TUSCARORA SUBSISTENCE PRACTICES IN THE LATE WOODLAND PERIOD: THE ZOOARCHAEOLOGY OF THE JORDAN'S LANDING SITE

BY

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NORTH CAROLINA ARCHAEOLOGICAL COUNCIL
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PREFACE

Subsistence is at the core of every culture. Other aspects of culture such as religion, politics, and technology exist in large part to facilitate human subsistence. Consequently, reaching an understanding of any facet of a human culture requires investigation first into its foodways. Studies of human subsistence, then, should be at the heart of understanding human adaptations and their temporal and geographical variation. Sufficient knowledge of a prehistoric culture's foodways and all of the related behavioral and environmental factors can only be gained by the study of the resulting garbage. It is a wonder, then, that zooarchaeology—the study of archaeofaunal remains (mostly peoples' garbage)—is still in its nascency and considered secondary in importance to the study of artifacts such as pottery sherds and stone tools.

The monograph you are about to enjoy breaks away from the tradition of being an appendix lost and ignored in the back of a site report. It stands alone as an investigation into prehistoric human foodways. It is especially unique and laudable in its rejection of assumptions about the relationships between early historic accounts and late prehistoric reality, and between recovered faunal remains and prehistoric cultural activities. The reader will not only glimpse the prehistory of the Tuscarora people, but will appreciate the scientific rigor employed in providing that glimpse.

Indeed, this monograph promises to become a standard reference for prehistorians working in eastern North Carolina and for zooarchaeologists working anywhere who recognize the importance of identifying the behavioral, taphonomic, and sampling processes which inevitably form and transfigure archaeofaunal assemblages.

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ACKNOWLEDGMENTS

The data presented in this monograph were originally generated as part of my master's thesis project at the University of Tennessee, Knoxville. I am deeply indebted to those professors who served on the thesis committee and who guided my learning during the years spent in Knoxville. Walter Klippel was committee chair and my advisor through all of my graduate studies. His patience and support have been unwavering through the years and his guidance has served me well. Paul Parmalee served as a thesis committee member and gladly shared his vast experience in faunal analysis with me as I worked through the identifications presented in Chapter 2. Jefferson Chapman also served as a committee member and a source of knowledge during the days when I worked in the McClung Museum. The six years that have passed since I completed my thesis have included a great deal of personal and scholarly growth. Now that the dust generated by trying to complete requirements and graduate has settled, it is clear to me what a profound effect my professors and fellow students at the University of Tennessee had on me. Thank you all.

The materials that are the subject of this study were excavated by David Phelps of East Carolina University. Dr. Phelps has provided me unlimited access to the Jordan's Landing faunal remains since I was an undergraduate student of his in the late 1980s. He has inspired my interest in the native cultures of eastern North Carolina and the Southeast and has included me in many fascinating and significant research projects. His work in the coastal plain has laid the foundation upon which many future investigations in eastern North Carolina will be built.

Ken Robinson, President of the North Carolina Archaeological Council, was kind enough to invite me to submit this manuscript to the council for consideration. Both Ken and Alan May, the Council series editor, have provided many useful comments and encouraged me throughout the review and editing process. Two anonymous reviewers criticized the manuscript constructively. These reviewers are commended not only for offering useful comments but for completing their reviews in a very timely manner. R. P. Stephen Davis, Jr. worked to see the manuscript through to the presses.

The efforts of all who had a hand in on the publication of this monograph are appreciated. The many shortcomings that are destined to be discovered in it are the sole responsibility of the author.

Chapter 1

INTRODUCTION

The quest to illuminate processes of cultural change has led archaeologists in recent years to propose a number of theoretical relationships among variables that are believed to relate to the development of cultural complexity. It is common for social characteristics of societies, such as inequality and political organization, to be related directly or indirectly to a host of economic factors. For example, Price and Brown (1985) have recognized the following as features of more culturally complex hunter-gatherers (as listed in Keeley 1988:373–374): highly developed technologies, intensified subsistence economies that simultaneously utilize more species and concentrate on fewer species, greater sedentism, more differentiated settlements, some occupational specialization, greater territoriality and intergroup conflict, and some class differentiation. Keeley (1988:374) adds the heavy dependence on food storage, greater significance of trade, and the use of exchange mediums to the list. An important characteristic of many recent models of rising cultural complexity is the inclusion of subsistence and other economic data as key components without any form of environmental determinism. It is recognized that similar changes in subsistence strategies have affected in similar ways cultures widely separated in time and space. Rising complexity does not have to relate to specific environmental circumstances.

The application of cultural evolutionary models to the archaeological record requires a great array of information. Types of data that have now been collected for decades to facilitate dating and to describe past cultures are still highly relevant. However, the nature of many recent models requires more care in excavation such as that which comes with the use of flotation devices and refined sampling strategies. Dating of specific contexts in sites can hardly be precise enough. Laboratory analyses are increasingly quantitative and therefore require considerably greater sophistication in design and interpretation. As the new century approaches, archaeology appears to be reaching maturity as a scientific discipline.

Zooarchaeology has been at the forefront of the laboratory specialties in archaeology in the development of analytical methodology. Interpretations of faunal remains today involve identification of bones, examination of patterning in bone parts, the illumination of quantitative patterns, etc. The substantive information gleaned from these studies provides data concerning diet of a site's inhabitants, butchering patterns, site seasonality and sedentariness, food storage, food exchange and many other types of information crucial to modern cultural evolutionary models. Zooarchaeologists have been exceptionally cognizant in recent years of the many difficulties inherent in interpreting faunal data from archaeological context (cf. Binford 1981; Brain 1981; Grayson 1984; Klein and Cruz-Uribe 1984; Morey and Klippel 1991; Lyman 1994; Byrd 1997). This recognition has led to fertile research in areas such as taphonomy that has greatly complicated analytical methods but increased confidence in interpretations. Although much progress has been made, close scrutiny of analytical methods remains a large part of the research process. New ways of interpreting faunal data are of at least equal value to whatever substantive conclusions can be made in a given study.

The purpose of this study is to examine faunal remains from the Jordan's Landing site (31BR7) with the intent of making inferences concerning subsistence practices of the

Cashie phase occupants of the site as well as of Cashie peoples in general. Systematic analyses of faunal remains from Cashie phase sites have not been previously conducted; consequently, the information reported here serves as an initial observation of animal remains recovered from a Cashie phase village. Considerable attention will be paid to methodology throughout this monograph. A subsistence model incorporating many elements of recent evolutionary models is developed that spawns several hypotheses to be tested in future studies. The prehistoric archaeological data will be treated after information from ethnohistoric sources has been summarized.

Tuscarora Culture in the Historic Period

Cashie phase culture has been identified as the prehistoric antecedent to the culture labeled "Tuscarora" in the historic period (Phelps 1983). Boyce (1978) has written a summary of Tuscarora culture as it existed in the North Carolina coastal plain in the early eighteenth century. Consequently, only what relates directly to the exploitation of animals or are believed to be salient new points concerning Tuscarora culture as it is seen through the historic record will be included below. The Tuscarora were Iroquois speakers who, possibly along with the Nottoway and the Meherrin, came to settle in northeastern North Carolina at an unknown time in the prehistoric past (see below). The geographic distribution for the Tuscarora is best conceived of as falling in major stream drainages and included in the historic period the Roanoke River, Tar River, and Contentnea Creek drainages from their mouths to the fall line (see Figure 1.1 for locations of the drainages). Archaeological surveys have shown that the distribution was at least roughly similar in the late prehistoric period (Phelps 1983).

Ethnohistoric sources (Barnwell 1908; Todd and Goebel 1920) indicate that settlements in the Contentnea Creek drainage were essentially clusters of plantations, at least some of which had a community name and plaza area used for gatherings and ceremonies (see Byrd 1996a). However, von Graffenried visited in 1711 a palisaded village called "Tasky" that was situated somewhere north of the Contentnea Creek drainage (Todd and Goebel 1920). Since the prehistoric Jordan's Landing site was also a palisaded village located north of the Contentnea Creek area (see below) the possibility that community design varied in the different drainages must be considered.

The total population size of all Tuscarora-speaking peoples in the historic period is currently not known. Barnwell (1908:34) reported in 1712 that his forces destroyed 374 houses in the vicinity of Torhunta, a large Tuscarora community in the Contentnea Creek drainage. He also estimated that the Tuscarora warriors attacking him at that time, which included men from the nearby town of Kenta, numbered not less than 1,200. It is not clear whether he believed this to be the total number of Tuscarora warriors involved in the conflict or simply the number operating in that theatre of the war. Given the large number of houses counted in the Torhunta area coupled with the knowledge that there were at least five of these large communities along Contentnea Creek (see Byrd 1996a), it is reasonable to estimate the Contentnea Creek area population to be at least 5,000 individuals in 1712. The total population of the Roanoke, Tar, and Contentnea Creek settlements was probably on the order of at least 8,000 individuals (see Parramore 1982:313).

It is clear that the historic Tuscarora were what some researchers call an "intermediate society" (Arnold 1996); that is, in cultural evolutionary terms, they were at an

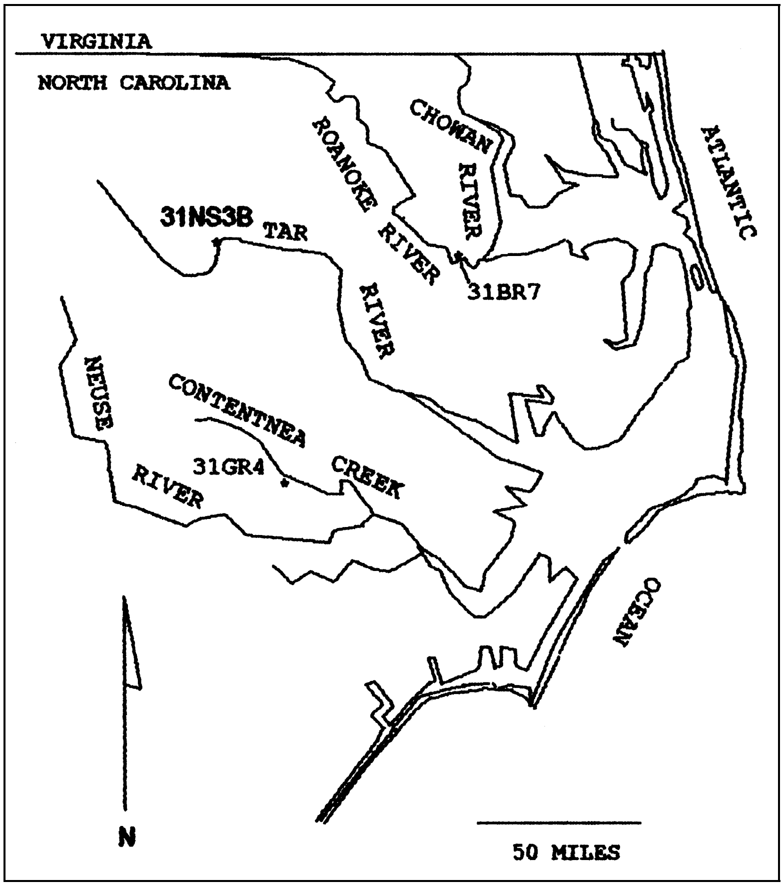

Figure 1.1. Map of northeastern North Carolina showing the locations of the Neoheroka Fort site (31GR4), the Thorpe site (31NS3B), and the Jordan's Landing site (31BR7).

intermediate level of complexity between simple hunter-gatherers and state-level societies. Boyce (1975; 1978:283) has argued that Tuscarora villages were autonomous during the historic period. Viewed against the band-tribe-chiefdom-state sequence of sociopolitical organization for purposes of comparison (the band-tribe-chiefdom-state model is best seen as a continuum of social development rather than rigidly defined types), Boyce's argument would place the Tuscarora firmly in Service's (1962) "tribal" level of sociopolitical organization. Tribes are characterized as familistic, egalitarian cultures with no separated bodies of political control, no economic specialization, and no true religious specialization (see Service 1962).

There are good reasons, however, to propose that in the late seventeenth century at least some of the Tuscarora communities were experiencing political centralization that led to the more integrated sociopolitical elements ascribed to early "chiefdoms" (see Noble 1985 for a summary of the characteristics of chiefdoms). It is not suggested that necessarily all of the communities affiliated with the name "Tuscarora" underwent these changes. With the chiefdom comes an end to individual village autonomy as the leadership in a single village is able to achieve a degree of control over others (see Arnold 1996). Typically, a single paramount chief gains control over the traditional political system. This control is usually both expressed and enhanced by the redistribution of surplus goods (Service 1962).

In the seventeenth and early eighteenth centuries, the fur trade between the Tuscarora communities and the colonial inhabitants of the region could have provided a stimulus for the rise to power of certain village headmen. That this is indeed what happened is supported by the following ethnohistorical observations.

Francis Yeardley (Salley 1911) reported in 1654 that two Virginians interested in extending their fur trade to the Tuscarora met with the "emperor of the Tuskarorawes" and 250 of his men at a winter hunting quarter. This "emperor" urged the men to visit his chief town, where a Spanish trader and associates were currently residing. Important elements of this account are the use of the label "emperor," the reference to a "chief" town, and the presence of a Spanish trader. It must be considered that trade with the Spanish (see Parramore 1982:310) could have been influential in the cultural developments for Tuscarora communities that would reach their peak half a century later. In 1667, a German explorer working out of Virginia, John Lederer, visited a Tuscarora community (Katearas) and was received by a person he referred to as the "emperor" (Cumming 1955:33). Lederer described the town as " a place of great Indian trade and commerce, and chief seat of the haughty Emperor." Once again, the notions of "emperor" as opposed to "king" and the existence of a "chief town" are noted.

The account written by Christoph von Graffenried (Todd and Goebel 1920) of his captivity at the hands of the Tuscarora in 1711 offers further evidence relevant to the state of sociopolitical integration. Von Graffenried, along with North Carolina's surveyor-general John Lawson, was taken prisoner by Tuscarora Indians from the community of Catechna as they were attempting to explore deep into Tuscarora territories. Von Graffenried frequently distinguished between "chiefs" and "kings" in his account and noted that kings are "really only the chiefs of a certain number of wild Indians, but still, it is hereditary and is passed on to posterity" (Todd and Goebel 1920:245). One chief in particular, Chief Hancock, appeared to have authority over the other chiefs from various communities who assembled at Catechna. Tribal chiefs in Service's (1962) formulation do not inherit their positions but rather come to them as adults through a variety of means. Service notes that "[t]he creation of the hereditary office of chief, with its high status for the person who occupies it, naturally carries the possibility of other statuses of high degree. We might think of the beginning of this system as an otherwise egalitarian society with but one exalted social position....It is the presence of the office of chief that makes a chiefdom" (Service 1962:149–150). In his account Von Graffenried distinguished between "principal villages" and "villages" and made one reference to prior trade relations between the Tuscarora and Spanish (Todd and Goebel 1920:280).

