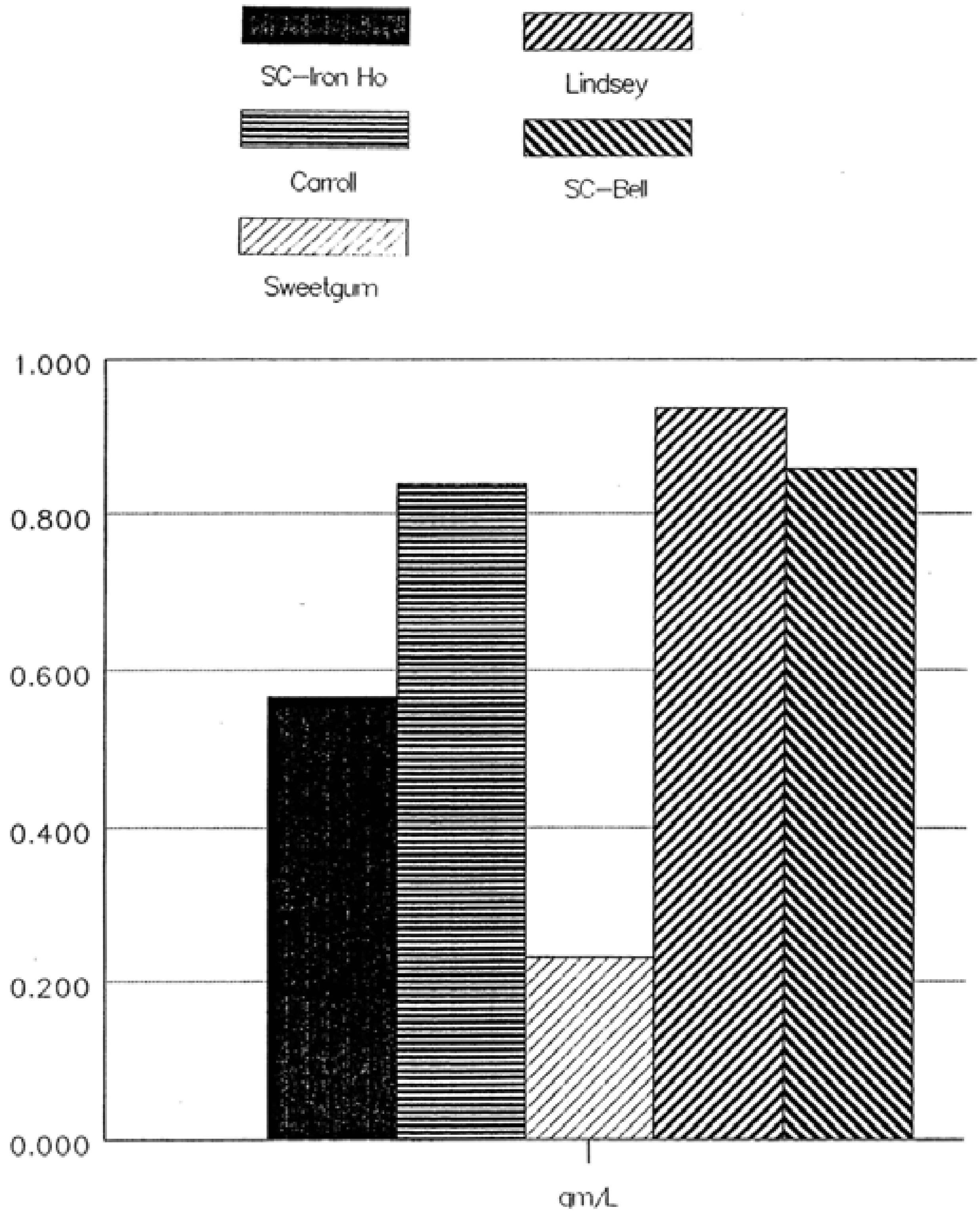

Figure 8: Average density of macrobotanical remains (g/l).

second lowest tally, Iron Horse at Sugar Creek. It is only about 25% of the highest overall figure, Lindsey. This pattern is repeated, to a lesser extent, in Figure 7, the occurrence listing, where in four out of six categories fewer species are noted at the Sweetgum site compared to the Carroll site.

In Table 11 (phase) and Table 12 (site) density of taxa representative of individual habitats is determined by counting the total number of seeds or fragments of other botanical remains (e.g., tuber fragment), and dividing them by the total volume of flotation which was sorted from the site or phase, as described elsewhere in the occurrence list discussion. Figures 9 and 10 graphically depict these density ratios. Density of corn cob and nut shell in Table 13 (phase) and Table 14 (site) and Figures 11 and 12 are calculated by weight, rather than count. This practice is followed for many reasons. The most important reason is a practical one. Corn, in particular, is often represented elsewhere in the assemblage by the actual seeds, and this practice presents an independent measure of the relative contribution of these provisions to subsistence. Finally, it is difficult to equate nut shells with numbers of seeds, and each corn cob fragment represents multiple seeds.

According to the density ratios of Table 11 and Table 12, the amount of botanical remains from either the woods or wetlands categories remains fairly steady over time. Old field seeds are 11 times more prevalent in the Iron Horse than the succeeding Dyar phase, and 5 times more prevalent in Iron Horse than in Bell. The intra-site comparison at Sugar Creek supports the authenticity of this trend with Iron Horse containing 3.5 times more old field species than Bell.

Table 11: Density ratio (phase). Number of seeds or plant parts per liter of floated soil matrix.

Habitat	Iron Horse	Dyar	Bell
Agricultural Field	0.522	0.151	1.588
Open Field	0.597	0.655	0.579
Old Field	0.650	0.061	0.122
Woods	0.080	0.039	0.115
Wetlands	0.142	0.140	0.023

Table 12: Density ratio (site). Number of seeds or plant parts per liter of floated soil matrix.

Habitat	Sugar Creek - Iron Horse	Carroll - Dyar	Lindsey - Bell
Agricultural Field	0.522	0.073	2.242
Open Field	0.597	0.578	0.760
Old Field	0.650	0.118	0.187
Woods	0.080	0.099	0.034
Wetlands	0.142	0.248	0.038

	Sweetgum - Dyar	Sugar Creek - Bell
Agricultural Field	0.197	0.780
Open Field	0.699	0.386
Old Field	0.028	0.052
Woods	0.005	0.158
Wetlands	0.077	0.007

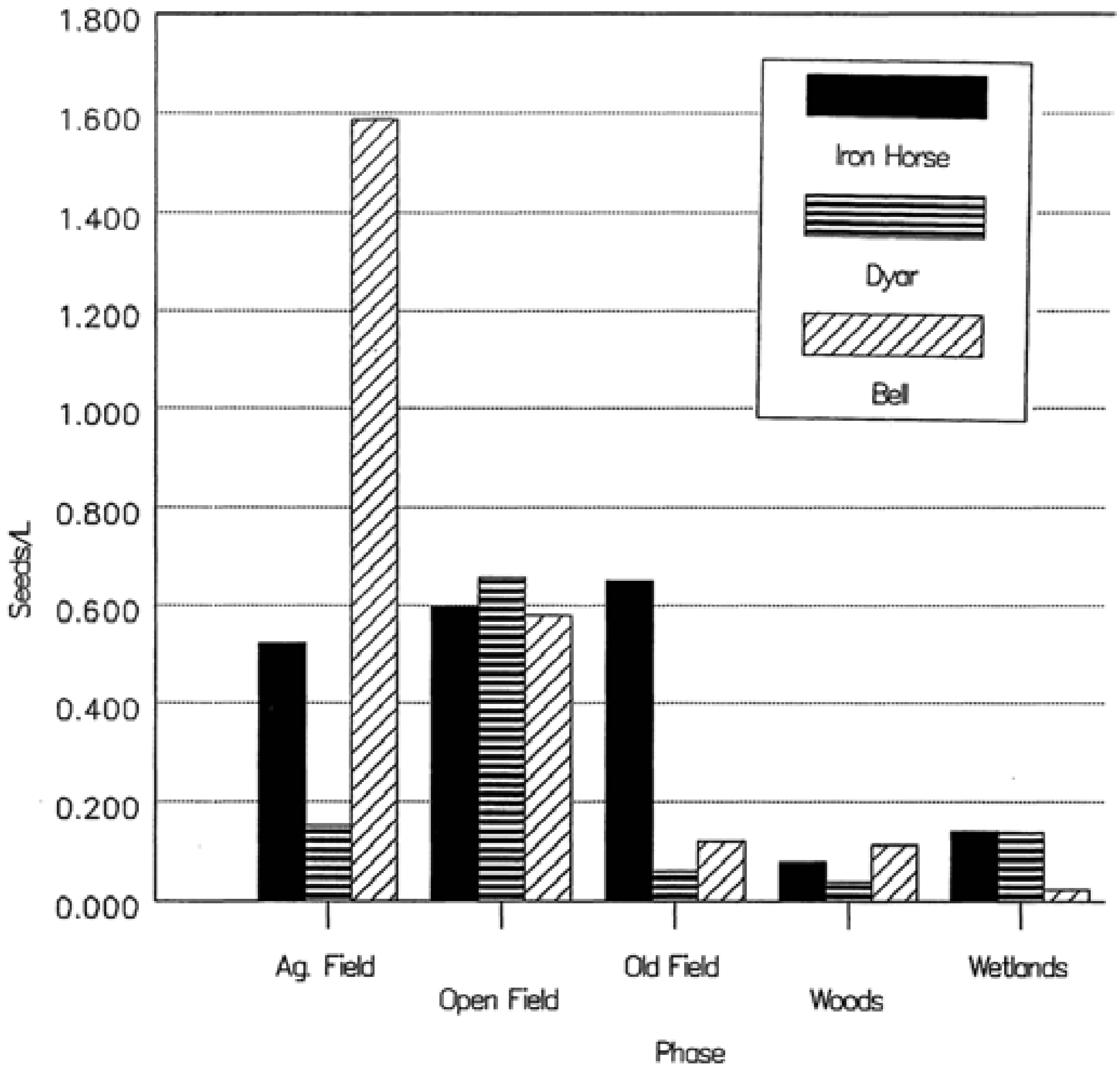

Figure 9: Density ratio (phase). Numbers of seeds or plant parts per liter of floated soil matrix.

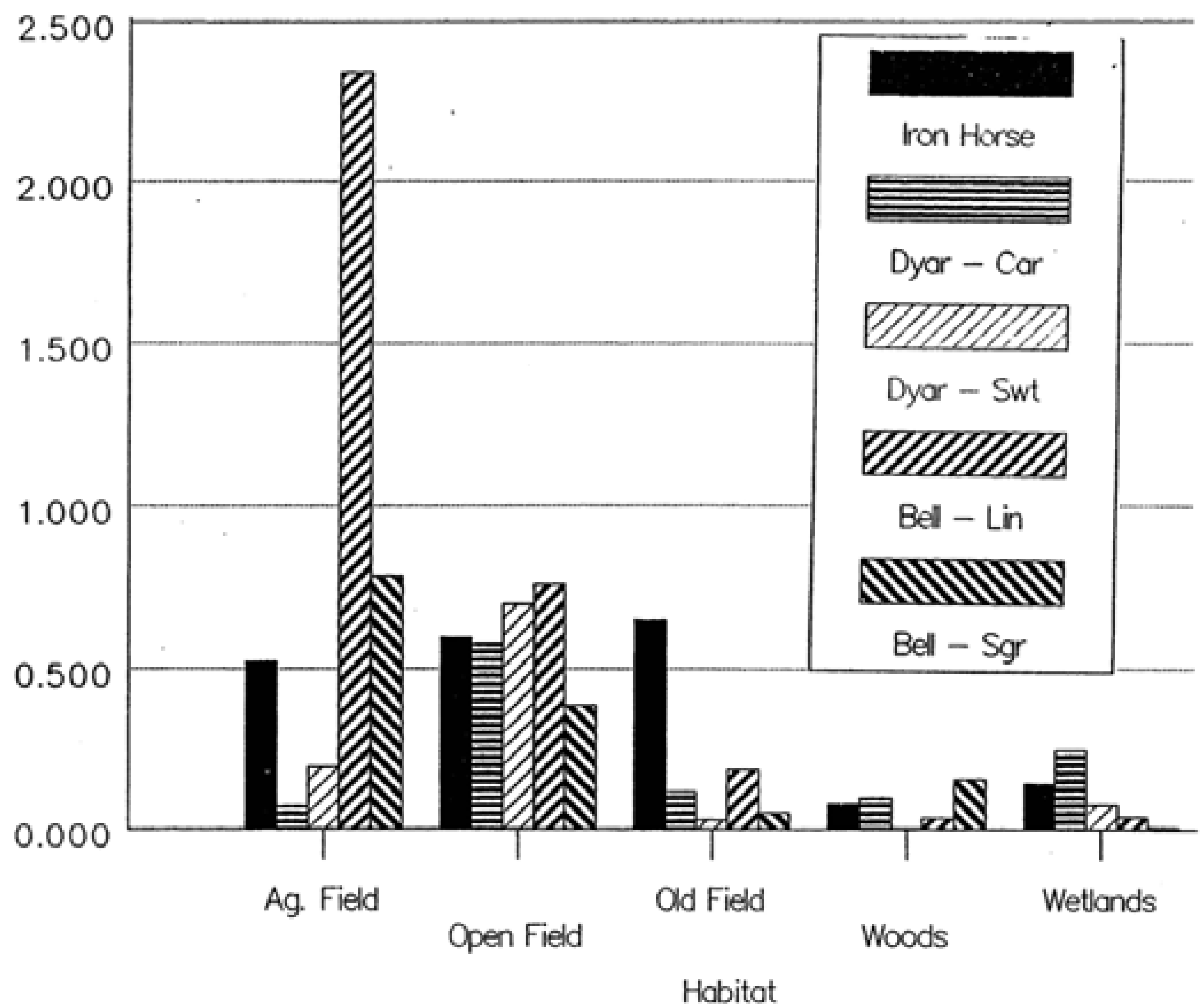

Figure 10: Density ratio (site). Number of seeds or plant parts per liter of floated soil matrix.

Table 13: Density ratio (phase) for corn cob and nut shell. Grams per liter of floated soil matrix.

Phase	Corn Cob	Nut Shell
Iron Horse	0.014	0.036
Dyar	0.003	0.050
Bell	0.084	0.199

Table 14: Density ratio (site) for corn cob and nut shell. Grams per liter of floated soil matrix.

Site/Phase	Corn Cob	Nut Shell
Sugar Creek / Iron Horse	0.014	0.036
Carroll / Dyar	0.003	0.119
Sweetgum / Dyar	0.003	0.013
Lindsey / Bell	0.055	0.273
Sugar Creek / Bell	0.114	0.126

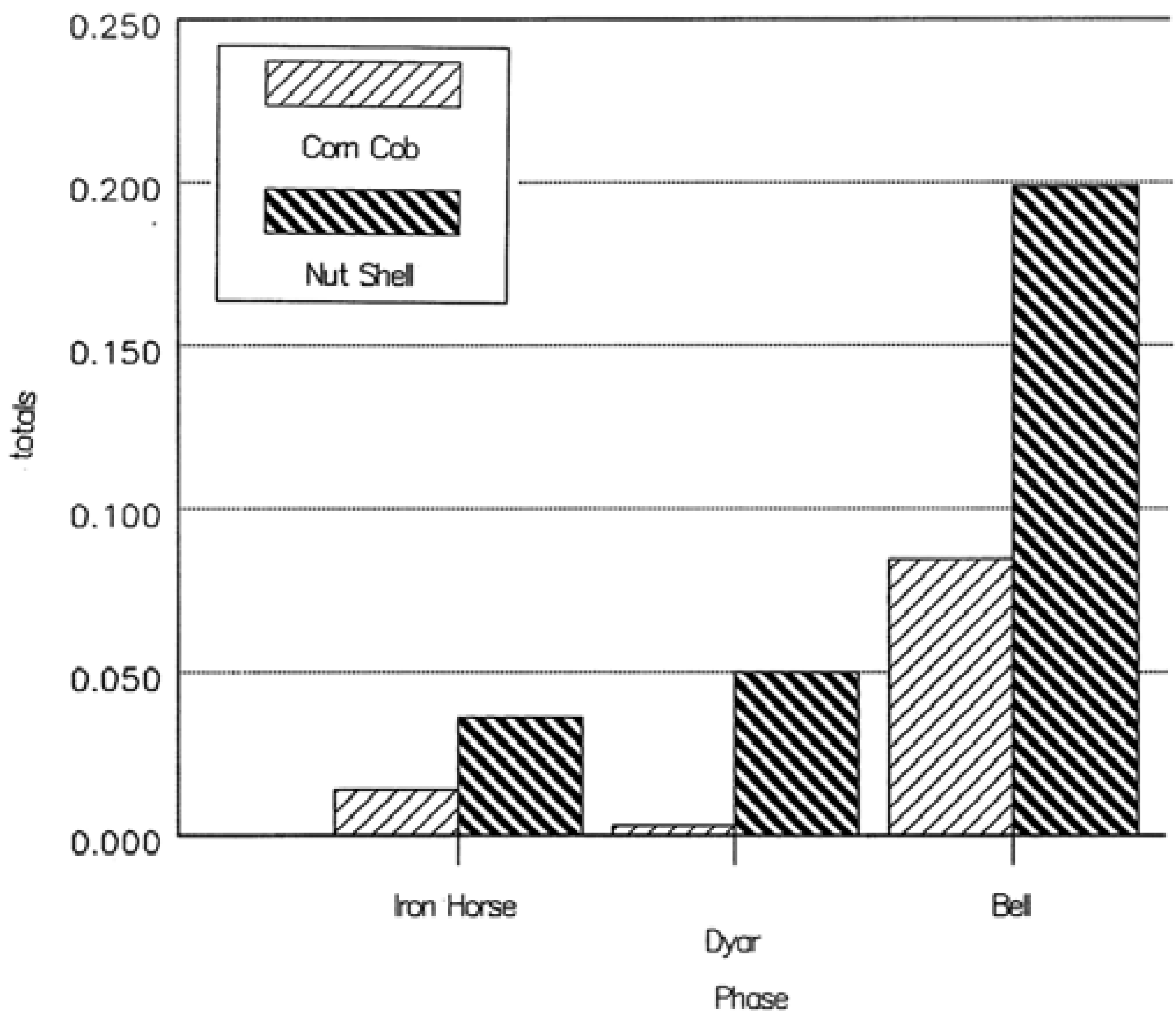

Figure 11: Density ratio (phase) for corn cob and nut shell. Grams per liter of floated soil matrix.

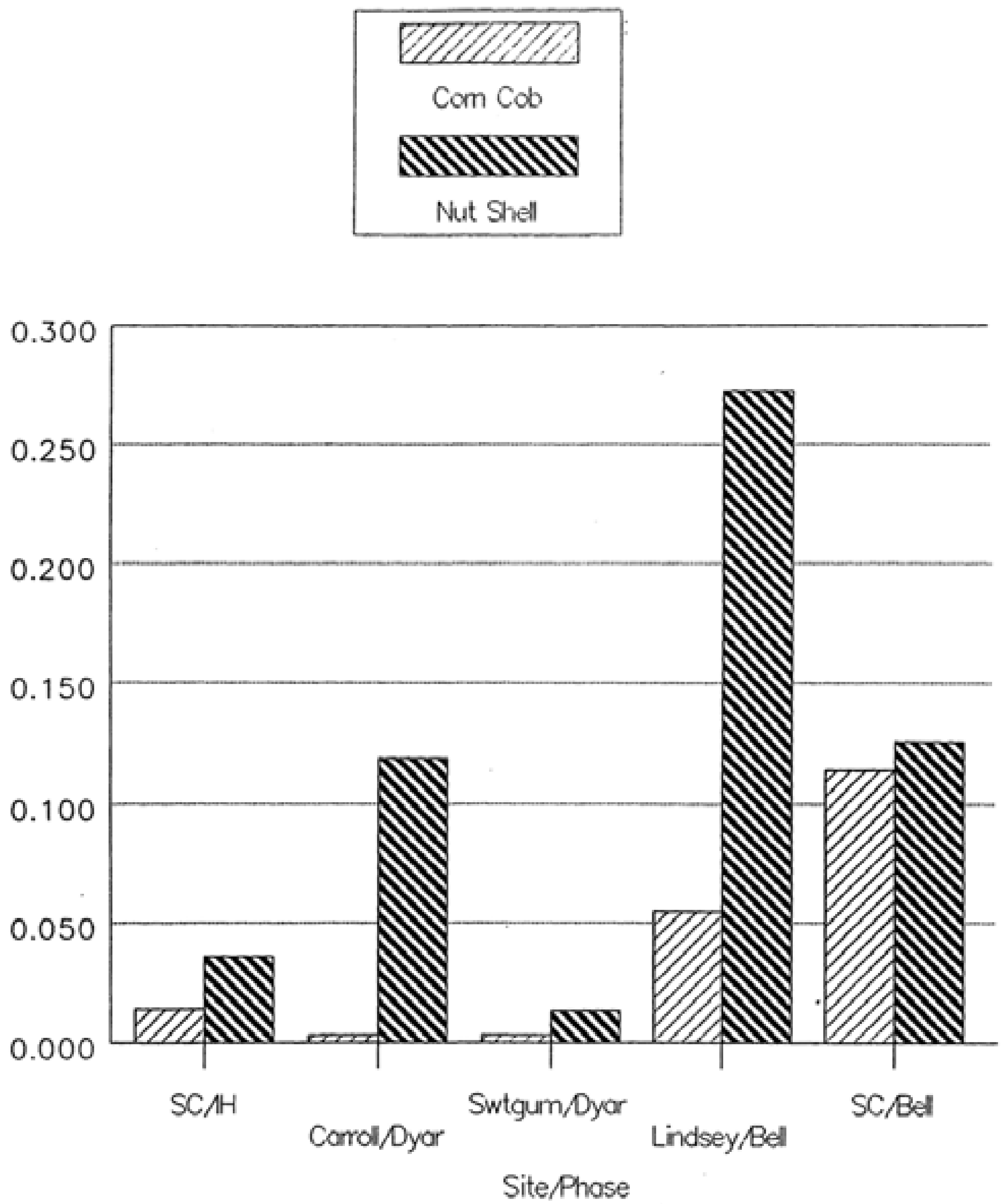

Figure 12: Density ratio (site) for corn cob and nut shell. Grams per liter of floated soil matrix.

Nut shell and corn cob exhibit a generally ascending pattern in Table 13, Table 14, Figure 11, and Figure 12, indicating an increasing dependence on both of these resources between the Iron Horse and Bell phases. Although the density of corn cob is 4.6 times higher in Iron Horse than Dyar (Table 13), Bell phase corn cob density is 6 times higher than that of Iron Horse. This finding corresponds well with the increased agricultural activity depicted in the occurrence index. The drop in maize during the Dyar phase may be related to drought conditions discussed above. This apparent plunge in maize production is seen at both Dyar phase sites (Table 15, Figure 12).

Nut density steadily ascends over time, with Dyar phase nutshell being 1.4 times greater than that of Iron Horse, and Bell phase nutshell measuring nearly 4 times greater than that of Dyar (Table 15). Sweetgum, however, has a nutshell density nearly three times less than that of Iron Horse at Sugar Creek (Table 14). If Sweetgum is disallowed, due to its atypical botanical recovery, the general pattern of increased nut utilization is upheld.

As is often the case in archaeological data (Derr 1995, personal communication), in performing an analysis of variance on these density data, the assumption of constant variance could not be met, even after several attempts at transforming the data. However, the error term approximates normality after square root transformation. This work is documented in appendix G. Using the transformed data from all five occupations, clustered by phase, ANOVA was performed to test the reliability of differences observed in density of macrobotanical material. It was found that the degree of variance in density of floral macrofossils which is attributable to either temporal (phase) or to habitat assignment is valid to the 99% confidence level. These analyses of variance support the authenticity of the observed temporal variations in abundance of taxa from individual habitats.

Discussion

The density ratios indicate a sizable increase in both agricultural production and nut harvesting over time. This trend may be related to reduced animal protein availability, resulting from growing human population pressure on all upland resources during the late Lamar period (McCabe and McCabe 1984:25; Kay 1994). Agricultural extensification displaced wild turkey (*Meleagris gallopavo*) and racoon (*Procyon lotor*), which favor the woods environment, while providing ideal habitat for deer (Whittington 1984:364). Nevertheless, over-hunting of the deer-turkey-raccoon triad by the burgeoning human population doubtless depressed all three species, reduced their availability and increased reliance on plant foods. Deer (*Odocoileus virginianus*), in particular, were more scarce, in Bell phase than Iron Horse (Boyko n.d.). Deer bones recovered were splintered and boiled in upland Bell phase contexts, as if exploited to the limit, a pattern not observed earlier in time (Boyko n.d., 1988).

Large-scale expansion of agricultural fields provided ideal conditions for many small terrestrial species. Not only could these animals be gathered, snared, or otherwise collected in agricultural fields, but to do so was a necessity as these animals prey on field crops. Control of the squirrel and rodent populations, and a reduction of deer due to human predation, would not only have increased cultigen yields, but also the number of nuts available to humans. In fact, an unusually high proportion of very small animals, in particular, grey squirrels (*Sciurus carolinensis*), cottontail rabbit (*Sylvilagus floridanus*), mice (*Peromyscys* spp.) and other rodents, oppossum (*Didelphis marsupialis*), skunk (*Mephitis*), snakes and small birds surfaces in the Bell phase sites (Boyko n.d.). Freshwater species, encompassing frogs (*Rana* spp.), salamander (*Ambystoma* spp.), gar (*Episosteus* spp.), catfish (*Ictalurus* spp.), minnows (*Cyprinidae*), and many types of turtles are commonplace, and water fowl are occasionally observed (Boyko n.d.). This faunal assemblage reflects the harvesting of a non-specialized array of diverse animal taxa, many of which would be exploited through a strategy dubbed "garden hunting" (Linares de Sapir 1976).

Nuts were an important source of fats, proteins, and calories for humans (Gardner 1992). Although hickory could be rendered into "butter" by means of a labor-intensive process, it could more easily be smashed into bits and tossed into the constantly simmering cooking pot. The shells sank to the bottom, and the oily nutmeats floated. Many of the acorns growing in the Oconee region are bitter due to high tannic acid content, and require laborious processing to be rendered palatable (Plummer 1975; Haecker 1977). As a consequence hickory, while less abundant, would be preferred to acorn for its higher energetic return (Petruso *et al.* 1984; Talalay *et al.* 1984). An increased emphasis on plant foods in the human diet would have focused on cultivated grains and pseudo-grains (e.g., *Chenopodium* spp.), and wild nuts, which together provided the greatest net energy yields. Reduced competition from animals for both corn and nuts would have actually increased the energetic return of mast exploitation.

A word of caution is in order in the final consideration of the overall density measures. A breakdown of density ratios by feature versus postmold, presented in Table 15, Table 16, Figure 13, and Figure 14, manifests a striking mirror-image of disposal patterns between these general provenience types over time. Each of the major habitat categories is disproportionately represented in either features or postmolds at any given point in time. For example, all peach pits remains at the two Bell phase occupations were recovered from house posts. This differential recovery may be related to customary food storage, preparation, consumption, and other socially designated activity areas. By overlooking one class of archaeological evidence, such as post molds, food items associated with these site elements are excluded from the density ratio. This oversight may become a problem if activity areas or discard patterns change over time.

In addition, the Bell phase occupations at Lindsey and Sugar Creek are thought to have been relatively short term occupations. There is little evidence of rebuilding, and there are relatively few features. Consider that garbage is deliberately deposited in disposal pits, but enters post molds as back-fill during construction, repair, or soil disturbance (*e.g.*, sweeping) from routine activities. Accordingly, the longer a site is occupied, the more macrofossils would be worked into the postmolds. Thus, the longer a site is occupied, the more debris is anticipated in the structure posts. In this case, if either postmolds or features were considered alone, completely opposite interpretations of subsistence activities would result from the density ratio. Ideally, both should be sampled, and combined, to average the effects of differential deposition. This procedure can only be accomplished if both postmolds and features have been sampled in an

Table 15: Density ratio - features (phase). Floral remains representing selected habitats, measured in grams per liter of floated matrix.

Habitat	Iron Horse	Dyar	Bell
Agricultural Field	0.077	0.190	1.763
Open Field	0.128	0.873	0.570
Old Field	0.528	0.080	0.062
Woods	0.059	0.053	0.074
Wetlands	0.030	0.187	0.013

Table 16: Density ratio - postmolds (phase). Floral remains representing selected habitats, measured in grams per liter of floated matrix.

Habitat	Iron Horse	Dyar	Bell
Agricultural Field	2.080	0.213	0.785
Open Field	1.878	0.023	0.621
Old Field	0.871	0.000	0.396
Woods	0.165	0.000	0.304
Wetlands	0.578	0.000	0.118

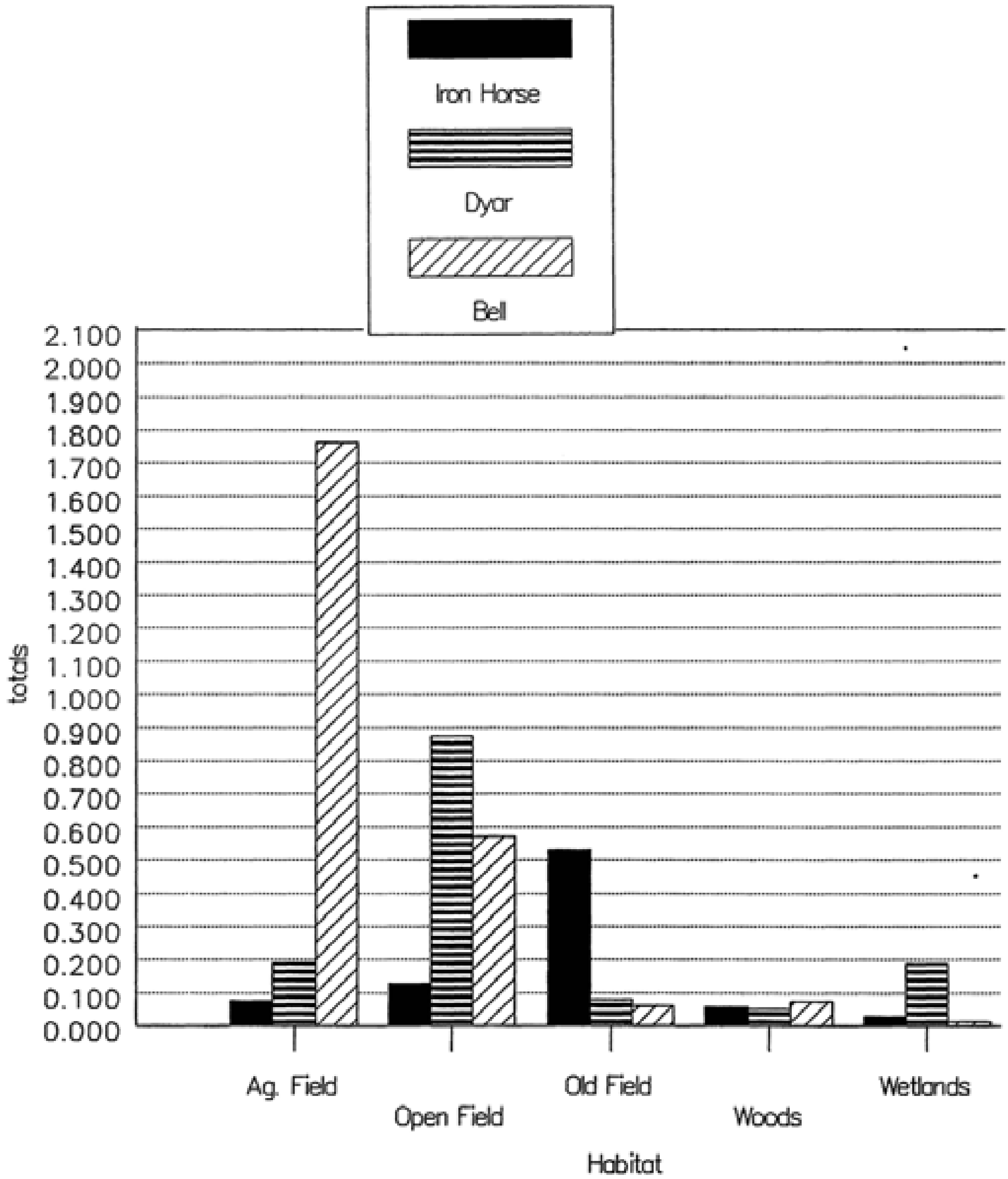

Figure 13: Density ratio - features (phase). Floral remains representing selected habitats, measured in grams per liter of floated matrix.

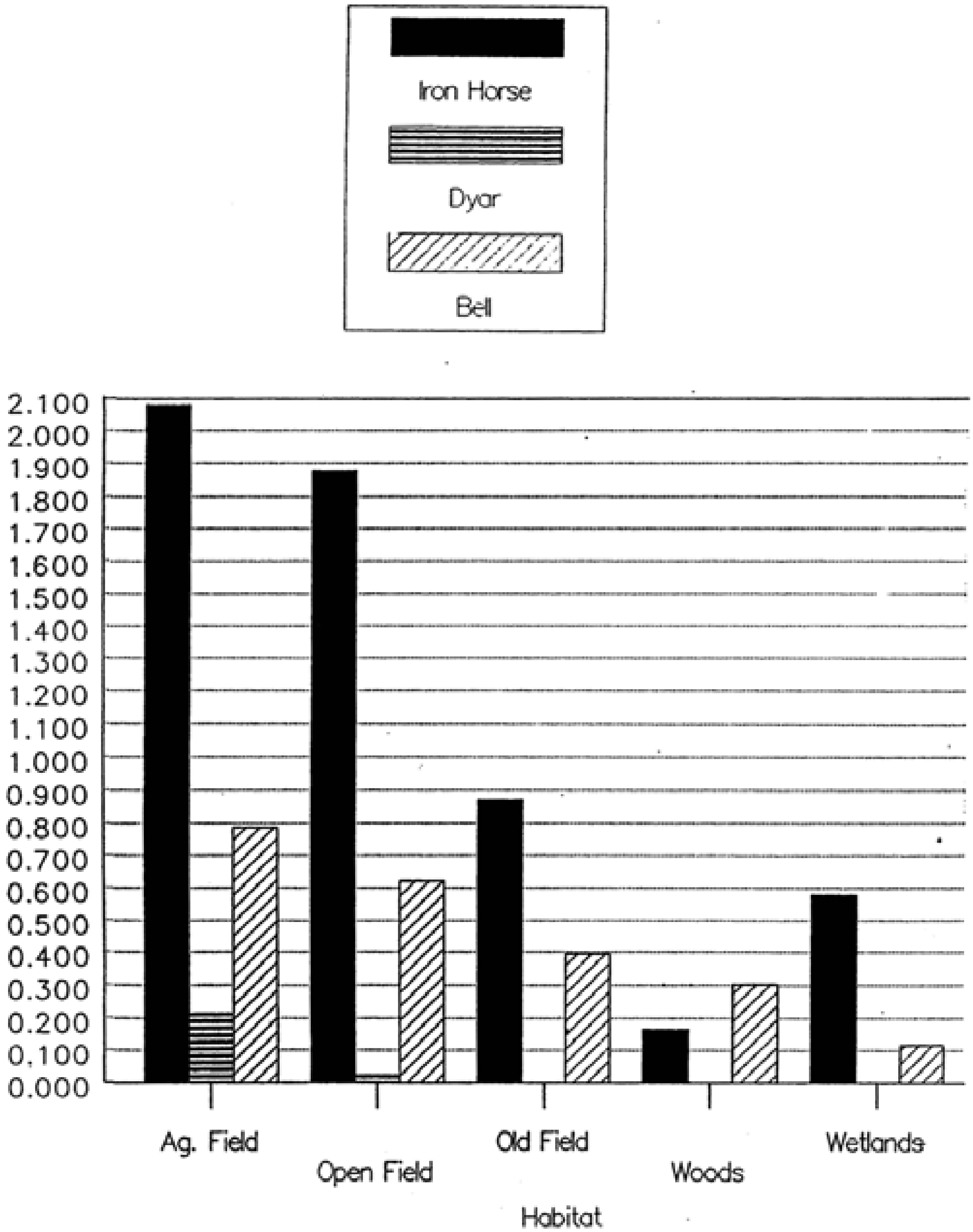

Figure 14: Density ratio - postmolds (phase). Floral remains representing selected habitats, measured in grams per liter of floated matrix.

analogous fashion at all sites and occupations under consideration.

The primary concern in this study is the Carroll site where no postmolds are considered. Fortunately, during the Dyar phase agricultural remains appear in essentially equal proportions in features and postmolds, as illustrated in Table 15, Table 16, Figure 13, and Figure 14. A second concern is the Bell phase of Sugar Creek in which only a single trash pit was included in the density analysis. The lack of additional Bell phase features at Sugar Creek may account for the contrasts in occurrence and density between the two Bell phase sites. This discrepancy does not, however, cloud the overall picture of Bell phase plant exploitation. Although the Bell phase of Sugar Creek does not exhibit such dramatic values as Lindsey, the trends at both sites are comparable.

Analysis of variance, using square root transformation, indicates that the differences in overall resource density in postmolds is attributable to the phase variable is significant at the 99% confidence level. It is noted, however, that the assumption of constant variance could not be met. These data are presented in Appendix F. The variance between the overall Iron Horse (phase 1) and Dyar (phase 2) density ratios of postmolds is significant at the 99% confidence interval, and between Dyar and Bell phase (3) indices to the 90% level. The overall variance between Iron Horse and Bell is significant at about the 95% confidence level. Although the variance is uneven, ANOVA demonstrates that the overall variance between postmold densities attributable to time (phase) is significant. The ANOVA test of interaction effects between phase and habitat indicate that the variation in density of cultigen remains in postmolds is significant at the 90% confidence level between Iron Horse phase (habitat 1) and both the Dyar (habitat

6) and Bell (habitat 11) phases. The variation observed between density of cultigen remains in postmolds recovered from the Dyar and Bell phases is not significant. When the identical ANOVA is applied to resource density in features, it is found that the overall variance which is attributable to phase is insignificant. These data are presented in Appendix I.

When density data from postmolds and features are combined (Appendix J), the assumption of normality is met without transformation. The results of this final ANOVA of density data indicate that the overall variance in density is significant to the 95% confidence level; however, direct comparisons between phases are not so clear. The variance between Iron Horse and Dyar phases is significant at only the 85% confidence level, and others are much less significant. Nevertheless, the statistics clearly indicate that the Dyar phase is more similar to the Iron Horse phase than to the Bell. Overall interaction effects are found to be insignificant. These findings may signify a significant shift in subsistence strategy during the Bell phase, manifest in distinctive quantities of waste products.

Ubiquity Analysis

As addressed in the previous chapter, ubiquity analysis measures the percentage of site proveniences in which each taxon occurs. Table 17 and Table 18 summarize these scores by phase and site respectively, and Figure 15 and Figure 16 present them

Table 17: Ubiquity of floral macrofossils from selected habitats (phase). Only floated proveniences are considered.

Habitat	Iron Horse	Dyar	Bell
Agricultural Field	0.461	0.368	0.333
Open Field	0.539	0.520	0.490
Old Field	0.237	0.179	0.135
Woods	0.184	0.063	0.219
Wetlands	0.184	0.137	0.104

Table 18: Ubiquity of floral macrofossils from selected habitats (site). Only floated proveniences are considered.

Habitat	Iron Horse - Sugar Creek	Dyar - Carroll	Bell - Lindsey
Agricultural Field	0.461	0.400	0.283
Open Field	0.539	0.550	0.450
Old Field	0.237	0.350	0.117
Woods	0.184	0.150	0.167
Wetlands	0.184	0.300	0.080
Forest/Nuts	0.842	0.750	0.666
		Dyar - Sweetgum	Bell - Sugar Creek
Agricultural Field		0.360	0.429
Open Field		0.373	0.571
Old Field		0.133	0.171
Woods		0.040	0.343
Wetlands		0.093	0.171
Forest/Nuts		0.610	0.779

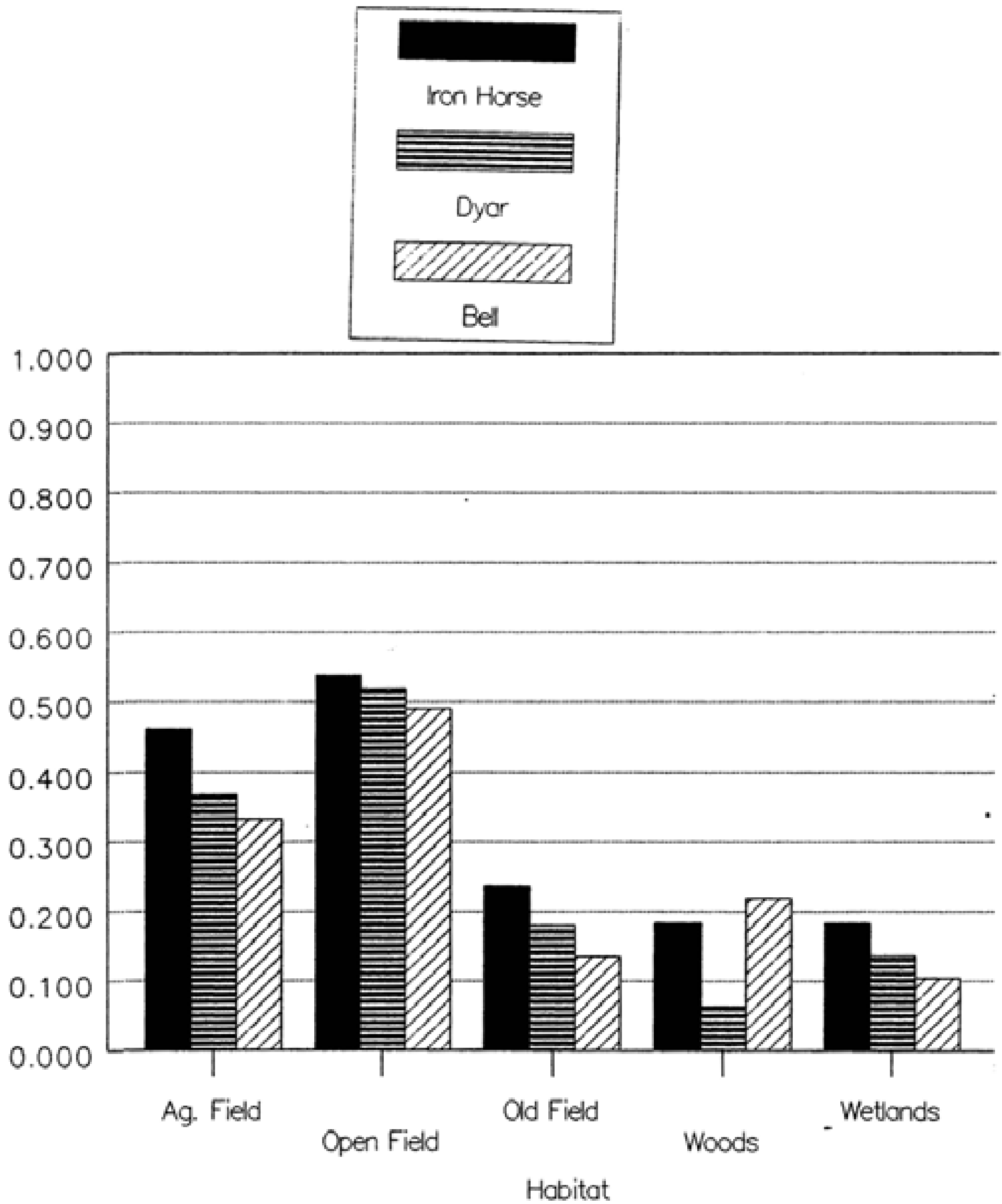

Figure 15: Ubiquity of floral macrofossils from selected habitats (phase). Only floated proveniences are considered.

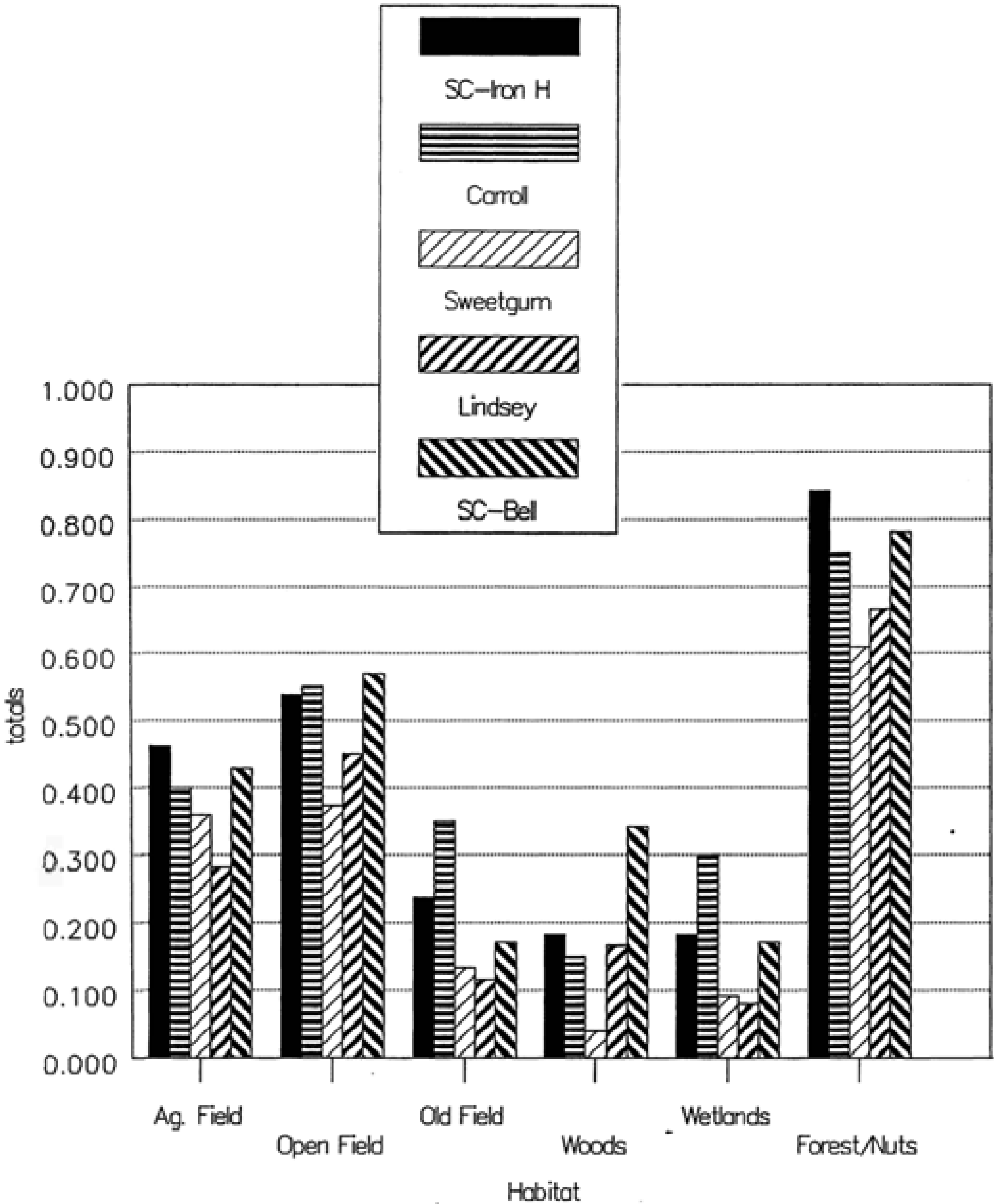

Figure 16: **Ubiquity of floral macrofossils from selected habitats (site). Only floated proveniences are considered.**

graphically.

Discussion

In contrast to the increasing diversity of taxa noted in the occurrence list (Table 10, page 185), the phase level ubiquity index, modeled in Table 17 and Figure 15 reveals that each habitat, other than woods/thicket, is represented in a decreasing number of proveniences over time. Agricultural crops and the complementary open field genera decline from 46% to 33% and 54% to 49% respectively between Iron Horse and Bell. Old field and wetland taxa also decline. The woods/thicket habitat drops dramatically during the Dyar phase but recovers, and stands alone in increasing by 3.5% over the Iron Horse phase in the Bell phase. Nut shell declines slightly from 84.2% to 77.9% between the Iron Horse and Bell phases, but during the intermittent Dyar phase, it drops as low as 61%. In each phase, however, the proportion of proveniences containing representatives of the various habitats remain comparable relative to each other, with the noted exceptions of the woods/thicket habitat, and the decline in nuts during the Dyar phase. Analysis of variance, presented in Appendix K, indicates that the overall differences between mean ubiquity scores can be attributed to time period (phase) with 95% certainty. Variance in habitats is significant at the 99% confidence level.

An examination of individual sites by phase, depicted in Table 18 and Figure 16 reveals an analogous pattern, although the Dyar phase Sweetgum site and the Bell phase occupation at Sugar Creek are somewhat irregular. It must be recalled that while Sugar Creek-Bell includes abundant postmolds, it contains only one feature under consideration. This fact affects the data by limiting the potential number of proveniences in which a taxon may be represented. The phase level data also illustrate that the bulk of nut shell decline in Dyar phase may, again, be attributed to poor floral recovery at the Sweetgum site. Analysis of variance, presented in Appendix L, confirms that site-phase (temporal-spatial unit designated as "site") and habitat individually contribute to the total variance in ubiquity scores at the 99% confidence level. The mean ubiquity score of the Sweetgum site (#3) varies from three of the remaining four site-phases, at a significance level of 90% or greater. It does not differ significantly from the Lindsey site (#4). This same ANOVA illustrates that differences in overall mean taxa ubiquity between the Iron Horse (#1) and Bell (#5) phases at Sugar Creek are essentially devoid of statistical significance.

This ubiquity analysis, superficially, contradicts the density ratio, showing a decline in representation of all habitats over time. However, additional factors must be considered. Although every category of habitat is represented in a decreasing number of features and postmolds over time, concentrations of most categories increase accordingly, as demonstrated in the density study (Table 11, Figure 9, Table 12, Figure 10).

Ubiquity is greatly affected by circumstances of deposition. Several different scenarios concerning changes in disposal habits during the Lamar period can be proposed. First, there may be a relationship between the size of a site's population, length of occupation, and the amount of activity resulting in the scattering of botanical remains to various proveniences. Based on the limited physical site dimensions and minimal architecture, each Bell phase component, Lindsey and Sugar Creek, is thought to represent a shorter-term occupation than those having multiple rectangular structures. This condition probably limited the amount of disturbance of the assemblage, relative to activity at earlier phase sites. Second, the numbers, types, and locations of features and postmolds may also affect the ubiquity analysis. Williams has observed a change in disposal patterns over the course of the Lamar period in the Oconee region (Hatch 1995, personal communication). During the earlier phases, numerous, relatively small litter-filled basins were identified at typical sites, and there were no large trash pits reminiscent of borrow pits (Dickens 1985). By the late Lamar period, sites typically featured a dominant trash-filled pit, with far fewer small refuse basins (Hatch 1995, personal communication). While incidental deposition of trash still occurs elsewhere, the majority of refuse is anticipated in the designated trash receptacles (Hatch 1995, personal communication). As the pits formally designated for garbage disposal declined in number and expanded in size, a corresponding decrease in ubiquity of any given taxon should be observed. This change is exactly what occurs over the course of the Lamar period.

The high percentage of proveniences in every phase containing agricultural products and nuts, denotes an agricultural society having a strong reliance on the piedmont forest nut resources. Mast represents an important source of calories and protein, and complements the high carbohydrate contribution of corn to the diet. The vegetative products of other habitats merely provide variety and supplementary nutrients, with the possible exception of wild beans. Wild beans most likely filled a dietary role similar to that of domestic varieties (Strachey 1849 [1612]; Wilson 1987 [1917]), and unlike the common bean, were found in small but constant proportions of proveniences in every phase.

Comparison Ratios and Proportions

A series of comparison ratios, described in Chapter 7, is employed to track patterns of plant use over time. The first three equations, repeated here, measure the relative dietary importance of wild foods versus cultigens, using wood charcoal as the norming variable. As is discussed in Chapter 7, these ratios are based solely on feature fill, to preclude confusing charcoal from construction wood with that of fuel wood. The latter type of wood is most likely to be found in association with foodstuffs. The first calculation is the ratio of seed[1] counts from edible taxa of various habitats to wood charcoal.

The results of this test are presented in Table 19 (phase) and Table 20 (site), Figure 17 (phase) and Figure 18 (site).

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[1]As described elsewhere, the term "seed" is used, throughout this dissertation, to include both the reproductive structures of plants, and also small portions of non-reproductive plant tissue (*e.g.*, grass stem internodes, tuber fragments, cucurbit rind), that are present in numbers similar to seeds.

Table 19: Ratio of seed count:wood weight (g) of edible taxa.

Habitat	Iron Horse	Dyar	Bell
Agricultural Field	0.296	0.382	2.504
Open Field	0.524	1.606	1.042
Old Field	1.410	0.107	0.097
Woods	0.153	0.013	0.105
Wetlands	0.005	0.380	0.005

Table 20: Ratio of seed count:wood weight (g) of edible taxa.

Habitat	Iron Horse - Sugar Creek	Dyar - Carroll	Bell - Lindsey
Agricultural Field	0.296	0.110	3.393
Open Field	0.524	0.886	1.522
Old Field	1.410	0.118	0.139
Woods	0.153	0.004	0.118
Wetlands	0.005	0.371	0.005

		Dyar - Sweetgum	Bell - Sugar Creek
Agricultural Field		0.930	1.606
Open Field		3.102	0.557
Old Field		0.085	0.054
Woods		0.017	0.141
Wetlands		0.397	0.000

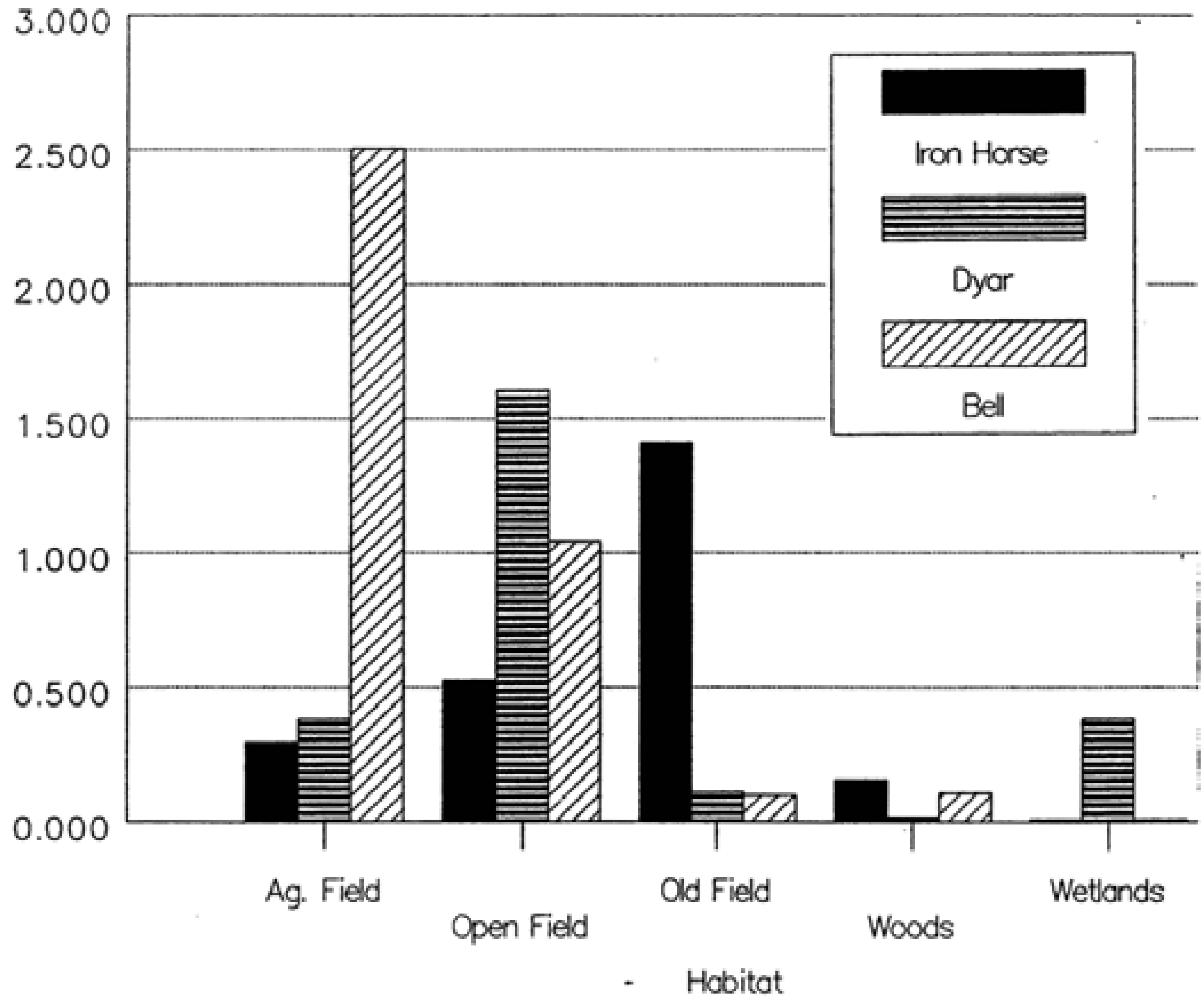

Figure 17: Ratio of seed count:wood weight (g) of edible taxa.

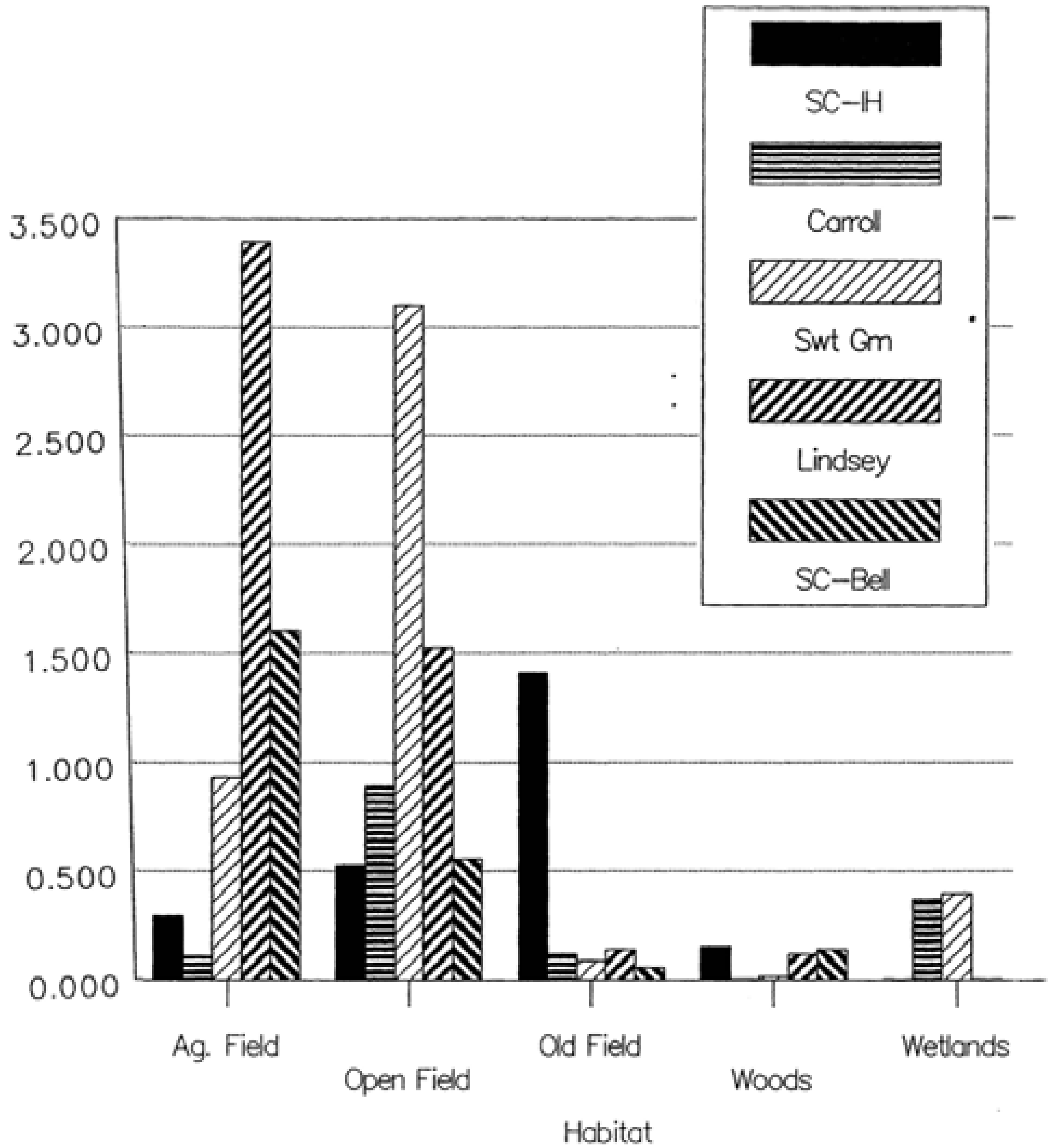

Figure 18: Ratio of seed count:wood weight (g) of edible taxa.

$$N_e:\ W \tag{8.1}$$

(8.1) N_e = total number of edible seeds

W = total weight of wood in (g)

The ratios of edible seeds to wood charcoal portray a sharp increase in agricultural products during the Bell phase. This result is as clear at each individual site (Table 20, Figure 18), as it is at the phase level evaluation (Table 19, Figure 18). Old field taxa, on the other hand, dominate the Iron Horse assemblage (Table 19, Figure 17), and drop off quickly, and permanently, in the Dyar phase. Of interest is the fact that open field taxa, often associated with agriculture, are highest in the Dyar phase (Table 19, Figure 17), and at the Sweetgum site (Table 20, Figure 18), although these are the phase and site which have the least overall evidence of agricultural activity.

Two similar sets of ratios evaluate the prominence of corn cob and nut shell in the assemblages.

$$W_{z_c}:W \tag{8.2}$$

(8.2) W_{zc} = total weight of corn cob (*Zea mays*) (g)

W = total weight of wood charcoal (g)

$$W_n:W \tag{8.3}$$

(8.3) W_n = total weight of nut shell (g)

W_w = total weight of wood charcoal (g)

For reasons discussed in chapter 7, only corn cob and nut shell from features are considered and these are measured by weight in grams, rather than by count. Each is contraste to the weight of the norming variable, wood charcoal. Results are presented in Table 21, Table 22, Figure 19, and Figure 20.

These two sets of proportions, based on discrete plant tissues, test the importance of wild versus cultivated foods from different perspectives. In contrast to seeds, which represent an unintended loss during processing, both nut shell and corn cob are deliberately discarded food by-products. Under certain circumstances, both nut shell and corn cob were used as fuel, a circumstance that enhances the possibility of preservation. However, nut shell was more often burned as fuel than corn cob and corn cob degrades more readily than nut shell. Considering these factors, absolute ratios of nut shell or corn cob to wood are unimportant, rather, it is the configuration of ratios that is meaningful.

Table 21 and Figure 19 the ratios of nut shell and of corn cob to wood, clearly illustrate that nut use increased nearly ten times between Iron Horse and Bell phases. Both nut shell and corn cob are more abundant over time, but each varies considerably in abundance between sites and phases. These fluctuations are most likely related to field and forest productivity. At Sugar Creek the ratio of corn cob to wood is virtually identical in the Iron Horse and Bell occupations, with the ratio of cob to wood being only .003 higher in the earlier time frame. At the same site, the nut shell to wood ratio inflates by 0.222 in the Bell phase. These ratios point to a steady dependence on corn as the main staple over time, with an increased harvesting of nut resources.

Table 21: Ratio of nut shell (g) and corn cob (g): wood charcoal (gm) (phase).

Phase	Nuts: Wood	Cob: Wood
Iron Horse	0.040	0.013
Dyar	0.135	0.006
Bell	0.395	0.021

Table 22: Ratio of nut shell (g) and corn cob (g): wood charcoal (g) (site).

Phase / Site	Nuts: Wood	Cob: Wood
Iron Horse / Sugar Creek	0.040	0.013
Dyar / Carroll	0.172	0.005
Dyar / Sweetgum	0.061	0.009
Bell / Lindsey	0.526	0.033
Bell / Sugar Creek	0.262	0.010

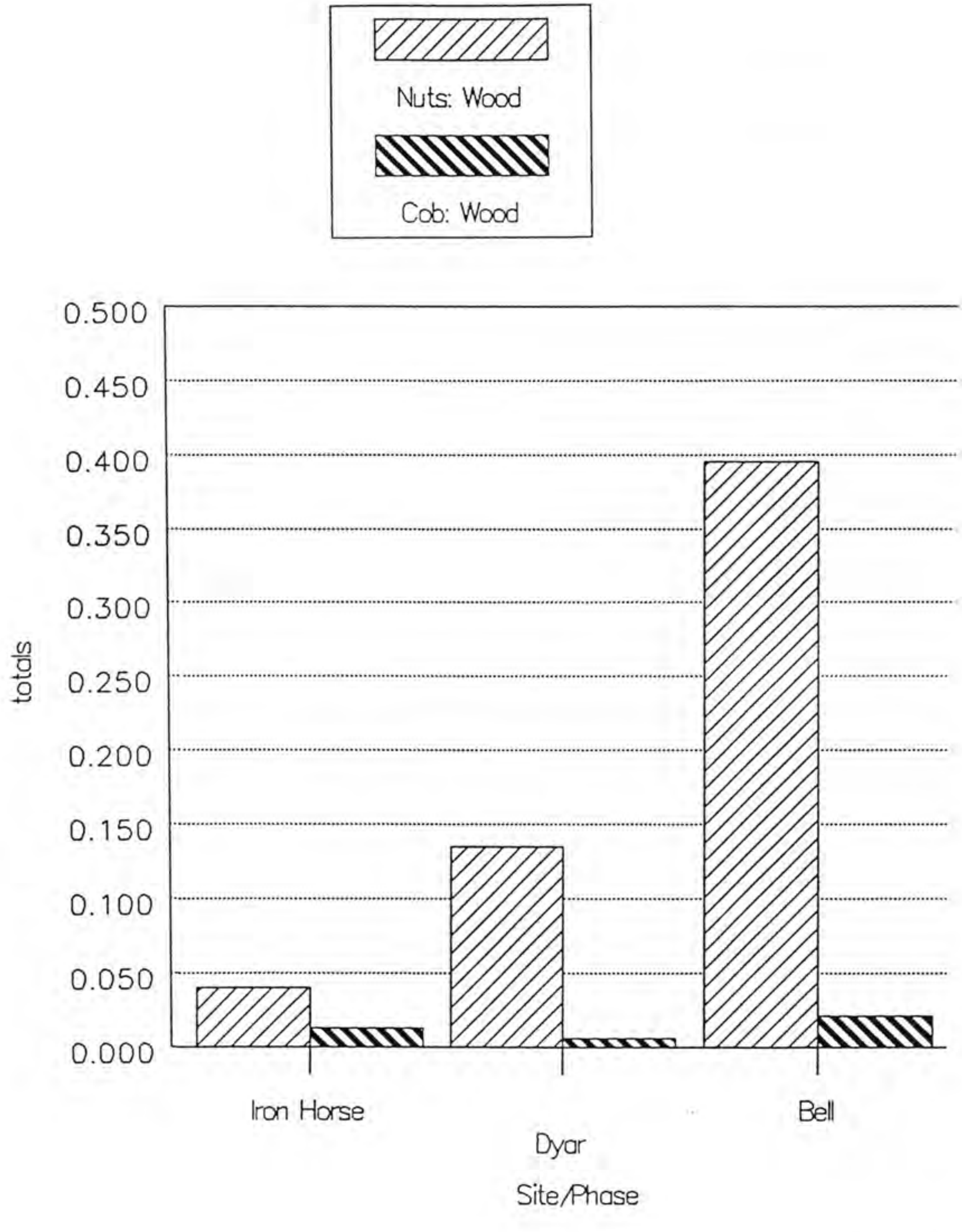

Figure 19: Ratio of nut shell (g) and corn cob (g): wood charcoal (g).

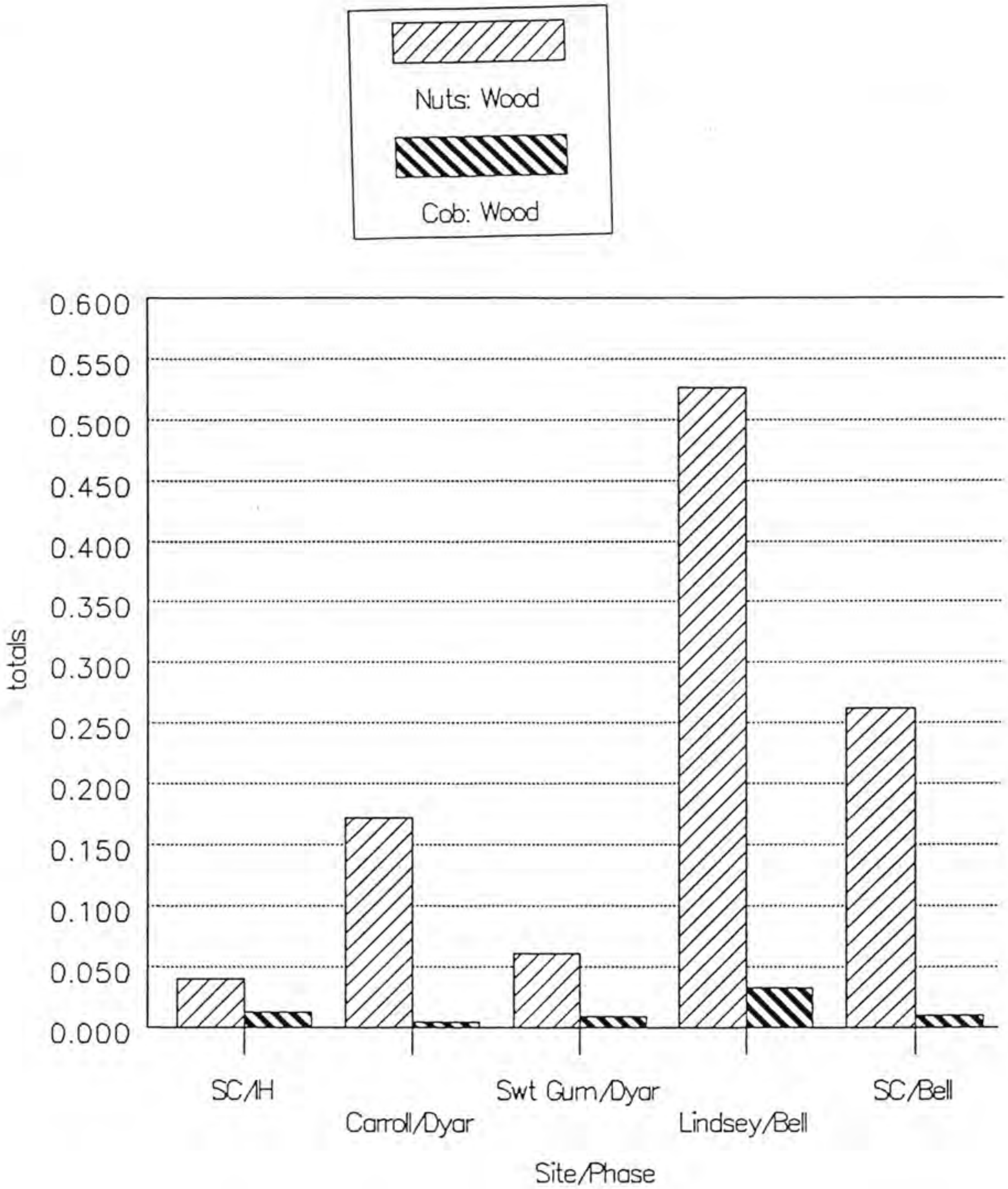

Figure 20: Ratio of nut shell (g) and corn cob (g): wood charcoal (g).