In the historic records passing references indicate that there was some degree of occupational specialization among the Tuscarora in the early eighteenth century. For example, Von Graffenried noted (Todd and Goebel 1920:274,277) that a shaman was quite active in Catechna during his stay. It is clear that this individual ran the ceremonies Von Graffenried observed and did not leave the community with the warriors during the raids. Lawson (1967:217[1709]) noted that those Indian men who were not extraordinary hunters performed a number of other tasks such as making wooden bowls, dishes, spoons, and clay tobacco pipes (see below). These items were traded for food and animal skins.

The extensive fur trade carried on between the Tuscarora and their colonial neighbors should have stimulated an increase in sociopolitical complexity. Though the Spanish were seemingly involved in trade with the Tuscarora in the mid-seventeenth century (see above), it was trade with the Virginia colony that became of primary

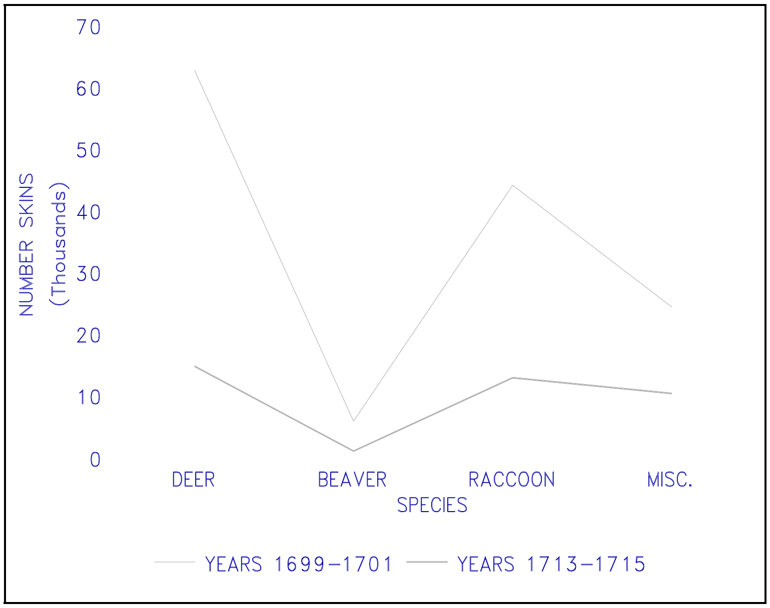

Figure 1.2. Numbers of animal skins exported from Virginia at the turn of the eighteenth century. Data taken from Theobald (1980).

importance in the late seventeenth and early eighteenth centuries. Indian trade was rivaled only by tobacco in economic importance for Virginians in the second half of the seventeenth century, and furs were the commodity that colonial traders sought after the most (Theobald 1980). In the years 1699–1701, Virginia traders exported over 130,000 animal skins (see Figure 1.2) (Theobald 1980). By 1709, the Tuscarora had established themselves as "middlemen" in the Indian trade routes running south out of Virginia (Theobald 1980) and maintained this position of advantage until the Tuscarora War of 1711–1715. The Virginia fur trade declined along with Tuscarora hegemony following the war as evidenced by the dramatic drop in exports (less than 40,000 skins exported) for the years 1713–1715 (see Figure 1.2) (Theobald 1980). A peak in the effects of trade on Tuscarora sociopolitical organization would have been realized around 1711.

The establishment of control over trade with the colonists by certain village headmen provided a mechanism by which some community leaders achieved a dominant status. These newly elevated chiefs made the trade agreements with individual colonial traders as well as organized the large-scale game drives carried out by groups of men numbering in the hundreds to obtain the prized animal skins in large quantities. The role of the game drives should not be underestimated. Game drives involved hundreds of men presumably from multiple communities (given the large numbers) working cooperatively to burn sections of forest so that deer and other animals might be forced into close proximity of shooters. Logistics necessary in setting up game drives would include decisions made as to how skins would be divided among the participants, which sections of forests would be burned, how food stores would be usurped and dispensed, etc. Hunting grounds must have become an increasingly valuable commodity as the fur trade grew and disputes between hunting parties from various communities arose. Clearly, leadership above the village level would be advantageous during the winter hunting forays.

Ethnohistoric sources provide some information concerning Tuscarora subsistence as has been summarized by Boyce (1978). The historic Tuscarora were agriculturalists who also engaged in hunting and gathering. Colonel John Barnwell was impressed by the quantities of corn (over 2,000 bushels) his troops discovered stored in the Tuscarora homes in and around the community of Torhunta in February of 1712 (Barnwell 1908:34). He also discovered large peach and apple tree orchards that were mature and productive (Barnwell 1908:34). Von Graffenried reported being fed venison once while in captivity and cornbread twice (Todd and Goebel 1920:265,275). He observed one "fine corn field" (Todd and Goebel 1920:273) and a gathering foray by the women of Catechna, who went "somewhat distant to get cherries, others to dig sweet potatoes, a species of yellow roots, very good and pleasant" (Todd and Goebel 1920:271). More general statements have been made by Lawson (1967[1709]) that were intended to describe subsistence practices of the Indians of North Carolina at the turn of the eighteenth century. These statements, which should apply to the Tuscarora, include the following:

> When these savages go a hunting, they commonly go out in great Numbers, and oftentimes a great many days Journey from home, beginning at the coming in of the Winter; that is, when the leaves are fallen from the Trees, and are become dry. 'Tis then they burn the Woods, by setting Fire to the Leaves, and wither'd Bent and Grass, which they do with a Match made of the black Moss that hangs on the Trees in *Carolina,* and is sometimes above six Foot long.... Thus they go and fire the Woods for many Miles, and drive the Deer and other Game into small Necks of Land and Isthmus's, where they kill and destroy what they please. In these Hunting-Quarters, they have their Wives and Ladies of the Camp, where they eat all the Fruits and Dainties of that Country, and live in all the Mirth and Jollity, which it is possible for such People to entertain themselves withal. Here it is, that they get their Complement of Deer-Skins and Furs to trade with the *English*, (the Deer-Skins being in Season in Winter, which is contrary to *England*.) All small Game, as Turkeys, Ducks, and small Vermine, they commonly kill with Bow and Arrow, thinking it not worth throwing Powder and Shot after them. Of Turkeys they have abundance; especially, in Oak-Land, as most of it is, that lies any distance backwards. I have been often in their Hunting-Quarters, where a roasted or barbekued Turkey, eaten with Bears Fat, is held a good Dish; and indeed, I approve of it very well; for the Bears Grease is the sweetest and least offensive to the Stomach (as I said before) of any Fat of Animals I ever tasted. The Savage Men never beat their Corn to make Bread; but that is the Women's Work, especially the Girls, of whom you shall see four beating with long great Pestils in a narrow wooden Mortar; and every one keeps her Stroke so exactly, that 'tis worthy of Admiration. Their Cookery continues from Morning till Night. The Hunting makes them hungry; and the *Indians* are a People that always eat very often, not seldom getting up at Midnight, to eat. They plant a great many sorts of Pulse, Part of which they eat green in the Summer, keeping great Quantities for their Winter-Store, which they carry along with them into the Hunting-Quarters, and eat them.
>
> The small red Pease is very common with them, and they eat a great deal of that and other sorts boil'd with their Meat, or eaten with Bears Fat.... The wild Fruits which are dry'd in the Summer, over Fires, on Hurdles and in the Sun, are now brought into the Field; as are likewise the Cakes and Quiddonies of Peaches, and that Fruit and Bilberries dry'd, of which they stew and make Fruit-Bread and Cakes. In some parts, where Pigeons are plentiful, they get of their Fat enough to supply their Winter Stores. Thus they abide in these Quarters, all the Winter long, till the Time approach for planting their Maiz and other Fruits. In these Quarters, at Spare-hours, the Women make Baskets and Mats to lie upon, and those that are not extraordinary Hunters, make Bowls, Dishes, and Spoons, of Gum-wood, and the Tulip-Tree; others (where they find a Vein of white Clay, fit for their purpose, make Tobacco-pipes, all which are often transported to other *Indians*, that perhaps have greater Plenty of Deer and other Game; so they buy (with these Manufactures) their raw Skins, with the Hair on, which our neighboring *Indians* bring to their Towns, and, in the Summer-time, make the Slaves and sorry Hunters dress them, the Winter-Sun being not

> strong enough to dry them.... They are not only good Hunters of the wild Beasts and Game of the Forest, but very expert in taking the Fish of the Rivers and Waters near which they inhabit, and are aquainted withal. Thus they that live a great way up the Rivers practise Striking Sturgeon and Rock-fish, or Bass, when they come up the Rivers to spawn; besides the vast Shoals of Sturgeon which they kill and take with Snares, as we do Pike in *Europe*. The Herrings in *March* and *April* run a great way up the Rivers and fresh Streams to spawn, where the savages make great Wares, with Hedges that hinder their Passage only in the Middle, where an artificial Pound is made to take them in; so that they cannot return. This method is in use all over the fresh streams, to catch Trout and the other Species of Fish which those Parts afford. Their taking of Craw-fish is so pleasant that I cannot pass it by without mention; When they have a mind to get these Shell-fish, they take a Piece of Venison, and half-barbakue or roast it; then they cut it into thin Slices, which Slices they stick through with Reeds about six Inches asunder, betwixt Piece and Piece; then the Reeds are made sharp at one end; and so they stick a great many of them down in the bottom of the Water (thus baited) in the small Brooks and Runs, which the Craw-fish frequent. Thus the *Indians* sit by, and tend those baited Sticks, every now and then taking them up, to see how many are at the Bait; where they generally find abundance; so take them off, and put them in a Basket for the purpose, and stick th reeds down again. By this Method, they will, in a little time, catch several Bushels, which are as good, as any I ever eat [Lawson 1967:215–218].

Because the majority of ethnohistoric sources concerning the Tuscarora date to the early eighteenth century, they must be used with caution in making inferences concerning subsistence in the prehistoric period. Potential problems in using these anecdotal accounts include misunderstandings of the various species the writers refer to and failure to recognize changes in subsistence after contact with Europeans. An example of the former is Lawson's statement (see above) that "trout" were taken in "fresh streams." This would certainly not be brook trout nor sea trout in inner coastal plain freshwater rivers and streams. There is no way to determine which species of fish Lawson refers to, and such circumstances raise doubts about other field identifications made by early colonists. The latter problem mentioned above can be illustrated by Lawson's (1967[1709]) observation that the Carolina Indians were raising peaches. Peaches are not endemic to North America and thus must have been obtained in trade, possibly via Spanish traders with whom the Tuscarora were rumored to have trade relations with early in the Colonial Period (see Parramore 1982 and above). How long the Tuscarora had been raising peaches is unknown, but by the turn of the eighteenth century they were apparently standard fare.

Excavations carried out at the Neoheroka Fort site (31GR4) have produced data that appear to verify some of the observations made by the colonists. The Neoheroka Fort was the site of the last major battle of the Tuscarora War in 1713. Built and occupied by Tuscarora men, women, and children, the fort was well provisioned with corn, beans, peaches, and other plant foodstuffs. Flotation samples taken from within the houses inside the fort have produced large quantities of corn along with various other plant taxa; however, the most impressive evidence of the abundance of food stores are the concentrations of corn (Figure 1.3), peaches (Figure 1.4), and beans that have been found lying in the storage areas of the houses. It is clear that the inhabitants of the fort were able to procure large surpluses of domesticated plant foods. The relatively few animal remains recovered from within the fort consist primarily of deer, though some raccoon bone fragments have been recovered. Poorly drained clay subsoils along with acidic conditions within the houses has left the bone and shell fragments in very poor condition. The relative abundance of deer remains could

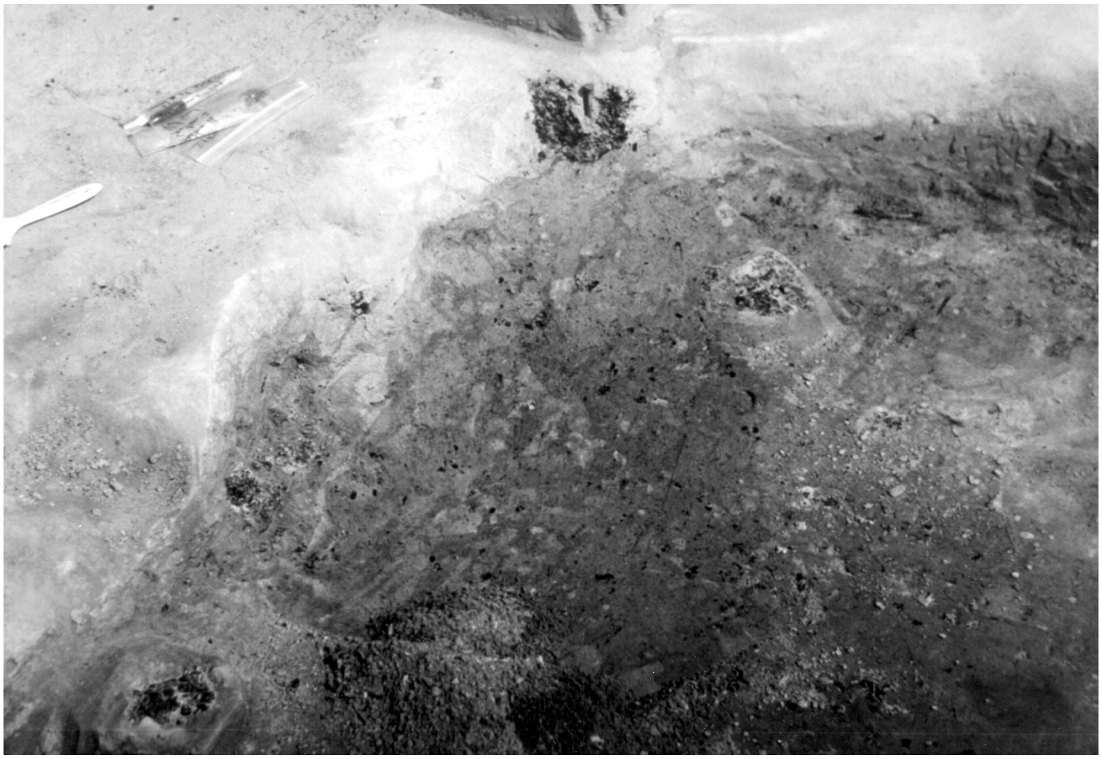

Figure 1.3. The storage area of a structure within the Neoheroka Fort. Charred concentrations are bundles of corn and beans.