A ratio of corn kernel weight to corn cob weight is calculated to approximate the amount of corn being produced and retained at the sites over time. This ratio is reported for each phase and site in Table 23, Table 24, Figure 21, and Figure 22 respectively, and is based on (8.4), reproduced here from chapter 6.

$$W_z:W_{zc} \tag{8.4}$$

(8.4) W = total weight (g)

z = *Zea mays* kernels

zc = *Zea mays* cob

The phase level analysis (Table 23, Figure 21) depicts a rambling decrease in the ratio of corn kernels to cob. Table 24 and Figure 22 represent a series of site-specific ratios exhibiting no apparent relationship between phase-paired sites. The patterns represented are superficially counter-intuitive, showing little consistency, and an overall decline in ratio. As discussed in Chapter 7, any number of preservation, technological, political, or social factors may account for these circumstances. As noted in Chapter 7, over time a decrease in the kernel to cob ratio actually indicates higher corn production, due to the increased likelihood of cobs being used for fuel and thus being more apt to preserve than kernels (Lopinot 1992). While the corn-cob filled feature at Sugar Creek is not incorporated in this ratio, it is important to note that it dates to the Bell phase and that the cobs clearly functioned as fuel. This finding dovetails with the supposition that lower kernel to cob ratios in the Bell phase represent increased use of cobs as fuel.

Table 23: Ratio of corn kernels (g): corn cob (g) (phase).

Phase	Ratio
Iron Horse	0.348
Dyar	0.556
Bell	0.119

Table 24: Ratio of corn kernels (g): corn cob (g) (site).

Phase / Site	Ratio
Iron Horse / Sugar Creek	0.348
Dyar / Carroll	0.069
Dyar / Sweetgum	0.557
Bell / Lindsey	0.243
Bell / Sugar Creek	0.056

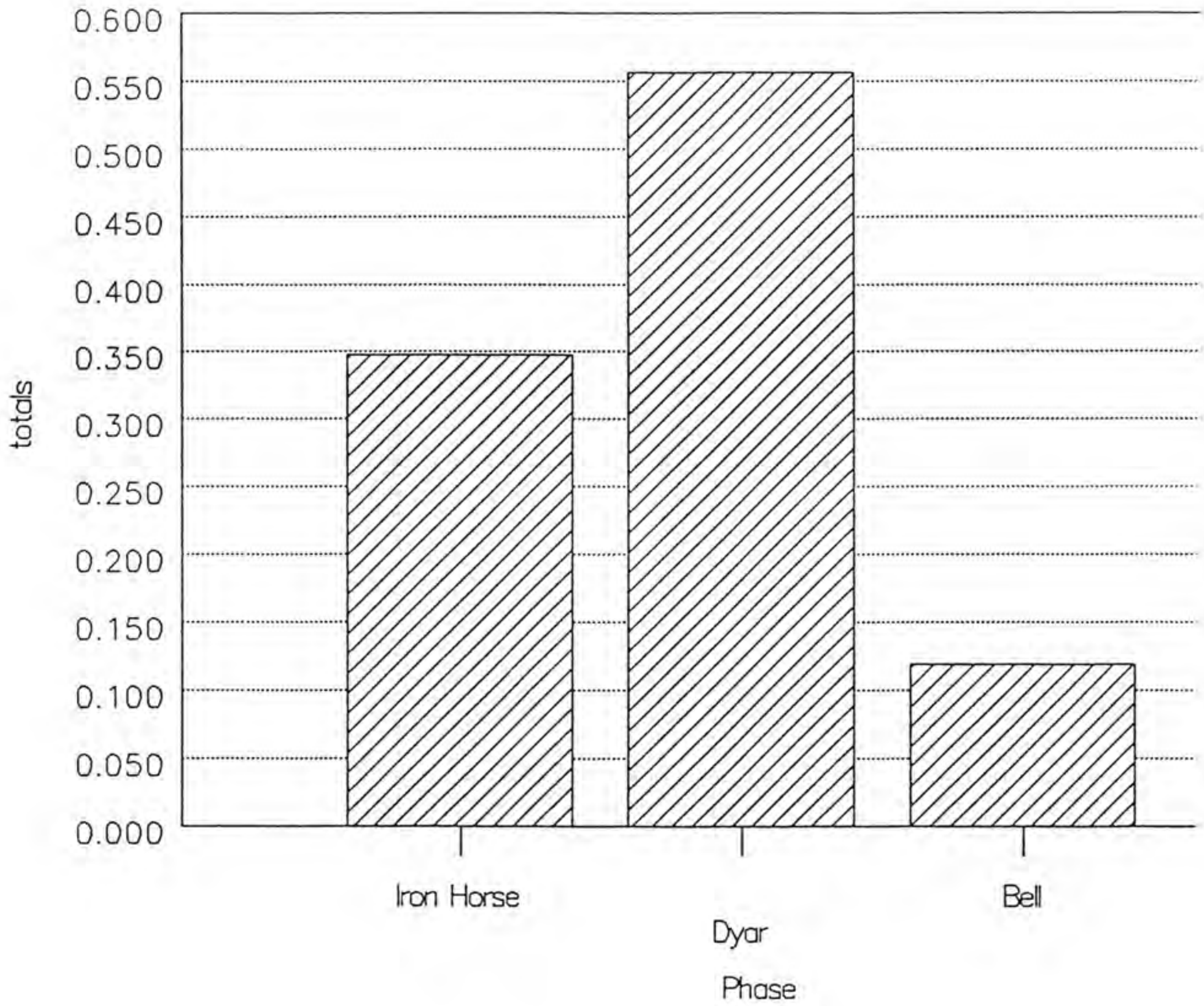

Figure 21: Ratio of corn kernels (g): corn cob (g).

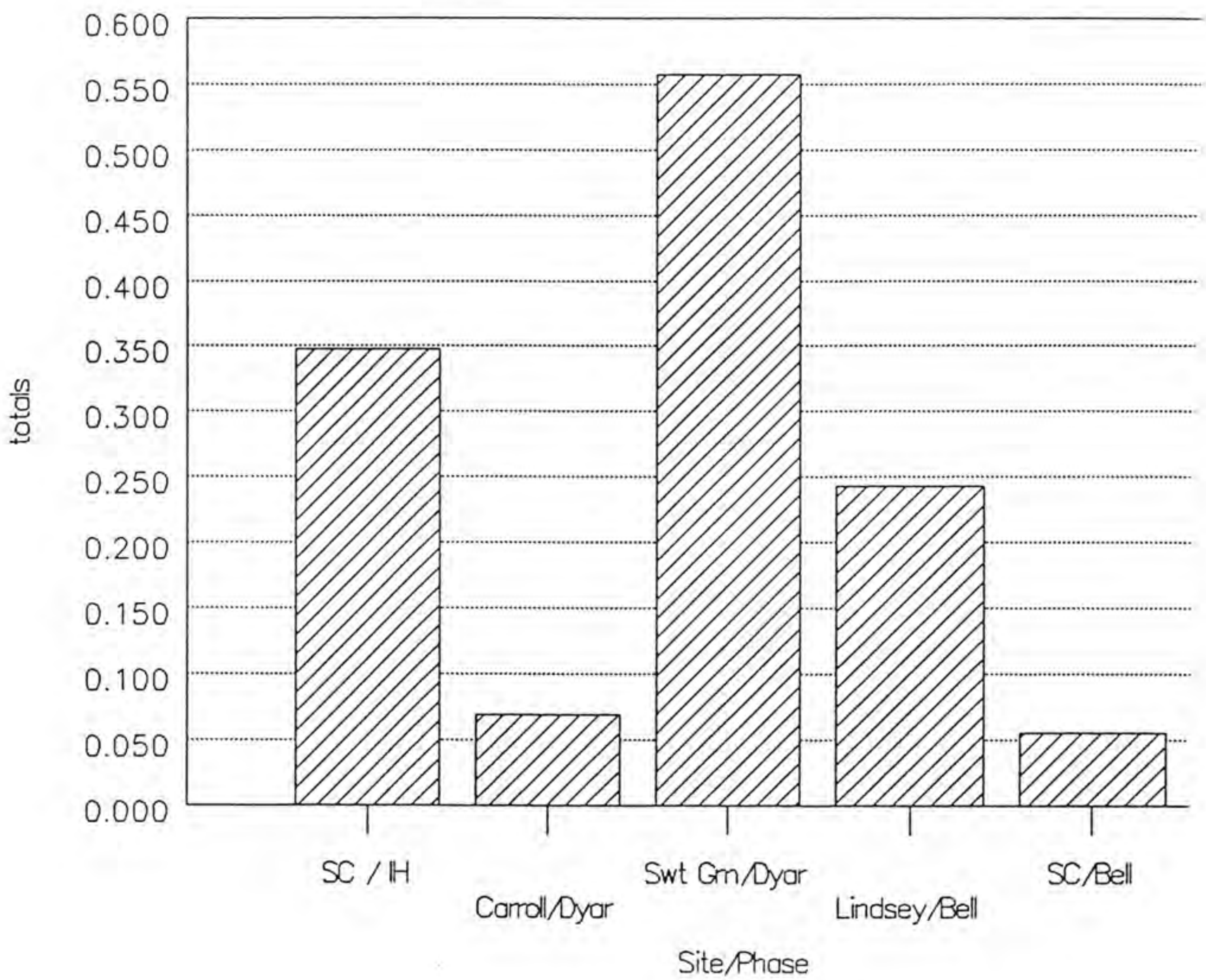

Figure 22: Ratio of corn kernels (g): corn cob (g).

Finally, as discussed in Chapter 7, the relative abundance of edible wild seeds and cultigens in each phase is evaluated by expressing each as a proportion of total seed count.(8.5) All floated proveniences are included in this ratio.

$$N_x{:}Q \tag{8.5}$$

(8.5) N = count of seeds

x = class of seeds

Q = sum of all seeds

Proportions of wild edible plants, cultigens, inedible seeds, and unidentified seeds in the assemblage present a pattern, which is particularly clear at the phase level of consideration (Table 25 and Figure 23). Wild edible plant and cultigen seeds are inversely variable. As cultigens achieve prominence, wild seeds decline in number. The contrast between Bell and the earlier Lamar phases is striking. Note that these ratios do not include nuts, which are considered separately. At the phase level (Table 25 and Figure 23), the seeds of wild edible plants dominate in the Iron Horse and Dyar phases, while cultigens achieve indisputable prominence in the Bell phase sites . The relative stasis of the proportion of unidentified seeds attests to the validity of these observations. At the site level, Table 26 and Figure 24, these same patterns are evident. This result does not necessarily imply that wild edible seeds and cultigens are fully substitutable for one another. Configurations of inedible wild plants parallel those of edible wild plants.

Table 25: Proportions of seed types (phase).

Ratio	Iron Horse	Dyar	Bell
Cultigens: All Seeds	0.257	0.125	0.604
Inedible: All Seeds	0.056	0.159	0.041
Unidentified: All Seeds	0.054	0.082	0.050
Wild Edible: All Seeds	0.633	0.635	0.299

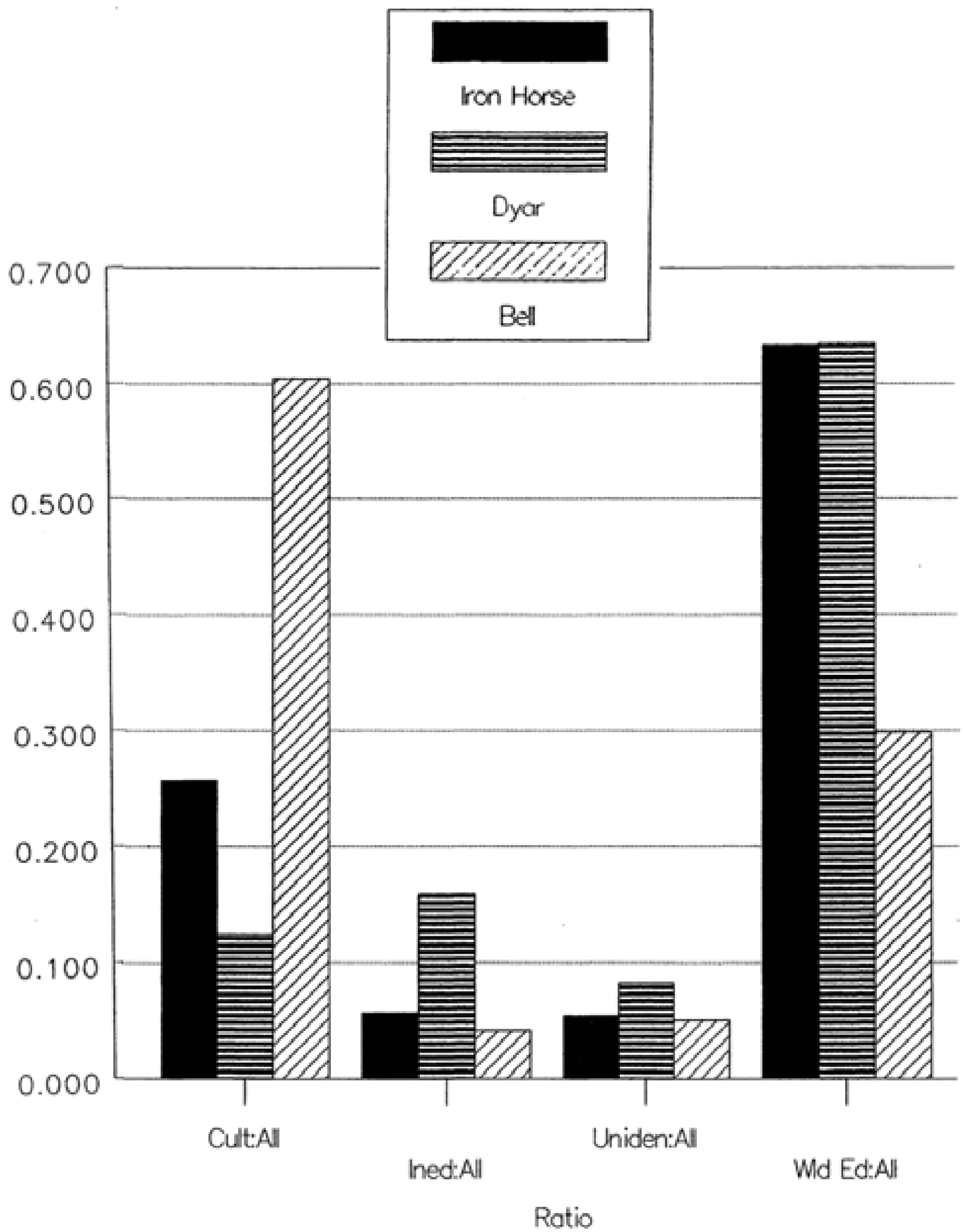

Figure 23: **Proportions of seed types (phase).**

Table 26: Proportions of seed types (site).

Ratio	Sugar Creek / Iron Horse	Carroll / Dyar	Sweetgum / Dyar	Lindsey / Bell	Sugar Creek / Bell
Cultigens: All	0.257	0.050	0.179	0.658	0.469
Inedible: All	0.257	0.220	0.113	0.026	0.079
Unidentified: All	0.054	0.090	0.074	0.036	0.103
Wild Edible: All	0.633	0.636	0.634	0.279	0.349

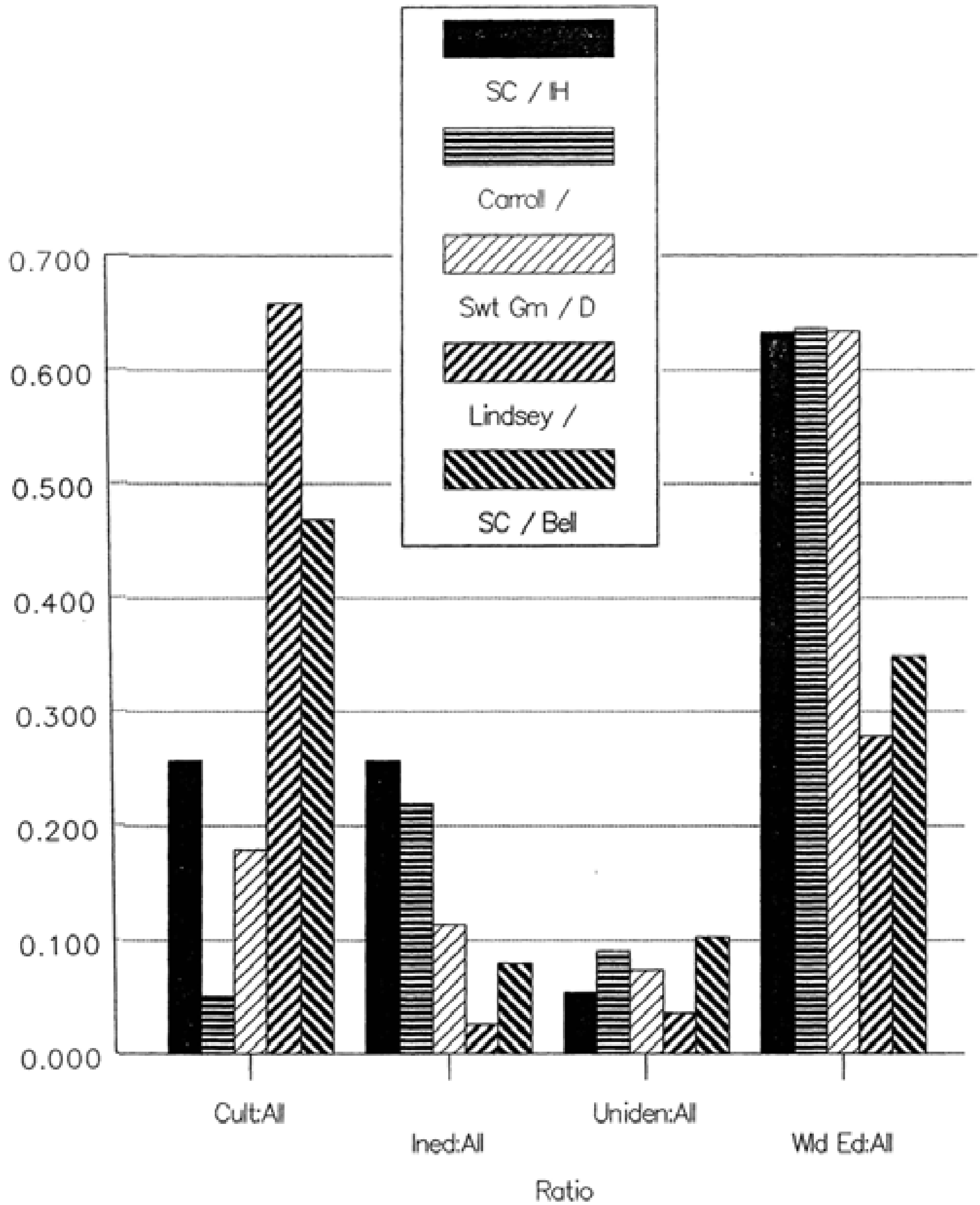

Figure 24: Proportions of seed types (site).

These inverse relationships between seeds of all wild plants versus cultigens is most likely due to the habitat modification dictated by agricultural extensification. In fact, as all wild seeds except mast and first-line animal resources decline, nut shell and cultigens become more prominent in the archaeological record (Figure 11, Figure 19).

Conclusion

In Chapter 8, I explore and manipulate the data acquired through laboratory analysis of field specimens. This study supports a model of increasing dependence on agriculture and nuts over the course of the Lamar period. An agricultural based subsistence system is supplemented by a suite of wild plant products, which are husbanded to some extend through the careful manipulation of fallow fields. In Chapter 9, I employ these results in exploring the research problems proposed in Chapter 2.

Chapter 9

ANALYSIS OF DATA II: WOOD

Wood is evaluated from three main perspectives for each phase and site. First, the varieties of wood are enumerated. Second, the proportions of hardwood, pine, and unclassifiable wood represented in various contexts is calculated. Finally, the number of proveniences in which each type of wood dominated is presented. Hardwood, pine, or a balanced mixture of each are the groupings used for the last appraisal. It should be noted that pine was the only softwood positively identified at any of these sites.

Wood Taxon Occurrence

Table 27, the wood occurrence list, Table 28 (phase) and Table 29 (site), wood inventories taxa, and the corresponding Figures 25 and 26, represent individually distinguishable genera from which the wood charcoal was derived. Neither the phase (Table 28) nor the site level analysis (Table 29) demonstrates sizable disparity among analytical units. Perhaps the most significant contrast is found between the Iron Horse and Bell phases at Sugar Creek. Table 27, the wood occurrence list, discloses that while there is a net difference of three taxa between phases at Sugar Creek, in reality, there are

Table 27: Wood taxa occurrence.

Taxon	Iron Horse - SC	Dyar - Carroll	Dyar - Swt Gum	Bell - Lindsey	Bell - SC
Acer spp. (maple)	+	+	+	+	+
Carya spp. (hickory)	+	+	+	+	+
Castanea spp. (chestnut)	+	-	+	-	-
Castanopsis spp. (chinkapin)	-	-	-	-	+
Celtis spp. (hackberry)	-	+	-	-	-
Cornus florida (dogwood)	-	+	-	-	-
Diospyros virginiana (persimmon)	-	-	-	-	+
Fagus spp. (beech)	+	-	-	-	+
Fraxinus spp.(ash)	+	-	+	+	+
Ilex spp. (holly)	-	+	-	-	-
Juglans spp. (walnut)	+	+	-	+	+
Liquidamber styraciflua (sweetgum)	-	+	-	-	+
Morus rubra (mulberry)	+	-	-	-	-
Nyssa spp. (blackgum)	+	-	-	-	-
Pinus spp. (pine)	+	+	+	+	+
Platanus sp. (sycamore)	+	-	-	-	-
Populus sp. (poplar)	+	-	-	-	-
Prunus spp. (cherry family)	+	+	+	-	-
Quercus spp. (oak)	+	+	+	+	+
Robinia pseudoacacia (black locust)	+	-	-	+	-
Salix spp. (willow)	-	+	+	+	-
Sassafras albidum (sassafras)	-	-	-	-	+

Table 28: Wood taxa counts (phase).

Phase	Species Count
Iron Horse	14
Dyar	13
Bell	13

Table 29: Wood taxa counts (site).

Phase / Site	Species Count
Sugar Creek / Iron Horse	14
Carroll/ Dyar	11
Sweetgum / Dyar	8
Lindsey / Bell	8
Sugar Creek / Bell	11

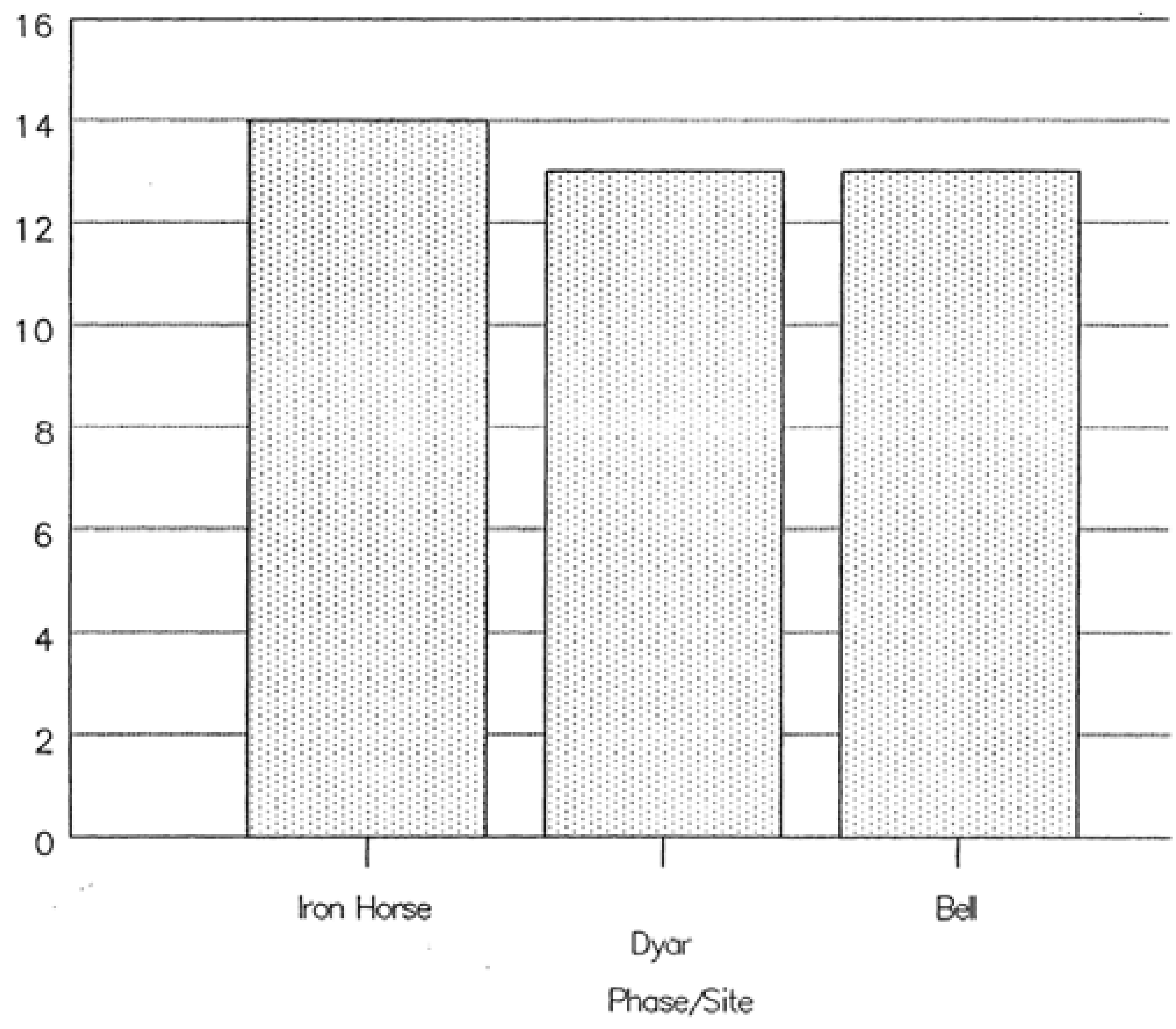

Figure 25: **Wood taxa counts (phase).**

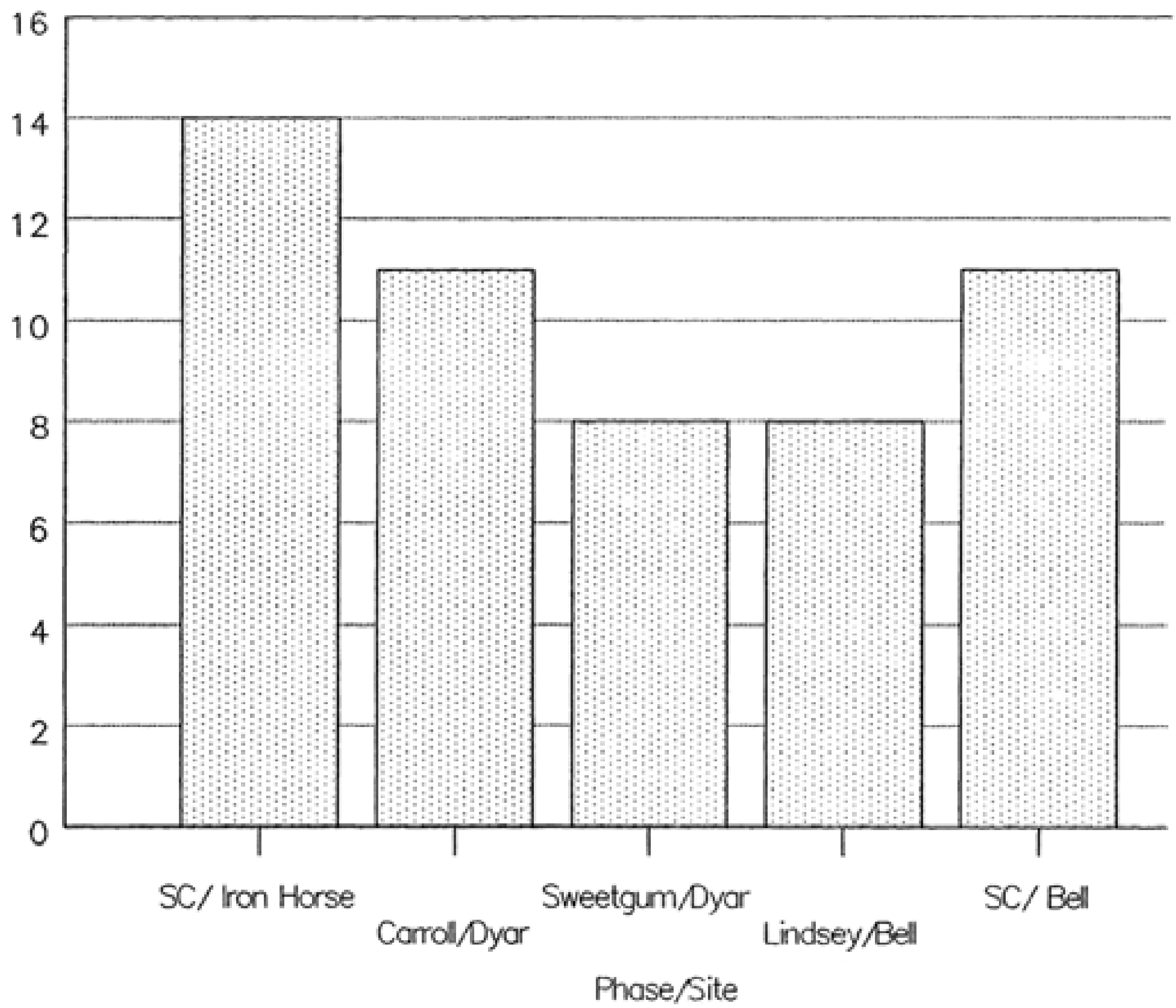

Figure 26: Wood taxa counts (site).

10 individual taxa present in one or the other phases exclusively. This variation most likely reflects the random collection of firewood representing minor forest components. Of special interest is the fact that the only site to contain beech charcoal is Sugar Creek, where it is represented in both the Iron Horse and Bell phases. Beech nuts were also identified at both phases of Sugar Creek and no where else (Table 10). This discovery strengthens the premise that beech nuts were locally available and easily acquired at Sugar Creek.

Proportions of Wood Types

Table 30 (phase), Table 31 (site), and the corresponding Figure 27, and Figure 28, depict the proportion of each major classification of wood charcoal relative to the total wood charcoal assemblage. These tables and figures are based on the following equation, repeated from Chapter 7.

$$N_x\text{:}\quad Q \tag{9.1}$$

(9.1) N = count

X = taxon

Q = sum of identified species

These tabulations indicate that there is little overall change in the pattern of wood resource exploitation during the Lamar period. Pine is consistently recovered in the

Table 30: Proportions of wood types (phase).

Phase	Hardwood	Pine	Mixed
Iron Horse	0.302	0.676	0.022
Dyar	0.311	0.665	0.024
Bell	0.390	0.582	0.034

Table 31: Proportions of wood types (site).

Phase / Site	Hardwood	Pine	Unclassified
Iron Horse / Sugar Creek	0.302	0.676	0.022
Dyar / Carroll	0.393	0.584	0.024
Dyar / Sweetgum	0.279	0.695	0.026
Bell / Lindsey	0.394	0.586	0.032
Bell / Sugar Creek	0.386	0.577	0.036

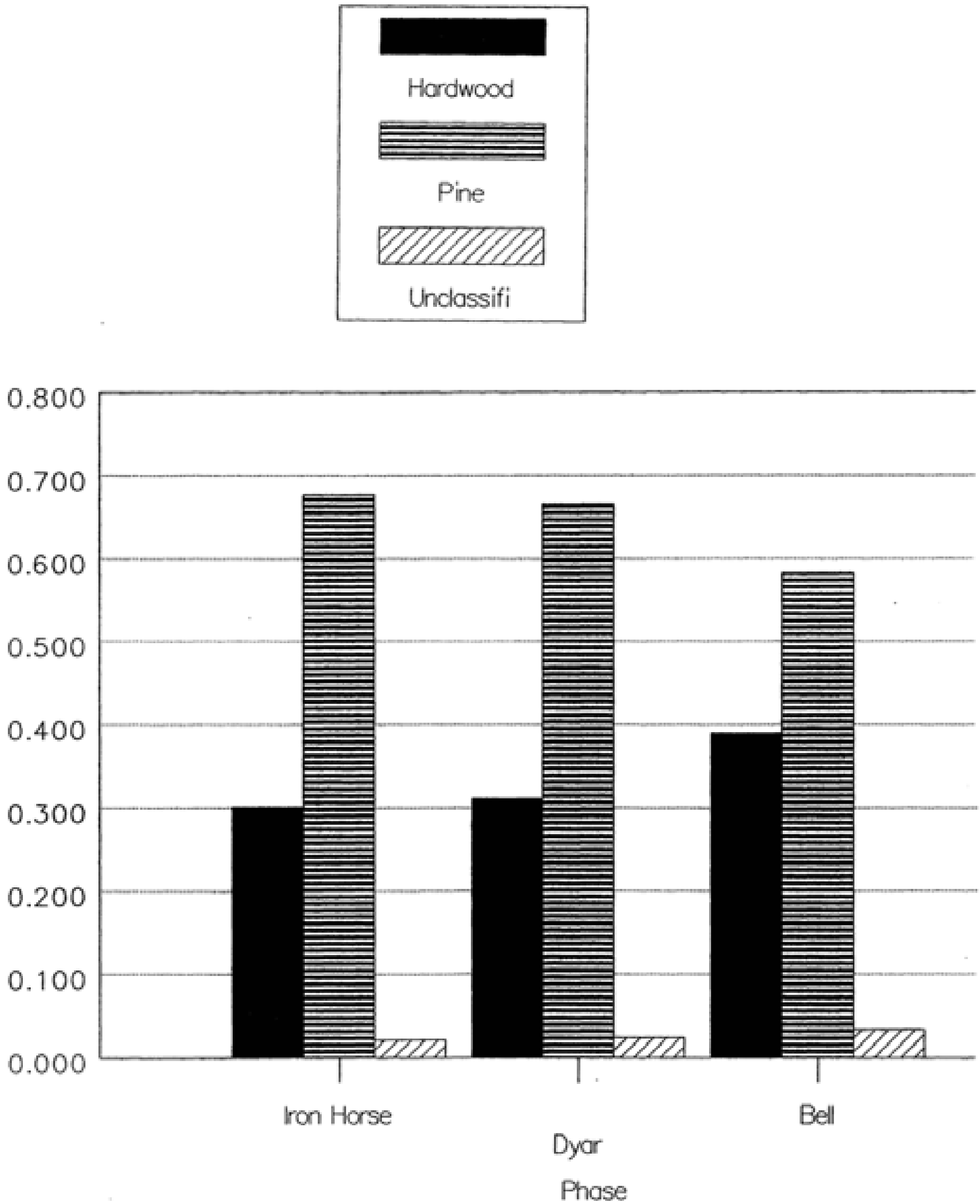

Figure 27: Proportions of wood types (phase).

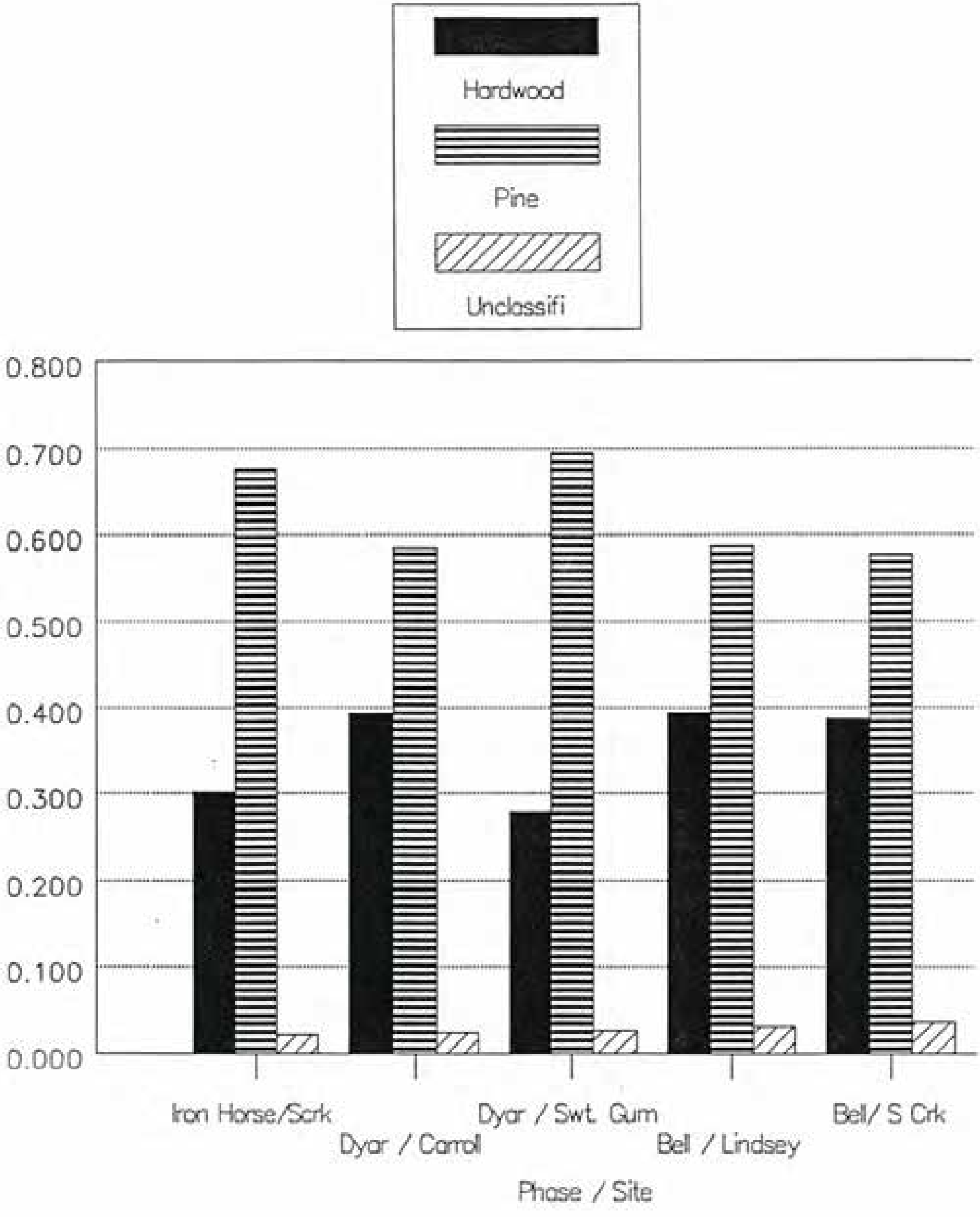

Figure 28: Proportiona of wood types (site).

greatest quantities, ranging from 58% to 68% of the wood at the phase level (Table 30, and Figure 28). There is a minor (9%) reduction in the use of pine between the Iron Horse and Bell phases, with a complementary slight increase (9%) in hardwood utilization. At the individual site level (Table 31 and Figure 28), pine consistently dominates hardwood in similar proportions.

The analysis of variance (Appendix K) on these phase-average figures was uncharacteristically decisive. Both the assumptions of constant variance and normality of error term were clearly met. The results indicate that there is no significant variance between the different proportions of wood which is attributable to phase alone, while observed variance is associated with type (wood classification) at the 99% confidence interval. Each type of wood differs in proportion from the other with 99% certainty. This same test was run using data from individual proveniences and is presented in Appendix L. In this case the assumption of constant variance proved to be false, but the normality of the error term was clearly met. The results were nearly identical to those based on over-all phase averages. Interaction effects, in the more complex ANOVA of appendix L, indicate that variation in the wood charcoal of assemblages which is attributable to a combination of time and place is significant to the 99% confidence interval. These two analyses of variance demonstrate that the slightly different proportions of hardwood and pine noted are statistically significant, and that the temporal association of the variation is also statistically significant.

Analysis By Provenience

In order to ascertain whether the quantitative discrepancies between wood taxa are an artifact of the timber's original function, or if they simply reflect availability of a particular taxon, an independent comparison between the wood assemblages of features and of postmolds is presented. In this comparison each provenience is classified according to the single type of wood that dominated its assemblage. The classifications employed were hardwood, pine, or "mixed." The "mixed classification is used in cases where neither hardwood nor pine is approximately 10% more abundant than the other. Indeterminate charcoal is excluded from this determination. Because only two Bell phase features were distinguished at Sugar Creek, the feature analysis is restricted to the phase level to minimize the skewing of results at Sugar Creek. Water-screened samples are included in this test, thus the Carroll site is fully represented.

Table 32, Table 33, Table 34, and Figure 29, Figure 30, and Figure 31 depict the proportions of features and postmolds that are dominated by particular woods. All indications are that pine outweighs hardwood in both the feature and postmold categories, throughout the Lamar period. This same phenomenon is observed in late prehistoric South Carolina and has been linked to the clearing of fields for agriculture, and use of fire for maintenance of vegetation (Wagner 1995, 1996).

Nevertheless, there is a greater overall tendency for hardwood to be found in features. Pine prevails in postmolds in 68 to 83% of cases at the phase level of analysis (Table 33, Figure 30). In contrast, hardwood, or mixed hardwood and pine is more prominent in features. Table 32 and Figure 29 indicate that up to 79% of Bell phase

Table 32: Proportion of features dominated by each wood type (phase).

Phase	Hardwood	Pine	Mixed
Iron Horse	0.222	0.556	0.220
Dyar	0.127	0.671	0.203
Bell	0.292	0.208	0.500

Table 33: Proportion of postmolds dominated by each wood type (phase).

Site / Phase	Hardwood	Pine	Mixed
Iron Horse	0.128	0.830	0.043
Dyar	0.159	0.683	0.202
Bell	0.167	0.682	0.152

Table 34: Proportion of postmolds dominated by each wood type (site).

Site / Phase	Hardwood	Pine	Mixed
Sugar Creek / Iron Horse	0.128	0.830	0.043
Carroll / Dyar	0.190	0.587	0.222
Sweetgum / Dyar	0.136	0.682	0.182
Lindsey / Bell	0.278	0.500	0.222
Sugar Creek / Bell	0.033	0.900	0.067

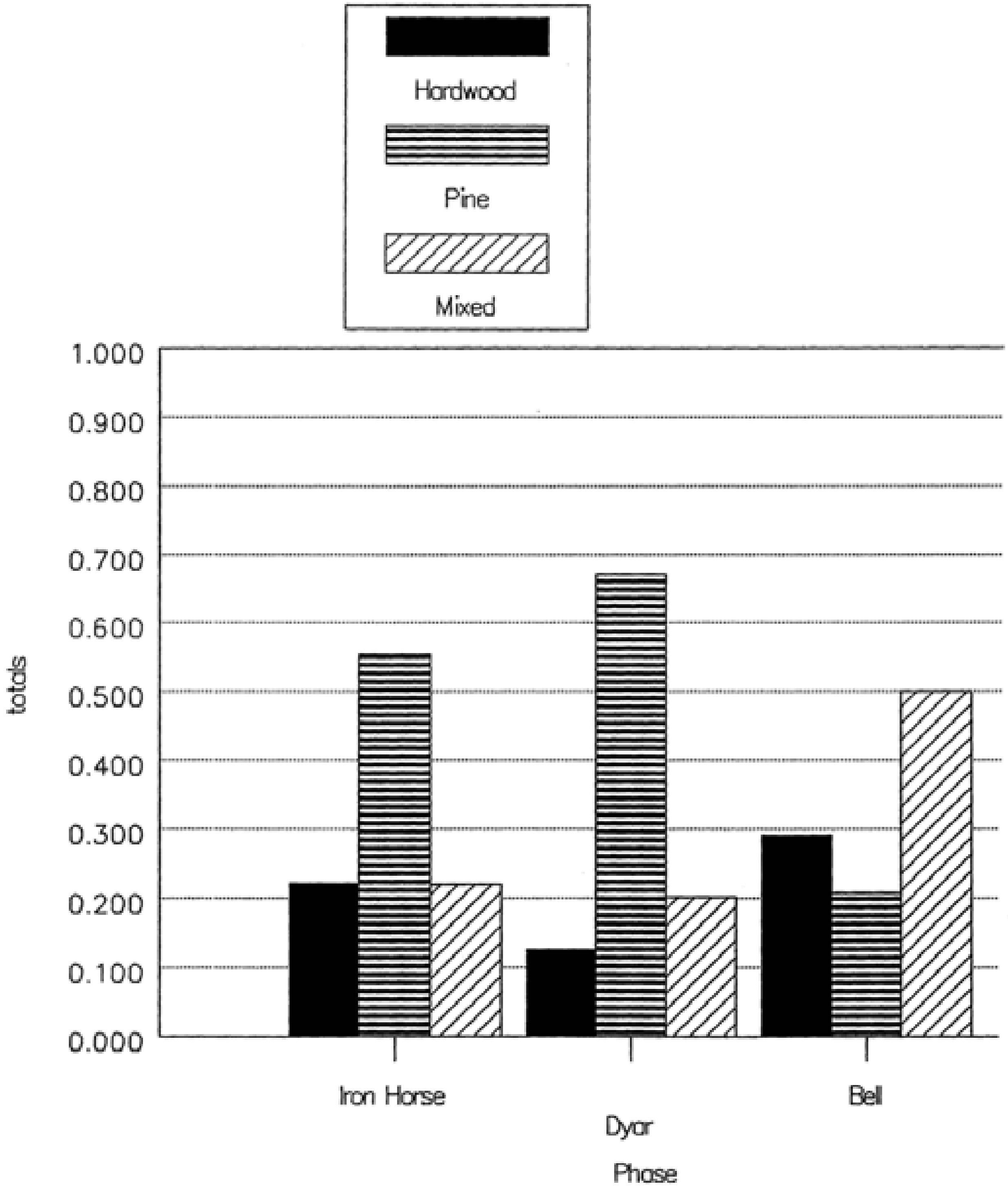

Figure 29: Proportion of features dominated by each wood type (phase).

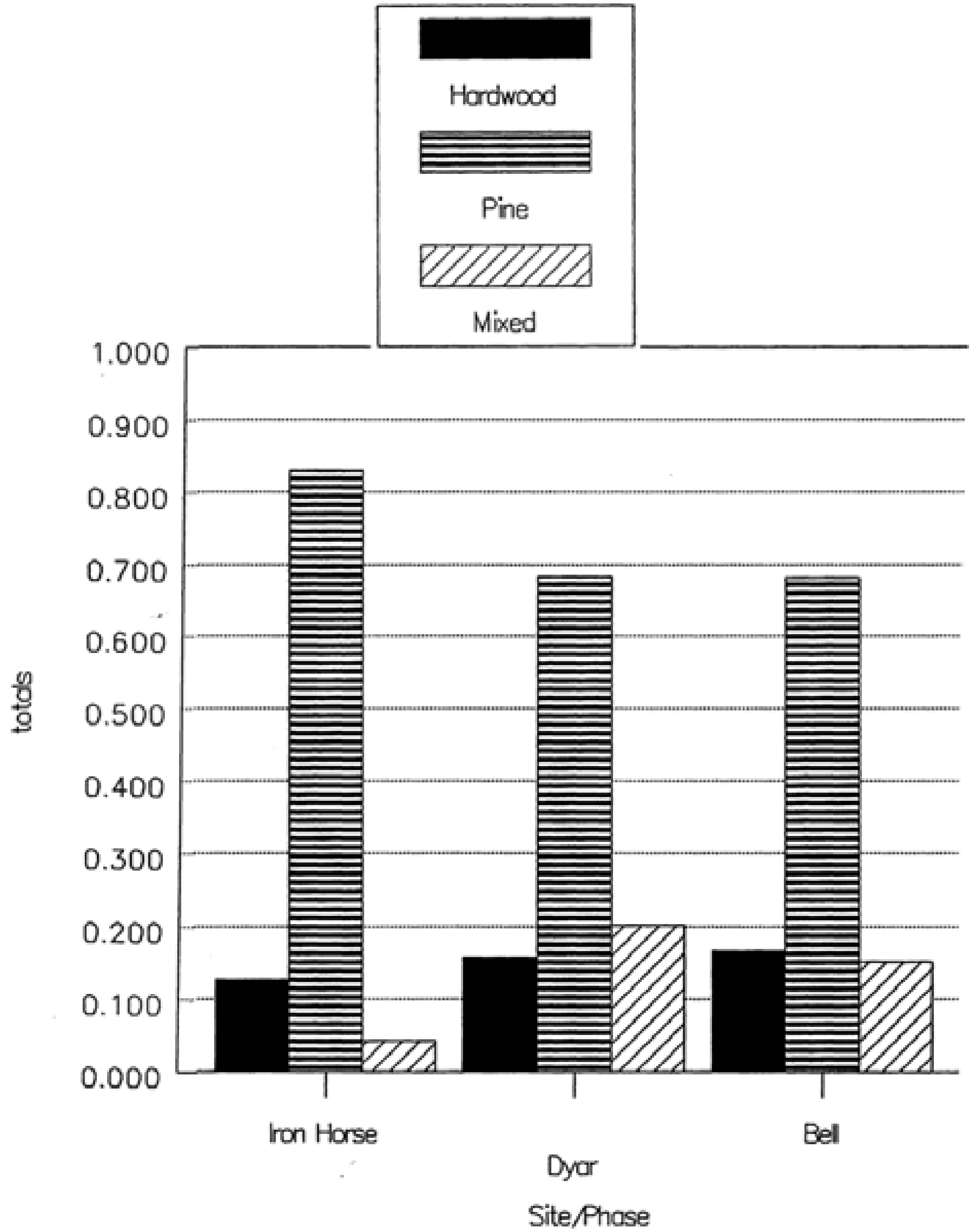

Figure 30: Proportion of postmolds dominated by each wood type (site).

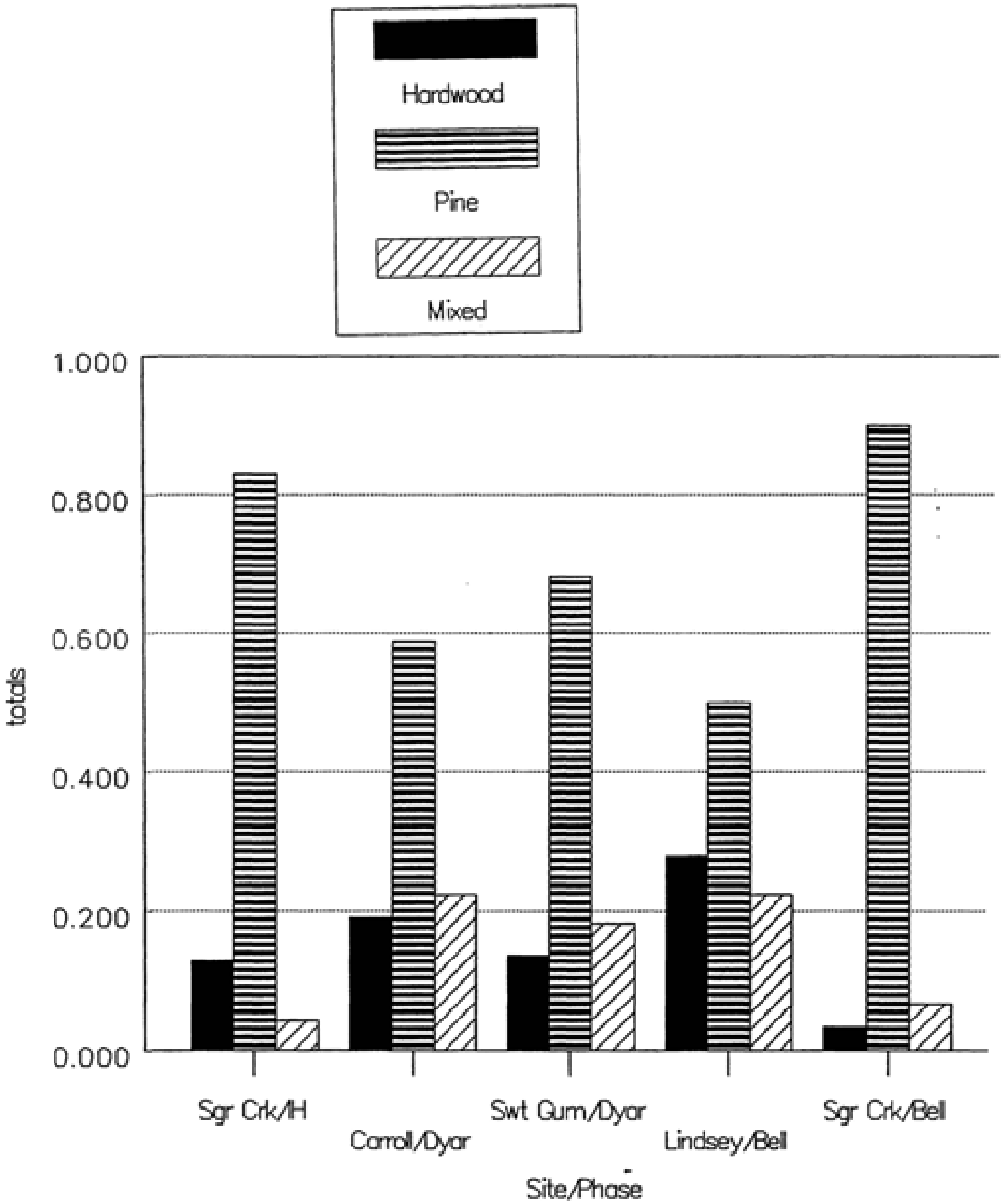

Figure 31: Proportion of postmolds dominated by each wood type.

features and 44% of Iron Horse features emphasize either hardwood or a mixture, but this figure dips to of 33% in the Dyar phase. In considering the proportion of postmolds characterized by each type of wood at the site level (Table 34 and Figure 30) some unevenness in the proportion of postmolds dominated by hardwoods or having a mixed assemblage is noted. Pine prevails in 59% to 90% of the postmolds at every site except Lindsey. As is true in the balance of the macrobotanical assemblage, the Lindsey wood distribution is unique.

These data indicate a slight but definite preference for particular types of wood to be used in different contexts. Since all posts were grouped together in this analysis, regardless of their original function as wall posts, interior house posts, supports for racks, or other miscellaneous functions, one further level of investigation was undertaken.

In this final wood appraisal, aimed at substantiating selectivity in regard to wood, house wall posts of both rectangular and circular houses were evaluated for their dominant wood type in Table 35, Table 36, Figure 32, and Figure 33. These charts clearly illustrate, that with the exception of the Lindsey site (Table 36, Figure 33), pine far outweighs hardwood as the material of choice in house wall construction. At every site except Lindsey, hardwood predominates primarily in contexts other than wall posts (Table 32, Figure 29). This test demonstrates that throughout the Lamar period, wood used for construction was consciously selected, rather than collected at random. The same can neither be said, nor ruled out, for firewood. The slightly higher presence of hardwood in features may indicate that this category was preferred as a fuel (Table 32,, *Table* 35: Proportion of house-posts dominated by each type of wood (phase).

Phase	Hardwood	Pine	Mixed
Iron Horse	0.605	0.935	0.00
Dyar	0.072	0.783	0.145
Bell	0.156	0.733	0.133

Table 36: Proportion of house-posts dominated by each type of wood (site).

Site / Phase	Hardwood	Pine	Mixed
Sugar Creek / Bell	0.065	0.935	0.00
Carroll / Dyar	0.100	0.750	0.150
Sweetgum / Dyar	0.061	0.796	0.143
Lindsey / Bell	0.385	0.583	0.077
Sugar Creek	0.061	0.788	0.152

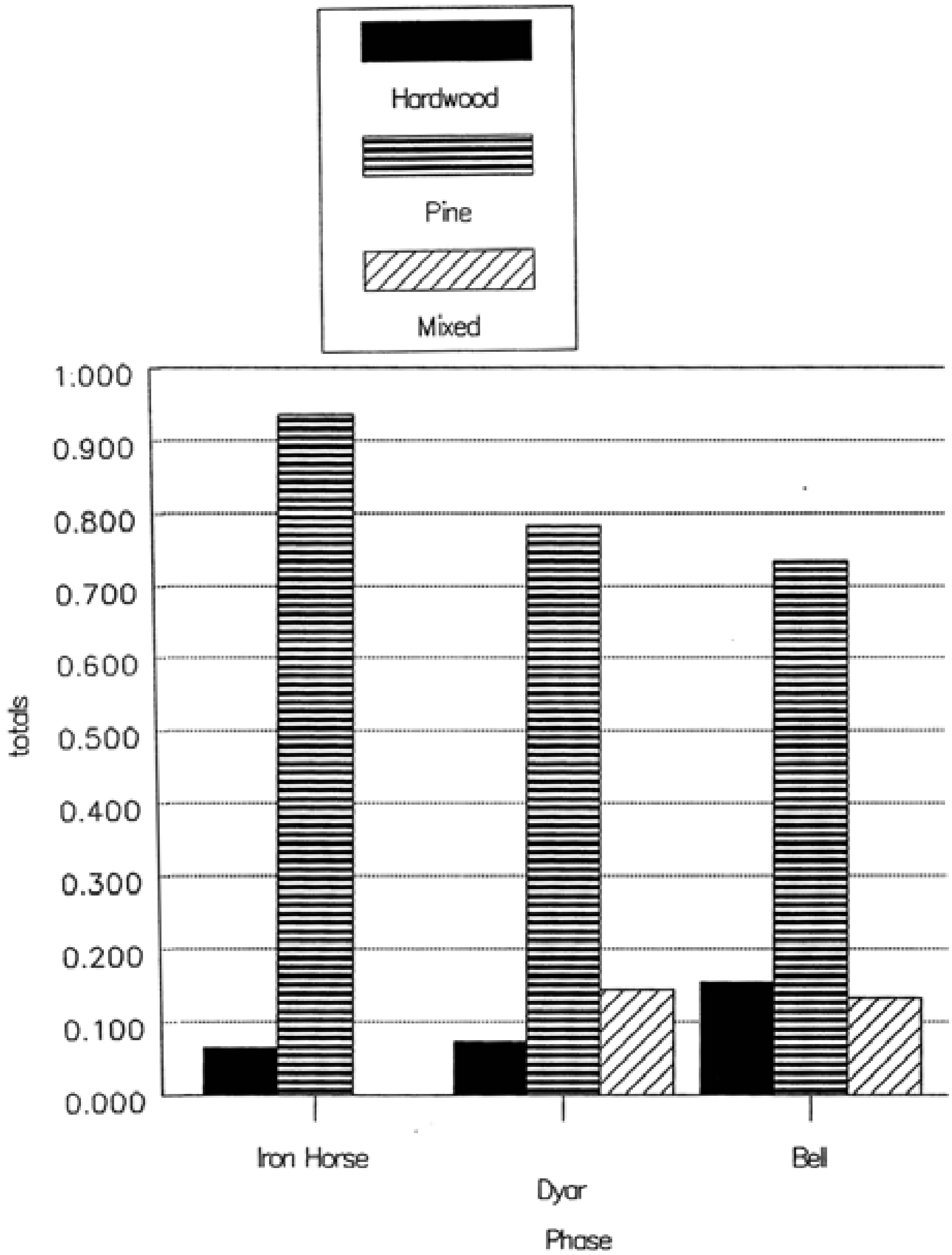

Figure 32: Proportion of house-posts dominated by each type of wood (phase).

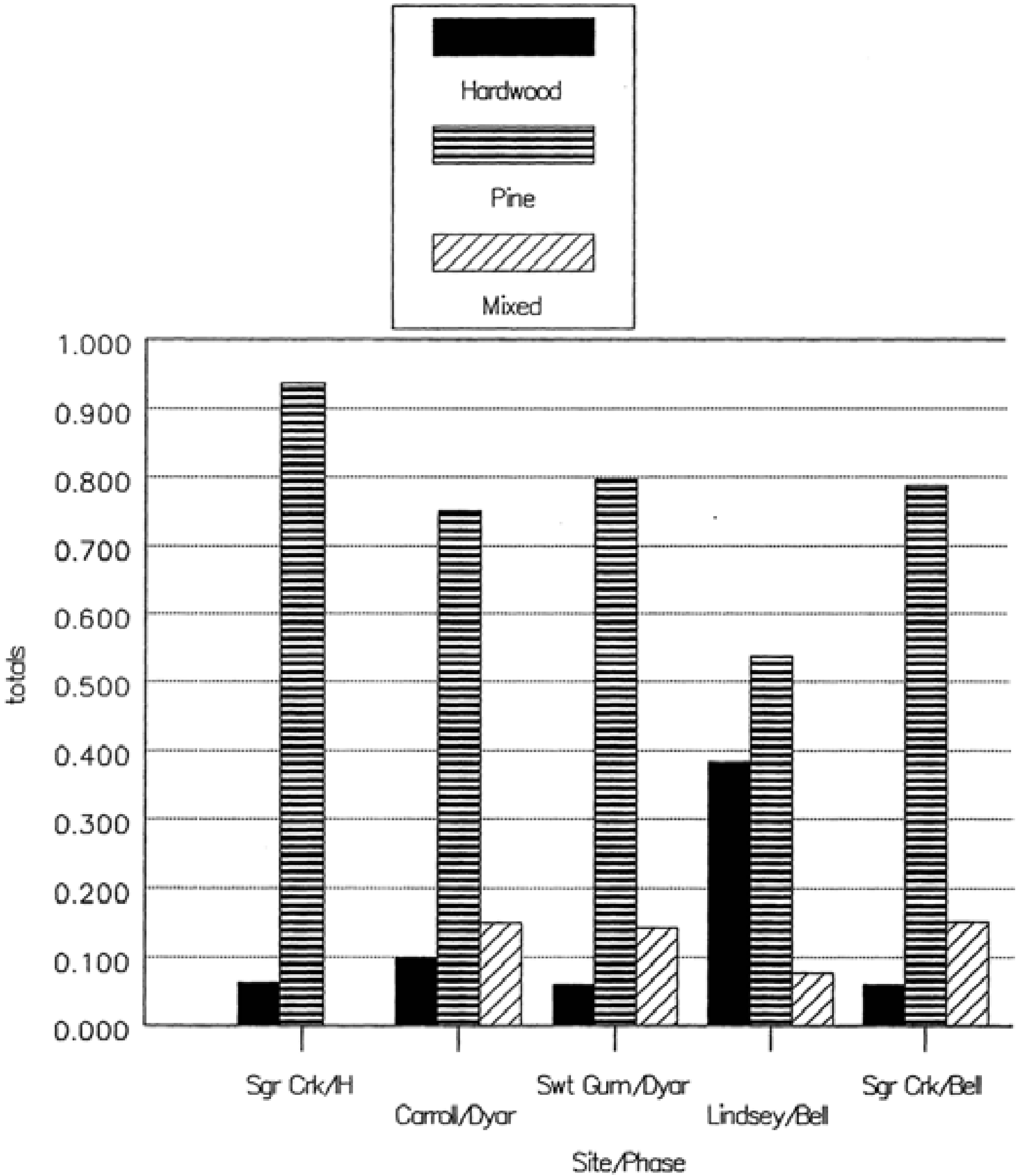

Figure 33: Proportion of house-posts dominated by each type of wood (site).

Figure 29). The majority of features at all four sites were associated with some burning. While pine ignites quickly, hardwoods burn longer, hotter, and more completely. The fact that there was a greater amount of hardwood present in features may indicate that even larger proportions of hardwood relative to pine were present at the time of deposition. Due to the more complete combustion of hardwood this presumption of heavy hardwood exploitation as fuel is almost required in order to generate the relatively high proportions of hardwoods surviving in feature contexts. In any case, despite the practice of swidden agriculture, it is evident that an ample supply of both hardwood and pine was available throughout the Lamar period.

Chapter 10

DATA INTERPRETATION: HUMAN ECOLOGY OF THE MIDDLE OCONEE REGION

Introduction

In Chapter 2, three research problems related to the human ecology of Oconee upland colonization during the Lamar period were delineated. In Chapter 10, these three fields of inquiry are evaluated individually and in combination in order to establish a model of "upland adaptation."

Research Problem One: Evolving Subsistence Patterns

The first research problem investigates the stability of subsistence strategies in the Oconee uplands during the Lamar Period. Sometime during the Vining or Duvall phase, the first permanent upland habitations were established (Kowalewski and Hatch 1991; Worth 1996). However, the earliest occupation in this study dates to the Iron Horse phase. This Iron Horse occupation at Sugar Creek (MG4) is designated as the baseline for gauging temporal variations in subsistence and environment alike in this project.

Climatic, demographic, and other pressures, outlined elsewhere in this dissertation, may have created disequilibrium in the local ecosystems, stimulating cultural responses. This first research problem seeks to identify the effects of any perturbations on human ecology in the Middle Oconee uplands.

Hypothesis One: No Change

The first, and null hypothesis asserts that the Lamar upland populations never experienced population pressure relative to their resource base, maintaining a relatively static adaptation throughout the Lamar period. This hypothesis predicts the following findings, which represent virtual ecosytemic stasis, or dynamic equilibrium. First, the proportion of wild plant foods relative to domesticates remained essentially constant over time. Second, the breadth and mix of exploited plant species remained fairly uniform. Third, these latter two conditions should be met by the faunal assemblage as well. Fourth, the number of plant taxa deriving from particular habitats within the catchment zone remained stable. Fifth, settlement patterns relative to resources remained comparable over time. Sixth, skeletal evidence from each phase recorded a relatively healthy and adequately nourished population with a normal mortality curve.

Prediction One

The first prediction, stable proportions of wild plant foods to domesticates, is best measured by the density index. Density provides a tangible measure of the significance of each taxon. Corn and nuts were the most important cultivated and wild foods respectively. The density of nut shell climbed steadily over time, while the density of corn cob increased dramatically between the Iron Horse and Bell phases (Table 13, Figure 11). However, the density of corn kernels, cobs and of all agricultural seeds was severely depressed during the Dyar phase (Table 13, Figure 11, Table 11, Figure 9). Duck potato or some other wild tuber was disproportionately harvested in the Dyar phase. The numbers of wild edible plants and cultigens, as a percentage of the entire number of seeds, were inversely proportional to cultigen seeds in the assemblages of these four sites. As cultigens achieved preeminence, the proportion of wild edible seeds declined (Table 25, Figure 23).

The first prediction of Hypothesis one is not met. Far from remaining stable, diet breadth expanded and contracted during the late Lamar period. Dependence on mast steadily mounted. Finally, there was an noticeable increase in agricultural productivity between the Iron Horse and Bell phases.

Prediction Two

The second prediction requires that the breadth and mix of exploited species remained uniform over time. This prediction is best gauged by the occurrence list (Table 10, Figure 6, Figure 7). In fact, the numbers of unique edible species scarcely differed from one phase to another. The Iron Horse phase exhibits five cultigens, Dyar - three (five including 9HK33). and Bell - seven. Wild edible species, other than nuts, numbered 13, 12, and 15 in Iron Horse, Dyar, and Bell respectively, and three to four types of nuts were used in each phase. While the Bell phase did show an upward trend in all three of these categories, these differences are not great enough confidently to reject the prediction. In addition, proportions of hard and soft woods remain steady throughout the Lamar period (Table 30, Table 31). Prediction two is provisionally upheld.

Prediction Three

Prediction three requires that the breadth and mix of exploited faunal species remained uniform. Boyko's (1988) faunal analysis of the Sugar Creek, Carroll, Sweetgum, and Lindsey sites clearly contradicts this requirement. The Iron Horse phase emphasized large mammals, with a considerable proportion of minimally modified deer bone, while the Bell phase was an eclectic assemblage focusing on low-ranked resources. Deer bone in the Bell phase was cracked and boiled, manifesting increased investment of energy in processing, as well as a probable decrease in the availability of this prime resource. The Shannon-Wiener Index (Ricklefs 1979:686) was used by Boyko to determine the diversity of faunal assemblages in the three phases represented at the project sites (Boyko n.d.). A diversity of 4.99 is the highest possible value and indicates numerous taxa and high equitability (Boyko n.d.). The diversity index values for the Bell phase samples taken together are significantly greater (3.1186 and 2.8451) than those for the preceding phases (2.6616 and 2.2110) (Boyko nd.). These values indicate that there are a greater number of taxa represented in the Bell phase assemblages than those of the earlier two phases. Therefore, prediction three is not met.

Prediction Four

The fourth prediction dictates that the overall mix of exploited habitats within the catchment zone remained stable over time. The number of taxa deriving from different habitats as seen in the occurrence listing (Table 10) is judged to reflect the local environment.

Between the Iron Horse and Bell phases there was a steady increase in the number of recognizable taxa in four out of six plant categories including agricultural fields, open fields, woods, and wetlands. Only the forest / nuts and old fields remain fairly constant, except for a slight dip in taxon counts during the Dyar phase. Agricultural field taxa also declined in Dyar only to bounce back in the Bell phase.