Figure 1.4. A bundle of peaches discovered lying on the floor of a structure within the Neoheroka Fort.

result simply from taphonomic pressure having removed the more fragile bones of smaller taxa (see Chapter 3). An alternative explanation relates to the fact that the fort was destroyed in March of 1713: March falls at the end of the season in which large game animals were being taken in large numbers to supply the fur trade and were consequently a more common food item. It also appears that traditional spring fishing activities were disrupted in 1713 by the war. Future analyses will address this problem.

The rapid changes that Tuscarora culture must have undergone throughout the seventeenth and eighteenth centuries present excellent research problems for anthropologists. While the ethnohistoric sources concerning Tuscarora culture suggest that some significant changes were underway by 1711, these sources will never offer more than incomplete, synchronic glimpses of certain variables deemed relevant to studies of process (Drennan and Uribe 1987). The archaeological record has the greatest potential for studies of process (Drennan and Uribe 1987) as it is the only source of data that can provide a general coverage of Tuscarora culture as it evolved through these many centuries in eastern North Carolina. Tuscarora culture change in the historic period will not be reasonably understood in the absence of knowledge of the prehistoric culture. Archaeological research of the Cashie phase is the only means of obtaining this knowledge of prehistoric Tuscarora culture and is a prerequisite to any meaningful studies of process.

The Cashie Phase

The Cashie phase has been defined and described by Phelps (1983). The temporal placement of the phase is in the late Woodland period, beginning approximately A.D. 800 and lasting until the mid-seventeenth century, when Cashie manifestations are recognizable historically as "Tuscarora." The phase ends with the dramatic changes introduced to the Tuscarora by the impact of colonizing Europeans.

The geographic distribution of Cashie phase culture falls in the inner coastal plain of present-day northeastern North Carolina and southeastern Virginia, stretching from the western estuarine border to the fall line, primarily between the Roanoke and Neuse Rivers (Phelps 1983). This region today contains some of the richest agricultural lands in the state. Other resources of the region include the following: deciduous forest containing nuts, grapes, and other edible plants as well as an abundance of wildlife; rivers, streams, and swamps providing habitat for fish, mussels, and other aquatic resources. The settlement pattern generally consists of small villages and homesteads, located on sandy loam ridges along the major rivers, often near the confluence of a small stream (Phelps 1983). Other types of settlements include seasonal camps and perhaps temporary villages used as "winter hunting quarters" (Phelps 1983; also, see above). While cases of winter hunting quarters being used by the Tuscarora have been documented in the historic period (Salley 1911; Lawson 1967 [1709]; Boyce 1978), it is unclear if these temporary villages were a traditional practice inherited from prehistoric Cashie culture or the product of the fur trade vigorously pursued with the colonists. One prehistoric Cashie phase site located on the Tar River near the fall line is a candidate for one of these winter hunting quarters, but awaits further analysis (Phelps 1983).

Phelps (1983) has identified several characteristics of Cashie culture that are highly relevant to cultural evolutionary studies. Subsistence technologies included the bow and arrow for hunting, milling stones for processing wild plant foods, and field agriculture with an emphasis on corn and beans and possibly other cultigens as well. The prevalence of advanced fish capture technologies (weirs, tidal traps, etc.) among Carolina Algonkian societies to the east suggests that such devices were known to the Cashie inhabitants of the inner coastal plain. The fragile nature of the materials used to construct fish traps has probably prevented the recovery of direct evidence of their use prehistorically.

Differential burial patterns (Phelps 1983:46) indicate that social structure during the Cashie phase could have included some class stratification. Burial treatments include secondary bundle burials; flexed, single, primary inhumations; and extended, single, primary inhumations. Grave offerings vary considerably. Shell beads are a common inclusion in the secondary burials but vary greatly in the number of beads in the pit (Phelps 1983:46). One secondary inhumation recovered thus far appears to be the burial of a shaman (Phelps 1983:45–46). Other relevant social factors are the significance of trade and territoriality. Shell beads, diamondback terrapin shells, and occasional shell-tempered sherds all indicate trade connections with coastal Colington phase groups (Phelps 1983:44). The accounts of the first English explorers who ventured up the Roanoke River in the late sixteenth century (Quinn 1991) make it clear that the Tuscarora villagers in that region had a definite notion of territoriality.

There is mounting evidence that suggests that the advent of the Cashie phase marks the initial colonization of North Carolina's inner coastal plain by the ancestors of the Tuscarora. The Tuscarora exhibit close linguistic and anthropometric similarity to the northern Iroquois-speaking tribes (Byrd 1996b). Close similarity in language and biology indicates that the split which led eventually to the migration to North Carolina occurred in the relatively recent past, most likely in the Middle or Late Woodland period (Byrd 1996b). This interpretation is in line with a current model of Iroquois history outlined by Snow (1995; 1996) that has the group ancestral to the northern Iroquois tribes residing in central Pennsylvania and splitting up after A.D. 600.

Reconstructing Subsistence Practices during the Late Prehistoric Period

The temptation to simply graft what is known about subsistence practices in the historic period onto the prehistoric culture is to be carefully resisted. Such a procedure would force a picture of continuity onto the past that would obscure any differences that might exist between subsistence practices during the late prehistoric period and those during the historic period. For example, assuming that the abandonment of villages in the winter to reside in hunting quarters was a common practice during the Cashie phase could possibly mask an important development of the historic period relating to the fur trade. Expectations for subsistence practices can, however, be established by appealing to previous work that has identified general trends in eastern North American subsistence technology (see Smith 1986; Steponaitis 1986; Custer 1988), summarized data from prehistoric sites in eastern North Carolina (Phelps 1983; Byrd 1995), or provided theoretical constructs that are applicable to Cashie culture (Price and Brown 1985; Keeley 1988; Byrd 1997).

It is clear that native cultures in eastern North America relied heavily upon wild plant and animal resources from the earliest colonization during the late Pleistocene Epoch until well into the historic period. Though many of the same species were exploited through much of this time, important additional species were added to the subsistence mix as new technologies such as cooking pots, gardening, and field agriculture were introduced. There are historical trends in the development of subsistence strategies that appear to characterize much of the eastern woodlands area (see Smith [1986] for a summary of developments in the southeast that is generally applicable to much of the eastern woodlands). Early Holocene subsistence strategies appear to have involved generalized foraging in the deciduous forests that covered the region after the close of the last ice age. Tool technologies were simple and efficient given the high mobility necessitated by a foraging lifestyle. The middle Holocene saw continuity in subsistence practices except for one important development: aquatic animal species assumed more significant roles as food resources in many interior river valleys. This intensification of fishing and shell-fishing appears to relate to middle Holocene climatic changes that both improved habitat for many riverine plant and animal species and reduced the quality of many upland habitats (Smith 1986). By the late Holocene, most eastern woodlands cultures were tied to stream valley habitats and the abundant aquatic animal resources that they afforded. Mobility was reduced as groups spent most of the warm season at choice locations along major creeks and rivers. Simple gardening was in place over much of the region by 4000 B.P. with cultigens such as sunflower, gourd, squash, sumpweed, and goosefoot being commonly grown. New food processing and storage technologies were introduced, including steatite cooking pots, ceramic cooking pots, and storage pits. Trade in commodities such as steatite became important at this time as well. The implications of the intensification of aquatic resource exploitation appear to be great: the reduced mobility promoted simple gardening, food storage, and ultimately greater human population densities. Population densities could have reached high enough levels in some areas to create problems of environmental circumscription that promoted increasing sociopolitical complexity (Custer 1988). It is clear that the earliest complex culture of the region, Poverty Point, dates to this era (Smith 1986; Steponaitis 1986).

Another important addition to the list of cultigens was adopted into eastern gardens by approximately 1600 B.P.: maize (Smith 1986). Maize-based agriculture was common by 1200 B.P. and is believed to be correlated with significant growth in human population as well as cultural complexity in the eastern woodlands during the last 1,000 years of prehistory (Smith 1986; Steponaitis 1986). Though there was significant regional variation in specific hunting and gathering strategies (Smith 1986:59–60), the species of wild plants and animals exploited during earlier periods were still taken after agricultural techniques were fully developed (Steponaitis 1986:389). Domesticated animals never became important in the eastern woodlands during the prehistoric period, though it appears that the process of domestication of the white-tailed deer was under way in at least one area at the time of contact (Noble 1985:139).

Phelps (1983) has provided a summary of the prehistoric cultures of eastern North Carolina. The data from this region are generally in line with those of the eastern woodlands, but do provide a closer examination of cultural developments in the specific region of interest in this study. The prehistoric sequence is divided into three periods: Paleoindian (ca. 14,000–10,000 B.P.), Archaic (10,000–3,000 B.P.), and Woodland (3,000–350 B.P.). Note that no "Mississippian" period is recognized. The extension of the Woodland period into historic times reflects the lack of many of the classic Mississippian characteristics (e.g. temple mounds, Mississippian ceremonial paraphernalia) in eastern North Carolina in the late period. It is clear that late prehistoric cultures in northeastern North Carolina were more closely tied to groups in the north than to groups in the southeast proper. Information concerning cultures in these respective periods is concisely summarized below. Refer to Phelps (1983) for more complete descriptions.

The Paleoindian period in eastern North Carolina is represented by a few artifacts that have all been recovered in surface context. Intact Paleoindian sites should exist in the region on remnant levees along major trunk streams, but to date little effort has been made to identify them. It is reasonable to assume that human groups during this early era were highly mobile foragers with relatively low population densities. Sites of the following Archaic period are far more numerous but, as with the Paleoindian sites, are usually discovered in the disturbed context of plowed fields. Archaic peoples were foragers like their predecessors but were more numerous and were probably, in a sense, less mobile. Higher populations and greater knowledge of local habitats could have encouraged Archaic groups to move within a more limited space. There is a gradual increase in numbers of sites from Early to Middle Archaic times and then a decrease in regional site density during the Late Archaic period. A Late Archaic trend toward fewer, larger sites along major trunk streams apparently reflects changing subsistence strategies and increasing sedentariness (Phelps 1983).

The transition from the Late Archaic period to the Early Woodland period is marked by the appearance of early ceramic vessels with flat bottoms and temper consisting of fiber, steatite, or clay. Early Woodland sites are often found together with Late Archaic components suggesting that settlement and subsistence systems were relatively continuous through these eras. The trend toward increasing sedentariness apparently continued in the Woodland period since Middle Woodland sites are still fewer in number and typically found in greatest numbers along the major stream banks. Riverine sites appear to be warm season subsistence camps that reflect dependence on the exploitation of aquatic resources and gardening, though little direct evidence of cultigens has been recovered. The Late Woodland period includes the Cashie phase in the inner coastal plain and the Colington phase in the tidewater area. It is clear that the Late Woodland period saw the development of field agriculture based on corn, beans, and squash throughout most of northeastern North Carolina as well as a continued emphasis on aquatic resources. Fishing technology was greatly enhanced and included weirs and tidal traps on the coast. It is currently unclear whether Colington sites consist of permanent villages that were occupied year round or villages that were seasonally occupied. The variety of specific habitat types occupied by Colington phase groups (i.e., coastal strand on the outer banks versus the freshwater marsh in western Albemarle Sound) raises the possibility that both descriptions apply (Phelps 1983). The Cashie phase is discussed more fully above.

A detailed examination of site distributions in a limited geographic area within the inner coastal plain has been reported in Byrd (1995). The settlement data can be used to make inferences about subsistence strategies. Archaeological sites from all subperiods were analyzed to determine their exact positioning within the landscape with regards to soil properties, elevation, proximity to water, stream order, and the presence of stream junctions in the vicinity of the sites. The data were then subjected to a variety of multivariate statistical treatments including analyses of variance. The results can be summarized as follows.

Temporal variation is seen most strongly among the archaeological sites with respect to the order of the streams and whether or not they are found close to stream junctions. Late Woodland sites shows the least variability in these characteristics indicating that groups at this time had very specific ideas about where to settle: they preferred to be on sandy soils, along a major stream, and near a stream junction. Middle Woodland sites were found on loams and sands, at a variety of elevations, and most often next to major streams. Sites of the Early Woodland period were located in loams or sands and frequently along smaller, tributary streams near stream junctions. Late Archaic sites tend to lie in sandy or loamy soils along major streams near stream junctions. Sites of the Middle Archaic period were located most often on loams or sands along small streams while those of the Early Archaic were most often found on medium-order streams.

The most striking pattern observed in the site distributional data was not unidirectional change in the arithmetic means of the respective variables but a consistent reduction in the variance of site location data as time advanced. Early and Middle Archaic sites were situated in a wider variety of habitats (as habitat is defined by the physiographic variables) than sites of the Late Archaic period and after. This result has been interpreted by Byrd (1995) as a reflection of the changing subsistence practices through time in the project area: the gardening and fishing that became important ca. 4000 B.P encouraged greater selectivity in site locations than was practiced by the previous highly mobile, foraging cultures. There is a clear trend beginning in the Late Archaic period, though disrupted during the Early Woodland period, of inhabiting sites along the major trunk streams.

Early Woodland sites are found along major trunk streams but also frequently along tributary streams. This Early Woodland anomaly could be the result of expanding population at the close of the Late Archaic. According to this argument, gardening communities experienced considerable population growth over time and eventually fissioned in response to population pressure (as described by Custer [1988:129]). The return to major trunk streams in the Middle Woodland period would then reflect changes in sociopolitical organization that made more populous communities possible. An equally plausible alternative explanation holds that Early Woodland sites include at least two site types: 1) warm season fishing and gardening locations on the large streams and 2) winter foraging locations along the small streams. Though the latter explanation is harder to reconcile with the Late Archaic and Middle Woodland settlement patterning (in the sense that one is left to explain why the seasonal transhumance strategy was developed during Early Woodland times and subsequently abandoned), it is testable should floral and faunal remains be recovered from sites of this era in the project area.