This configuration suggests that no habitat type considered in this dissertation was ever eliminated by the Lamar upland inhabitants, but the physical extent of each habitat and its importance as a source of resources, probably varied temporally. The probable harvesting of *Sagittaria* sp. (duck potato) in the Dyar phase represented a short-term focus on wetland resources. The overall increase in numbers of unique species signals major anthropogenic disturbance of the landscape in the Bell phase (Figure 6), documented by the proliferation of pioneering species, which favor newly ope
yned fields. Open woods taxa also experienced a sharp increase during the Bell phase, which may be related to the introduction of additional light into the understory by the clearing of vegetation. Old field shrubs nearly disappeared from the assemblage during

phase, presumedly being displaced by agricultural field crops. Based on observations, prediction four, ecosystemic equilibrium, is not met.

<u>Prediction Five</u>

Prediction five demands that upland settlement patterns relative to adequate resources remain comparable over time. This prediction is less reliably measured than the previous four. The four main sites in this upland sample were all located on patches of prime agricultural land, adjacent to adequate water, and having access to prehistoric creek floodplains of unknown extent (Kowalewski and Hatch 1991). However, it is known that during the late Bell phase small upland farmsteads occupied dispersed pockets of arable soils as far north as Jackson and Madison counties (Pluckhahn 1994). The occurrence list (Figure 5) shows no lack of access to any of the habitats under consideration, but currently available data do not permit an assessment of the proportion of each site/s catchment represented by each habitat

The four project sites were fairly equivalent in architectural design, number of inhabitants, and proximity to water. Nevertheless, based on the number and characteristics of structures and features, and the lack of evidence of rebuilding, the two Bell occupations were significantly more brief than those of the earlier phases. This brevity of occupation provides indirect evidence that local resources had diminished in quality, quantity, or both. Faunal assemblages indicate a switch to low ranked species in the Bell phase. In any case, upland settlements in the Iron Horse phase were differentially located adjacent to prime resources, as compared to Bell phase settlements.

Prediction Six

The sixth prediction maintains that skeletal evidence from each phase represents a relatively healthy and adequately nourished population. Humpf (personal communication, 1995) has examined burials from Iron Horse, Dyar and Bell phase components in the present site sample. As described in Chapter 8, the Iron Horse and Bell populations do fit this description. All lesions were minor and healed. Normal discomforts of aging, such as mild arthritis, tooth loss, and bone resorption were noted. The Bell phase had a much greater rate of caries and dental anomalies than Iron Horse. In contrast, many Dyar phase burials exhibited active lesions and hypoplasias (Humpf 1995, personal communication). Due to the disparity of skeletal health between Dyar and the other two phases, prediction six appears not to be met. However, due to the small of this sample size, these observations must be considered tenuous.

Hypothesis One: Evaluation

Five out of six predictions necessary for the acceptance of Hypothesis one are contraindicated. Therefore, Hypothesis one, undisturbed equilibrium in the upland ecosystem throughout the Lamar period, must be rejected. Two additional hypotheses remain to be tested.

Hypothesis Two: Modification of Subsistence Strategy

The second hypothesis proposes that, at some point, the Lamar population began to press on its biotic resources, and was forced to respond to food shortages. Acceptance of this hypothesis is dependent on seven predictions.

First, over time, secondary resources, requiring increasing increments of human labor in their exploitation, characterized the wild plant assemblage. Second, diet breadth consequently broadened over time. Third, either an increased dependence on first-line animal foods, or the adoption of low ranked faunal resources paralleled the broadening of the plant assemblage. Fourth, the mix of wild versus cultivated plant foods shifted as production costs of one versus the other change. Fifth, new mixes of agricultural species were adopted, emphasizing those with lower environmental demands, higher yields, or nutritional enhancement, even at the cost of increased production investment (Turner and Brush 1987:28ff). Sixth, evidence of technological modification, such as agricultural extensification, intensification, or diversification is expected. Seventh, skeletal stress indicators, such as Harris lines or hypoplasias is expected as possible indicators of dietary stress, if the new diet is deficient in protein, calories, or other critical nutrients. In addition, the emphasis on plant foods from particular habitats may have been altered, although this change is not required to accept Hypothesis two.

Prediction One

Prediction one demands that, over time, secondary resources were added to the plant assemblage. In fact, this was not the case. The occurrence list (Table 10) demonstrates that certain resources dropped out of the assemblage during the Dyar phase, but they either returned during the Bell phase, or were replaced by more productive substitutes.

Density analysis contributes an additional perspective (Table 11, Figure 9, Table 12, Figure 10). The only edible wild resource steadily to increase in density over time was mast. In the uplands, archaeological nuts from all Lamar phases were overwhelmingly comprised of hickory, which can be processed very efficiently.

Patterns of wood exploitation for both fuel and construction remained consistent. Pine dominated all proveniences throughout the Lamar period, however, hardwoods consistently appear in contexts associated with burning (Table 32, Table 33, Table 34).

There is no evidence of secondary wild plant resources being added to the assemblage in other than an occasional and incidental manner. Even wood exploitation patterns were virtually stable throughout the Lamar period. Therefore, prediction one, the addition of secondary wild resources to the plant assemblage, is disconfirmed.

<u>Prediction Two</u>

The second prediction requires that diet breadth broadened over time. The occurrence listings (Table 10, Figure 6, Figure 7) reveal that this was true of agricultural field genera only, and even then, Iron Horse and Bell are very similar, having 5 and 7 taxa respectively. Paradoxically, elsewhere in the uplands at 9HK33, agricultural taxa declined from 5 in the Dyar phase to 2 in the Bell. Density analyses (Table 13,

Figure 11, Table 13, Figure 12,) reveal a disproportionate reliance on corn and nuts in the Bell phase.

In the Bell phase 0.199 g of nut shell was present per liter of flotation, compared to 0.05 in the Dyar phase, and 0.36 in the Iron Horse phase. Corn cob weight averaged 0.084 g per liter of flotation in the Bell phase, compared to 0.003 g in the Dyar phase and 0.014 g in the Iron Horse phase. In addition, agricultural seeds, primarily corn kernels, were measured at 1.588 g per liter of flotation in the Bell phase, compared to only 0.522 g in the Iron Horse phase and 0.151 g per liter in the Dyar phase (Table 11, Figure 9). At the same time, the density of open field and open woods taxa remained fairly steady, old field component diminished from 0.650 g per liter in the Iron Horse phase to 0.122 g in the Bell phase, and wetland macrofossils fell from 0.142 g per liter of flotation in the Iron Horse phase to 0.023 g per liter in the Bell phase (Table 11, page 203, Figure 9). These numbers imply that the diet was more limited in the Bell phase than in Iron Horse or Dyar.

Rather than broadening, the Bell phase plant food diet was more specialized than at any other phase of the Lamar period. It is important, however, to noted that breadth of animal foods expanded during the bell phase. In consideration of the total dietary package, prediction two is only conditionally rejected.

Prediction Three

The third prediction espouses that either an increased dependence on first-line animal foods, or the adoption of low ranked faunal resources, should be observed. The former would indicate a shift from dependence on plant foods to reliance on meat, the latter signify a shortage of game, plant foods, or both.

As agricultural field crops and mast gradually came to dominate the subsistence system, an unprecedented shift was seen in the faunal assemblages. The diet veered from a narrow focus on deer, raccoon, and wild turkey, to an extremely broad harvesting of wild animal species (Boyko 1988). Many of the newly exploited species are native to open and agricultural fields. They were abundant, but their small size and difficulty of capture placed them among the lowest ranked foods. A similar phenomena may have occurred among aquatic species. By the Bell phase, even minnows were harvested at upland sites (Boyko 1988). Together these observations point to a shortage of meat and wild plant foods other than mast. Prediction three is clearly met, as low ranked faunal species are routinely harvested in the Bell phase.

Prediction Four

The fourth prediction dictates that the mix of wild versus cultivated plant foods shifted as production costs of one versus the other changed. Although corn and nuts were the two dietary staples throughout the Lamar period, the importance of each fluctuated in nearly parallel fashion. During the Dyar phase when all plant macrofossils were sparse, nuts did not decrease quite as much as corn, perhaps in part compensating for failed maize crops (Table 13, Figure 11). Corn cob density dropped from 0.014 to 0.003 g per liter of flotation between Iron Horse and Dyar, but it reaches six times that level (0.84 g per liter) in the Bell phase. Nut shell rambled from 0.036 g per liter in the

Iron Horse phase to 0.05 g per liter in the Dyar phase, rebounding to over 5.5 times the Iron Horse density in the Bell phase (0.199 g per liter).

These observations are supported by ratios of corn cob and nut shell to wood. The ratio corn cob to wood (Table 21, Figure 19) declined from 0.013 in the Iron Horse phase to 0.006 in the Dyar phase, but increases to 0.21 in the Bell phase. Nut shell to wood ratio rose from 0.04 in the Iron Horse phase to 0.135 in the Dyar phase, reaching 0.395 in the Bell phase. The proportion of cultigen seeds, comprised mainly of corn kernels, to the entire seed assemblage also declined (Table 25, Figure 23) from 0.257 in the Iron Horse phase to 0.125 in the Dyar phase, but dominated the assemblage at 0.604 in the Bell phase.

A reversal in emphasis on cultigens versus wild foods other than nuts is also observed between the Iron Horse and Bell phases. Ratios of seed count to wood weight (Table 19, Figure 15, Table 20, Figure 18), and food by-products by weight (Table 21, Figure 19, Table 22, Figure 20) indicate that the Iron Horse and Bell phases were nearly mirror images, with cultigens displacing wild foods in the late Lamar.

These data may be linked to habitat modification. It was during the transition between the late Dyar and early Bell phases that the Oconee population approximates its peak (Kowalewski and Hatch 1991) and farmsteads dotted the bottomland and upland landscapes alike (Pollack 1988; Kowalewski and Hatch 1991; Pluckhahn 1994). Evidence of reduced availability of wild plant foods ostensibly due to the clearing of fields may be found in the diminished number of old field taxa in the Dyar phase assemblage. Taken together, these facts signify that by the Bell phase, the costs associated with harvesting wild foods other than mast had increased, relative to the energetic costs and returns of agriculture.

These variations in proportions of mast, other wild edible plants, and cultigens reflected a flexible response to ecological conditions. The most likely proximate causes of emphasizing one food type over another are production costs and energetic return. Prediction four, a flexible response to production costs of wild versus cultivated species, is thus supported.

Prediction Five

The fifth prediction is that new mixes of agricultural species, emphasizing those with lower environmental demands, higher yields, or improved human nutrition, even at the risk of increased production costs occurred over time. It is clear that there is only slightly more variety in the Bell phase agricultural suite than in the either of the other two phases. The single significant addition to Bell phase agriculture was the peach, which is so productive as to be considered "weedy" by some (Gremillion 1993a). Peaches were added to the agricultural suite on an opportunistic basis. Common bean (*Phaseolus vulgaris)* was not seen at any upland sites until the Bell phase. Beans recovered from the Iron Horse phase occupation of the nearby Racoon Ridge site have not yet been positively identified, but their size and description compare favorably to *P. polystachyus* (Mazingo 1996, personal communication). Common bean has been positively identified in the bottomlands during the Duvall and Iron Horse phases (Smith 1994).

All of the project phases and sites included wild polystachyus bean (*Phaseolus polystachyus*), which may have been encouraged, cultivated, or even domesticated, as discussed in Chapter 8. Wild bean is nutritionally similar to common bean, but *P. vulgaris* produces a larger edible seed for less effort. If wild bean were merely collected, rather than cultivated, travel and transport expenses would be added to the costs of procurement. Even if the polystachyus bean were encouraged or planted, due to its smaller size, harvesting and processing costs would have been disproportionately high, relative to the domesticated bean. The normal costs of field clearing, planting, and cultivating incidental to agricultural production are essentially "sunk costs," and do not significantly reduce the energetic return on common bean. The seeds of corn, bean, and squash were traditionally planted together in the same hole, and the three plants would have been jointly cultivated. The addition of domesticated beans and peaches to the assemblage indicate that prediction five, the addition of new cultivated species, is fulfilled, although minimally.

Prediction Six

The sixth condition holds that evidence of technological modification, such as agricultural extensification, intensification, or diversification must be observed. Again, the Bell phase is the focus of attention. Density measures (Table 11, Figure 9, Table 13, Figure 11) indicate that agricultural productivity plummeted during the Dyar phase, for reasons discussed elsewhere. However a resurgence of maize production and a substantial goosefoot yield at the Lindsey site in the Bell phase signal that strategic technological modifications were in place. High maize yields may signal the beginning of the double-cropping that was observed by early European explorers.

It is significant that the largest gain in evidence of agriculture is at the Lindsey site, which is situated on a comparatively small patch of agricultural soil, at the time of peak regional population (Kowalewski and Hatch 1991). It is here, too, that intercropping of the "horticultural trinity" (corn, squash, beans) of eastern agriculture can be inferred with the appearance of the common bean. All of this evidence points to agricultural intensification including the cultivation of complementary crops.

Chapter 7 describes how goosefoot, in particular, can be a highly profitable crop in terms of energetic return, even in marginal soils. Eastern tradition crops were common in both Iron Horse and Bell phases, but *Chenopodium berlandieri*, or goosefoot, was particularly abundant at the Lindsey site.

Agricultural intensification was not as dramatic at the Bell phase of Sugar Creek. In many ways, the Bell phase assemblage at the Sugar Creek site more closely resembles Sugar Creek's own Iron Horse occupation, than the Bell phase Lindsey site. The variety of agricultural, open, old field and forest/nut species (Figure 7), the overall ubiquity of these plus wetland taxa and the ratios of corn cob to wood (Table 22, Figure 20), are nominally more similar between the two phases at Sugar Creek than between the two Bell phase occupations under consideration. Nevertheless, similarities between the two Sugar Creek phases are not as striking as the gap in density measures which place these two occupations on opposite ends of the Lamar subsistence spectrum.

The Sugar Creek and Lindsey Bell phase occupations did share certain significant traits. The Bell phase of this study area is clearly the apex of agricultural activity as measured by agricultural field taxa density (Table 11, Figure 9, Table 12, Figure 10, Table 13, Figure 9, Table 14, Figure 12, Table 26, Figure 24), and mast processing as seen in the nut shell to wood ratios to wood ratios (Table 22, Figure 20). The proportions of seeds from other types of wild edible plants were significantly less at the two Bell phase occupations than in either the Dyar or Iron Horse phases (Table 26, Figure 24). A reduction in density of old field species was shared with the Dyar phase.

Late in the Bell phase, migration extended further northward in the uplands into former "no man's lands" (Pluckhan 1995). This movement would have allowed for the remaining families to lay claim to larger tracts of land and may help to explain the increase in density of both corn and nuts in the Bell phase. This indirect evidence of agricultural extensification does not preclude intensification as well.

Changes in the old field species assemblage may also signal technological modification. While the number of different old field taxa were at a low point at the Lindsey site (Figure 7), only highly productive tree and shrub species represented old field taxa at that site (Table 10), implying a deliberate focus on particular resources. All were genera that could be differentially spared in clearing fields for agriculture, and persimmon, black walnut, blackberry/raspberry, and grape. A similar pattern was observed at the Bell phase of Sugar Creek; however, two taxa of presumedly limited food value (*Ampelopsis* spp. and *Rosaceae*) were also noted there. This configuration was repeated at the Bell phase of 9HK33 where persimmon is the sole old field species (Table 5). The elimination of most old field shrubs extended a pattern begun in the Iron Horse and Dyar phases. It is highly likely that, like the Teenek (Alcorn 1984), Lamar people carefully engineered the progression of succession, and in effect "designed" the character of the old fields emerging from the fallow process.

Furthermore, the reduced number of herbaceous old field genera implies a shortening of the fallow cycle.

Reduced fallow may well be correlated with demographic pressure in the late Dyar and early Bell phases, increasing the ratio of agricultural to fallow fields. By controlling plant succession and preserving particular species, an adequate supply of first-line old field plant foods was most likely realized. The ratio between cultivated and fallowed areas has been deemed the best measure of agricultural intensification (Grigg 1982:37-41). While this ratio cannot be directly measured archaeologically, these subsistence data imply that the proportion of active over fallow fields increased over the course of the Lamar period.

Differences in the specific observations of the Sugar Creek and Lindsey Bell phases can be explained, and even anticipated, in terms of the unique character of each site. Local ecology, including human demography and differential preservation preclude direct comparisons even between two very similar sites. In fact, while the two sites differ in specific characteristics, such as the particular species representing some habitats, the overall character of subsistence strategy and technology was strikingly similar in these two sites and the uniqueness of the Bell phase ecological adaptation was apparent.

Considering the overwhelming evidence of agricultural intensification, and crop diversification; and limited evidence for agricultural extensification and habitat management, prediction six, technological modification, has been confirmed.

Prediction Seven

The seventh prediction requires that skeletal stress indicators, such as Harris lines or hypoplasias, be coincident with dietary stress. As is discussed above, under prediction six of the null hypothesis, both the Iron Horse and Bell phase populations were healthy and well-nourished. This prediction complies with the archaeobotanical evidence. Of additional note is the sudden proliferation of caries and dental anomalies in Bell phase individuals above the sub-adult level, which is characteristic of a diet emphasizing maize. The Bell phase population also exhibited marginally greater occurrences of healed lesions, some of which can be related to periods of inadequate nourishment. This implies that the more varied diet of the Iron Horse phase is healthier than that of the more maize-dependent Bell phase fare. The nutritional deficits may also be related to a shortage of high quality meat, as discussed above. Nevertheless, these two populations are comparable in general state of health. In contrast, the Dyar phase burials of Sweetgum represent a physically weakened population with active lesions at time of death (Humpf, personal communication 1995. This coincides with the observed low densities of all classes of plant resources, signifying dietary stress. These factors confirm the seventh condition.

Hypothesis Two: Evaluation

Hypothesis two asserts that over the course of the Lamar period, the human population began to press on its resources, and was forced to respond to food shortages. Four of the seven predictions following from this postulate have been met, and one is partially fulfilled. Therefore, it is maintained that agricultural intensification and a decline in dependence on wild resources were characteristic of late Lamar period upland subsistence.

It has been shown elsewhere that food production was depressed during the Dyar phase, yet the subsequent Bell phase exhibited the highest food productivity of the Lamar period. People of the uplands shifted from a more generalized collecting-hunting-horticultural strategy in the Iron Horse phase, to one emphasizing mast and cultigens in the Bell phase. A shift in subsistence strategy and technology clearly occurred between the Iron Horse and Bell phases. It is likely that reduced productivity during the Dyar phase was a major stimulus to this technological evolution. Faunal resources also declined in quality over the course of the Lamar period, in part, due to anthropogenic modification of the landscape.

During the Bell phase uplanders appear to have undertaken measures to boost productivity in both active and inactive agricultural fields, including more inter-cropping, crop diversification, and probably double cropping, and manipulation of wild species. There is indirect evidence of field extensification. Pest control was incorporated into the subsistence system in the form of garden hunting (Linares 1976; Boyko n.d.), but costs of animal protein production would still have been elevated in the late Lamar period.

Technological change during the Bell phase was in the form of modification of the existing technology and strategy.

On balance, the Bell phase energy system may have been more productive, but also more labor-intensive. By locating homesteads adjacent to food resources, search and transportation costs were reduced. Nevertheless, if the scale of agricultural production was increased, and fields were put into and taken out of fallow early, as submitted here, additional labor would have been required to clear land. Fields that are prematurely farmed are particularly difficult to open due to the abundance and tenacity of vegetation and roots.

In summary, increasing human occupation of the uplands during Dyar phase placed stress on all critical resources - land, flora, and fauna. By the Bell phase, both the subsistence strategy and technology had been somewhat modified. A narrow focus on prime plant resources was, at least in part, a response to a reduced availability of prime game species (Boyko n.d.). While low ranked animal foods characterized the diet, secondary plant resources were all but eliminated from the diet. The second scenario presented in hypothesis one, that of agricultural intensification in response to food shortage, is supported.

Conclusions: Research Problem One

It is clear that the upland subsistence system did change over time, as anthropomorphic stresses on the ecosystem escalated. From at least the Iron Horse phase on, upland subsistence included both cultivated and wild foods, with corn and hickory as the main staples. However by the Bell phase, wild seeds and fleshy fruits were relegated to a minor proportion of the diet.

Evidence of a regional decline in biotic productivity was noted during the Dyar phase, but the large quantity and variety of cultigens in the Bell phase indicated that agricultural intensification, and possibly extensification had mitigated these circumstances. There is evidence from another upland site, 9HK33 that agricultural intensification began in some parts of the uplands during the Dyar phase (Table 5). High amounts of pine in all Oconee Lamar sites denote the clearance of significant amounts of forest for agriculture, and use of a fire regimen (Wagner 1996). This regime mirrors conditions in prehistoric South Carolina (Wagner 1996).

There was no obvious shift in technology during the Lamar period as the existing process is transformed from a less intensive food energy system to a more intensive one. Expanded use of native cultigens in crop diversification, inter-planting of complimentary species, and management of fallow fields may have been used to enhance both productivity and human nutrition during the Bell phase. However, more frequent moving of homesteads and clearing of fields, requires higher inputs of human energy. In particular, if fields were taken out of fallow prior to returning to timber, effort in clearing fields would have been greater than if the cycle had been completed. Furthermore, soils would not yet have reached their maximum fertility.

By the Bell phase, deer browse and habitat appear to have diminished, virgin forests were in short supply, and habitat for rodents and other field-dwellers expanded.

As a consequence of these human-induced conditions, increased effort was invested in the removal of small mammals and birds from agricultural fields.

Another consequence of increased predation on small mammals and probable reduction in the local deer population, was the increased availability of mast. Although rodents, in particular, consume this resource, they often stockpile it. Chipmunks (*Tamias striatus*) accumulate acorns and other small nuts in storage chambers within their burrows (Koopman 1960; Jorgensen 1978). A single chipmunk will store up to a bushel of food (Jorgensen 1978). In the Southwest, packrat caches are regularly raided by native people (Martinez 1991, personal communication). I suggest that a similar practice may have minimized competition for nuts from chipmunks in the Oconee region. Human mast consumption peaked during the Bell phase, with hickory probably helping to make up the shortage of for meat. A combination of corn and hickory is adequate for basic human nutrition (Gardner 1992).

In summary, the maize-hickory based "upland adaptation" was continuously refined in response to environmental conditions. As the Lamar period progressed, people regulated their plant foods more precisely, as faunal resources shifted negatively. Agricultural intensification, and adoption of secondary sources of animal protein, point to a more costly subsistence system in the Bell phase. This elevated cost occurred in valley and uplands alike, and may have been is potentially related to a web of factors, including demographic pressure, and drought and as yet unknown factors. Nevertheless, through careful management of floral resources, people were able to maintain an adequate standard of living. Although energetic costs of subsistence probably increased in the Bell phase, these costs were partially mitigated by increased crop yields, and the incorporation of horticultural predators into the diet.

Research Problem Two: Stimulus for Migration to the Uplands

Mississippian lifeways have long been associated with mound towns and floodplain settlements. The existence of small, dispersed, upland farmsteads of year-round occupancy and in good states of archaeological preservation came as a surprise to many archaeologists working in the Oconee region (Halley and Rudolph 1986b). The Oconee river valley offers all the advantages of shoals, meanders, and friable, annually renewed alluvial soils. However, the uplands also provide a vast array of resources. These were hardly tapped until the first permanent settlements appeared in the late Woodland Vining phase. This colonization of the uplands accelerated in the Dyar phase of the Lamar period, and continues through at least the early Bell phase. While five mound centers and a variety of large communities are found in the bottomlands (Smith and Kowalewski 1980, 1981; Hally and Rudolph 1986b), no such constellations appeared in the uplands.

At issue is the reason for significant expansion into the uplands. Ecological, social and political issues may all come into play. The following hypotheses explore the impetus that set serious upland colonization into motion.

Hypothesis One: Diminishing Returns In The Bottomlands

The premise of the first and null hypothesis is that upland settlements were solely indicative of diminishing returns on subsistence effort in the river valley. This premise is based on the following conditions. First, critical upland resources were, on average, inferior to those of the river bottom, and consequently the cost/benefit ratio of upland subsistence was higher than in the valley. Second, from the earliest upland settlements on, subsistence reflected high energy costs with respect to those of the bottomlands. Third, the number of river-bottom sites diminished as intensified upland colonization relieved some of the pressure.

Condition One

The first condition maintains that critical upland resources were, on average, inferior to those of the river bottom, and that the energetic return of upland resources to inputs of human labor was lower than in the river valley. Thus people would relocate there only when offered no viable alternative.

The river bottoms provided moist, fertile, easily tilled soil, alternating with shoals and in juxtaposition to forest resources. Fields located within southeastern floodplains have the potential to be permanent (Woods 1987), but whether or not this was true in the Oconee valley is uncertain (Larson 1971; Pollack 1988; Baden 1995). Agricultural soils in the uplands also held high agricultural potential (Hally 1987; Kowalewski and Hatch 1991).

It is unknown how much creekside bottomland existed in late prehistory, but some other upland soils, lacking fine silts and clays commonly deposited in floodplain soils, may actually have been easier to work than those of the valley floodplain. Some upland soils in eastern North America, particularly humus from virgin forests, has been productively farmed for up to 10 years (Hurt 1987). In Ontario, it has been estimated that the length of cultivation on the "best soils" would be in the range of 5 to 12 years (Heidenrich 1971:16). Similar appraisals have not been made for Oconee soils. The clearing of lands for farming would add cost to agricultural production, but if this expense were amortized over the use-life of the field, the additional energetic input would be modest.

The upland system of slash and burn agriculture, presumedly featuring controlled succession, provided a suite of economically useful plants and animals as byproducts of land clearance. Since the majority of floodplain agricultural fields were most likely permanent, old fields and their resources would have been restricted in the bottomlands. Such is the case for the modern historic Hidatsa, who plant separate "orchards" to fill this void (Wilson 1987 [1917]).

Bottomland floodplain and terrace forests feature many nutritionally useful species, as discussed in Chapter 3. White oak (*Quercus alba*, *Q. stellata*, *Q. lyrata*) acorns require little or no leaching, but the caloric return is only in the range of 288 kcal per hour of collection and shelling (Table 9). Red oaks (*Q. rubra*) yield 998 kcal per hour of collecting and shelling, but require additional extensive processing to remove tannin (Petruso and Wickens 1984). Bottomland swamp forests contain a variety of water-tolerant oaks (Joseph and Cantley 1990:11) with similar yields. Some bottomland hickories (*Carya carolinae-septentrionalis*, *C. ovata*) are sweet, and produce almost 3500 kcal per hour of collecting and shelling, but comprise a much smaller proportion of the forest than oaks (Petruso and Wickens 1984). However, the primary swamp forest hickory species (*C. cordiformis* and *C. aquatica*) produce bitter kernels, and would probably have been avoided.

Oak (*Quercus spp.)* also dominates the upland forest, with the sweet types prevailing, and hickory (*Carya* spp.) is much more abundant in the uplands than the river valley. Two additional mast species have been positively identified, beech (*Fagus grandifolia*) and walnut (*Juglans nigra*). The ability to focus on hickory lowers subsistence costs in the uplands.

On balance upland ecosystems and resources compare favorably to those of the bottomlands. While upland resources are not identical to those of the bottomlands, they hold somewhat equivalent subsistence potential. Thus condition one, upland resources which are inferior to those of the bottomlands, is not met.

<u>Condition Two</u>

The second condition proposes that, throughout the Lamar period, upland settlements should contain evidence of high energy costs with respect to bottomland subsistence. As was discussed under Condition One, both upland and bottomland zones possessed unique and productive agricultural resources and conditions. The labor costs of clearing new upland fields to compensate for a lack of alluvium would raise the costs of upland agriculture relative to that of the floodplain, but at least during the Iron Horse phase fields cut from virgin soil would remain for many years (Heidenrich 1971). (See discussion in Chapter 5.) However, by the Dyar phase, bottomland settlements diffused beyond the floodplain proper, into bottomland terraces and rises of moderate soil fertility (Pollack 1988), and into tributary valleys (Rudolph and Blanton 1980). Like their upland counterparts, the new bottomland fields cut from mature forest would lacking the subsidized fertility of alluvium. Evidence presented earlier demonstrates that crop diversification and intercropping were practiced in both zones, and that similar cultivars were grown. Thus, basic labor costs of agricultural production would be similar by the late Dyar or early Bell phase.

The uplands have the topographic advantage that cool air drains into the valley, reducing frost in the uplands, while increasing it in the bottomlands (King 1993:252). In addition, any southern-facing slopes would possess on average, warmer ambient and soil temperatures than other topographical areas, and would also be well-drained, although erosion might be a problem (Ricklefs 1979:42). The cooling trends of the "Little Ice Age," discussed below under Hypothesis Four, would have been minor this far South; maximization of frost-free days might have been important for double-cropping. These characteristics may have enhanced upland agricultural yields, assuming that adequate moisture were available for crop development.

Patterns of nut use varied between the two residential zones. Throughout the Lamar period, people in the bottomlands differentially utilized acorns. The average energetic return and nutritional value of acorns is far less than that of hickory. There is limited evidence, discussed in Chapter 3, that valley inhabitants harvested hickory in the uplands, processed it into "milk" or oil, and transported it to the bottomlands. This practice would have added considerably to subsistence costs.

In the Iron Horse phase both bottom and uplands had adequate meat supplies, as evidenced by the quantity of deer bone recovered. The abundance of acorn in the bottomland assemblage may have attracted deer throughout the Lamar period. Even in the Bell phase, when a broad spectrum faunal assemblage was seen in both upland and bottomland sites deer, still comprised about a third of the assemblage at the Joe Bell site (Williams 1982a). There is, however, a possibility, based on the existence of repeatedly occupied "hunting camps," that seasonal deer harvests in the uplands contributed to the bottomland meat supply, adding to its costs. The proportion of deer bone in the zooarchaeolgical assemblage is much lower at the two upland Bell sites, Lindsey and Sugar Creek (Boyko n.d.) than in the bottomland assemblages, insinuating relatively higher costs of meat capture in the uplands during the Late Lamar period.

In the valley, aquatic resources were bountiful and comprised the bulk of animal foods during a century-long period centering around the Dyar phase (Rudolph and Hally 1982.) While some feel that the localized high biomass value and ease of capture of shellfish reduces subsistence costs (Smith 1975), the exploitation of aquatic resources has also been linked to "overpopulation" due, in part to their relatively low nutritional value (Binford 1962:223; Cohen 1977:79; Osborn 1977:171; Rudolph and Hally 1982:65-66). On the other hand, if the crop failures hypothesized to have played a role during the

Dyar phase extended to the bottomlands, aquatic resources may have actually lowered subsistence costs in relation to other local and upland options.

For some unknown reason, there was a shift away from the river resources during the Bell phase. Reports from the Wallace reservoir project (Table 2) chronicle only a limited Bell phase presence at the shoal sites (Shapiro 1981a:26; Rudolph and Hally 1982:32). The Dyar phase residents at the Joe Bell site (9MG28) abandoned local river resources in its Bell phase (Williams 1982aa). This possible abandonment of aquatic fauna is difficult to explain. The Bell phase faunal assemblages of the uplands and bottomlands were equally diverse except that the Joe Bell site contained a larger proportion of deer. It is possible that not too far into the Bell phase the population pressure began to ease in upland and bottomland alike. Alternatively, the diffusion of the population into the uplands may have altered the cost/benefit ratio of shellfish exploitation.

In summary upland subsistence costs appear to have remained in balanced equilibrium with those of the bottomlands, with returns on plant foods being equal to or higher than those of the riverbottom. Upland residents realized lower nut production costs during all Lamar phases, due to differential access to hickory nuts. By the Bell phase, agricultural costs were more similar between the two zones, and upland crop productivity may even have been higher. Whether or not bottomlands enjoyed greater energetic return on game capture is open to debate. Likewise, the exploitation of shellfish is energetically taxing, but in the wake of universal food shortage it may have raised the energetic return on animal protein during the Dyar phase. This being the case, bottomland subsistence costs did not decrease as a result of upland settlement, but their stability may have been more secure. However, it is possible that during the Bell phase bottomland subsistence became more cost-effective, as seen in the abandonment of extractive sites on the shoals. The second condition is rejected with caution.

Condition Three

The third condition is a prediction: it requires that the number of riverbottom sites diminish as upland colonization intensifies. This prediction follows from the proposition that upland migration was undertaken to alleviate population pressure in the river valley. In fact, site counts continued to climb throughout the Lamar period in both the bottomlands and uplands, particularly during the Dyar and Bell phases (Kowalewski and Hatch 1991). The third condition is rejected.

Hypothesis One: Discussion

Hypothesis one explores the possibility that the sole stimulus to upland migration was demographic pressure. Under this scenario, bottomlands were the preferred settlement location, and colonization of the uplands occurred as a direct response to severely diminishing returns on subsistence efforts. Upland opportunities were seen as inferior to those of the bottomlands, with excessive effort being required for survival there. As upland colonization increased, population pressure and reliance on secondary resources should each have been reduced in the bottomland.

Chronological markers are not yet refined enough to distinguish whether the river valley became saturated with habitations before or concurrent with the mass migration to the uplands during the Dyar phase. However, new habitation sites continued to be established in both zones throughout the remainder of the Lamar period. It is certain that upland settlement began prior to the regional demographic escalation, implying that increased population pressure, alone, is not the key to this enigma.

Whether the chronic dependence on acorns indicates that the point of diminishing returns had already been reached in the bottomlands during the early Lamar period, is not certain. Faunal resources did not reflect any food shortages until the Dyar phase, when an abundance of extractive sites were situated on shoals. At that point in time upland settlement was already well established.

As has been demonstrated above, subsistence costs were probably comparable between the bottomlands and uplands. From an economic perspective, the uplands were different than, but not inferior to, the bottomlands. There was no visible reduction in bottomland subsistence costs following substantial upland settlement. In fact, a new focus on aquatic resources during the Dyar phase may have been associated with food shortages. If nutritional distress did contribute to the Dyar phase push into the uplands, it was not the sole stimulus. The ostensible famine was regional, so any attempt to escape it in the uplands would prove futile. (See Chapters 3 [climate], and 8.) Such action would, however, support the postulate that the uplands were considered to hold economic potential by the Oconee people.

In conclusion, it cannot be proven that movement into the uplands was solely, or even primarily, motivated by demographic pressure. Uplands and bottomlands featured different resources but similar economic potential. Movement into the uplands began long before any signs of resource deficiency in the bottomlands. During the period of most vigorous upland colonization the quality of subsistence declined concurrently in the uplands and bottomlands.

Hypothesis Two: Uplands Offered Attractive Alternative to Bottomlands

Hypothesis two proposes that permanent upland colonization was a voluntary choice, based on the cognisance that it could maintain a culturally acceptable standard of living at reasonable energetic cost. If this hypothesis is correct, the following predictions must be noted. First, the energy costs of subsistence in the uplands were lower than or equal to those of the river bottom (Styles 1981). Second, only the highest ranked foods were harvested in the earliest periods of upland colonization, with particular emphasis being placed on those wild taxa that are complementary to cultigens. On average, upland resources should have been equal or superior to those of the lowland for the duration of upland encroachment. Third, the skeletal population should be robust, although caries may be evident due to a diet high in maize.

Prediction One

The first condition maintains that energetic costs of subsistence in the uplands are lower than or equal to those of the river bottom (Styles 1981). This has been thoroughly investigated under conditions one and two of hypothesis one above. It is concluded that the two zones are approximately equivalent, and so the condition is acknowledged to be true.

Condition Two

The second prediction alleges that only the highest ranked foods were harvested in the earliest periods of upland colonization, with particular emphasis being placed on those wild taxa that are complementary to cultigens. On average, upland resources should have been equal or superior to those of the lowland for the duration of upland encroachment.

It has been previously demonstrated in Chapter 8 that two top-ranked plant foods, corn and hickory nuts, comprised the basis of upland subsistence for the duration of the Lamar period. They were complemented by game, additional cultivars, and wild plant foods. In contrast, prime game was differentially harvested in the Iron Horse phase, and was rare by the Bell phase. In the Bell phase, the faunal assemblage expanded to include a much larger proportion of local vertebrates, and several invertebrates as well. Thus during the earliest stages of upland farmsteading, prime wild resources were abundant. All wild resources declined in quantity and quality by the time of the Dyar phase regional demographic peak, but this decline also took place in the river bottom. Upland wild plant resources and agricultural production consistently equalled or surpassed those of the bottomlands, albeit it at a greater cost than during the early Lamar period. Thus, the second condition is met.

Prediction Three: Good Health

The skeletal remains should reflect a generally healthy population. While caries may be observed, due to the presumed importance of corn in the diet, there should be a low occurrence of Harris lines or hypoplasias.

The small burial sample revealed a dichotomy between Iron Horse and Bell phase populations. At Sugar Creek, Iron Horse phase, the skeletal population consisted of three adults, three adolescents, and one child. One adolescent exhibited mild hypoplasias on four teeth. No other hypoplasia and no bone lesions were noted on any of the skeletons. One of the adults suffered caries on a single molar, but no other caries were noted.

In stark contrast, the Bell phase Sugar Creek population, consisting of three adults and one adolescent, endured multiple caries and abscessed teeth. In addition, one adolescent exhibited both remodeled porotic hyperostosis and healed cribera orbitalia. The Bell phase population at Lindsey consisted of three adults and a four to six year old child. All individuals, including the child, displayed caries and one adult suffered an abscess and slight enamel hypoplasia. There was no evidence of active lesions, although some healed skeletal insults, resulting from disease, were noted in one adult.

While these samples are small, it is noted that the overall health of the populations is comparable, while dental health is superior in the Iron Horse phase. Populations were healthy enough that neither temporary nutritional distress nor bone-damaging disease resulted in death. Evidence of bone remodeling and healing of lesions and enamel hypoplasia attests to relatively hardy population. The low caries rates in the Iron Horse phase, contrasted to high rates of caries and tooth abscesses in the Bell phase is attributable to a substantial increase in dietary maize during the late Lamar period. Corn has long been associated with a variety of dental anomalies and tooth decay. The third condition is provisionally upheld. The upland population showed no sign of nutrition deficiency except during the Dyar phase when there was independent evidence for regional food shortage. (See Chapter 8).

Hypothesis Two: Discussion

Hypothesis two proposes that permanent upland colonization was a voluntary choice, based on the understanding that this adaptation could maintain a culturally acceptable standard of living at reasonable energetic cost. This position is argued to be true.

The earliest upland inhabitants enjoyed abundant hickory, agricultural resources, and enjoyed plentiful game. Slash-and-burn agriculture, ultimately including controlled succession in fallowed fields, ensured an array of lesser economically useful wild plants.

During the Dyar and early Bell phases, regional demographic pressure initiated extensive modification of the landscape, ultimately affecting the character of local ecosystems and lowering the culturally acceptable standard of living. Yet the uplands were able to sustain agricultural intensification, to counter the lower availability of game. Subsistence costs were greater in the Dyar and Bell phases than in the Iron Horse, but this problem was not unique to the uplands. In short, it is likely that the uplands were long recognized as adequate to maintain a culturally acceptable standard of living, and movement into the area was voluntary.

Hypothesis Three: Relaxation of Political Circumscription

The third hypothesis asserts that the relaxation of political circumscription opened the floodgates to upland expansion. As discussed in Chapter 4, at the time of De Soto's explorations the middle Oconee region comprised the powerful chiefdom of *Ocuté* (Bourne 1904; Elvas 1933, 1968 [1557]; Smith and Kowalewski 1980; Garcilaso 1988 [1605]). It is also known that this political system had devolved by the beginning of the Bell phase, and that dispersed settlements dominated the entire region by that time. Prior to the Dyar phase, settlement was largely restricted to riverbottoms, but by the late Dyar there was massive upland colonization. It is difficult to prove a causal link between these phenomena, however inferences can be made based on ecological evidence.

First, the appearance of large numbers of dispersed farmsteads must coincide with decentralization of the political system. Second, the differential between cost/benefit ratios of upland versus bottomland subsistence must be great enough to break the inertia of continuing with the *status quo* of life in the riverbottom. Third, there may have been some compelling reason to abandon the bottomlands or some specific attraction to upland migration.

Prediction One

The first prediction requires that the appearance of large numbers of dispersed farmsteads coincide with a weakening of the political system. This prediction is confirmed. The *Ocuté* chiefdom gradually declined during the Dyar phase, and by the early Bell phase all evidence of mound building had ceased. It is during the Dyar phase that settlement is decentralized in the bottomlands, and the dispersed configuration is intensified in the uplands (Smith 1987; Williams 1987; Kowalewski and Hatch 1991).

Prediction Two

The second prediction requires that the differential between cost/benefit ratios of upland versus bottomland subsistence was great enough to break the inertia of the *status quo*. It has been demonstrated above that upland and bottomland subsistence costs were very similar, although the character of subsistence was slightly different. The energetic costs of survival increased in both topographic zones after the Iron Horse phase.

In the initial phases of upland settlement, independent farmers were attracted by the virgin soil, abundant mast, other economically useful plants, and game. The move may have reduced their subsistence costs. Steady regional population growth effected a noticeable strain on local resources during the Dyar and early Bell phases, encouraging more individuals to relocate in the more expansive uplands. While upland and bottomland subsistence costs remained comparable, it is likely that standard and cost of living would have been negatively impacted if expansion into the uplands had not occurred.

In summary, it is likely that prior to the Dyar phase, upland settlement did elicit a reduction of subsistence costs for migrants. After the Iron Horse phase the cost/benefit ratio of upland versus bottomland living were similar, although each possessed a somewhat distinct character. In the late Lamar period it was the avoidance of further environmental decline, and a desire to maintain a culturally acceptable standard of living, that most likely drove people into the more spacious uplands. Given the desire to reduce or control subsistence costs by movement into the uplands, the second prediction is tentatively confirmed.

Prediction Three

The third prediction presupposes either an additional compelling reason to abandon the bottomlands or specific attraction to upland migration. This stipulation can be addressed only in a speculative manner.

Examples of additional incentives for moving to the uplands could include, proximity to particular resources, aesthetic, religious, or other cultural or personal preferences. These incentives are too obscure to address. An attempt to flee from disease is a possibility which will be discussed below. One additional scenario does need to be discussed - the possibility of deliberate productive diversification within a localized exchange network.

No historical or archaeological evidence of either kinship network (Ford 1991) or chiefly redistribution has been found for the middle Oconee region, and one analysis seems to negate it (Boyko 1996). It is known, however, that Southeastern chiefs kept stores of surplus food at mound centers (Elvas 1933, 1968 [1557]). It is very likely that kinship networks were in place among the people of *Ocuté*. Subsistence risk could have been reduced by dispersing kin across the landscape into different ecological zones, and this motive could easily explain a desire to establish farmsteads in the uplands. Such diversification could hedge against total economic failure in a year where a major resources in one ecological zone failed, and at the same time tend to even out subsistence costs between the two major topographic zones. Even today, native American groups such as the Tewa practice productive specialization, and incorporate economic redistribution into social, economic, and religious institutions (Ford 1976; 1991).

Two facts are particularly significant - upland site density increased during the late Dyar and early Bell phases and the bottomlands remained fully occupied. The former fact is important, in part, because this time interval coincided with the demise of the chiefly system. The elimination of centralized surpluses required the creation of a decentralized back-up system. Furthermore, it was in this time period that regional food shortages prevailed. Kinship ties, which are essential to the functioning of a chiefdom, would already be in place, ready to step in and orchestrate redistribution. As part of a long-term strategy, relatives would deliberately live in different ecological zones to diversify their collective production. Familial and religious obligations and other socially prescribed reciprocal relationships would ensure economic redistribution. Such a process would even out risks, costs, and benefits of life in one zone versus the other. The absence of chiefly tribute or political constraints to movement would allow for this system to function effectively.

Unfortunately, the archaeological correlates of such a system are either negative, or subject to multiple interpretation. The following are two examples. The increasing dominance of nutshell in the uplands, including a nutshell feature at the Dyar phase Carroll site could indicate intensified local use, or the production of "nut butter" for exchange. No trace of this commodity would be seen in the bottomlands. Substantial shell middens in the shoals might merely represent seasonal local exploitation, or the mollusks might be smoked for later consumption and for exchange. There would be no trace in the uplands.

One recent study implies a lack of inter-zonal exchange. Boyko (1996) found similar distributions of animal bone in assemblages from both topographical areas. If one were supplying the other the distribution should be skewed in some way. A low ratio of kernels to corn cob (Equation 8-4) in the uplands in the Bell phase may either indicate that corn was being shelled for transport to the bottomlands, or merely reflect agricultural intensification. As the amount of maize increases, so does the likelihood that the cob will be used for fuel, and preserved. Additional data are needed before this conclusion can be approached. Kernel to cob ratios need to be calculated for the bottomland sites. If they are found to be significantly higher for the valley sites, then some exchange or redistribution may be indicated. This issue remains to be tested.

In summary, although no archaeological evidence of compelling reasons to settle or avoid the uplands has been noted, it is likely that there were strong culturally based incentives involved in the movement out of the riverbottoms. One plausible scenario, grounded in ethnographic analogy, is argued to be likely. The deliberate diversification of production by kinship units would even out the costs and risks of production throughout the Oconee region. While prediction three cannot be accepted, based on the existing evidence, it must be strongly considered.

Hypothesis Three: Discussion

This hypothesis is accepted, based on the acceptance of two out of the three predictions. First, although a few isolated upland farmsteads were seen prior to the Dyar phase, the major shift from nucleated settlements in the bottomlands, to small farmsteads dispersed throughout all topographic areas occured during that phase. This shift is significant because it coincided with the gradual decline of chiefly authority in the valley.

Second, the resources for farming, collecting, and hunting were largely untouched and abundant to the pre-Dyar settlers of the upland. At that time the cost/benefit ratio of upland subsistence is judged to have been somewhat lower than that of the lowlands.

During the Dyar through Bell phases, subsistence costs increased throughout the region, and by the Bell phase were either in balanced equilibrium or those of the uplands were slightly lower. Upland settlement was still an attractive alternative as increasing demographic pressure throughout the region pressed particularly hard on lowland resources, and the upland held more potential for expansion as needed.

The third condition, the existence of additional, culturally moderated reasons for migration, cannot be determined with the current data. A strong possibility, for which there is no direct evidence, is that a kinship-mediated system of production and exchange promoted diffusion into distinct ecological zones. This dispersal would effectively diversify the resource base while minimizing risks to individual families. Only ethnographic analogy and "negative evidence" support this postulate. This prediction is not necessary for the acceptance hypothesis three, but it should considered now and in future research.

Hypothesis Four: Climate

Hypothesis four submits that the cooling effects of the "Little Ice Age" can at least partially account for migration to the uplands. Marginally warmer temperatures in the uplands favored agricultural productivity in all time periods, but were particularly important during a cooling trend. The potential for less frost may have marginally extended the growing season in the uplands.

To allow a causal role of climate in upland migration, the following predictions must be met. First, cooler temperatures, which would depress agriculture, and in particular adversely affect tropical cultigens, must have appeared prior to upland settlement. If climate played no role in upland colonization, no distinct weather pattern should be observed. Second, the uplands must have been, on average, warmer than the lowlands to the extent that productivity was positively affected. Third, uplands should experience a longer growing season than the bottomlands. The predictions do not demonstrate, themselves, a causal role for climate, but if they are disconfirmed, a causal role for climate can be ruled out.

Prediction One

The first prediction requires that cooler weather prevailed prior to upland settlement. Although palynological studies of late Holocene climate and vegetation have been conducted for the Southeast, no such analyses have been performed for the north central Georgia region. Furthermore, the time frame of just over 200 years between the Iron Horse and Bell phases is too small a window to reconstruct useful climatic estimates, even if a suitable source of pollen cores could be located.

It is known that sometime between A.D. 1200 and 1500, the Neoboreal, or "Little Ice Age," had a cooling effect on the area. However, experts cannot agree on the boundaries of this period of renewed glacial activity, nor its affects on microclimate. The Neoboreal cooling was not a steady state and warm intervals did occur within this colder time, although their timing is unknown (Muller 1986; Bradley and Jones 1992).

Another complication is the fact that the effects of this cooling trend on regions that approach subtropical or tropical conditions are not well understood (Bradley and Jones 1992). Nevertheless, if it is accepted that the Neoboreal period occurred by at least A.D. 1500, then the cooling trend did begin in the Oconee region by the Iron Horse phase, and prior to the bulk of upland colonization.

It is likely that climatic and environmental changes played a critical role in social evolution, but until climatic variations can be documented at a finer scale, the extent of such influences will remain controversial (Bradley and Jones 1992). Regardless of the ultimate interpretation, the first prediction, that of a long-term cooling trend prior to major upland colonization, is met.

Prediction Two

Prediction two holds that the uplands were on average warmer than the bottomlands to the extent that productivity was positively affected. Unfortunately, current and historic United States government climatological data do not provide a gauge against which directly to measure temperature variations between upland and bottomland, ambient or ground-level temperatures. All weather stations in the Oconee region are fixed at fairly standardized elevations above sea level, with no significant variances (National Climatic Data Center 1994).

As has already been discussed under Hypothesis One, ambient and soil temperatures of southern-facing slopes would have been, on average, warmer than those of other topographical areas (Ricklefs 1979:42). Such microclimates, found primarily in the uplands, might confer an extremely marginal advantage to upland farmers during times of adequate to excessive rainfall, but would create moisture stress under normal to dry conditions (Rickleffs 1979:42). Depending on actual elevation, ambient temperature of the remaining portions of the uplands may actually be, on average, 0.3° to 0.6°C cooler than the bottomlands (based on Rickleffs 1979:43; Smith 1994:1). Based on Illinois data an decrease of 1°C shortens the growing season by ten days. The potential loss of three to six days thus represented would probably be mitigated by the thermal inversion discussed above (King 1993). In addition, elevation, slope, exposure, soil structure, and bedrock all affect soil and air temperature (Rickleffs 1979:188), which, in turn, affects the length of the growing season (King 1993:238).

Prediction two is neither upheld nor overridden by the available data. It is most likely that ambient temperatures were comparable in the uplands and bottomlands. Soil temperatures would have varied primarily in proportion to exposure to sun. Additional research is likely to lead to rejection of the second prediction.

Prediction Three

The third prediction states that uplands should have experienced a longer growing season if climate were an impetus to upland settlement. Although the cooling trends of the "Little Ice Age" would have been minor as far South as the middle Oconee (King 1993:236-237), any curtailment of the growing season might have adversely affected agriculture. As discussed above under Condition Two of Hypothesis One, the uplands do have the advantage that cool air drains into the valley, reducing frost in the uplands, while increasing it in the bottomlands (King 1993:252). In southwestern Pennsylvania one interpretation of the preference of the Monongahela for upland village locations has been interpreted as their way of avoiding cold air drainage on their cornfields (King 1993:238). These observations support prediction three.

Hypothesis Four: Discussion

There is only limited and tenuous evidence of climate being a causal factor in upland settlement. While it is true that the onset of the Neoboreal period may have predated the major thrust into the uplands, there is no obvious correlation between the two. The "Little Ice Age" may have begun prior to the Lamar period, or as late as the end of the Iron Horse phase. In the latter case, it is possible that movement into the uplands was in part motivated by a desire to extend the growing season, by maximizing the number of frost-free days. It would not have been motivated by temperature differential because, there is little practical climatic difference between the two regions. If there were any difference, the uplands were marginally cooler.

The most convincing argument for climatic influence on upland settlement is the issue of cold air drainage. During the "Little Ice Age" the Oconee probably manifested fewer than the 255 frost free days seen today. Nevertheless, if this figure were reduced by as much as 20%, it would still be well within the bounds of the 140 day frost-free season that Yarnell (1964:137; King 1993) calculated to be the limit to maize cultivation.

Southeastern peoples raised multiple varieties of maize, with varying maturation rates. Although it is likely that all maize varieties grown in the Oconee region could be brought to fruition within a 204 frost-free day growing season, this same time frame might have been insufficient for double-cropping. Since the onset of first and last frosts is variable, the margin of error provided by any additional frost-free days would prove critical to agricultural success at both ends of the growing season. This characteristic would favor upland settlement. While no evidence of ridged fields has yet been discovered in the Oconee region, they were definitely used at Ocmulgee (Fowler 1969) on the not too distant Macon Plateau. This device draws off cold air at a microclimatic level, effectively protecting the plant from frost. Use of ridged-field agriculture would help to guarantee an extended growing season in the uplands.

Despite the phenomenon of cold air drainage, there is no evidence that the upland air or soil temperatures were any warmer than those of the lowlands, and in some areas they may have been cooler. Southern exposed slopes would have been the exception, but they are a double-edged sword. Depending on soil and moisture conditions, such slopes could prove suitable for crops, or desert-like. In any case, they are more subject to erosion than more level areas and would probably not have been a major attraction for these agricultural people.

Hypothesis Five: Epidemic Disease

Hypothesis five submits that a sudden increase in the upland population of the Oconee region represented an attempt to escape epidemic diseases as would be evident from the following pattern: first, there should be clear archaeological correlates of an epidemic in the bottomland sites, beginning as early as the Dyar phase when the Spanish first passed through the region; second, a marked reduction in the number and sizes of bottomland sites occured in synchrony with a dramatic increase in the number of upland sites; third, sites that show evidence of fatal epidemics had fewer domesticated crops in the botanical sample, due to a shortage of people to cultivate them (Garcilaso 1988 [1605]:298).

Prediction One

The first condition states that there should be clear archaeological correlates of epidemic disease in the bottomland sites, beginning as early as the Dyar phase when the Spanish first passed through the region. This evidence should include an abnormally high number of graves, many of which contain two or more bodies. The physical remains should exhibit no evidence of violent death. Individuals from all age, sex, and socio-economic groups would be represented.

Although burials at the Dyar mound site cross-cut status, sex, and age lines, there was no evidence of rampant pathology. Smith (1987:73) considers the gradual abandonment of the Dyar site as itself indicative of European disease. While burial samples were small in the uplands, they represented fairly normal age spreads, and held no evidence of violent death. The Dyar phase Sweetgum population was less robust than those of the Iron Horse or Bell phase sites. However, both the Bell phase occupation of Sugar Creek, and the Dyar phase Sweetgum site featured one multiple burial, often interpreted as a sign of epidemic. Because the population of the bottomlands was relatively healthy, it does not appear that epidemic disease precipitated the move to the uplands. However, the presence of active lesions at time or death among the Sweetgum site burials and multiple burials in the Dyar and Bell phases, suggests that disease may have surfaced in the uplands. Alternatively, active lesions are typical of a malnourished population, as would be expected during a prolonged drought, which may have occurred during the site's occupation. The other Dyar phase burial at the Carroll site was that of a child (Kowlewski and Williams 1989:53), which is not unusual in prehistoric times. The double grave skeletons appear to be relatively normal, discounting the probability of epidemic. The physical evidence of epidemic is unsubstantial, and so prediction one is conditionally refuted.

Prediction Two

The second prediction requires that a marked reduction in the number and sizes of bottomland sites occured over time in tandem with a dramatic increase in the number of upland sites. This shift did not occur. Absolute site size diminished between Dyar and Bell phases in the bottomlands (Smith 1987), while numbers of sites increased. During this same interval small sites proliferated in the uplands (Kowalewski and Hatch 1991). These conditions imply population growth, rather than decline.

Prediction Three

The third prediction is that sites that show evidence of fatal epidemics show fewer domesticated crops in the botanical sample, due to a shortage of people to cultivate them (Garcilaso 1988 [1605]:298). The density index shows shortages of all plant categories, except open fields, occur at the Dyar phase Sweetgum site, (Table 11, Figure 9, Figure 8) where there was evidence of disease in the skeletal population. Shortages of edible taxa, particularly cultigens is most severe at the Carroll site (Table 20, Figure 18), but there were no burials encountered there by the Penn State team, and only one by the WPA crew (Kowalewski and Williams 1989).

According to density calculations (Table 12, Figure 10), while there was an average reduction in cultigens in the Dyar phase, open field plants proliferated. This pattern intimates that the clearing of fields, representing significant human labor, continued during the Dyar phase, despite the scarcity of cultigens. Since many open field plants tolerate xeric conditions, these data may indicate reduction of moisture, rather than work force. The latter position is supported by increased dependence on mast and probably low-ranked wetland plants during the Dyar phase.

Hypothesis Five: Discussion

A limited skeletal population hinders the resolution of this hypothesis, although the issue warrants attention. Smith (1987) found that both the number and size of sites per square km were reduced in number between the Dyar and Bell phases in the Oconee River bottom in the region of Wallace reservoir. He sees in this finding a general reduction of population over time. These findings corroborate the hypothesis that people fled to the uplands to escape an epidemic, as was observed in early historic accounts (Garcilaso 1988 [1605]:298). It should be noted that Smith's (1987) study was based on a small sample of sites. Kowalewski and Hatch (1991) reach a contradictory conclusion, finding in the archaeological record a substantial and growing population throughout the Oconee region during the Lamar period, until at least A.D. 1600. This latter study was based on more extensive survey data of the Oconee Region, and contradicts the epidemic hypothesis.

At *Cofachiqui* (*Cofitachequi*) in South Central North Carolina the Spanish were informed by Indian leaders that a recent epidemic, contemporary to the Dyar phase, had induced fearful inhabitants to flee

> "to the forests without sowing their fields" and that the leaders had been unable to induce them to "...to (return) to their homes and towns..." (Garcilaso 1988 [1605:298).

As discussed above, a similar shortage of agricultural crops is indicated by some measures at both Dyar phase sites. However, all classes of seeds, wild, edible, and inedible alike, were about equally diminished, according to the density ratio. Since many of these taxa would be expected as incidental inclusions, it is more likely that this condition reflected other cause, perhaps drought, rather than lack of manpower in the Lamar Oconee.

It is possible that the Oconee region represented a temporary "haven" from epidemics. There was no convincing evidence of epidemic there. Ultimately the Oconee region experienced demographic decline some time after A.D. 1600. One of the two double graves was found in the Bell phase occupation of Sugar Creek, perhaps indicating a delayed introduction of foreign pathogens into the uplands at that time.

In summary, the same paleopathological conditions typify both nutritionally stressed and epidemic victims. Arguments could be drawn from these archaeobotanical, ethnohistoric, and paleopathological data to depict the Dyar phase upland population as victims of either of these plights. Although this hypothesis holds possible merit given ethnohistoric reports, its full consideration is currently beyond the scope of either this dissertation or the extant Lamar data base.

Research Problem Two: Discussion

Research problem two seeks to explain the impetus for upland settlement. No single factor can account for this phenomenon. A complex of economic, social, political, an ecological conditions must be considered.

For the duration of the Lamar period, the Oconee uplands held abundant energy potential. Prior to the Dyar phase, this potential had barely been tapped, except from short-lived hunting camps and extractive sites, and a limited number of more permanent Vining phase habitations. Until the late Lamar period, most settlements were restricted to the riverbottom, and centered on five mound-towns, representing the upper echelons of the complex chiefdom of *Ocuté*. Ethnographic accounts of inter-polity warfare help to interpret these nucleated settlements as being in a state of readiness for warfare (Garcilaso 1988 [1605]). Furthermore, loyalty to chiefs typically ebbed and flowed with power and influence (Anderson 1990). Therefore, strong leaders aimed to consolidate the populace into manageable sectors to prevent defection.

A demographic upswing in the Oconee watershed, which probably fueled upland migration, most likely had its roots in a series of late Mississippian population movements across the Piedmont region (Anderson 1990). As chiefdoms in the Savannah River basin cycled into devolution, their populations sought respite under the umbrellas of more powerful chiefs, particularly during the period equivalent to the Iron Horse phase (Anderson 1990). There is archaeological evidence of well-established ties with the *Ocuté* chiefdom, with safe connecting routes established along the Little River (Anderson 1990). Although some people appear to have migrated northward toward *Cofitachequi* in what is now south central North Carolina, the bulk of the population most likely relocated to the Oconee valley (Anderson 1990).

Sometime during the late Lamar period the *Ocuté* chiefdom failed, but without evidence of military engagements within its territory, or of seizure, conflagration, or elimination of its territory or population. Denucleation of the settlement pattern coincided with the decline of the political hierarchy. Throughout the river valley, numerous small farmsteads dotted the landscape, presumedly surrounded by their agricultural fields (Pollack 1988). Large sites disappeared as the chiefdom dissolved. During the Dyar phase, small farmsteads were also distributed throughout the uplands, which experienced its first period of heavy occupation. The precision with which this movement can be isolated leads to several conclusions.

First, a relaxation of political control, or a suspension of external warfare, freed the population to disperse across the landscape to be close to their fields during the Dyar phase. This configuration saved travel and transportation costs in the production of cultivated foods. However, by the Bell phase, bottomland sites were poised on very small plots of fertile soil, indicating that inhabitants may have switched to an infield-outfield system consisting of large gardens surrounding their homes and floodplain corn fields. This pattern would have continued to provide easy access to a variety of crops that ripen at various points in the growing season, but would add transportation costs to the cultivation and harvesting of field crops in the floodplain. In the uplands it was still possible to live near the major agricultural fields.

Maize was the primary food of the Oconee people, and easily-worked floodplain fields undoubtedly produced bumper crops. As early as the Duvall phase, riverine maize agriculture was primarily supplemented by acorns and deer. While deer could apparently be captured in the bottomlands, more intensive hunting may have been conducted seasonally from upland base camps. Acorns served as high-cost back-up staples, but hickory was less plentiful in the valley than on higher ground. Hickory may have been processed into to oil in upland extractive centers and transported to the bottomlands. All of these presumed forays into the uplands would have added considerable costs to subsistence, although the ease of farming in the floodplains would lower the average to some extent. This potentially high-cost of living implies that some real or virtual barrier prevented upland settlement.

Colonization of the uplands accelerated during the Dyar and early Bell phases (Kowalewski and Hatch 1991). It is possible that migration from the Savannah river valley prior to or during the Iron Horse phase contributed to the swelling population of the middle Oconee watershed (Anderson 1990). The *Ocuté* chiefdom began to devolve sometime in the late Dyar to early Bell phases as manifested by the complete cessation of mound building by the Bell phase (Smith 1987; Williams and Shapiro 1987). There is no archaeological or ethnohistoric evidence to explain how this cessation occurred. Likewise, there is no evidence of epidemic. It is likely that social networks gradually assumed prominence over the chiefly redistributional system, ultimately replacing them when the ranked polity failed. Relatives and/or trading partners in different ecological zones would have exchanged surpluses, according to their respective needs and capabilities. This process was most likely reinforced by religious protocol (Ford 1977; Turner and Brush 1987:15). Unfortunately, only sparse and indirect evidence can support the possibility of reciprocity between the two topographic zones.

There is no clear evidence of a lessening of subsistence costs in the valley after the uplands were opened. In fact, over the course of the Lamar period subsistence costs rose throughout the Oconee region. While the plant inventory actually contracted, the varieties of fauna harvested in both upland and valley expanded in number and declined in quality over time, and agricultural intensification surely incurred some extra costs. These changes are related to increased human pressure on animal populations and habitats. Since these conditions are seen in both the river valley and the uplands, they did not change the relative costs of living in one zone versus the other.

In the uplands, subsistence potential and costs are projected to have been comparable to those of the bottomlands, with the greatest energetic returns being achieved prior to the Dyar phase. This conclusion is based on comparisons of the particular resources evident in archaeobotanical assemblages in each topographical zone (Table 4, Table 5, Table 10) and their calculated energetic potentials (Table 9). A greater number of frost-free days may have extended the growing season enough to ensure successful double-cropping of maize, or of maize and an alternate crop. (See discussion in Chapter 5, "Agricultural Practices"). As population pressure increased in the Oconee valley, expansion into the uplands was a natural extension of the evolving settlement-subsistence system. Once centralized political authority declined, a need or desire for societal nucleation waned, and dispersal into all topographic zones ensued.

As demographic pressure continued to build during the Dyar and early Bell phases, both upland and lowland people pushed to intensify food production in response to severe shortages. By the Bell phase, measurable increases in maize and nut production signaled the successful manipulation of plant resources in the uplands. Prime fauna began to be in short supply, but the admittedly small skeletal samples suggest that overall health was good in the Bell phase uplands.

In short, the uplands held high economic potential throughout the Lamar period, while the bottomlands reached the point of diminishing returns on labor invested in subsistence. Once real or culturally dictated restrictions were lifted, people naturally gravitated toward the uplands. Upland subsistence may have been either self-contained, or part of an integrated, reciprocal, socio-economic system with the bottomlands. As discussed above, the only relevant current archaeological data suggests that no such exchange was taking place in the case of major game. This question warrants further investigation.

Research Problem Three: Rate of Migration

Research problem three is an effort to determine whether the increased population and settlement density observed in the Oconee Region was a gradual, internal development or the consequence of sudden migration (Anderson 1990; Kowaleski and Hatch 1991). This issue is evaluated by testing the following three hypotheses.

Hypothesis One: *Stable Upland Occupation*

The null hypothesis holds that there was no change in upland population and site density after the initial colonization. In this case a settlement-subsistence pattern should have been established in the Iron Horse phase, and maintained over time.

It has already been explained that during the Dyar phase, continuing in to the early Bell, there was a tremendous increase in site density, and presumedly, human population (Hally and Rudolph 1986a, 1986b; Kowalewski and Hatch 1991). This growth was reflected in the subsistence system by the depletion of first ranked animal resources, and by an increased investment in agriculture and mast processing, following an ongoing adjustment that typified the Dyar phase subsistence regimen. (See Chapter 8). The null hypothesis is rejected.

Hypothesis Two: Gradual Upland Colonization

The second hypothesis advances the idea that a steady expansion of Oconee population brought about the gradual occupation of the uplands. In this case, a gradual increase in diet breadth is anticipated.

A gradual increase in evidence of corn and other agricultural crops and in hickory nut harvesting occurred between the Iron Horse and Bell phases, with a complementary reversal in exploitation of other wild plants ensuing in the Bell phase. The quality and quantity of animal protein declined over the same period. These observations are consistent with a steady, rather than sudden, occupation of the uplands. However, a brief spike in population during the Dyar phase may have triggered the final episode of agricultural intensification in the Bell phase. Hypothesis two generally is upheld.

Hypothesis Three: Rapid Upland Occupation

The third hypothesis is that upland occupation was rapid and sweeping. In this case sharply altered diet breadth is anticipated, along with a rapid increase in open field taxa as agricultural fields were cut from woodlands. As discussed in hypothesis one, problem three, the uplands filled with people during the Dyar and early Bell phases, but the rate and precise timing cannot be determined. No evidence of sharply altered diet was observed, with the possible exception of the spectacular agricultural and hickory production at the Bell phase Lindsey site. Hypothesis two is conditionally rejected.

Research Problem Three: Discussion

Although demographic trends cannot be fully assessed by paleoethnobotanical analysis, this technology provides an independent source of confirmation of population levels. It was observed that all shifts in subsistence strategies over time were gradual. The single possible exception was the sudden push of agricultural intensification and hickory exploitation during the Bell phase, particularly at the Lindsey site. Even this change was merely a variation on the already existing technology and strategy.

From a purely paleoethnobotanical point of view, the subsistence assemblage reflects a gradual flow of population into the uplands, until the early Bell phase. At that time, a point of diminishing returns was reached, and concentrated agricultural intensification was the cultural response. During the early Bell, a sudden final push of upland colonization may have precipitated this situation, or it may have been the penultimate stage of upland occupation - to be followed by a gradual decline in later Bell.

This scenario is supported by the archaeological, archaeobotanical, and zooarchaeological record. In particular, regional settlement patterns indicate saturation of culturally acceptable bottomland habitation sites, and a persistent diffusion into the uplands, rather than a mass relocation. By the Bell phase, only small resident populations remained at mound towns, yet permanent settlements persisted within a 23 km radius of these former political centers (Hally 1993; 1996). Site density is not uniform, and dropped by 50% between 10 and 23 km (Hatch 1995). This pattern suggests a gradual outward diffusion from a population center.

Conclusion

These research problems offer a framework for the exploration of human adaptation in the central Oconee region during the Lamar period. While the research problems addressed in this chapter cannot be completely solved using the current data base, they do provide partial answers, multiple insights, and much food for thought. It is evident that an interplay of anthropogenic, climatic, biotic, and geomorphological forces and conditions slowly transformed the broad flora - narrow fauna diet of the Iron Horse phase into the exact opposite in the Bell phase. Future work will refine this base outline of human ecology in the middle Oconee system.

Chapter 11
CONCLUSION

Introduction

The Lamar period in the Oconee watershed was a significant era of social, political, and economic reorganization, culminating in the dissolution of the political hierarchy. The data presented in the preceding chapters indicate that the area's inhabitants responded to demographic and environmental perturbations with minor adjustments, or refinements, of the existing coping mechanisms. Over time, these modifications accumulated and precipitated an array of systemic responses.

Cultural Ecology of the Oconee Uplands

Stresses on Carrying Capacity

Political Circumscription

Ocuté is a historically documented archaeological province, consisting of one or more closely related late prehistoric-protohistoric chiefdoms (Elvas 1933, 1968 [1557]; Brain 1985). Rural settlement centered around five archaeologically documented mound centers, located along rivers in the floodplain. Colonization was largely constrained to a 23 km radius of each major town, spilling into the uplands. A few permanent settlements appeared in the uplands as early as the Vining phase (Worth 1996:51), but upland settlement was particularly heavy during the Dyar and early Bell phases. Site density was not uniform, and dropped by 50% between 10 and 23 km (Hatch 1995). Twenty-three km represents one day's travel by runner and is hypothetically linked to socio-political control (Hally 1993). This political circumscription is the first of three probable major stresses on subsistence returns for labor.

Demography

Mississippian settlements were traditionally associated with riverine environments, and, in fact, few permanent habitations were located beyond the bottomlands of the middle Oconee prior to the Lamar period. Nevertheless, over 300 "homestead" sites and hamlets, averaging 0.3-0.6 ha in size are documented in the Oconee uplands, most dating to the Dyar and Bell phases, while the bottomlands remained fully occupied. Moreover, it has been predicted that well over 10,000 sites lie within the Oconee archaeological district (Kowalewski and Hatch 1991). This pattern suggests a human "population explosion" and represents the second major pressure on the ecological balance. This second imbalance may have its roots in A.D. fourteenth century emigration from devolving Savannah watershed chiefdoms (Anderson 1990), as well as *in situ* population growth (Kowalewski and Hatch 1991).

Climate

Climatic conditions represent the third ecological imbalance within the territory of the *Ocuté* chiefdom. The Lamar period largely coincided with the Neoboreal event, or "Little Ice Age." The effects of this generalized cooling trend on the Southeast are not well understood. It is known, however, that as far North as upstate New York and Ontario, maize was raised successfully during this period (Waugh 1916; Heidenrich 1971; Brose; Tuck 1978). Thus effects on the Oconee region were probably minimal. The single greatest effect that the Neoboreal may have had on Oconee subsistence was a reduction in the number of frost-free days. This reduction may have curtailed successful double-cropping of maize. Farming in the uplands would be one way partially to mitigate this damage. Cold air drains into the bottomlands, protecting the uplands from frost for a period on either end of the growing season. If combined with the use of ridged fields, which drain cold air at a microclimatic level, an extended growing season for corn may have been possible in the uplands.