A similar settlement pattern study dealing exclusively with Cashie phase sites was conducted by Byrd (1996a) in the Contentnea Creek drainage. This analysis included both the same physiographic variables and statistical analytical procedures reported in Byrd (1995). Cashie sites were found in sandy soils, near stream junctions, at higher elevations, and within 300m of a trunk stream. Most of these sites were located along either Nahunta Swamp or Contentnea Creek itself. These are two of the largest streams in the region (Contentnea "Creek" is a misnomer) and would have provided the best riverine habitat. This pattern is interpreted as reflecting a reliance on field agriculture and aquatic resources.

The information from previous summaries and analyses reported above suggests that expectations can be established for subsistence strategies in the late prehistoric period by viewing them as the continuation of trends that were initiated in the preceding millenia. To the extent that these temporal trends are generally pan-eastern woodlands phenomena, this approach is valid. However, in light of the possibility that the Cashie phase occupants of North Carolina's inner coastal plain were newcomers to the region (see above), it cannot be assumed that local Middle Woodland subsistence practices would be repeated in the Late Woodland period. Snow (1995) clearly sees migrating Iroquoians as having taken their farming practices with them. Consequently, some insight can possibly be gained by referring to subsistence practices in central Pennsylvania, the proposed ancestral land of the Northern Iroquois (Snow 1995; 1996), during the late Middle Woodland period. Snow (1995) has identified the Clemson's Island culture of Pennsylvania as the likely precursor of most of the Northern Iroquois groups. Clemson's Island sites date from approximately A.D. 750–1300 (Snow 1995:74–75) and appear to have been horticultural hamlets. Maize was an important crop (Snow 1995:74). Site locations often appear to have been ideal for hunting and fishing as well as farming (Stewart 1990:97). New York's Owasco culture, purported by the Snow model to be a late prehistoric descendant of Clemson's Island, also includes maize agriculture in the subsistence mix. Tuck's (1971) settlement study of Owasco sites in Onondaga County, New York, yielded data regarding subsistence practices in the Late Woodland period. All six of the sites for which faunal data were available include the remains of deer and fish (Tuck 1971). One of the sites (Furnace Brook) has yielded a substantial number of fish bones along with those of deer, birds, and reptiles. Shellfish were present as well. The Owasco data as a whole suggest that the white-tailed deer was the most significant animal resource exploited; however, it is possible that taphonomic biases (see Chapter 3) have distorted this picture substantially. Regardless, the Onondaga data indicate that at least some sites were situated next to large streams where aquatic fauna were exploited as well as terrestrial mammals such as white-tailed deer.

An altogether different approach to deriving expectations from utilizing regional and local data is to appeal to general theory regarding the relationship between subsistence and other cultural attributes. Keeley (1988) has analyzed a worldwide ethnographic data set in an attempt to evaluate the significance of population pressure as a driver of socioeconomic development. Two of his conclusions are of special interest here. The first is that there exists a strong relationship between food storage, population density, and social inequality (Keeley 1988:395). Second, there is a dietary trend in cultures away from terrestrial animal foods and toward aquatic animal foods as population density rises (Keeley 1988:393). Human groups with high local population densities and no domesticated animals tend to heavily exploit aquatic animals. Those with any form of class ranking also store the aquatic resources.

A number of general expectations can be drawn from the information summarized above. It is reasonable to expect that Cashie phase subsistence strategies included maize-based field agriculture as a primary focus. Squash, beans, and a variety of other cultigens and wild plant species should be recovered in addition to maize where preservation conditions allow. Animal resources should include the white-tailed deer as an important terrestrial mammal. Aquatic resources including fish, turtles, and freshwater mussels should prove to have been more significant than terrestrial mammals as a source of protein and calories. The apparent class differentiation, territoriality, and significance of trade suggest that Cashie culture was at a level of complexity that would have demanded sedentary communities, developed food storage technologies, and intensified exploitation of animal resources.

The research results presented below will base few assumptions on information obtained from ethnohistoric literature and regards the faunal materials from the Jordan's Landing site as a starting point in the study of subsistence during the Cashie phase. Chapter 2 discusses the methods employed in the identification of the animal remains in four assemblages, each recovered from a separate feature. A description of each of these features appears below. The representation of taxa in the respective assemblages will be presented along with discussion of general qualitative and quantitative patterns observed in the faunal data. The results of taphonomic studies of the faunal assemblages are presented in Chapter 3. Most analyses of archaeological faunal assemblages are prone to error resulting from a variety of biasing factors. Examples of such factors include excavation and recovery techniques and taphonomic agents of attrition. The four assemblages were examined for signs of taphonomic agents before further analyses were conducted.

The diversity of the prey species exploited by the villagers is examined in Chapter 4. It is of fundamental importance to understand whether subsistence practices concentrated on some few species or were more diversified, including a large number of species in the diet. Such information relates directly to the intensification of resource exploitation. Diversity measures provide a standard means by which assemblages can be compared. However, the interpretation of diversity indices must take into consideration the effects of sampling. The methodology employed in Chapter 4 deals with sample size effects and provides an estimate of the number of species commonly exploited by the villagers.

The seasons of occupation of the village are examined in Chapter 5. It is hypothesized that the village was not completely abandoned at any time during the year, but was inhabited by at least some villagers year round. This hypothesis is made plausible by the density of the archaeological materials recovered from the midden, which suggests that the site was much more than a seasonal camp. The Tillet site (31DR35), located on Roanoke Island, has been recognized as a Colington phase seasonal village and contains on average 36 sherds per 10 cm level in a 2x2 m square in the midden (Phelps 1984). The midden at Jordan's Landing has rendered on average several hundred sherds per level in a 2x2 meter square. Excavation techniques at the two sites are comparable. An alternative hypothesis is that the village was abandoned in winter as was possibly common practice in the historic period (Boyce 1978).

The Jordan's Landing Site, 31BR7

The Jordan's Landing site is located on the Roanoke River below Williamston, North Carolina, about 30 miles above where the river meets the Albemarle Sound. The village was situated on a sandy loam ridge on the north bank of the river, occupying about three acres (Phelps 1983:45–46). A small creek drains a swamp on the northeast side (see Figure 1.5). Excavations at the site have been conducted at various times since 1971 under the direction of David S. Phelps of East Carolina University. Though excavation has not been so extensive as to reveal details of intrasite patterns, some information is available. The village is roughly oval and bounded on the north and west sides by a ditch, Feature 1, which apparently resulted from the removal of dirt used to bank the base of a palisade (Figure 1.6). A variety of pits and hearths are distributed on the west and north sides of the site and a number of burials are concentrated on the southeastern side (Phelps 1983:45–46).

The immediate environment around the site contains several distinctive habitats (see Figure 1.5). The higher ground is dominated by deciduous climax forest or, as the case may be, fields cleared for agriculture or in some state of succession. There is also lowland deciduous forest closer to the river and creek, as well as natural levee communities near the river's edge. In the vicinity of the mouth of the creek there is a gum-cypress forest dominated by bald cypress and water tupelo gum. Gum-cypress forest is also found upstream on the north shore and directly across from the site on the south side, seemingly

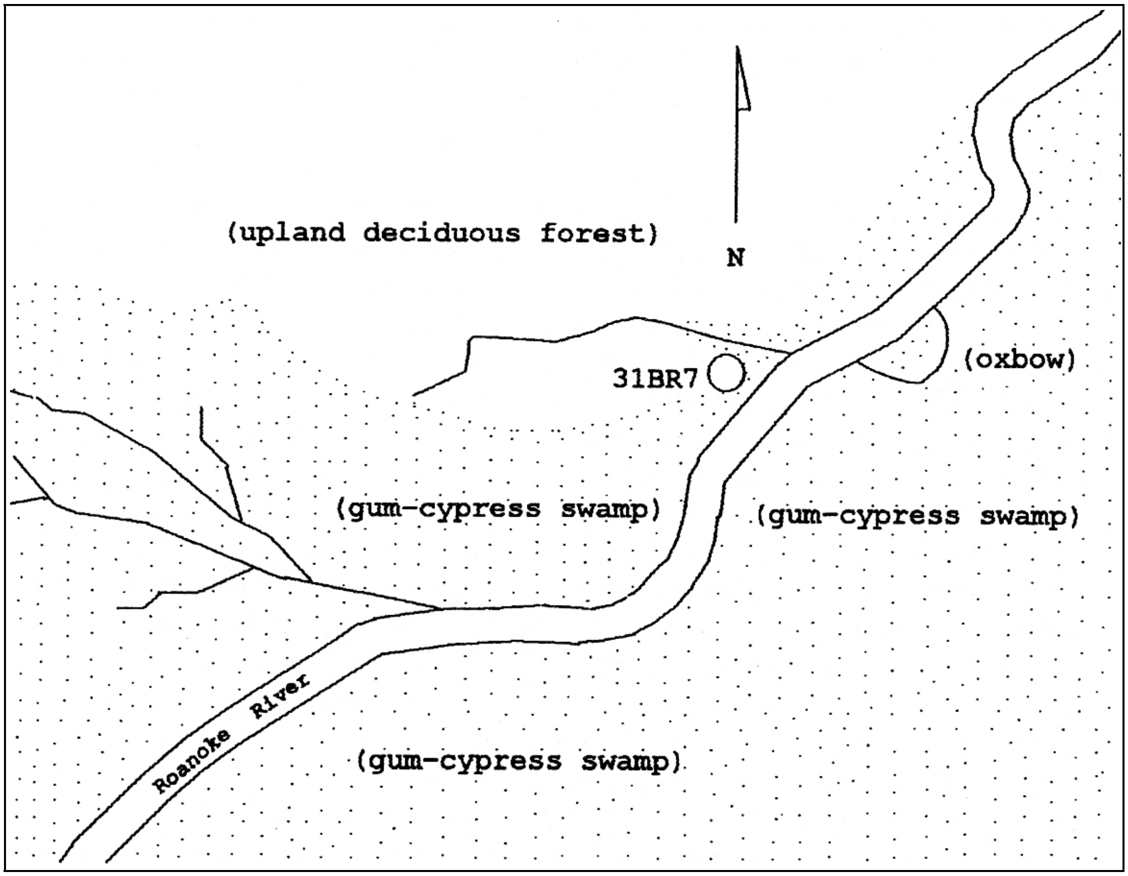

Figure 1.5. The location of the Jordan's Landing site with respect to local habitats.

thriving in the floodplains created by bends in the river. Oxbows are also found in the vicinity, one occurring within one quarter mile of the site. The dominant soil series located on and around the site are as follows: Wickham Series, found on the higher ground; and Chewacla Series, found at river's edge (U.S. Department of Agriculture 1990). The Wickham fine sandy loam has been identified as "prime farmland" (U.S. Department of Agriculture 1990).

The Faunal Assemblages

The four faunal assemblages enlisted for this study originate from four features belonging to the Cashie phase component at 31BR7. Descriptions of these features are given below, along with accounts of the recovery methods employed in the field and any sampling schemes used in obtaining the assemblages for study.

Perhaps the most impressive feature yet observed at Jordan's Landing is Feature 1, the ditch that flanks the north and west sides of the village (see Figures 1.6 and 1.7). As mentioned above, the ditch probably served as a borrow pit for banking the village palisade. It follows the palisade postholes in a broad arc. Subsequent to the construction of the palisade this feature assumed another function. As Phelps (1983:46) describes it, "quite literally it was the village dump, identifiable from the first basketloads to the final overflow

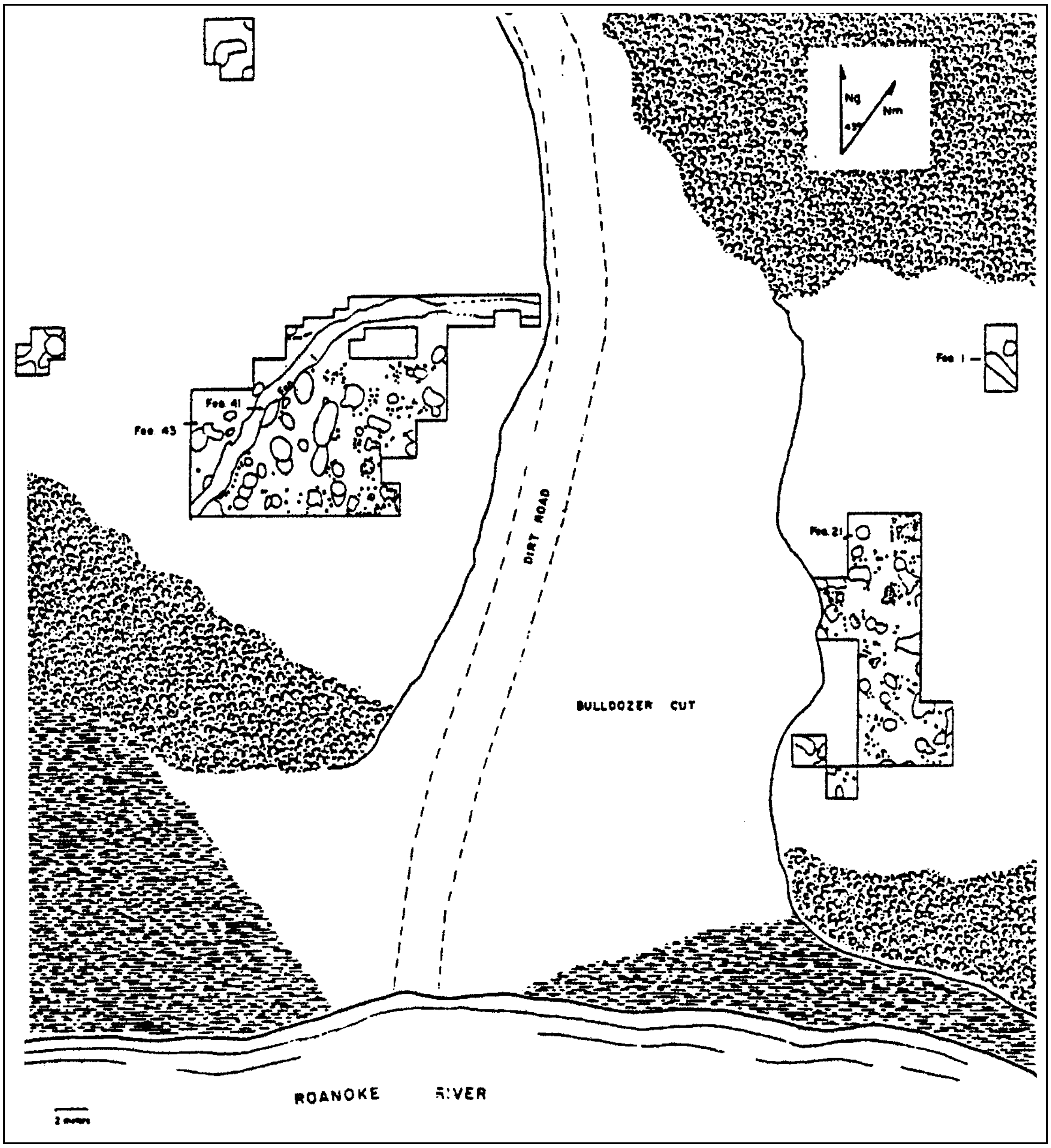

Figure 1.6. The Jordan's Landing site showing excavation areas and selected features.

at the top." Cashie ceramics found in abundance throughout this feature establish its origin during the Cashie phase. Though only a section of Feature 1 has been excavated to date, there are tens of thousands of animal bone fragments along with a plethora of other refuse from the village, that have been recovered.

Feature 1 was excavated in arbitrary 10 cm levels with a detailed plot drawn at each level. The standard screen size used for the sample analyzed here was 1/4 inch, though a large number of random samples (in 5-gallon buckets) was taken and washed through a 1/16" screen. Analysis of fine screened materials from Feature 1 awaits future analysis. The state of preservation of most materials in the ditch is excellent; this is remarkable given the acidity of the soils (pH 4.5–6.0) found on the site (U.S. Department of Agriculture 1990). There is variability in the condition of the faunal remains that appears to be partly

Figure 1.7. The ditch (Feature 1) that formerly flanked the palisade of the Jordan's Landing village (photo courtesy of David S. Phelps).

the result of differential weathering prior to deposition in the ditch. Other sources are discussed in Chapter 3.

The analysis of all animal remains from Feature 1 is beyond the scope of this study. Therefore, a sample of faunal remains from the 2 m square unit 0L2 was deemed appropriate for this study, as it lies in the approximate center of the ditch and provides a cross section from top to bottom of the feature. Henceforth, any reference to the Feature 1 assemblage is a reference to the 0L2 sample.

Feature 21 is a small, circular pit feature located on the east side of the site (see Figures 1.6 and 1.8). It is interpreted as originally having served as a cooking pit, and, interestingly, has two post molds located at opposing ends on the perimeter. At some point after its tenure as a cooking pit ended the pit was filled with the remains of one or more meals and covered with earth. A large Cashie series sherd was discovered near the bottom of the feature placing it with the Cashie phase component of the site. Feature 21 has been radiocarbon dated at A.D. 1425 ± 70 (UGa-1086) (Phelps 1983:44). The contents of the feature are predominantly mussel shell (much of it badly eroded), with strong representation of fish as well (see Chapter 2). Excavation of the feature was as a single unit. Plots were drawn at surface and at base. All fill was washed through 1/16 inch screens. The entire assemblage from Feature 21 was analyzed.

Features 41 and 43 are located on the west side of the site adjacent to the ditch (Figure 1.6). Both share many characteristics and are interpreted as hearths. The shape of each is oblong. The depths are between 30 and 40 cm. Materials found in these features include fire-cracked rock, fired clay lumps, Cashie ceramics, fish bone, mussel shell (some

Figure 1.8. Feature 21 excavated to base of pit (photo courtesy of David S. Phelps).

badly eroded), and other animal remains. The large quantity of refuse situated above the burned materials in these features, along with the small percentage of burned bone fragments (see Chapter 3), indicates that these pits were secondarily filled with trash. The deposition was rapid, if not all at once, as evidenced by the squirrel remains in Feature 43. A radius in Plot Level 2 articulates with an ulna in Plot Level 1, and teeth from the base of the pit belong to the jaws discovered in Plot Level 1. It is likely that these cavities were simply utilized as trash pits after their service as hearths had ended (David S. Phelps, personal communication). Both features were excavated in arbitrary 10 centimeter levels with plots drawn at each level. All materials were washed through 1/16 inch screens. The entire faunal assemblages from Features 41 and 43 were analyzed.

Chapter 2

FAUNAL ANALYSIS OF THE FOUR ASSEMBLAGES

The animal remains from Features 1, 21, 41, and 43 were kindly loaned to the author by David S. Phelps of the Archaeology Laboratory, Institute for Historical and Cultural Research, East Carolina University. Identification of vertebrate remains were done in the Zooarchaeology Laboratory, Department of Anthropology, University of Tennessee, Knoxville. The skeletal collections of the Zooarchaeology Laboratory proved to be more than adequate for the task, there being a series of comparative specimens for every species encountered in the assemblages. The Pelecypod fauna was identified in the Malacology Laboratory, Frank H. McClung Museum, University of Tennessee, Knoxville, under the patient supervision of Dr. Paul W. Parmalee.

Table 2.1 lists the minimum number of individuals (MNI) and the number of identified specimens (NISP) for all taxa with representation in the four assemblages. Common names are given in Table 2.2. Generally, bone fragments were identified as precisely as possible, often assigned to the species level. A great many fragments could not be assigned to a species but could be placed in a genus or higher taxonomic category. The mammals were divided into large (deer, bear, wolf), medium (beaver, raccoon, squirrel), and small (voles, moles) size categories. Not all taxonomic groups can be considered equally identifiable among the fragments partly because of differential taphonomic histories (see Chapter 3) and the limited skills of the analyst. For example, a majority of the fish remains are vertebrae, which is probably a result of the vertebrae having a greater inherent ability to survive attrition than the bones of the skull. Most fish vertebrae can be assigned to their respective families, based on overall shape (including processes) and sculpturing, but few species have vertebrae sufficiently distinctive to allow the author to confidently identify them to a lower taxonomic category. Thus, for the class Osteichthyes in Table 2.1, a high percentage of the NISP's reported are at the Family level.

A result of the conservative approach adopted here is that many fragments that are recognized as likely belonging to a particular species are left out. An important example of this situation is the many ungulate bone midshaft fragments that are most likely white-tailed deer, but are not placed in the species because they lack a morphological trait that removes all doubt. It would cause a serious observer-created bias in the taphonomic analysis to simply ignore these fragments, so a popular convention has been adopted to solve this dilemma. The "cf." appearing before the species name indicates that the species designation of those fragments is most likely correct, but not unquestionable.

The Pelecypod fragments present a problem in quantification: there are several bags of rubble that represent the remains of hundreds of shells. The 100+ number that appears with taxa in Features 21, 41, and 43 is necessarily ambiguous. It will have to suffice to say that large numbers of mussel shells were deposited in these features.

Table 2.1. Faunal Remains from Features 1, 21, 41, and 43 at the Jordan's Landing Site.[1]

			Plot Level		
Species	1	2	3	4	5
Feature 1					
Phylum Chordata, Subphylum Vertebrata					
Class Mammalia (Large Size)					
Odocoileus virginianus	95(4)	112(4)	71(2)	13(2)	21(2)
c.f. *O. virginianus*	1	9	8	3	3
Ursus americanus	6(1)	2(1)	1(1)	-	1(1)
c.f. *Canis lupus*	-	-	1(1)	-	-
Unidentified Large-Size Mammalia	275	144	130	6	-
Class Mammalia (Medium Size)					
Lynx rufus	1(1)	-	-	-	-
Urocyon cinereoargenteus	-	-	2(1)	-	-
Castor canadensis	2(1)	2(1)	2(1)	-	-
Procyon lotor	12(2)	6(2)	14(2)	2(1)	3(1)
Didelphis marsupialis	9(2)	2(1)	8(1)	2(1)	-
Ondatra zibethica	1(1)	1(1)	2(1)	-	-
Sylvilagus floridanus	2(1)	1(1)	1(1)	-	-
Sciurus sp.	4(1)	-	4(1)	9(1)	4(2)
Mephitis mephitis	2(2)	-	-	-	-
Unidentified Medium-Size Mammalia	28	8	3	1	-
Class Aves					
Meleagris gallopavo	1(1)	5(1)	8(2)	-	2(1)
Unidentified Anserinae	-	-	1(1)	-	-
Unidentified Aves	20	1	9	-	2
Class Reptilia, Order Testudines					
Chelydra serpentina	8(2)	17(2)	19(3)	27(1)	7(1)
Terrapene carolina	4(1)	3(1)	6(1)	14(1)	1(1)
Pseudemys sp.	1(1)	2(1)	-	-	2(1)
Unidentified Testudines	358	83	142	40	23
Class Reptilia, Order Squamata, Suborder Serpentes					
Agkistrodon piscivorus	4(1)	-	-	-	-
Unidentified Viperidae	-	-	-	-	1
Elaphe guttata	-	2(1)	1(1)	-	-
Unidentified Squamata	5	2	-	-	-
Class Amphibia					
Rana catesbeiana	1(1)	-	-	-	-
Unidentified Amphibia	16	-	-	-	-
Class Osteichthyes, Superorder Holostei					
Amia calva	22(2)	13(2)	98(12)	19(2)	14(2)
Lepisosteus sp.	16(1)	5(1)	10(1)	9(2)	5(1)
Unidentified Holostei	14	-	156	4	-
Class Osteichthyes, Superorder Teleostei					
Ictaluridae					
Amieurus catus	1(1)	-	-	1(1)	-
Amieurus natalis	-	-	-	-	8(1)
Unidentified Ictaluridae	9	-	-	1	-
Moronidae					
Morone saxatilis	-	7(1)	3(1)	-	-
Morone americanus	-	-	8(2)	-	-
Unidentified Moronidae	2	-	-	-	-

Table 2.1 continued.

Species	Plot Level 1	2	3	4	5
Feature 1 (continued)					
Class Osteichthyes, Superorder Teleostei					
Unidentified Centrarchidae	1	-	-	-	-
Esocidae					
Esox sp.	-	-	1(1)	-	-
Unidentified Teleostei	-	-	98	3	-
Unidentified Osteichthyes	85	8	-	6	7
Unclassified Vertebrate Fragments	570	237	131	73	74
Phylum Mollusca, Class Pelecypoda					
Elliptio complanata	-	3(2)	-	-	-
Unidentified Pelecypoda	-	70+	4	-	-
Feature 21 (no plot levels)					
Phylum Chordata, Subphylum Vertebrata					
Class Mammalia (Large Size)					
Odocoileus virginianus	21(2)	-	-	-	-
c.f. *O. virginianus*	21	-	-	-	-
Ursus americanus	1(1)	-	-	-	-
Unidentified Large-Size Mammalia	151	-	-	-	-
Class Mammalia (Medium Size)					
Lynx rufus	1(1)	-	-	-	-
Procyon lotor	5(1)	-	-	-	-
Didelphis marsupialis	12(2)	-	-	-	-
Ondatra zibethica	2(1)	-	-	-	-
Sylvilagus floridanus	1(1)	-	-	-	-
Sciurus sp.	14(2)	-	-	-	-
Unidentified Medium-Size Mammalia	15	-	-	-	-
Class Aves					
Unidentified Aves	30	-	-	-	-
Class Reptilia, Order Testudines					
Chelydra serpentina	24(2)	-	-	-	-
Terrapene carolina	6(1)	-	-	-	-
Pseudemys sp.	2(1)	-	-	-	-
Unidentified Order Testudines	434	-	-	-	-
Class Reptilia, Order Squamata, Suborder Serpentes					
Unidentified Colubridae	23	-	-	-	-
Agkistrodon piscivorus	3(1)	-	-	-	-
Unidentified Serpentes	24	-	-	-	-
Class Osteichthyes, Superorder Chondrostei					
Acipenser sp.	2(1)	-	-	-	-
Class Osteichthyes, Superorder Holostei					
Amia calva	78(2)	-	-	-	-
Lepisosteus sp.	40(1)	-	-	-	-
Unidentified Holostei	96	-	-	-	-
Class Osteichthyes, Superorder Teleostei					
Ictaluridae					
Amieurus catus	24(6)	-	-	-	-
Amieurus natalis	19(5)	-	-	-	-
Unidentified Ictaluridae	44	-	-	-	-

Table 2.1 continued.

Species	Plot Level 1	2	3	4	5
Feature 21 (continued)					
Unidentified Clupeidae	191	-	-	-	-
Centrarchidae					
Lepomis sp.	8(4)	-	-	-	-
Micropterus sp.	1(1)	-	-	-	-
Unidentified Centrarchidae	8	-	-	-	-
Moronidae					
Morone saxatilis	1(1)	-	-	-	-
Unidentified Moronidae	115	-	-	-	-
Esocidae					
Esox sp.	10(1)	-	-	-	-
Catostomidae					
Moxostoma sp.	1(1)	-	-	-	-
Percidae					
Perca flavescens	4(1)	-	-	-	-
Sciaenidae					
Micropogonias undulatus	71(33)	-	-	-	-
Anguillidae					
Anguilla rostrata	3(1)	-	-	-	-
Unidentified Teleostei	2886	-	-	-	-
Unclassified Vertebrate Fragments	3166	-	-	-	-
Phylum Mollusca, Class Pelecypoda					
Elliptio complanata	100+	-	-	-	-
Unidentified Pelecypoda	?	-	-	-	-
Feature 41					
Phylum Chordata, Subphylum Vertebrata					
Class Mammalia (Large Size)					
Odocoileus virginianus	5(1)	1(1)	-	-	-
c.f. *O. virginianus*	-	4	1	-	-
Unidentified Large-Size Mammalia	34	-	6	-	-
Class Mammalia (Medium Size)					
Procyon lotor	1(1)	-	1(1)	-	-
Didelphis marsupialis	2(1)	-	-	-	-
Ondatra zibethica	2(1)	-	3(1)	-	-
Sciurus sp.	2(1)	1(1)	1(1)	-	-
(Fired Clay Area A)					
Ondatra zibethica	1(1)	-	-	-	-
(Fired Clay Area B)					
Odocoileus virginianus	3(2)	-	-	-	-
Unidentified Large-Size Mammalia	6	-	-	-	-
Procyon lotor	3(1)	-	-	-	-
Ondatra zibethica	1(1)	-	-	-	-
Sciurus sp.	1(1)	-	-	-	-
(North Side of Shell Pit)					
Odocoileus virginianus	4(1)	-	-	-	-
c.f. *O. virginianus*	4	-	-	-	-
Unidentified Large-Size Mammalia	16	-	-	-	-
Didelphis marsupialis	3(1)	-	-	-	-

Table 2.1 continued.