Dendroclimatological evidence suggests that a nearly continuous decade of drought in the A.D. 1560's imposed a third ecological disturbance (Stahle and Cleaveland 1992, 1994). Such a drought may be reflected in the Dyar phase Sweetgum floral assemblage, which contained significantly fewer archaeobotanical remains than any other site or occupation. According to these same sources, the balance of the Lamar period sustained variable, but generally adequate, precipitation.

Evolving Subsistence System

Prior to the Lamar period, people of the Eastern Woodlands independently developed their own horticultural tradition, based on indigenous starchy and oily seeds, including *Chenopodium berlandieri*, or goosefoot; *Iva annua* var. *macrocarpa*, or sumpweed; and *Helianthus annuus* or sunflower, among others (Yarnell 1978, 1993; Gremillion 1989a). DeSoto and others documented that habitats for game and economically useful plants were maintained by controlled burning (Strachey 1849 [1612]; Beverley 1947 [1705]; Day 1953; Adair 1968 [1775]; DuPratz 1972 [1774]; Pyne 1983; Hurt 1987). By Mississippian times, a Mesoamerican transplant, *Zea mays,* had largely displaced native cultigens, and field agriculture in river floodplains provisioned burgeoning chiefdoms. During the Lamar period, Eastern tradition crops had nearly disappeared in the middle Oconee bottomlands, where corn, oak acorns, and aquatic resources comprised the subsistence base. The high percentage of pine in both features and postmolds suggest that horticulture had been long practiced in the region (Quaterman and Keever 1962; Wagner 1996).

Between the Iron Horse and Bell phases there was a dramatic increase in agricultural productivity, and in nut harvesting. However, in many other ways the subsistence in both the Iron Horse and Bell phases were similar. Eastern tradition and Mesoamerican crops were present in both Iron Horse and Bell phases. *Chenopodium berlandieri* and *Iva annua* var. *macrocarpa* temporarily dropped out in the Dyar phase, resurfacing in the Bell phase. The most pronounced contrast between the Iron Horse and Bell phases was the volumetric increased in agricultural products and nut shell. In addition, *Prunus persica* and *Phaseolus vulgaris* first appeared in the study sites in the Bell phase, although the latter was is seen elsewhere as early as the Iron Horse phase.

Other differences among the three phases were more subtle. Agricultural crops, and nut shell remains decline in the Dyar phase, but corn and hickory are the major dietary components, as at the other occupations. The drought-tolerant open field pioneering genera actually increased in numbers of taxa and in density during the Dyar phase. A reduction in arboreal fruits and pods and an absence of most herbaceous plants in the old field category, along with the tapping of wetland resources, particularly *Saggitaria* tubers, was noted for the duration of the Dyar phase. Tree species recovered in the Bell phase, implying depressed productivity, rather than eradication, in the Dyar phase. However, overall emphasis on edible old field taxa declined after the Iron Horse phase. Wild edible seeds were much more common in the Iron Horse and Dyar phases than in the Bell phase. Throughout the Lamar Period mast was the dominant wild food, and *Phaseolus polystachyus* (polystachyus bean), *Passiflora incarnata* (maypop), *Vitis* spp. (grape), and *Nyssa aquatic* (black haw) were dietary supplements. The majority of agricultural seeds were corn, and the nuts category was strongly dominated by hickory.

Upland Colonization and Technological Development

A synthesis of the data presented in this dissertation reveals that movement into the uplands was a response to diminishing returns on labor in the bottomlands. The bottomlands had reached the culturally perceived saturation point for human habitation. The region could still accommodate more people, but only if they were willing to occupy upland tracts. While agriculture was marginally more difficult in the uplands, proximity to mast and prime game initially reduced the overall subsistence costs. Both upland and riverbottom people relied on corn and nuts as staples, but acorns were deemphasized in the uplands, in favor of protein and oil-rich hickory nuts. Hickory could be crushed and added to stews without further processing. Protohistoric and archaeological evidence suggest that genetically wild *Passiflora incarnata* and *Phaseolus polystachyus* were encouraged or cultivated (Beverley 1947 [1705]; Strachey 1849 [1612]; Fritz 1986;

Gremillion 1989). Relatively abundant open land in the uplands allowed for an economically productive patchwork of actively managed fields and gaps in diverse stages of succession. Ethnohistoric accounts note the park-like conditions near villages, and the selective sparing of slow-maturing, economically useful species, such as *Diospyros virginiana* (persimmon), and *Juglans nigra* (black walnut) in the clearing of woodlands for agriculture (Dobyns 1983). While edge zones were artificially eliminated in the analytical phase of this project, maintenance of these areas of ecotone is presumed to be an essential component of the upland Lamar subsistence system. (See chapter 7, "Grouping By Habitat.") Thus, the upland diet was rich, and energetic returns were high, compared to the river bottom during the initial phase of colonization.

The burst of settlement in the Dyar and early Bell phases implies that demographic pressure influenced political leadership to permit agricultural extensification into the less easily monitored "hinterlands." Alternatively, this dispersal may signal a confident chiefdom anticipating no imminent raids from adversaries. While DeSoto encountered prisoners of war from *Ocuté* at *Cofitachequi* (Garcilaso 1988 [1605]), there is no evidence of military campaigns within the Oconee Valley. Fortified outposts were seen on the Eastern and Western boundaries of the chiefdom at different points in the Lamar period, however (Williams 1987). In either case, the linear dispersal of settlements along the Oconee valley, and population diffusion into the uplands marked the incipient devolution of the *Ocuté* chiefdom. Suboptimal agricultural soil patches were farmed in both uplands and bottomlands at some point during the Dyar phase (Pollack 1988; Kowalewski and Hatch 1991).

If the proposed ten-year drought did, in fact, occur, this water deficit would have exacerbated environmental stress. The serious drop in numbers and density of all classes of taxa except those that are drought-tolerant, and the small skeletal sample of the weakened Dyar phase population, are submitted to support the existence of an extended dry period during the Dyar phase. These factors, particularly the indisputable floral data, generated a need for compensatory technological modification. The absence of Eastern Tradition crops in the Dyar phase may well signal the trading of risk of crop failure for the hope of maximum productivity. As discussed in Chapter 3, Smith (1992:208) alleges that a field of unhybridized corn yielding 25% below its maximum potential would still equal the yield of a similar field planted in domesticated chenopods. In addition, incremental intensification of human labor increases corn yields disproportionately in comparison to goosefoot.

A possible shortening of the fallow cycle in the Dyar phase is reflected in the lack of herbaceous old field species. Economically useful old field tree species persisted as a minor component of the floral assemblage, and nuts maintain prominence. Probable harvesting of *Saggitaria* tubers may have been related to famine. Possible over-hunting, over-fishing, and depressed agricultural productivity brought on long-term subsistence challenges, and these overwhelming pressures could not be compensated by chiefly redistribution. By the beginning of the Bell phase, all mound building had ceased, signaling the demise of centralized political authority.

By the Bell phase, traditionally targeted animal species were apparently becoming increasingly scarce, as a result of direct human predation and shifting habitat (Boyko n.d.). At the same time, species diversity of plants and animals within farmstead catchments was increased due to human manipulation of the landscape, and harvesting of fauna became highly generalized, ranging from the occasional whitetail deer down to minnows (Boyko n.d.). Those few deer that were taken were processed so thoroughly that even the bones were rendered to produce grease (Boyko n.d.) At this point, crops and nuts began partially to substitute for first-line game animals.

In response to regional human population growth, agricultural intensification occurred in the early Bell phase, complete with renewed crop diversification, implied intercropping, probable double-cropping, and labor-intensive pest-control. In light of the theoretical soil degradation of the Dyar phase, a leap in maize production in the Bell phase (Chapter 8) suggests agricultural extensification. However, this scenario is contraindicated by bottomland surveys. There, Dyar phase soil catchments for dispersed farmsteads tended to be more extensive than the typical 0.25-0.50 km radius around Bell phase sites, but encompassed soils of varying productivity. Bell phase soil catchments in the valley tended to be more productive (Pollack 1988:41-42). It has been speculated that during the Dyar phase catchment extensification was the rule in the valley, while intensification was practiced during the Bell phase (Pollack 1988). There is an alternative interpretation.

Given the circumscribed nature of the bottomlands, it is not surprising that only small catchments of fertile soil remained for colonization in the Bell phase. It is reasonable to assume that in the bottomlands, homesteaders occupying scattered plots practiced an in-field, out-field system of agriculture. The relatively small but highly fertile gardens surrounding homes are typical of many late prehistoric and historic agricultural people (Alcorn 1984; Wilson 1987 [1917]; Woods 1987; Emerson 1992). With the demise of the chiefdom, maize could be raised in large agricultural fields in the river floodplain by individual families or larger social units. Each family would also maintained its own mixed-horticultural garden proximal to its habitation (Woods 1987:285). These contrapuntal subsistence strategies of bottomland and uplands exploitation underscore the uniqueness of upland and bottomland ecology.

Once human population began to decline in the Bell phase, depleted agricultural lands could theoretically be put under normal fallow cycles. Although the Bell phase occupations in the Penn State project were typically of brief duration, families could hypothetically lay claim to increasingly larger soil catchments as regional population diffused into former no-mans lands (Pluckhahn 1995). This proposal remains to be tested with the excavation of additional sites.

Eastern tradition plants (Chapter 5) had dropped out of the Dyar phase assemblages of the Penn State project sites, as demonstrated in Chapter 8. *Chenopodium berlandieri, Iva annua var. macrocarpa*, and *Helianthus* spp. assumed renewed importance in the Bell phase, possibly due to their low soil fertility demands. Together these plants provided more and different nutrients than corn, and suffered from different pests, boosting productivity through crop diversification. *Phaseolus vulgaris* appeared for the first time in these sites, to supplement the polystachyus bean, and *Prunus persica* was fully incorporated into native arboriculture. Common bean was most likely inter-cropped with *Cucurbitae*, *Zea mays*, and possibly with encouraged wild species such as like *Phaseolus polystachyus* and *Passiflora incarnata*.

Despite reduced competition from game for corn, acorns, and hickory nuts, field crops still faced stiff competition from open field and edge zone fauna. These small birds and mammals became the major meat source in the Bell phase (Boyko n.d.) as garden hunting (Linares 1976) became an important part of pest control, as well as a protein source.

Summary

In summary, paleoethnobotanical analysis of four upland sites reveals that the following conditions existed during the Lamar period in the Oconee uplands. First, there was a diachronic shift in plant exploitation strategy, from a highly complex mix of wild and cultivated taxa in the Iron Horse phase to an overwhelming emphasis on maize and other agricultural crops and mast in the Bell phase. Second, technological modification in the forms of agricultural extensification, intensification, and diversification in the Bell phase were consequential to prolonged ecological degradation. Third, the range of wild plant species harvested remained fairly stable over time, except during a possible drought-induced famine, but common beans and peaches were added to the upland assemblages in the Bell phase. Fourth, habitats were maintained, and wild plants were spared, encouraged, cultivated, and otherwise managed throughout the Lamar period.

Future Directions

Settlement-Subsistence Systems

The middle Oconee watershed provides a unique laboratory for the exploration of the interaction between political influence, human demography, and regional ecology during the terminal Mississippian period. In particular, the Lamar culture is abundantly represented in both upland and riverine settings through extant archaeological evidence. Many upland sites remain to be excavated. Limited first-hand Spanish accounts of the territory enhance archaeological interpretation. While most bottomland studies must be restricted to the data gained in the Wallace Reservoir mitigation project, the uplands persist as a largely untapped, and important source of data. As early as the A.D. 1520's direct European contact began to erode aboriginal socio-cultural systems in the coastal and adjacent Piedmont regions of the Virginia and North Carolina (Gremillion 1989a:5; 260-262). About the same time, European explorers passed through the interior Piedmont; however most contact with the largely autonomous interior cultures was accomplished through middlemen, and not until at least A.D. 1620 (Gremillion 1989a:5-6).

Both this dissertation and the Pennsylvania State University project on which it is based introduce extensive data on upland settlement and ecology in the Oconee region, but also raise many questions. Vining, Duvall and late Bell phase sites need to be scientifically excavated in order to create a base-line reference for the upland settlement-subsistence sequence. It is imperative that flotation, soil, and where possible, pollen samples be obtained according to current standards. In particular, the use of 0.5 mm or smaller mesh, standard samples sizes or measurements, and the routine collection of control samples in flotation work will facilitate a detailed analysis of paleoethnobotanical data. Samples of uncharred seeds of suspected prehistoric origin should be subjected to radiocarbon dating. Where practical, paleopathological and stable carbon isotope studies of skeletal material will aid in the paleoethnobotanical analysis.

Further manipulation of the existing data base is essential. Features and postmolds must be classified as to their relative position in the site, as well as their probable function. Macrobotanical and faunal data should be correlated with these proveniences to aid in the determination of functional areas within sites. This information, in turn, may reflect technological modification over time, and may also reveal as yet unknown uses of faunal and floral resources. As part of this continuing study, samples of wood should be identified in each provenience, as discussed earlier in this dissertation.

Until recently archaeologists disregarded upland regions surrounding Mississippian period floodplain settlements as potential locations of permanent, largely self-sufficient habitations. The present study, among others, demonstrates the error of this supposition. Research in the Dog River Valley of western Georgia demonstrates that at least two small upland farmsteads were occupied on a year around basis (Gremillion 1990). Other small upland sites have been located at Moundville in Alabama (Scarry

1986). Upland regions must be routinely included in future regional studies of Mississippian cultures, and those already completed must be revisited to determine their role in the socio-political and subsistence systems. Mere identification of upland sites is insufficient. Selected sites must be excavated to discover details of size, occupational duration, seasonality, subsistence, and biotic resources.

The ultimate goals of this research must include not only a determination of the upland variant of Mississippian - late prehistoric settlement-subsistence patterning, but the position of this strategy within the regional socio-economic ecology. This dissertation undertakes the initial steps toward these goals as they apply to the middle Oconee region in particular, and the Georgia Piedmont in general. It is possible that upland settlements were economically integrated with those of the bottomlands, particularly during the period of chiefly rule. To date there is no conclusive evidence to support this integration, however. While general late Mississippian subsistence patterns are anticipated for the uplands, as they have been denoted for the riverbottoms, local variations related to natural resources and social ecology are predicted. The hallmark of survival in the uplands appears to have been flexibility.

The issue of institutionalized reciprocity or redistribution between people of different ecological zones must also be pursed. While Boyko's (1996) work contraindicates such a system, he focuses on a single resource type, animal protein. As was discussed above, certain types of evidence for faunal export (*e.g.*, mollusc shell) would be difficult to interpret. If game resources were similar between the two topographical regions, it is likely that they would not have been included, except perhaps in a token amount, in socially dictated exchange. Since plant foods dominated Lamar subsistence, it is likely that evidence for reciprocal exchange lies in that domain. Corn ritualism is well established throughout the Southeast (Swanton 1969; Hudson 1976), and may be the basis for economic redistribution. A first step to test this hypothesis would be to calculate kernel:cob ratios for Oconee bottomland assemblages. If they are found to be substantially higher or lower than those of similar upland phase sites, this evidence would support the redistribution of this resource. Another important plant resource is hickory. The problems with documenting the transport of this commodity have been discussed in Chapter 10. However hickory might be indirectly measured through ceramic analysis. If it can be demonstrated that a particular container was used for storage of hickory oil, these vessels should be differentially present in the uplands where hickory shell is abundant. If such containers are found in equivalent numbers in both upland and bottomland sites, the export of hickory "milk" to the hickory deficient bottomlands could be inferred. Every effort should be made to devise direct and indirect measures of interdependence of inhabitants of the two zones.

Plant Manipulation

While paleoethnobotanists have for some time recognized the gradual nature of domestication (Ford 1985; King 1987), most plants are arbitrarily classified as "wild," or "domesticated," based on presumed or measurable characteristics or supposed natural habitat boundaries (King 1987). While a grey area of "tolerated,""cultivated" and "encouraged" species is theoretically recognized and discussed, such species are rarely acknowledged in paleoethnobotanical analyses.

Gremillion (1990) has built a convincing case for the regular cultivation of maypop (*Passiflora incarnata*). The time has come to acknowledge other regularly manipulated genera, some of which may be in incipient stages of domestication. Throughout the Lamar period, wild kidney bean (*Phaseolus polystachyus*), was present in sizable quantities in the study sites. Recent discoveries place it tentatively at the Iron Horse occupation of the Racoon Ridge site (9MG271), as well (Mazingo 1996, personal communication). This taxon is always more abundant than common bean (*P. vulgaris*), which does not even appear until the Bell phase. As described elsewhere, early explorers described beans resembling the wild polystachyus bean elsewhere in the Southeast. While this taxon grows naturally in the woods habitat, it may proliferate in open fields, if introduced. Fritz, too, presents evidence in her dissertation consistent with domestication (Fritz 1986; 1995, personal communication). In short, here is one species whose position in the subsistence system needs to be reevaluated.

So-called "wild" sunflower (*Helianthus* spp.) must also be reassessed. Most of the sunflower achenes recovered in the Oconee upland sites fall below the arbitrary dimensions established for Mississippian period domesticated plants. (See Appendix A.) Nevertheless, they do fall within the range of Woodland domesticates, and occur within an established pattern of Eastern tradition domesticates. Under current standards, these specimens must be considered to be "wild." However, other examples of small-seeded sunflower have been discovered in agricultural context on Mississippian sites in Mississippi and West Central Illinois and disregarded as potential domesticates based on size (Asch and Asch 1985 170). It is possible that the somewhat diminutive proportions are attributable to phenotype, rather than genotype. In summary, more research is needed on the position of plants in the continuum of human manipulation. Native local plants cannot always be assumed to be wild or to lack human husbanding. On the other hand, traditional standards may be inadequate accurately to classify either wild or domesticated variants of a given taxon. Protohistoric accounts need to be examined for reference to these and similar taxa. Old collections must be examined for "outlier" plant populations, and even for misidentified specimens. Such work will lead to a more complete understanding of the domestication process, as well as of the relationship between human-dependent and wild varieties of the same genus.

Taphonomy

Often uncharred organic matter is found in archaeological context in late prehistoric sites. The ordinary practice is to label it as "modern intrusions" (Kaplan and Maina 1977; Keepax 1977). While some such macrofossils are clearly the product of bioturbation, or other postdepositional disturbance (Wood and Johnson 1982), this supposition is not necessarily true in late prehistoric sites.

In the Penn State project sites, seeds with particularly hard testa, and wood fragments, were often found in a mineralized, or partially degraded state. In the case of several proveniences, charred, partially charred, and mineralized maypop seeds were found in the same undisturbed feature, in good archaeological context. In other proveniences, partially charred wood was mixed with charred wood of the same species (usually pine). It is possible for uncharred wood to survive for hundreds of years (Baldwin 1994, personal communication). Thick-coated lotus seeds recovered in a Manchurian peat bog, estimated to be between 830 and 1250 years old, have been successfully germinated (Quick 1961). Other seeds are widely recognized to be viable for up to 150 years (Quick 1961). It is suggested that while discounting uncharred seeds is the conservative approach, it may also mask important archaeobotanical data.

Future research should include the radio carbon dating of uncharred seeds and wood from undisturbed proveniences, and in good archaeological context. This work is particularly important in the case of late prehistoric and protohistoric sites where seed degradation may have been delayed, giving the macrofossils a more modern appearance. Seed viability under natural conditions is not well documented for most species (Quick 1961).

Conclusion

This dissertation opens up important new spheres of inquiry. Evidence of flexible responses to changing ecology highlights the adaptability of the established Mississippian subsistence system. Unanticipated numbers and varieties of wild and domesticated plants challenge our preconceived notions of traditional plant husbandry.

The upland subsistence variant can be more fully interpreted through integration with concurrent river bottom patterns, resulting in a more refined understanding of the regional Mississippian adaptation. It is possible that the uplands and floodplain settlements were part of an economically integrated system (Sauer 1967; Butzer 1982). Until now it has been assumed that the Oconee system of upland settlements is somewhat unique. This interpretation is not necessarily true. Upland farmsteads may, in fact, represent a more essential part of late Mississippian adaptation than is presently acknowledged.

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Appendix A

NOTES ON RARE OR UNUSUAL TAXA

Scope

Certain rare or unusual taxa require special discussion. These distinctive genera fall within three categories, (1) members of the "Eastern Tradition,"[1] (2) "Exotics," or non-native plants, and (3) indigenous plants that are scarce in the regional archaeological record. The Eastern Tradition plants comprise a suite of native plants that were cultivated and domesticated in the region east of the Mississippi River, prior to the adoption of mesoamerican cultigens. All non-native plants found in the four sites of this study are traced to Spanish contact. Finally there is the issue of rare indigenous plants, some of which may actually be naturalized exotics.

An assessment of the corn cob assemblage follows the review of rare and unusual taxa. It is intended to appraise the variety or varieties of corn grown at the Bell phase of Sugar Creek. This is the only site for which relatively intact cobs were available.

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[1]Also known as the "Eastern Agricultural Complex."

Indigenous Cultigens

The term, "Eastern Agricultural Complex," is a misnomer often applied to the indigenous agrarian systems of eastern North America. While a suite of domesticated plants were cultivated in the Midwest and Midsouth (Smith 1992), rarely is there evidence of the entire association of plants being grown together, nor was there a pan-eastern America agricultural system. Finally, in some early cases, horticulture[2], and not field agriculture[3], was practiced. Hence, following Gremillion (1989) I use the term "Eastern Tradition" in reference to these crops. Not all of the seeds that fit into this suite were sufficiently well preserved in the study samples to obtain adequate measurements. In the case of *Chenopodium berlandieri* (domesticated goosefoot) funding limitations restricted the number of individual seeds subjected to measurement.

Eastern tradition crops are distinguished from their wild relatives by evaluating a number of characteristics. Seed size is the main determinant of domesticate status in the cases of marshelder, sunflower, giant ragweed (*Ambrosia trifida*) and erect knotweed (*Polygonum erectum*), while testa thickness distinguishes domesticated goosefoot. Maygrass (*Phalaris caroliniana*) and little barley (*Hordeum pusillum*) are evaluated mainly in terms of their density, and distribution. Distribution beyond the natural range,

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[2]This term refers to the cultivation of relatively small gardens of mixed taxa, often in close proximity to habitations.

[3]This term refers to the practice of clearing relatively large tracts of land, usually for the cultivation of staple crops. Intercropping or other production of secondary crops may be integrated into this system. Fields may be either proximate to or distant from habitations.

where noted, is important corroborating evidence of domestication (King 1984). Not all of these species were recovered in the Oconee upland sites.

Iva annua

Iva annua is an oily-seeded annual thought to be native to the lower Piedmont, where it is "locally abundant" in fields (Radford et al. 1968:1016). Elsewhere, for example in west-central Illinois, it occurs in open, disturbed, wet floodplain habitats (Asch and Asch 1985:159). It was in west-central Illinois that this genus was first domesticated, by at least 2000 B.C. (Asch and Asch 1985; Smith 1992). The now extinct, domesticated variety, *Iva annua* var. *macrocarpa*, is distinguished from the wild form by the size of its achene. A mean achene length of 4.0 to 4.2 mm is generally accepted as the baseline value for the domesticated species. Marshelder achenes undergo considerable shrinkage during charring. Therefore, following Asch and Asch (1985:163), I have applied the following corrections to the macrofossils.

$$L(achene_{uncarbonized}) = 1.36xL(kernel_{carbonized}) + 0.17 \tag{A.1}$$

(A.1) L = length

$$W(achene_{uncarbonized}) = 1.45 x W(kernel_{carbonized}) - 0.06mm \qquad (A.2)$$

(A.2) W = width

Table 37 summarizes the available data for *Iva annua* achenes from the Oconee upland assemblages.

Three measurable *Iva annua* kernels were recovered from the Iron Horse phase of Sugar Creek and two from the Bell phase, as well as seven from the Bell phase at Lindsey. If allowance is made for the missing apex in sample 86-1, all of the specimens meet or surpass the minimum baseline length value for *I. annua* var. *macrocarpa*, even without adjustment for shrinkage. This size places them well within the limit of the domesticated variety. The largest specimens are found in the later Bell phase, and the sample size for the Bell phase is larger than that of Iron Horse. There is considerable overlapping in the lengths of marshelder seeds at the two sites. These facts lead to the conclusion that *Iva annua* var. *macrocarpa*, a fully domesticated variety of marshelder, was cultivated during both the Iron Horse and Bell phases of the Lamar period in these upland sites.

Helianthus annuus

Helianthus annuus, or common sunflower, is the only early north American domesticate to derive from the West. A weedy camp-follower, its natural range was

Table 37: Measurements of *Iva annua.*

Phase/Site	Master Sample Number - Sample	Dimensions (mm)	Adjusted Dimensions (mm)
IH/ 9MG4	086 - 1	3.75 x 3.75 (apex missing)	5.27 x 5.3775
IH/ 9MG4	111 - 1	5.00 x 3.75	6.97 x 5.3775
IH/ 9MG4	226 - 1	5.00 x 3.4	6.97 x 4.87
Lin/ 9MG231	061 - 1	5.25 x 4.00	7.31 x 5.74
Lin/ 9MG231	061 - 2	4.25 x 3.50 (broken, reconstructed)	5.95 x 5.015
Lin/ 9MG231	061 - 3	4.50 x 3.00 (broken, estimate)	6.29 x 4.29
Lin/ 9MG231	061 - 4	5.00 x 4.10	6.97 x 5.885
Lin/ 9MG231	061 - 5	4.00 x 3.00 (broken, estimate)	5.61 x 4.29
Lin/ 9MG231	087 - 1	5.50 x 4.00	7.65 x 5.74
Lin/ 9MG231	087 - 2	4.50 x 2.80	6.29 x 4.00
Bell/ 9MG4	035 - 1	6.00 x 3.50	8.33 x 5.015
Bell/ 9MG4	076 - 1	5.00 x 3.00 (broken, estimate)	6.97 x 4.29

extended eastward during the Terminal Archaic period. Consequently, the simple presence of sunflower east of the Mississippi River constitutes insufficient evidence of domestication, although it probably required some degree of cultivation to prosper (Asch and Asch 1985:165). One notable characteristic of the domesticated sunflower, monocephali, cannot be reconstructed from the archaeological record. Achene dimensions are the single remaining trait by which domestication can be assessed. Even this criterion is not guaranteed.

Heiser (1985:60) sets 7 mm as the baseline achene length for a domesticated specimen. However, unlike other plants, *Helianthus annuus* does not have strictly uniform seed size. Achene size is not uniform even within a single disk. The effects of selection under domestication may be partially obscured by diverse environmental conditions. This problem is exacerbated by the typically very small archaeological samples available for evaluation (Asch and Asch 1985:170). Research in west-central Illinois demonstrates augmentation of the mean sunflower achene size between the Terminal Archaic and Mississippian periods. Nevertheless, considerably smaller achenes were recorded for two late prehistoric sites in that region. This variation suggests that a greater allowance should be made for variability in late prehistoric times (Asch and Asch 1985: 170). This allowance would be in accord with the size variability documented by Heiser (1951) for traditional Indian varieties grown in the twentieth century (Yarnell 1981; Asch and Asch 1985:170).

Table 38 summarizes the data for *Helianthus annuus* specimens recovered from the four upland sites. Following Yarnell's (1978: 296) recommendations, measurements

Table 38: Measurements of *Helianthus spp*.

Phase/Site	Master Sample Number - Sample Type	Dimensions (mm)	Adjusted Dimensions (mm)	Index (L x W)
IH/ 9MG4	86 - kernel	7.00 x 3.75 (apex broken, estimate)	7.77 x 4.76	36.99
Dyar/ 9MG245	15 - kernel	4.50 x 3.80	5.00 x 4.83	24.15
Bell/ 9MG4	80 - achene	5.25 x 3.00	6.83 x 4.35	29.71

were corrected to compensate for shrinkage due to carbonization, and, if applicable, for loss of pericarp (Asch and Asch 1985: 165). The single achene length and width were increased 11% and 27% respectively, while kernel lengths and widths were increased by 30% and 45% respectively (Yarnell 1978: 296; Asch and Asch, 1985: 165).

This sample of one specimen from each phase of the Lamar period cannot be weighed too heavily. Regardless of correction factors, only the Iron Horse phase kernel falls within the statistical range of domesticated sunflower. Yarnell (in Asch and Asch 1985:165), however, uses a second measure of domestication, an index of the achene length multiplied by its width. Excluding outliers, he obtained the following trends in achene size.

20 to 24	Terminal Archaic
22 to 26	Early Woodland
25 to 35	Middle Woodland
35 to 60	Early Late Woodland
50 to 100	Mississippian

By this measure, even the Iron Horse specimen falls short of the criterion for domestication during Mississippian times. However, the Dyar sample falls within the range of domesticated achenes of the Early Woodland period, and the Iron Horse and Bell phase specimens lie within the ranges of Middle and Early Late Woodland domesticates, respectively.

Considering the variability and plasticity of this genus, these specimens cannot be rejected as domesticates. While they are small for Mississippian achenes, the Iron Horse and Bell specimens exceed the average 5 mm length of the typical modern wild achene (Martin and Barkley 1961). The late Mississippian sites in west-central Illinois featured size indices of 35 to 40 (Asch and Asch 1985: 170). Like the Iron Horse specimen in the present study, these figures resemble Early Late Woodland domesticates, rather than Mississippian. Of further interest is the fact that in calculating his indices, Yarnell excluded a collection of small Mississippian achenes from the state of Mississippi on the grounds that sunflower at the southern margin of its cultivation might be aberrant (Asch and Asch 1985: 170). Considering the fact that the upland sites of the Oconee region represent the third distinct geographical example of small Mississippian sunflower achenes, it is likely that rather than being irregular, small-fruited domesticates may have been a common Mississippian phenomena, particularly near the southernmost border of their cultivation.

Chenopodium berlandieri

In eastern north america, *Chenopodium berlandieri* (goosefoot), *Polygonum erectum* (erect knotweed), *Phalaris caroliniana* (maygrass), and *Hordeum pusillum* (little barley) comprise the indigenous starchy-seeded domesticate complex. Of these, only goosefoot was identified at the four Lamar sites under investigation. The "natural" habitat of this present day weedy species is poorly documented (Smith 1992: 53). It is occasionally observed growing in mud flats and along eroding river banks, but stands of thin, tall, sparsely-fruited plants may be found as a component of the black willow (*Salix nigra*) understory along the Mississippi river (Smith 1992: 53). It is clear, however, that the plant thrives in full sun, and requires only minimal disturbance for successful reproduction (Smith 1992: 54). The dominant paradigm finds goosefoot as coeval with local human communities, with domestication as the logical conclusion to this progression.

In contrast to both sunflower and marshelder, seed size is not a reliable indicator of domesticated status for goosefoot. Rather, the relative thickness of the testa is considered to be a dependable gauge of domestication in that it represents strong selective pressure for reduced germination dormancy (Smith 1992:50). This reduced testa also equates to higher proportionate food reserves in both the perisperm and cotyledon. Margin configuration and seed shape are additional points of morphological distinction between wild and domesticated goosefoot. Wild types tend to be thick and rounded in cross section, while cultivars tend to be rectanguloid with truncated margins (Smith 1992:113-114). Other marks of domestication, invisible in the archaeological record, include increased seed production, increased compaction and terminalization of seed heads, increasing loss of natural shatter mechanisms, and greater uniform maturation of seeds (Smith 1992:57).

Eight modern wild *Chenopodium* (subsection *Cellulata*) populations in the Eastern United States were found to have mean testa thickness value ranging from 39 to 78 microns (Smith 1992: 50). In contrast, modern populations of the Mexican cultigen *Chenopodium berlandieri* spp. *nuttalliae* were found to have mean thickness value of 16 microns, and in a second study a sample ranged between 9 and 21 microns (Smith 1992: 50; 123). Prehistoric chenopod assemblages from Newt Kash Shelter, Kentucky (Late Archaic), Russell Cave, Alabama (Early Woodland), Ash Cave, Ohio (Middle Woodland), and Thor's Hammer Shelter, Kentucky (Late Woodland) measured from 7 to 20.7 microns on average (Smith 1992: 50; 123; Gremillion 1993: 158), comparing favorably to the modern Mexican domesticate.

Table 39 summarizes chenopod testa thickness data for the Lamar sites, measured using a combination of scanning electron microscopy, and the IMIX system for image collection. As was discussed in chapter six, only four samples from two phases contained *Chenopodium* spp. seeds, and funding for SEM work was limited. I was able to obtain at least one set of testa measurements for each of the four Master Samples. Wherever possible, I located two measurable portions of seed coat from different parts of the seed. In the case of MSN 61 from the Lindsey (9MG231) site, the dorsal section of the fractured testa separated from the surface within the strong vacuum environment of the SEM. This accident more clearly exposed the 90 degree angles of the two previously measured surfaces, and I accordingly reevaluated each. The second measurement for each field is labeled as "a."

Using 40 mm as the baseline value for wild type testa, each of these seeds can conditionally claim domesticate status. An interesting phenomenon is that different points on the same seed may exhibit disparate testa thickness (Gremillion 1993: 155). The

Table 39: Measurements of *Chenopodium berlandieri*.

Phase/Site --------------- Seed Diameter	ID #	Field	N	Testa Diam. Mean	Testa Diam. S.D.	Testa Diam. Range
Iron Horse/9MG4	199-a	1	26	13.52	1.26	11.25 - 15.83
	241-a	1	5	7.39	0.51	6.80 - 8.05
	241-a	2	5	3.56	0.12	3.38 - 3.78
	241-b	1	6	32.26	3.17	37.76 - 46.65
	241-b	2	6	20.78	1.80	18.33 - 23.05
Bell/9MG231	61-a	1	3	38.89	1.92	36.67 - 40.00
1455.5 microns	61-a	2	19	2.97	0.77	1.53 - 4.36
	61-b	1	11	6.6	1.44	6.19 - 8.07
	61-b	1a	8	4.1	0.37	3.10 - 4.60
	61-b	2	8	4.7	0.44	4.04 - 5.32
	61-b	2a	7	4.37	0.52	3.33 - 4.79
1280.13 microns	61-c	1	8	10.46	0.96	9.48 - 12.16
	61-c	2	4	10.02	0.45	9.41 - 10.38
	77-a	1	5	4.63	0.19	4.45 - 4.94
	77-a	2	9	6.36	0.40	5.69 - 6.94
	77-a	3	7	11.57	0.25	9.17 - 14.72

densest portion of the seed coat is generally that closest to the "beak" (protrusion formed by the radicle), however, in the Oconee specimens seed coat thickness varied considerably between different points on the margin and also on the dorsal surface. Specimen 241-b of 9MG4 exhibits a mean testa width within the high end of the domesticate range. However, the first of the two fields to be evaluated manifests a range (37.76 - 46.65) extending well into that of the wild type. This disparity is even more pronounced in specimen 61-a from 9MG231. In this second case the mean of the first field (38.89) barely registers within the domesticate range, and its range extends as high as 40 microns. However, the second point of measurement is at the opposite extreme, having a mean of 2.97 microns, and a range of 1.53 - 4.36 microns. This specimen possessed a more rounded margin configuration - akin to the wild type, in contrast to all the others, which were clearly truncated. It is likely that each of these cases, while an outlier, is still an example of a cultivar. If some portion of the seed coat is thin enough to allow water and gasses to permeate then it is likely that this is sufficient to promote the early germination typical of domesticated varieties (Smith 1994, personal communication).