	Plot Level				
Species	1	2	3	4	5
Feature 41 (continued)					
Unidentified Medium-Size Mammalia	2	-	-	-	-
Class Aves					
Meleagris gallopavo	4(1)	1(1)	1(1)	-	-
Unidentified Aves	-	3	5	-	-
(North Side of Shell Pit)					
Meleagris gallopavo	2(1)	-	-	-	-
Colinus virginianus	1(1)	-	-	-	-
Unidentified Aves	5	-	-	-	-
Class Reptilia, Order Testudines					
Chelydra serpentina	7(1)	1(1)	4(1)	-	-
Pseudemys sp.	3(1)	-	-	-	-
Unidentified Testudines	52	24	61	-	-
Class Reptilia, Order Squamata, Suborder Serpentes					
Agkistrodon piscivorus	-	1(1)	-	-	-
Unidentified Viperidae	6	-	-	-	-
Unidentified Colubridae	18	-	-	-	-
Unidentified Squamata	1	5	2	-	-
(Fired Clay Area B)					
Terrapene carolina	1(1)	-	-	-	-
Unidentified Testudines	12	-	-	-	-
Nerodia sp.	3(1)	-	-	-	-
(North Side of Shell Pit)					
Chelydra serpentina	4(1)	-	-	-	-
Unidentified Testudines	4	-	-	-	-
(South Side of Shell Pit)					
Chelydra serpentina	6(1)	-	-	-	-
Unidentified Testudines	14	-	-	-	-
Class Amphibia					
Rana catesbeiana	1(1)	-	-	-	-
Class Osteichthyes, Superorder Chondrostei					
Acipenser sp.	2(1)	4(1)	-	-	-
Class Osteichthyes, Superorder Holostei					
Amia calva	15(1)	20(3)	15(1)	-	-
Lepisosteus sp.	22(1)	15(1)	13(1)	1(1)	-
Unidentified Holostei	3	-	-	-	-
Class Osteichthyes, Superorder Teleostei					
Ictaluridae					
Amieurus natalis	2(1)	10(6)	3(2)	-	-
Amieurus catus	2(1)	2(2)	4(1)	-	-
Amieurus nebulosus	-	-	4(2)	-	-
Unidentified Ictaluridae	19	16	41	1	-
Moronidae					
Morone saxatilis	1(1)	-	-	-	-
Morone americanus	1(1)	1(1)	2(1)	-	-
Unidentified Moronidae	7	5	-	-	-
Unidentified Centrarchidae	2	-	-	-	-
Unidentified Esocidae	2	2	2	-	-
Unidentified Clupeidae	27	21	63	-	-

Table 2.1 continued.

Species	Plot Level 1	2	3	4	5
Feature 41 (continued)					
Percidae					
Perca flavescens	-	4(1)	-	-	-
Unidentified Cyprinidae	-	-	1	-	-
Anguillidae					
Anguilla rostrata	-	4(2)	1(1)	-	-
Unidentified Teleostei	-	-	900	-	-
Unidentified Osteichthyes	596	1100	-	13	-
(Fired Clay Area A)					
Amieurus natalis	1(1)	-	-	-	-
Unidentified Osteichthyes	1	-	-	-	-
(Fired Clay Area B)					
Amia calva	2(1)	-	-	-	-
Lepisosteus sp.	1(1)	-	-	-	-
Esox sp.	4(1)	-	-	-	-
Perca flavescens	2(1)	-	-	-	-
Unidentified Osteichthyes	12	-	-	-	-
(North Side of Shell Pit)					
Amia calva	28(3)	-	-	-	-
Lepisosteus sp.	14(1)	-	-	-	-
Unidentified Holostei	5	-	-	-	-
Amieurus catus	2(1)	-	-	-	-
Unidentified Ictaluridae	6	-	-	-	-
Micropterus salmoides	2(1)	-	-	-	-
Unidentified Teleostei	28	-	-	-	-
(South Side of Shell Pit)					
Amia calva	2(1)	-	-	-	-
Anguilla rostrata	1(1)	-	-	-	-
Morone saxatilis	1(1)	-	-	-	-
Unidentified Osteichthyes	14	-	-	-	-
Unclassified Vertebrate Fragments	730	300	200	-	-
(Fired Clay Area A)					
Unclassified Vertebrate Fragments	4	-	-	-	-
(North Side of Shell Pit)					
Unclassified Vertebrate Fragments	110	-	-	-	-
Phylum Mollusca, Class Pelecypoda					
Elliptio complanata	100+	-	-	-	-
Feature 43					
Phylum Chordata, Subphylum Vertebrata					
Class Mammalia (Large Size)					
Odocoileus virginianus	5(1)	3(1)	4(1)	-	-
c.f. *O. virginianus*	-	2	4	-	-
Unidentified Large-Size Mammalia	10	11	26	-	-
Class Mammalia (Medium Size)					
Procyon lotor	1(1)	-	-	-	-
Didelphis marsupialis	1(1)	-	1(1)	-	-
Castor canadensis	-	-	1(1)	-	-
Sciurus carolinensis	4(1)	4(1)	2(1)	-	-

Table 2.1 continued.

Species	Plot Level 1	2	3	4	5
Feature 43 (continued)					
Unidentified Medium-Size Mammalia	-	1	5	-	-
Class Aves					
Unidentified Aves	8	-	-	-	-
Class Reptilia, Order Testudines					
Terrapene carolina	1(1)	1(1)	-	-	-
Chelydra serpentina	-	3(1)	-	-	-
Unidentified Testudines	-	4	7	-	-
Class Reptilia, Order Squamata					
Unidentified Squamata	-	-	1	-	-
Class Osteichthyes, Superorder Holostei					
Amia calva	15(2)	5(1)	8(2)	-	-
Lepisosteus sp.	12(1)	47(3)	12(1)	-	-
Unidentified Holostei	-	14	3	-	-
Class Osteichthyes, Superorder Teleostei					
Ictaluridae					
Amieurus catus	5(1)	5(2)	-	-	-
Amieurus natalis	-	-	4(1)	-	-
Amieurus nebulosus	-	-	2(1)	-	-
Unidentified Ictaluridae	3	-	2	-	-
Moronidae					
Morone saxatilis	10(1)	3(1)	2(1)	-	-
Morone americanus	2(1)	2(1)	-	-	-
Sciaenidae					
Micropogonias undulatus	-	-	1(1)	-	-
Unidentified Teleostei	30	53	22	-	-
Unclassified Vertebrate Fragments	-	10	29	-	-
Phylum Mollusca, Class Pelecypoda					
Elliptio complanata	100+	-	100+	-	-
Ligumia nasuta	2(1)	-	-	-	-

Total Fragments = 16,779

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[1] Listed as NISP, with MNI in parentheses where appropriate. References for taxonomy are as follows: mammals (Burt and Grossenheider 1976), birds (Peterson 1980), reptiles and amphibians (Redmond, Echternacht, and Scott 1990), and fish (Etnier and Starnes 1994; Robins, Ray, and Douglass 1986).

Table 2.2. Common Names of Taxa Identified from the Jordan's Landing Site.

Species	Common name
Mammals	
Odocoileus virginianus	white-tailed deer
Ursus americanus	black bear
Canis cf. lupus	gray wolf
Castor canadensis	beaver
Procyon lotor	raccoon
Didelphis marsupialis	opossum
Urocyon cinereoargenteus	gray fox
Lynx rufus	bobcat
Ondatra zibethica	muskrat
Sylvilagus floridanus	eastern cottontail
Sciurus carolinensis	gray squirrel
Sciurus niger	fox squirrel
Mephitis mephitis	striped skunk
Birds	
Meleagris gallopavo	turkey
Colinus virginianus	bobwhite quail
Reptiles	
Chelydra serpentina	snapper
Terrapene carolina	eastern box turtle
Pseudemys sp.	slider
Elaphe guttata	garter snake
Nerodia sp.	water snake
Agkistrodon piscivorus	cottonmouth
Amphibians	
Rana catesbeiana	bullfrog
Fish	
Acipenser sp.	sturgeon
Amia calva	bowfin
Lepisosteus sp.	gar
Amiurus catus	white catfish
Amiurus natalis	yellow bullhead
Amiurus nebulosus	brown bullhead
Morone americanus	white perch
Morone saxatilis	striped bass
Esox sp.	pickerel
Perca flavescens	yellow perch
Lepomis sp.	sunfish
Micropterus salmoides	largemouth bass
Moxostoma sp.	redhorse
Anguilla rostrata	American eel
Micropogonias undulatus	Atlantic croaker
Clupeidae	Herring family
Freshwater Mussels	
Elliptio complanata	eastern elliptio
Ligumia nasuta	eastern pondmussel

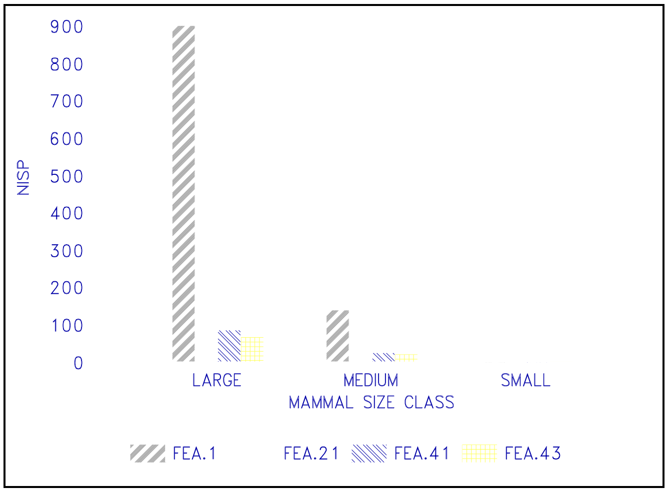


Figure 2.1. Relative abundances of the mammal size classes in the four features. (See text for definitions of size classes.)

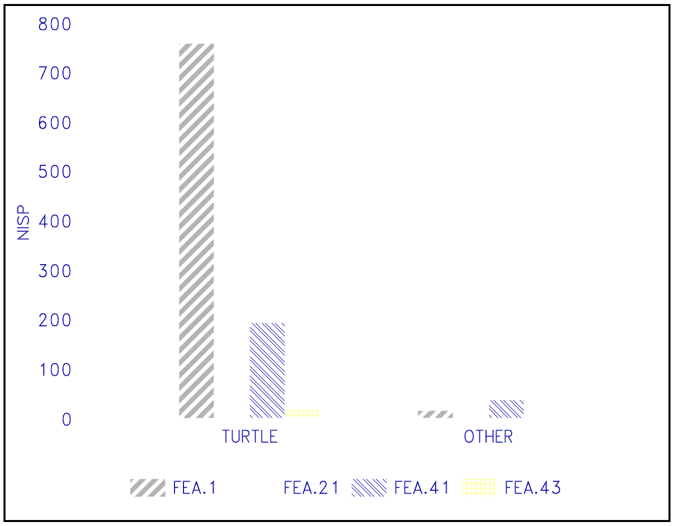


Figure 2.2. Relative abundance of turtles in comparison with other reptile taxa.

Summary of Faunal Compositions of the Four Features

The data reported in Table 2.1 reveal some general patterning among the four features. All four features lack small mammal remains and contain more large mammal bone fragments than medium (Figure 2.1). The Feature 1 sample exhibits this pattern more strikingly than the small pits. Reptile remains consist mainly of turtle, though Feature 43 contains very few reptile bone fragments (Figure 2.2). Birds are poorly represented in all of the features and, where found, consist primarily of turkey (Figure 2.3).

The greatest variation between the features is seen in the fish species compositions (Figure 2.4). Gar and bowfin (members of superorder Holostei) are strongly represented in all four features. Features 21 and 41 are dominated by the remains of bony fish (members of the superorder Teleostei), most of which could not be identified at the species level. Of

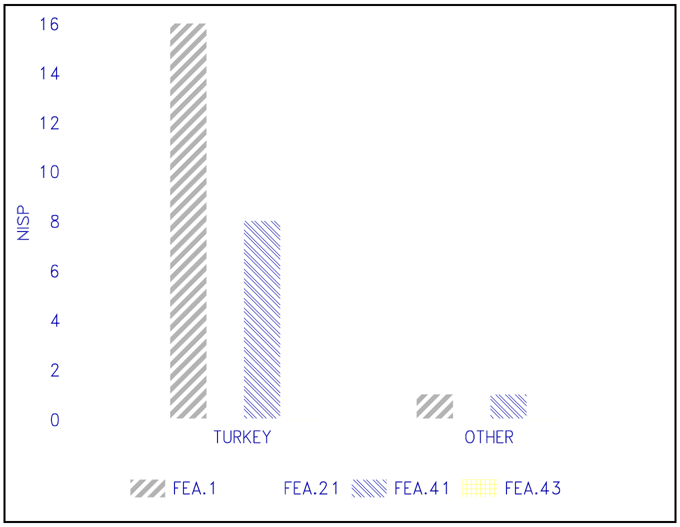


Figure 2.3. Relative abundance of turkey in comparison with all other bird taxa.

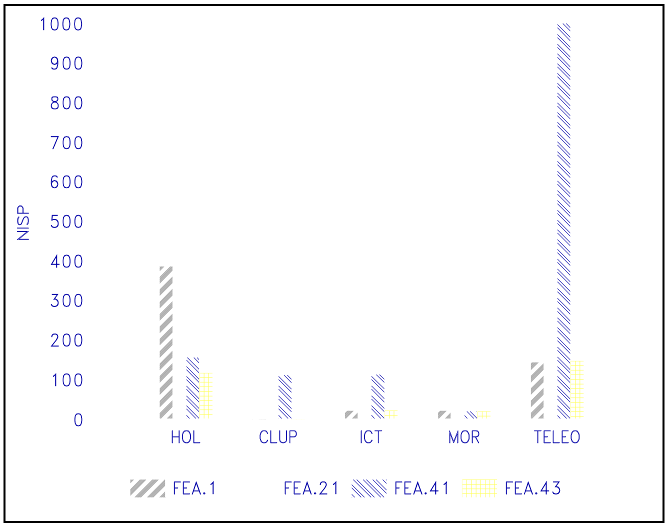


Figure 2.4. Relative abundances of selected fish taxa (HOL= fish of superorder Holostei, CLUP=fish of family Clupeidae, ICT=fish of family Ictaluridae, MOR=fish of family Moronidae, TELEO=fish of superorder Teleostei).

those that were identifiable, many were bullheads (members of the family Ictaluridae) and herring (members of the family Clupeidae). Feature 21 also contained an appreciable number of striped bass and white perch (members of the family Moronidae) bone fragments.