Although many ruptured fruits had incomplete margins, those that were fairly complete exhibited truncated margins, with only one exception, discussed above. This feature provides additional evidence of their domesticated status. Appendix B is a photograph of a typical specimen from these samples. Observations of both margins and testa thickness lead to the conclusion that the chenopods derived from the Lamar assemblages are of the *Chenopodium berlandieri* species, a confirmed domesticate.

In conclusion, three points must be emphasized. First, the pseudo-grain type of goosefoot was clearly cultivated by the Iron Horse inhabitants of Sugar Creek and the Bell phase inhabitants of Lindsey. Second, five of the seven seeds examined by SEM and computer clearly fall within the range of the prehistoric and modern domesticates. Two of these five, specimens 241-a and 61-b, exhibit testa thinner than previously reported. Third, further inquiries should be undertaken to explore the phenomenon of differential testa thickness in different portions of the seeds. These differences may represent back-crosses, recessive traits, individuals that are not fully domesticated, or a common characteristic that has never before been noted or reported.

Exotics

Spanish explorers and settlers introduced a variety of exotic species to the Southeast during the late sixteenth through seventeenth centuries. Hazelnut (*Corylus* sp.), watermelon (*Citrullis vulgaris*), melon (*Cucumis melo*), peaches (*Prunus persica*), peas (*Pisum sativum*), fig (*Ficus carica*), black pepper (*Piper nigrum*), wine grapes (*Vitis vinifera*) and wheat (*Triticum* sp.) are nine old world crops that have been reported from sixteenth century sites (Ruhl 1990, 1993; Gremillion 1993a). Of these nine, only peach (*Prunus persica*) was identified from the sites in this study, and this genus was restricted to the Bell phase.

Two complete stones, measuring 24x18x10 mm and 21x15x6 mm, were recovered from a single winter house structure post at the Lindsey site. Numerous fragments of one or more peach stones were scattered among the winter house structure posts at the Bell phase of Sugar Creek. The presence of peach pits implies that arboriculture was practiced by the Bell phase inhabitants of these two sites. This conclusion is supported by early ethnohistoric reports (Bartram 1955; Adair 1968).

While some argue that orchardry is a trait that diffused from European settlements to the native Americans, there is convincing archaeological evidence that trees were cultivated in prehistoric times (Smith 1987; Watson 1989). In this case, the cultivation of peaches would have been grafted on to an already existing agricultural technology. Peach trees must develop for three years before producing fruit. This duration lends support to the stability of the overall upland settlement system. While homesteads may have relocated periodically, they would have maintained a catchment zone including their cultivated groves.

Other Noteworthy Taxa

Acorus calamus

Two fragments of rhizomes that compare favorably to sweet flag (*Acorus calamus*) were identified from the Dyar phase Sweetgum site. This plant is thought to be indigenous to India, spreading along trade routes throughout temperate to sub-temperate regions of Eurasia and the Americas (Fernald 1950; Motley 1994). Sweet flag was thoroughly integrated into native American pharmacopeia. Many north American Indian tribes ingested sweet flag as a decoction, or chewed raw or smoked it to fight fatigue and hunger (Ott 1975). Medicinally some tribes chewed the rhizome daily as a panacea (Moerman 1981). These two specimens are somewhat smaller than modern specimens, even considering the effects of charring. They may represent immature plants, a native variety of the genus, or both. Considering the early date and the size of these specimens, it is possible that they represent an indigenous variety.

Phaseolus polystachyus

Of special interest is the abundant presence of the *polystachyus* bean, or wild kidney bean *(Phaseolus polystachyus*[4]), which has never before been reported in good archaeological context at an open site (L.Kaplan, personal communication, 1994). Specimens of this taxon were collected from multiple contexts in all project sites and phases. While most abundant in house posts, they were are also well represented in features. This distribution is in contrast to that of the common bean, *Phaseolus vulgaris*,

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[4]This taxon was positively identified by Lawrence Kaplan, Department of Biology, University of Massachusetts at Boston.

which was recovered only from a single house post at the Lindsey site. Beans are rare in all late prehistoric and protohistoric sites in the region (Blanton 1985).

Phaseolus polystachyus is a perennial vine native to the woods and thickets of eastern North America (Medsger 1945:122; Uphof 1959:274; Radford *et al* 1968; Strausbaugh and Core 1977). It is relatively rare (Medsger 1945; Strausbaugh and Core 1977), but may be locally abundant in the Southeast (Lawrence Kaplan 1994, personal communication). The *polystachyus* bean was reported by early explorers and settlers (Strachey 1612; Romans 1775; Bartram 1792; Josselyn 1865). Its seeds are said to have been "highly prized by North American Indians" (Medsger 1945:122; Uphof 1959:274).

The *polystachyus* bean was previously reported from caches in Ozark mountain caves (Fritz 1986). The Ozark specimens are desiccated, rather than charred, and exhibit intact pods. They have never been radiocarbon dated, nor can their age be positively determined from context, as the caves endured multiple occupations. They are thought to date to the late Woodland period (Yarnell 1993:16; Johannessen 1993:60).

Fritz (1986) conjectures that these unruptured pods may represent the genetic manipulation of this genus. Mature wild beans rupture along the suture, dispersing the seeds, and precluding efficient collection by humans. Alternatively, the *polystachyus* bean may have been collected before reaching full maturity. Other varieties of wild beans are known to have been collected, but not cultivated, by native American peoples (Wilson 1987). In the eighteenth century, Beverley (1705) describes the cultivation, or encouragement, of what may be *Phaseolus polystachyus*. He wrote, "They have an unknown Variety of them [beans], (but all of a Kidney-Shape) some of which I have met with wild..." (Beverley 1705:144).

The *polystachyus* bean closely resembles cow pea (*Vigna unguiculata*). The best of the specimens under consideration were too degraded absolutely to distinguish between these two genera. However, the early date of the Iron Horse specimens precludes contact, and the consistent physical appearance and abundance of this taxon over the course of the Lamar period leads me to conclude that all of the specimens under consideration are *P. polystachyus*.

A Note On *Zea mays* (Corn)

Zea mays remains in the eastern United States are generally forced into the three-part topology -- Eastern Eight-Row ("flint" type), Midwestern Twelve-Row ("flour" type), or North American Pop -- that Cutler and Blake (1976) developed using data from the Northeast and Midwest. Recent studies indicate great variability in the morphology of archaeological corn in the Southeast, and call into question a strict tri-partite classification system. However, a viable alternative has not yet been developed (Scarry 1994). Ethnohistoric accounts clearly indicate that multiple types of corn were cultivated in the Southeast, and sufficient variation in collections of southeastern cobs has been identified to verify this fact (Scarry 1994).

The only *measurable Zea mays* cobs from these Lamar sites were 42 incomplete specimens clumped together in a "smudge pit" type feature in the Bell phase component of Sugar Creek. Wherever possible, row number, and mean cupule length, width, and depth were measured, and cob shape, row-pairing, and cross-section shape were also evaluated. The results are reported in Table 40. As is predicted by Scarry's (1994) study, these data do not perfectly correspond to any of the three traditional categories.

Eastern Eight-Row is characterized by 85-90% of eight-row cobs, tapered ears that frequently have enlarged butts; wide, thick crescent-shaped kernels; wide, shallow cupules; and strongly-paired rows (Scarry 1994: 352). Roughly eighty percent of this sample of 42 cob segments is comprised of 8-row cobs, having wide (mean 8.56 mm), shallow (mean 2.06 mm) cupules. However, the majority (77.4%) of ears are cylindrical, rather than tapered. Since the apex and / or base are missing from 100% of the sample cobs, any number of them may have actually been tapered or cigar-shaped to some extent. As is often the case in smudge pits, only a single kernel was recovered. This was "popcorn" shaped, rather than the anticipated "crescent," shaped. In addition, 10% of the assemblage exhibits some degree of row spiraling. While these observations do not perfectly meet the criteria for Eastern Eight-Row, they are closely parallel and most of the collection is likely to be a variant of that type. The observations that 10% of the collection is comprised of ten-row cobs, having a variety of cross -section and cob shapes, including some spiraling, signal the probability that more than one variety is represented in the assemblage. Because a "smudge pit" is composed of cobs saved from any number of food processing episodes, there is no reason to expect that the entire

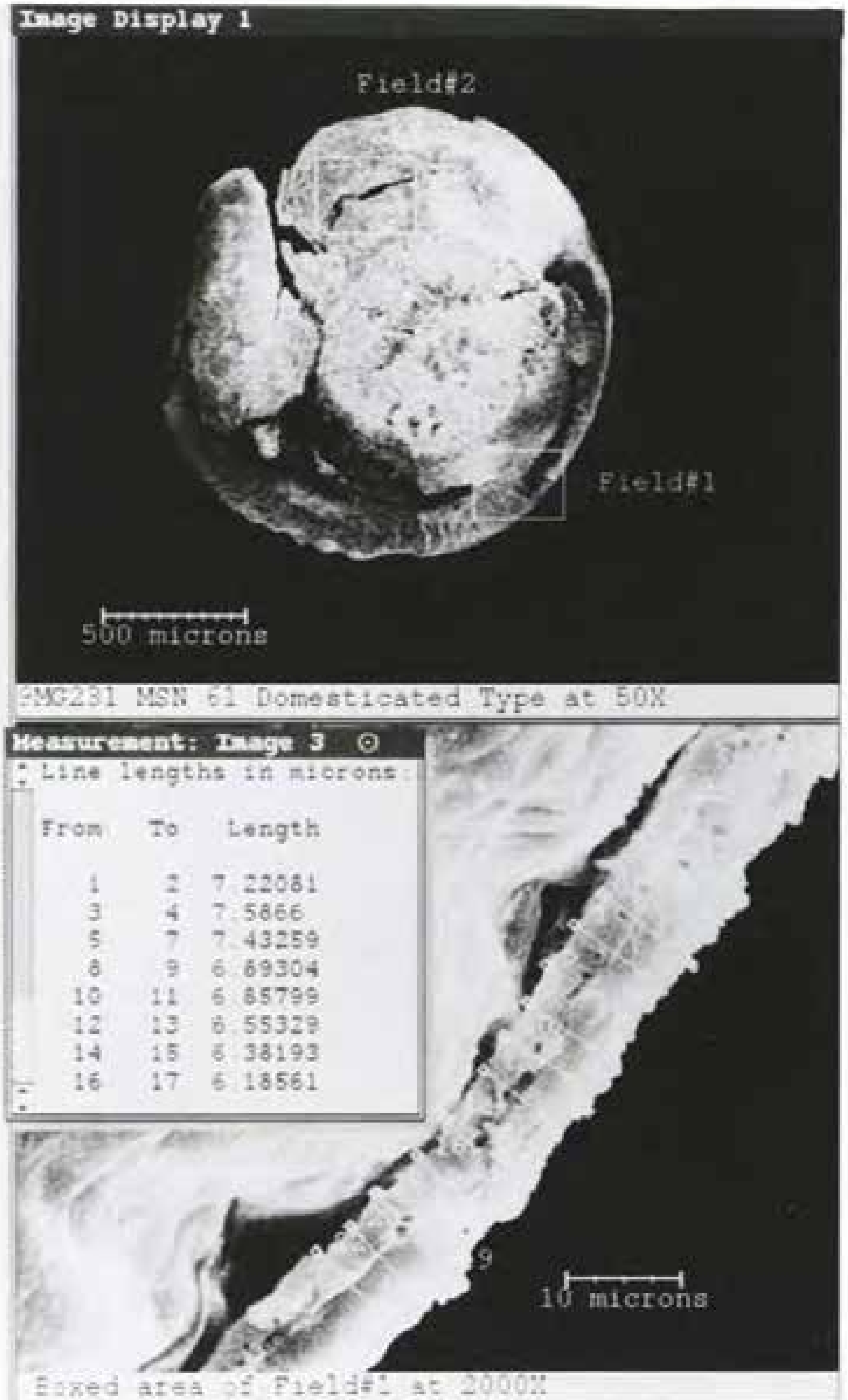
Table 40: *Zea mays* cob statistics - Feature 33, 9MG4, Sugar Creek, Bell phase.

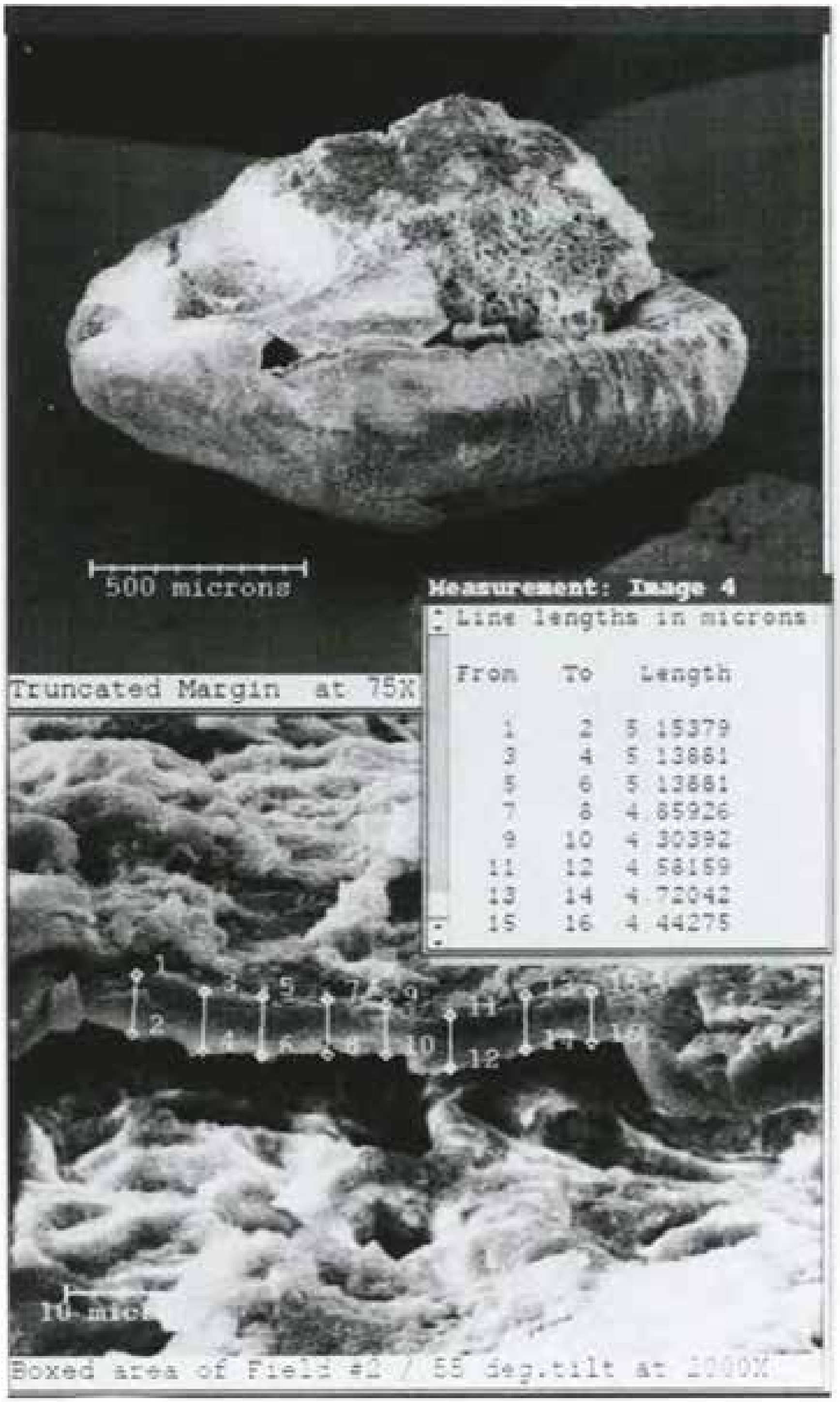
N	Measurement	Description	#
41	Row Number	10 8	8 33
42	Rachis Segment Length	3	42
230	Mean Cupule Width	Mean	8.56
		Std. Dev.	1.64
		Range	5.0-14.0
77	Mean Cupule Length	Mean	3.41
		Std. Dev.	0.48
		Range	2.0-4.32
233	Mean Cupule Depth	Mean	2.06
		Std. Dev.	0.71
		Range	0.5-4.0
42	Cob Entirety	Missing Base & Tip	42
42	Cob Shape	Tapered	8
		Cylindrical	33
		Indeterminate	1

assemblage represents a single variety of corn. This conclusion is consistent with observations of other Mississippian corn assemblages of the Southeast (Blake 1986; Scarry 1994). It does not, however, preclude the possibility that other varieties of maize were grown on the site. In fact, variations in kernel shape, even considering distortion, indicate that at least two different varieties ("flint" and "pop") were grown at these sites.

Appendix B

TYPICAL MEASURED SPECIMEN OF *CHENOPODIUM BERLANDIERI* - FEATURING TRUNCATE FORM AND THIN TESTA




500 microns
Truncated Margin at 75X
Measurement: Image 4
Line lengths in microns
From To Length
1 2 5.15379
3 4 5.13881
5 6 5.13881
7 8 4.85926
9 10 4.30392
11 12 4.58159
13 14 4.72042
15 16 4.44275
Boxed area of Field #2 / 55 deg.tilt at 2000X

Appendix C

LATIN BINOMIALS AND VERNACULAR NAMES OF IDENTIFIED TAXA, GROUPED BY HABITAT

Cultigens

Chenopodium berlandieri - goosefoot
Cucurbita spp. - various species of squash genus, including pumpkins
Helianthus annuus - sunflower
*Iva annu*a var. *macrocarpa* - sumpweed
Phaseolus vulgaris - common bean
Prunus persica - peach
Zea mays - corn, maize

Open Field

Acalypha sp. - 3-seeded mercury
Asclepias sp.- milkweed
Ambrosia artemesiafolia - ragweed
Chenopodium spp. - various species of goosefoot
Cirsium sp.- thistle
Convulvus sp. - bindweed
Delphinium sp. -larkspur
Desmanthus sp. - bundleflower
Digitaria sp. - crabgrass
Euphorbia sp. - spurge
Gramineae - grass family
Lespedeza sp. - bushclover
Lithospermum sp. - gromwell
Passiflora incarnata - maypop
Physalis sp. - groundcherry
Plantago lanceolata - plantain
Polygonum spp. - knotweed
Portulaca oleracea L. - purslane
Solanum rostratum nightshade
Veronica sp. - speedwell
Vicia so. or *Lathyrus* sp. - vetch or vetchling

Old Field

Celtis spp. - various species of hackberry genus
Diospyros virginiana - persimmon
Gleditsia triacanthos L. - honey locust
Juglans nigra - black walnut
Malus sp. - crabapple
Phytolacca americana - pokeweed
Rosaceae - rose family
Rubus sp. - various species of brambles (e.g., blackberries, raspberries, dewberries)
Sambuccus sp. - elderberry
Vaccinium sp. - blueberry
Vitis sp. - various species of grapes

Woods

Carpinus carolineana - American hornbeam
Cornus sp. - dogwood
Cretaegus sp. - hawthorn
Desmodium sp. - stick-tight
Galium sp. - bedstraw
Liriodendron tulipfera - tulip tree
Medeola virginiana - Indian cucumber
Ostrya virginiana - hop hornbeam
Phaseolus polystachus - wild bean
Prunus sp. - cherry or plum
Sorbus spp. - mountain ash, or *Amelanchier* sp. - serviceberry
Viburnum sp. - haw
Viola sp. - violet

Forest

Acer rubrum - red maple
Carya spp. - various species of hickory genus
Carya ovata - shagbark hickory
Fagus grandifolia - American beech
Juglans spp. - various species of walnut genus
Pinus spp. - various species of pine genus
Platanus occidentalis L. - sycamore
Populus spp. - various species of poplar genus
Quercus spp. - various species of oak genus
Quercus alba - various species of white oak type
Quercus rubra - various species of red oak type

Quercus stellata - post oak

Wetlands

Arundinaria spp. - various species of cane
Acorus calamus - sweetflag
Nyssa sylvatica var. *biflora* - blackgum
Polygonum hydropiper - water pepper
Sagittaria L. spp. - duck potato

Appendix D

ANALYSIS OF VARIANCE - OCCURRENCE INDEX PHASE LEVEL DATA

The SAS System
02:58 Wednesday, October 18, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
HABITAT	6	1 2 3 4 5 6

Number of observations in data set = 18

General Linear Models Procedure

Dependent Variable: OCCUR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	150.05556	21.43651	9.65	0.0009
Error	10	22.22222	2.22222		
Corrected Total	17	172.27778			

R-Square	C.V.	Root MSE	OCCUR Mean
0.871009	23.33288	1.4907	6.3889

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	28.44444	14.22222	6.40	0.0162
HABITAT	5	121.61111	24.32222	10.94	0.0008

Appendix E

ANALYSIS OF VARIANCE - OCCURRENCE INDEX SITE LEVEL DATA

The SAS System
02:59 Wednesday, October 18, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	5	1 2 3 4 5
HABITAT	6	1 2 3 4 5 6

Number of observations in data set = 30

General Linear Models Procedure

Dependent Variable: OCCUR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	111.53333	12.39259	3.76	0.0065
Error	20	65.93333	3.29667		
Corrected Total	29	177.46667			

R-Square	C.V.	Root MSE	OCCUR Mean
0.628475	37.30834	1.8157	4.8667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	4	34.466667	8.616667	2.61	0.0661
HABITAT	5	77.066667	15.413333	4.68	0.0055

Appendix F

PALEOPATHOLOGY

A limited amount of paleopathological data is available for the four upland sites excavated by the Penn State upland project. Skeletal material from all 23 burials was assessed for general indicators of health status by Dorothy Humpf (n.d.). A single burial was encountered at the Carroll site in 1936 (Kowalewski and Williams 1989). The fourteen Iron Horse burials represent a fairly healthy population with a normal demographic spread. Four mature adults ($\geq$ 45 years), three adolescents (12-18 years), and three sub-adults (2-6 years) were identified. The adults were robust with no bone lesions. One young and one mature adult exhibited minor enamel hypoplasias. Only two individuals suffered caries. The Bell phase population was only slightly less healthy. At Sugar Creek, two adults and one adolescent were reasonably healthy. The oldest individual (45-50 years) showed normal signs of aging loss of most teeth, with bone resorption and exposed dentine, as well as moderate lipping on the cervical vertebrae. The younger adult (30-35 years) suffered caries and abscessed teeth. The adolescent manifested remodeled porotic hyperostosis and healed cribera orbitalia, but had no active lesions at the time of death. Three adults were evaluated at the Lindsey site. Two of them endured caries, and the eldest (40-50 years) had severely worn teeth with exposed dentine, and the younger (30-35 years) displayed a slight hypoplasia. This latter individual exhibited healed periostitis, but had no active lesions at time of death (Humpf n.d.).

Overall, the greatest difference between the Iron Horse and Bell populations was an increase in caries and other dental anomalies. In contrast, the Sweetgum population exhibited a variety of hypoplasias and active lesions at the time of death, creating a picture of a less healthy population in Dyar than either Iron Horse of Bell (Humpf 1995, personal communication). The single Carroll site burial was that of an eight to ten year old child.

Appendix G

ANALYSIS OF VARIANCE - DENSITY INDEX DATA FOR PHASE LEVEL DATA

The SAS System
02:57 Thursday, October 5, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
HABITAT	5	1 2 3 4 5

Number of observations in data set = 1398

General Linear Models Procedure

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	50.378721	3.598480	7.27	0.0001
Error	1383	684.741991	0.495114		
Corrected Total	1397	735.120712			

R-Square	C.V.	Root MSE	DENSITY Mean
0.068531	269.2622	0.7036	0.2613

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	10.133944	5.066972	10.23	0.0001
HABITAT	4	34.643269	8.660817	17.49	0.0001
PHASE*HABITAT	8	5.438184	0.679773	1.37	0.2037

Appendix H

ANALYSIS OF VARIANCE - DENSITY INDEX DATA FOR POSTMOLDS

The SAS System
02:49 Thursday, October 5, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
HABITAT	5	1 2 3 4 5

Number of observations in data set = 782

General Linear Models Procedure

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	50.440093	3.602864	5.24	0.0001
Error	767	527.868851	0.688225		
Corrected Total	781	578.308945			

R-Square	C.V.	Root MSE	DENSITY Mean
0.087220	268.3387	0.8296	0.3092

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	13.421488	6.710744	9.75	0.0001
HABITAT	4	16.569523	4.142381	6.02	0.0001
PHASE*HABITAT	8	8.922149	1.115269	1.62	0.1151

Least Squares Means

PHASE	DENSITY LSMEAN	i/j	1	2	3
1	0.47881595	1	.	0.0001	0.0038
2	0.06609045	2	0.0001	.	0.0152
3	0.28414069	3	0.0038	0.0152	.

Pr > |T| H0: LSMEAN(i)=LSMEAN(j)

Least Squares Means

HABITAT	DENSITY LSMEAN	i/j	1	2	3	4	5
1	0.52444781	1	.	0.4603	0.0007	0.0011	0.0002
2	0.44259146	2	0.4603	.	0.0065	0.0099	0.0024
3	0.14416079	3	0.0007	0.0065	.	0.8888	0.7619
4	0.15956509	4	0.0011	0.0099	0.8888	.	0.6573
5	0.11098001	5	0.0002	0.0024	0.7619	0.6573	.

Pr > |T| H0: LSMEAN(i)=LSMEAN(j)

Least Squares Means

PHASE	HABITAT	DENSITY LSMEAN	LSMEAN Number
1	1	0.98635628	1
1	2	0.70986978	2
1	3	0.22732288	3
1	4	0.21444492	4
1	5	0.25608588	5
2	1	0.17037788	6
2	2	0.07759576	7
2	3	0.08247861	8
2	4	-0.00000000	9
2	5	-0.00000000	10
3	1	0.41660925	11
3	2	0.54030882	12
3	3	0.12268087	13
3	4	0.26425035	14
3	5	0.07685415	15

Pr > |T| H0: LSMEAN(i)=LSMEAN(j)

1/1	1	2	3	4	5	6	7	8
1	.	0.1067	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
2	0.1067	.	0.0045	0.0035	0.0075	0.0131	0.0032	0.0040
3	0.0001	0.0045	.	0.9394	0.8652	0.7931	0.4835	0.5048
4	0.0001	0.0035	0.9394	.	0.8058	0.8392	0.5219	0.5434
5	0.0001	0.0075	0.8652	0.8058	.	0.6930	0.4036	0.4240
6	0.0002	0.0131	0.7931	0.8392	0.6930	.	0.7140	0.7314
7	0.0001	0.0032	0.4835	0.5219	0.4036	0.7140	.	0.9846
8	0.0001	0.0040	0.5048	0.5434	0.4240	0.7314	0.9846	.
9	0.0001	0.0011	0.2953	0.3235	0.2384	0.5059	0.7592	0.7474
10	0.0001	0.0009	0.2875	0.3157	0.2309	0.5010	0.7565	0.7446
11	0.0003	0.0589	0.2224	0.1926	0.3008	0.2325	0.0944	0.1053
12	0.0030	0.2514	0.0344	0.0277	0.0547	0.0656	0.0190	0.0228
13	0.0001	0.0001	0.4789	0.5346	0.3667	0.8122	0.8189	0.8412
14	0.0001	0.0026	0.8027	0.7361	0.9559	0.6400	0.3434	0.3652
15	0.0001	0.0001	0.3105	0.3537	0.2271	0.6419	0.9970	0.9777

	9	10	11	12	13	14	15
1	0.0001	0.0001	0.0003	0.0030	0.0001	0.0001	0.0001
2	0.0011	0.0009	0.0589	0.2514	0.0001	0.0026	0.0001
3	0.2953	0.2875	0.2224	0.0344	0.4789	0.8027	0.3105
4	0.3235	0.3157	0.1926	0.0277	0.5346	0.7361	0.3537
5	0.2384	0.2309	0.3008	0.0547	0.3667	0.9559	0.2271
6	0.5059	0.5010	0.2325	0.0656	0.8122	0.6400	0.6419
7	0.7592	0.7565	0.0944	0.0190	0.8189	0.3434	0.9970
8	0.7474	0.7446	0.1053	0.0228	0.8412	0.3652	0.9777
9	.	1.0000	0.0436	0.0072	0.5411	0.1882	0.7024
10	1.0000	.	0.0399	0.0062	0.5334	0.1799	0.6970
11	0.0436	0.0399	.	0.3455	0.0252	0.2454	0.0101
12	0.0072	0.0062	0.3455	.	0.0007	0.0243	0.0002
13	0.5411	0.5334	0.0252	0.0007	.	0.2475	0.7096

Appendix I

ANALYSIS OF VARIANCE - DENSITY INDEX DATA FOR FEATURES

```
              The SAS System                                    1
                        03:22 Wednesday, October 4, 1995

      General Linear Models Procedure
          Class Level Information

        Class      Levels     Values

        PHASE           3     1 2 3

        HABITAT         5     1 2 3 4 5

Number of observations in data set = 616

Dependent Variable: DENSITY
                          Sum of              Mean
Source        DF         Squares            Square  F Value      Pr > F

Model         14       13.855187          0.989656     4.28      0.0001

Error        601      138.895410          0.231107

Correctec    615      152.750597
 Total

R-Square             C.V.        Root MSE          DENSITY Mean

0.090705         239.6548          0.4807                0.2006

Source           DF    Type III SS   Mean Square   F Value      Pr > F

PHASE             2      0.1084177     0.0542089      0.23      0.7910
HABITAT           4      6.6656832     1.6664208      7.21      0.0001
PHASE*HABITAT     8      3.5077867     0.4384733      1.90      0.0579
```

Appendix J

ANALYSIS OF VARIANCE - DENSITY INDEX DATA FOR ALL PROVENIENCES

The SAS System 1
02:53 Thursday, October 5, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
HABITAT	5	1 2 3 4 5

Number of observations in data set = 1398

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	1227.6237	87.6874	1.73	0.0436
Error	1383	69917.2128	50.5547		
Corrected Total	1397	71144.8364			

R-Square	C.V.	Root MSE	DENSITY Mean
0.017255	1196.745	7.1102	0.5941

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	274.76960	137.38480	2.72	0.0664
HABITAT	4	484.05208	121.01302	2.39	0.0488
PHASE*HABITAT	8	577.05375	72.13172	1.43	0.1805

Appendix K

ANALYSIS OF VARIANCE - PHASE LEVEL UBIQUITY INDEX DATA

The SAS System
13:24 Tuesday, October 24, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
HABITAT	6	1 2 3 4 5 6

Number of observations in data set = 18

Dependent Variable: UBIQ

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	0.9068350	0.1295479	39.99	0.0001
Error	10	0.0323950	0.0032395		
Corrected Total	17	0.9392300			

R-Square	C.V.	Root MSE	UBIQ Mean
0.965509	16.04792	0.0569	0.3547

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	0.0282310	0.0141155	4.36	0.0436
HABITAT	5	0.8786040	0.1757208	54.24	0.0001

Appendix L

ANALYSIS OF VARIANCE - SITE LEVEL UBIQUITY INDEX DATA

The SAS System 1
03:16 Friday, October 13, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
SITE	5	1 2 3 4 5
HABITAT	6	1 2 3 4 5 6

Number of observations in data set = 30

Dependent Variable: UBIQ

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	1.3263636	0.1473737	22.45	0.0001
Error	20	0.1313051	0.0065653		
Corrected Total	29	1.4576687			

R-Square	C.V.	Root MSE	UBIQ Mean
0.909921	22.54905	0.0810	0.3593

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SITE	4	0.1614582	0.0403645	6.15	0.0021
HABITAT	5	1.2005586	0.2401117	36.57	0.0001

SITE	UBIQ LSMEAN	Pr > |T| H0: LSMEAN(i)=LSMEAN(j) i/j	1	2	3	4	5
1	0.40783333	1	.	0.2834	0.0071	0.0243	0.9523
2	0.46033824	2	0.2834	.	0.0006	0.0023	0.3095
3	0.26766667	3	0.0071	0.0006	.	0.5821	0.0062
4	0.29383333	4	0.0243	0.0023	0.5821	.	0.0213
5	0.41066667	5	0.9523	0.3095	0.0062	0.0213	.

Appendix M

ANALYSIS OF VARIANCE - AVERAGE COUNTS OF WOOD TAXA BY PHASE

The SAS System
03:52 Friday, September 15, 1995

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PHASE	3	1 2 3
TYPE	3	1 2 3

Number of observations in data set = 9

General Linear Models Procedure

Dependent Variable: INDEX

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.5618164	0.1404541	54.77	0.0010
Error	4	0.0102571	0.0025643		
Corrected Total	8	0.5720736			

R-Square	C.V.	Root MSE	INDEX Mean
0.982070	15.19668	0.0506	0.3332

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	0.0000002	0.0000001	0.00	1.0000
TYPE	2	0.5618162	0.2809081	109.55	0.0003

Least Squares Means

PHASE	INDEX LSMEAN	Pr > |T| H0: LSMEAN(i)=LSMEAN(j) i/j	1	2	3
1	0.33333333	1	.	1.0000	0.9940
2	0.33333333	2	1.0000	.	0.9940
3	0.33300000	3	0.9940	0.9940	.

Appendix N

ANALYSIS OF VARIANCE - COUNTS OF WOOD TAXA FROM INDIVIDUAL PROVENIENCES

```
The SAS System
          03:57 Friday, September 15, 1995

General Linear Models Procedure
    Class Level Information

      Class     Levels     Values

      PHASE          3     1 2 3

      TYPE           3     1 2 3

Number of observations in data set = 384

Dependent Variable: INDEX
```

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	25.116196	3.139524	93.30	0.0001
Error	375	12.618671	0.033650		
Corrected Total	383	37.734866			

R-Square	C.V.	Root MSE	INDEX Mean
0.665597	55.02734	0.1834	0.3334

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PHASE	2	0.000123	0.000061	0.00	0.9982
TYPE	2	17.900445	8.950222	265.98	0.0001
PHASE*TYPE	4	1.034406	0.258602	7.69	0.0001

Appendix O

POCKET MATERIALS

Provenience information and data files are provided in both Paradox 4.5 for DOS and in ASCII files in the pocket attached to this dissertation.

VITA

Ph.D. (anthropology), The Pennsylvania State University.

M.A. (anthropology), 1990, The Pennsylvania State University.

M.B.A., 1983, University of Connecticut.

M.A.T. (social science), 1974, Duke University.

B.A. (anthropology - with distinction), 1973, The University of Pennsylvania.

Academic Appointments

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Juniata College, Huntington, PA. Instructor, (human ecology - world regional geography), Fall 1992.

Public Schools, Fairfield County, CT. Social Studies Teacher, 1974-1986.

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Garrow and Associates, Inc., Raleigh, NC. Paleoethnobotanist. 1996 - present.

New South Associates, Stone Mountain, GA. Paleoethnobotanist. 1996 - present.

Grants and Awards

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Publications (excluding contract reports)

1994 Tit-for-Tat Among the Iroquois: A Game Theoretical Perspective On Inter-Tribal Political Organization. With J. A. Kurland. *Journal of Anthropological Archaeology* 13: 278-305.

1996 *Cultural Anthropology*. Distance Education course of study / study guide. The Pennsylvania State University, University Park.

In press. Chapter 11, Floral Assemblage. Occasional Paper *Lindsey Site Report*, edited by J.W. Hatch and D. Humpf, The Pennsylvania State University Press.