Freshwater mussels were recovered from all four features, and were present in great concentrations in Feature 21, Feature 41, and Feature 43. Identified shell fragments consist mainly of the eastern elliptio. However, one complete shell of the eastern pondmussel was recovered. This species presently has a distribution that reaches no further south than the James River in Virginia (Johnson 1970).

Chapter 3

TAPHONOMIC ANALYSIS OF THE JORDAN'S LANDING ASSEMBLAGES

Analysts of archaeological bone assemblages are typically faced with situations in which interpretations must be made that depend upon the presence or absence of bones and bone parts. Representation of particular species might suggest preferences on the part of the human inhabitants of a site, while the persistent absence of certain elements from an animal might indicate patterns of treatment of the carcass. However, interpretations based on such information must proceed with caution, as archaeological and fossil bone assemblages are generally subjected to a variety of offences from the time the animal is killed until its remains are recovered (Brain 1976, 1981; Binford 1981; Gifford 1981). Such destructive treatments as gnawing by carnivores, weathering, and chemical attrition can radically alter the relative frequencies of bones and bone parts (Behrensmeyer 1975, 1984; Binford 1977, 1981; Brain 1976, 1981; Gifford 1981).

The study of processes affecting fossil bones and other organic remains before they are recovered has been called "taphonomy" by the paleontologist I. A. Efremov (1940). Efremov (1940) defines taphonomy as "the study of the transition (in all its details) of animal remains from the biosphere into the lithosphere, i.e. the study of a process in the upshot of which organisms pass out of the different parts of the biosphere and, being fossilized, become part of the lithosphere." Taphonomic research utilizes modern, or actualistic experiments (cf. Brain 1976; Binford 1977; Klippel, Snyder, and Parmalee 1987), and thus intends to discover processes that are at work in the contemporary world. Applications of such studies are with sets of remains that often exhibit great depth of time (Gifford 1981). Such applications to fossil or archaeological materials require uniformitarian assumptions (Gifford 1981).

Klein and Cruz-Uribe (1984) have questioned the validity of inferring past phenomena using information obtained in the present, pointing out that in modern studies the observer may affect the results, as when one's presence causes bone-collecting carnivores to alter their habits or when studies are conducted in settings that differ from those in which fossil assemblages accumulated. They add that modern studies can never reproduce the longevity that characterizes the fossil record. Most researchers using taphonomic data do not assume that conditions in the past were exactly as they were in whatever modern experiments were conducted. Rather, they seek to discover possible explanations for patterns observed in fossil remains by employing information gained through modern studies such as the differential ability of various bone parts to survive chewing, which has much to do with the inherent physical qualities of bones (Brain 1976; Binford 1977; Klippel, Snyder, amd Parmalee 1987). While Klein and Cruz-Uribe's points should be given careful consideration, it is reasonable to assume that there are processes to be discovered that are relevant regardless of temporal span.

Advances in taphonomic research have shown clearly the dramatic effects that taphonomic agents can have on bone assemblages. Analyses to identify these agents and their effects must necessarily become a standard part of the zooarchaeological research process though this has yet to happen in American archaeology. The stakes are high: neither qualitative data (presence or absence of taxa) nor quantitative data can be interpreted as representative of human activities in a site without due consideration of the factors that could have selectively removed shells, exoskeletons, bones, or bone parts from the assemblage. The role of taphonomic analysis in this study is to examine biases that exist in the data from the four features in the hope of preventing erroneous inferences concerning the behavior of the former inhabitants of the village. Such analyses could also be beneficial in providing information concerning village life not directly relating to human behavior. The approach taken is to identify the potential sources of bias in the assemblages and then to use results from actualistic studies to test hypotheses concerning those sources and their effects on the assemblages.

Taphonomic Agents and Their Effects in the Cashie Phase Bone Assemblages

Every fragment in each of the assemblages from the respective features was analyzed for evidence of possible agents of attrition. Examples of such evidence are cutmarks and percussion scars from human processing (Johnson 1985), dark discoloration from exposure to extreme heat (Shipman et al. 1984), and scoring and pitting from the teeth of canids (Binford 1981).

There is considerable variation in the present condition of the bone fragments both among the four features and within each of them. A continuum from whole and relatively undamaged elements to highly fragmented, burned, and eroded pieces is observed. Such variety suggests that numerous processes have affected on the assemblages and that perhaps some of these processes have not been consistent through time.

It is clear that the human occupants who introduced animals into the village altered the condition of the animals' skeletal elements. Most of the bones are broken into fragments. Cutmarks were found on many fragments (see Table 3.1). At least some of the bones were subjected to extreme heat, as evidenced by the discoloration associated with burning (see Shipman et al. 1984). Identifying the damage caused by human treatment of carcasses alone is difficult since there is no information outlining prehistoric Tuscarora butchery practices to date. Before data from the assemblages examined here can be used in making inferences concerning such butchery practices, the various nonhuman agents that have altered the assemblages must be identified and their effects isolated.

Canid Attrition of Large Mammal Remains

Canids as agents of attrition on bone have received an appreciable amount of attention from researchers in taphonomy (cf. Brain 1976; Binford and Bertram 1977; Klippel, Snyder, and Parmalee 1987). Wolves, which commonly accumulate bone debris in den areas, are known to produce a fairly consistent pattern of damage to ungulate skeletons (Binford 1977, 1981; Klippel, Snyder, and Parmalee 1987). The domestic dog has also been studied (cf. Brain 1976; Binford and Bertram 1977; Morey and Klippel 1991; Byrd n.d.) and determined to exhibit similar behavior to that of wolves regarding ungulate bones. There are some notable exceptions, however, which will be discussed below.

The domestic dog was common on the prehistoric North American landscape (Haag 1948; Olsen 1985) and dates back to at least 8500 B.C. on this continent (Olsen 1985). The presence of dogs at the Jordan's Landing site during the Cashie phase is suggested by gnaw marks observed on bone fragments (see Table 3.1) and is further indicated by dog burials

Table 3.1. Percentage of Bone Fragments Showing Evidence of Taphonomic Agents.

Class	Cutmarks	Burning	Canid Gnawing	Rodent Gnawing
Feature 1				
Mammalia	0.3	9.0	2.4	1.3
Reptilia/Amphibia	0	7.6	0	0
Osteichthyes	0	0.78	0	0
Aves	0	6.3	0	0
Unidentified	0	3.6	0	0
Feature 41				
Mammalia	0.72	2.0	1.0	0.72
Reptilia/Amphibia	0	0.88	0	0
Osteichthyes	0	0	0	0
Aves	0	0	0	0
Unidentified	0	1.0	0	0
Feature 43				
Mammalia	1.1	12.8	1.1	2.3
Reptilia/Amphibia	0	0	0	0
Osteichthyes	0	0.76	0	0
Aves	0	0	0	0
Unidentified	0	5.0	0	0
Feature 21				
Mammalia	0	24.0	1.2	0.40
Reptilia/Amphibia	0	25.5	0	0
Osteichthyes	0	1.8	0	0
Aves	0	13.0	0	0
Unidentified	0	8.3	0	0

that date to the Cashie phase. Wolves are also represented at the site as evidenced by the presence of a single radius that was in association with food remains and other debris (see Table 2.1). It is possible that wolves were scavenging discarded bones around the village. However, unless the village was abandoned at times, it is unlikely that wolves have had a significant impact on the faunal assemblages. The next step is to evaluate what effect canids have had on the assemblages.

An inspection of Table 3.2 reveals some patterns in the survivorship of certain ungulate bone parts in the experimental studies and in Feature 1. The data reported by Brain (1976) are goat bone parts collected from a Hottentot village where humans were smashing, cooking, and chewing the bones before throwing them to their dogs, which then subjected the already fragmented elements to further abuse. Because these goat skeletons were subjected to human attritional processes before being given to the dogs, Brain's data cannot be considered a "pure" representation of what dogs will do to ungulate bones.

Klippel, Snyder, and Parmalee (1987) report results from a controlled feeding study involving whole white-tailed deer carcasses and captive gray wolves. In this case, the canids were contained in an enclosure where their activities could be monitored and no

Table 3.2. Percentage Ungulate Bone Part Frequencies from Experimental Studies[1] and the Four Features from the Jordan's Landing Site.

Bone Part	Klippel, Snyder, and Parmalee	Brain	Byrd	Features			
				1	41	43	21
cranium	25.0	-	100.0	37.5	50.0	00.0	0
mandible	100.0	91.4	100.0	25.0	0	0	0
atlas	50.0	18.8	-	25.0	0	0	0
axis	25.0	21.9	-	37.5	0	0	50.0
cervical vertebra	15.0	3.8	-	7.5	0	20.0	0
thoracic vertebra	3.8	2.5	-	10.6	0	0	3.8
lumbar vertebra	29.2	8.1	-	12.5	0	0	0
innominate	87.5	26.6	100.0	50.0	0	50.0	0
ribs	1.0	0.2	-	2.0	2.0	0	2.0
scapula[2]	50.0	27.4	28.6	50.0	25.0	0	50.0
P. humerus	25.0	0	0	6.3	0	0	0
D. humerus	87.5	64.0	42.9	62.5	0	0	0
P. radius/ulna	75.0	50.8	14.3	68.8	0	0	0
D. radius/ulna	0	17.2	42.9	18.8	0	0	25.0
carpals	4.2	-	-	8.3	16.7	0	0
P. metacarpal	75.0	25.0	28.6	68.8	25.0	0	0
D. metacarpal[3]	0	18.0	0	43.8	0	0	25.0
P. femur	25.0	14.1	16.6	6.3	0	0	25.0
D. femur	37.5	7.0	33.3	12.5	0	0	25.0
P. tibia	12.5	10.1	28.6	12.5	0	50.0	0
D. tibia	50.0	56.3	28.6	75.0	0	50.0	0
tarsals	450	-	-	30.0	0	20.0	25.0
P. metatarsal	87.5	30.4	85.7	87.5	0	50.0	50.0
D. metatarsal	12.5	15.6	28.6	43.8	0	0	25.0
phalanges	1.0	2.7	40.0	25.5	6.3	16.7	20.8
MNI	4	64	4	8	2	1	2

[1] Data obtained from: Klippel, Snyder, and Parmalee (1987); Brain (1976); and Byrd (n.d.).

[2] Scapulae represented in Features by articular ends only.

[3] Distal metapodials that could not be designated as metacarpal or metatarsal were tallied and equally divided between the two respective categories.

other animals could interfere with the experiment. The resulting data are as close to a pure representation of what wolves will do to ungulate bones as is available to date.

Another controlled feeding study was conducted by Byrd (n.d.) with white-tailed deer carcasses and domestic dogs. One complete deer (#1) skeleton (live weight 66kg) was partially defleshed and offered to three Labrador retrievers, each weighing between 25 and 30 kg, for three days. A second deer (#2) (live weight 38kg) was quartered, defleshed, and the head and limbs given to the same three dogs. A third deer (#3) (live weight 40kg) was defleshed and the left front limb given to one dog and the left rear limb given to another. The fourth experiment involved the two dogs described above with deer #3 and a white-tailed deer (#4: live weight 39kg). The deer was defleshed, quartered, and the left front limb along with the right rear limb were boiled for a period of 50 minutes. The two raw limbs were fed to the two dogs separately, the dogs being in different enclosures. Next, the cooked limbs were offered to the dogs (again the dogs were separated). All of the above feeding sessions were controlled. The dogs were in enclosures that were cleaned before experimentation to prevent any debris from covering bone fragments. None of the deer skeletons were left with the dogs for more than three days. All of the domestic dogs used were wellfed with normal rations of dog food during the experiments. The first two deer, which were offered in a larger quantity, would have been further reduced if left with the dogs for a longer period. The last two deer were fed to separate dogs piecemeal, and in each of these feedings the dogs seem to have lost interest in the bones after about 24 hours.

Some notable observations made during the experiments were that the degree of damage done to the deer bones was directly related to the amount of time the dogs were given access to the bones and inversely related to the amount of skeletal material offered to them during a feeding. It was noted that there was no bone part in a deer skeleton that a medium-sized dog cannot destroy. When a single limb was fed to a dog, there typically was little left other than small fragments and splinters. In the cases where all four limbs were offered at once (as in the first two experiments), the dogs exhibited preferences for certain parts over others. For example, the proximal humerus, distal radius/ulna, scapula, proximal femur, distal metapodials, and the innominates were attacked immediately. The carcasses were taken away before further selections of parts could be made. It appears that the dogs prefer most of the bone parts that many researchers (Brain 1976, 1981; Binford and Bertram 1977; Binford 1981; Lyman 1984) have suggested are less durable and others have suggested have the highest utility (Binford and Bertram 1978; Metcalfe and Jones 1988). Thus, canids alone will often produce a negative utility curve for the survivorship percentage of ungulate bones plotted on their utility values (see Lyman 1985; 1994:258–281) if given access to ungulate bones for a sufficient period of time.

Canid preferences for certain bone parts are related to both ease of crushing and to differential nutrient values of the various bone parts and their associated tissues. The fact that such preferences exist lends support for the supposition that a canid pattern of ungulate bone destruction can be identified (Binford 1981; Morey and Klippel 1991), but the variability that domestic dogs exhibit in their behavior must be appreciated. For example, the ungulate distal humerus has been touted by many as resistent to destruction or even unchewable (Brain 1976). While it does not seem to be a first choice of bone parts to gnaw on, if other bones are absent then it will likely be destroyed. A distal humerus left from the 68kg deer mentioned above was offered to one of the dogs (25kg) approximately two years after the original experiment. The dog promptly began to gnaw the bone part even though it was hard, dried, and had seemingly no nutritive value. Binford (with Bertram 1977:132) has stated that "only hungry dogs really destroy bones." This clearly is not the case. Morey and Klippel (1991) report similar observations from controlled feeding experiments with a large (32kg) mixed breed dog named Kumba. Various white-tailed deer limb bones were offered to Kumba in quantities varying from whole limbs to single elements. Kumba's destruction of the bones was extreme, mirroring the results reported above when only single limbs were offered to a single dog. In regards to the degree of destruction, Morey and Klippel (1991:17) state, "[This] underscores the importance of feeding intensity in determining what degree of destruction will be inflicted by a canid. Kumba apparently can destroy any deer long bone she wants to. We suspect that any large, healthy canid can do the same."

If bone part frequencies recorded from the wolf pen experiments reported in Klippel, Snyder, and Parmalee (1987) can be considered a typical canid pattern of attrition (Morey and Klippel 1991), then the data from the experiments reported above involving the feeding of complete or nearly complete skeletons (first and second deer) to three dogs are nearly in line with the canid pattern. Similarities in survivorship between the two studies involve eight deer bone elements as follows: mandible high, proximal humerus low, distal humerus high, proximal radius/ulna high, distal radius/ulna low, proximal metapodials high, distal metapodials low, both ends of femur low, proximal tibia low, distal tibia high, and phalanges low (Figure 3.1a). The data presented in Table 3.2 and Figure 3.1a include results from all of Byrd's experiments combined into one data set, creating a picture that is a distortion of the typical canid pattern. This distortion is the result of the widely varying conditions imposed in the experiments that led to varying feeding intensities.

The assemblage analyzed for canid modification of ungulate bones at the Jordan's Landing site is Feature 1, the ditch that bounds the north and west sides of the village perimeter. Its role as a trash dump is plainly evidenced by the large quantity of materials contained in it. White-tailed deer bone fragments constitute the greatest proportion of animal remains. Varying degrees of weathering on the deer bone fragments indicate that some were exposed to the elements more than others. Such variable conditions are expected given that the materials that ended up in the ditch came from a variety of sources (floor sweepings from houses, leftovers from meals, bones that dogs dropped throughout the village, etc.). Table 3.1 lists the percentages of all bone fragments in Feature 1 that show evidence of gnawing. The figure of 2.4 percent for Mammalia (5.0 percent for white-tailed deer) appears low in comparison to the greater than 90 percent found in the wolf pen study (Lynn Snyder, personal communication); however, this low figure results from the bones having been subjected to smashing by humans before the dogs were given access (see Morey and Klippel 1991). This treatment creates more fragments to include in the calculation of percentages and a smaller proportion of bone parts that would interest a dog.

The ungulate bone part frequencies in Feature 1 are listed in Table 3.2 and shown in Figure 3.1b. Some consistencies in survivorship between Feature 1 deer bone parts, those reported by Klippel, Snyder, and Parmalee (1987), and the goat bone parts in Brain (1976) are exhibited in the axis, scapula, distal humerus, proximal radius/ulna, and proximal tibia. Close associations between the Klippel, Snyder, and Parmalee data and that in Feature 1 but not in Brain are seen in the cranium, ribs, carpals, proximal metacarpal, tarsals, and proximal metatarsal, while those between Brain and Feature 1 but not Klippel, Snyder, and Parmalee are evidenced in the atlas and distal radius/ulna (see Figure 3.1). The data from Byrd (n.d.) deviate more strongly from Feature 1 than those reported by Brain and Klippel, Snyder, and Parmalee. The most likely explanation for this phenomenon is that the dogs living in the village often had access to more than just the limbs of the animal, as was the case in the wolf pen and Hottentot village studies.

The strength of the relationships between data sets included in the comparisons above can be evaluated statistically (see Morey and Klippel 1991; Lyman 1994). Spearman's correlation coefficient was calculated for the Feature 1 and Klippel, Snyder, and Parmalee data and found to be significant (r_s=0.56 p=0.003). There is also a strong, positive relationship between the deer bone part survivorship in the Jordan's Landing ditch and the goat bone part survivorship in Brain's Hottentot village (r_s=0.77 p=0.000). The Feature 1 data correlate significantly with Lyman's (1985:227) bulk density data (r_s=0.51 p=0.02), but, interestingly, the wolf pen data do not (r_s=0.22 p=0.32). Morey and Klippel (1991:15) report a similar lack of correlation between Brain's density data and the wolf pen data. The lack of a significant correlation between the bulk density values and Klippel, Snyder, and

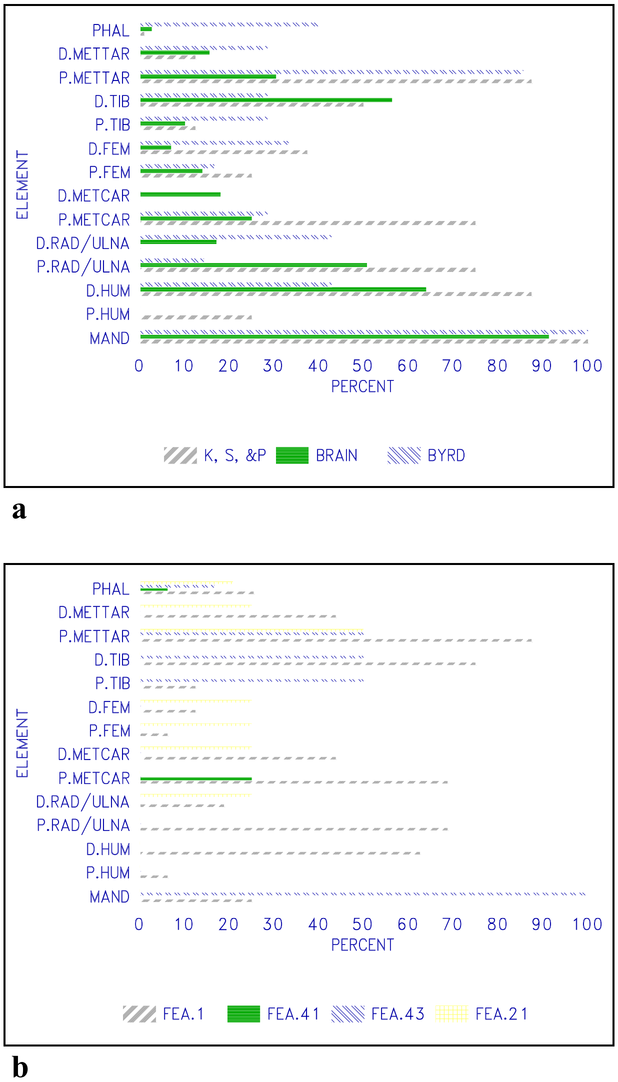


Figure 3.1. White-tailed deer bone part frequencies given as percentage of what was originally present before canid ravaging in experimental studies (a) and in the feature assemblages (b).

Parmalee's deer bone part survivorship values results from problems with bulk density as a measure of bone part robusticity (see below), relatively light feeding intensity (see Morey and Klippel 1991 and discussion above) on the part of the wolves in the experiment, and the fact that canid feeding behavior is not neatly dictated by the bulk densities of bone parts. Problems with bulk density as a measure of a bone part's inherent robusticity are discussed in detail below. The light feeding intensity interpretation implicitly assumes (quite reasonably, since the researchers did not starve the animals) that the wolves involved in the study were well fed. If the wolves were nutritionally stressed, it is expected that the deer skeletons would have suffered greater attrition and, consequently, more of the bone parts with low bulk density values would have been ravaged. The most important observation made here is that canids do not target only the bone parts with the lowest bulk density values in their attempts to systematically disarticulate a carcass, but immediately begin to crunch and swallow elements such as ribs that block the way to the most desirable soft parts. Note that artiodactyl ribs have a relatively high mean bulk density value of 0.40 (Lyman 1985:227)—roughly equal to that of the distal humerus—but only 1% of the ribs survived in the wolf pen (Klippel, Snyder, and Parmalee 1987:158). Similarly, the artiodactyl distal radius and distal ulna have a mean bulk density value of approximately 0.43, but none survived in the wolf pen experiment (Klippel, Snyder, and Parmalee 1987:158). It is clear that there is a canid pattern of attrition that is not entirely mediated by bone part densities.

There is no reason to attribute the bone part frequencies in Feature 1 that fit the canid pattern to any cause other than canid attrition, but alternative interpretations can be explored. Bone part frequencies are often used by zooarchaeologists along with utility indices (Binford 1978, 1981; Speth 1983; Metcalfe and Jones 1988; Lyman 1985, 1994) in the interpretation of site function. It is common to plot the survivorship percentage for bone parts (or %MAU, see Lyman 1985, 1994) against utility index values and then examine the shape of the point distribution. Site assemblages containing only high utility bone parts indicate that the site's occupants followed what some researchers have called a "gourmet strategy" or a "bulk strategy" (see Lyman 1994:228–229). The gourmet strategy is characterized by a point distribution that begins in the lower left of the bivariate plot and curves upward to the upper right (concave with respect to the left vertical axis) (see Lyman 1994:228). The bulk strategy point distribution also begins in the lower left, but quickly rises to the upper right and eventually rolls over near the top of the plot (convex with respect to the left margin) (see Lyman 1994:228). These patterns are generally taken as evidence that some degree of selectivity on the part of the human occupants of a site has led to only high utility (nutrient rich) body parts being deposited in the site. The reverse of these patterns is interpreted as evidence of the abandonment of the low utility body parts in the site. Sites where animals were butchered should in many instances exhibit the reverse curves.

The survivorship percentage of deer bone parts in Feature 1 is shown in Figure 3.2 plotted against the bone part food utility index (FUI) values (Figure 3.2a) and complete bone FUI values (Figure 3.2b) for caribou reported in Metcalfe and Jones (1988). Spearman's correlation coefficients were calculated for both (bone parts, r_s=—0.40 p=0.05; complete bones, r_s=—0.15 p=0.57). While the correlation analysis is unimpressive, both figures appear visually to exhibit the reverse bulk strategies in having point distributions that begin in the upper left and swing down into the lower right. These patterns suggest that the inhabitants of the village either introduced mostly low utility deer bone parts into the village or only discarded low utility bone parts in the ditch. However, an alternative interpretation is more plausible. It was noted above that domestic dogs prefer to gnaw the bone parts that have the highest utility values and that canid attrition can produce a negative utility curve. To illustrate this point, the data reported from the wolf pen study in Klippel, Snyder, and Parmalee (1987) were plotted against the caribou FUI values in Figure 3.2. Spearman's correlation coefficients were calculated for both comparisons (bone parts, r_s=0.05 p=0.82; complete bones, r_s=—0.17 p=0.53). The appearance of a reverse utility curve is obtained once again, but this time for deer bones and bone parts that were offered to wolves as complete carcasses. Lyman's (1985:231) assertion that only visually inspecting utility curves can lead to spurious conclusions is borne out here. Further, it is clear that differential preservation can produce bone part frequency patterns matching those sometimes attributed to human behavior (see Lyman 1985 for discussion). There is no

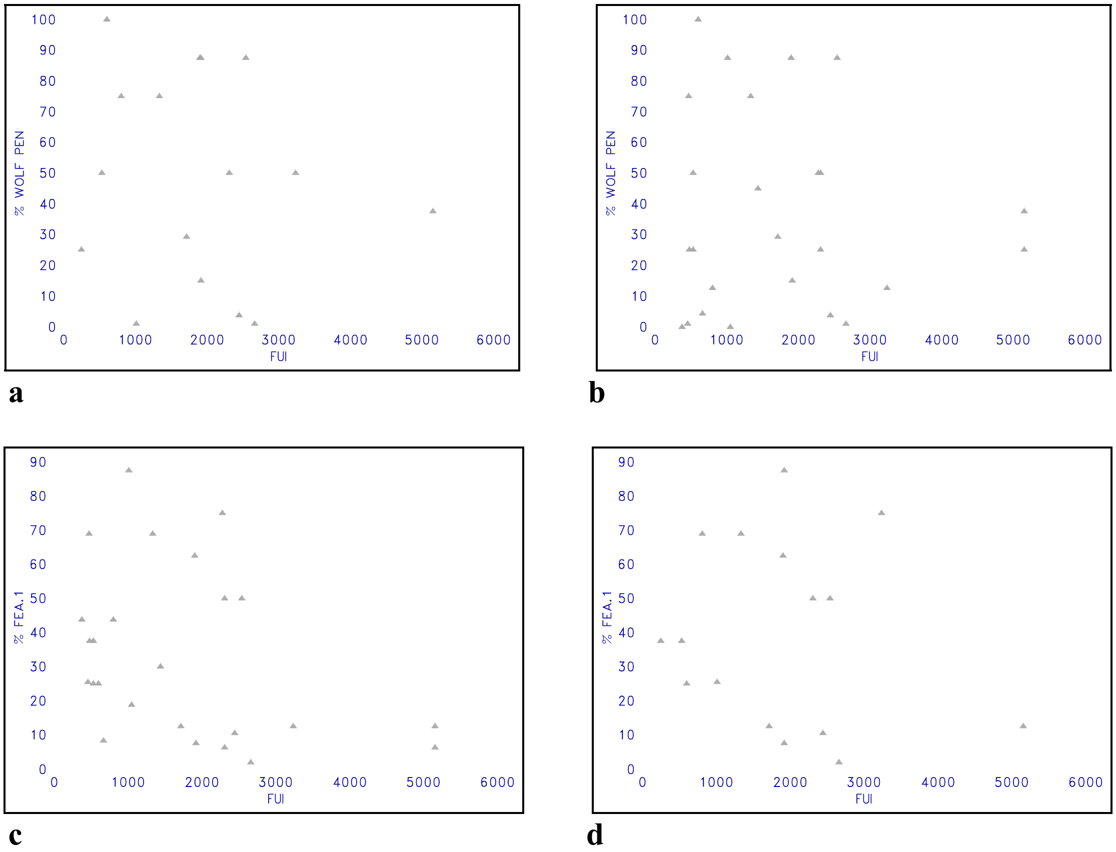


Figure 3.2. White-tailed deer utility curves for bone parts (a) and complete bones (b) from Feature 1 and bone parts (c) and complete bones (d) from the wolf pen study (see text for explanations).

reason to propose any selective transport or disposal of deer bone parts by the human inhabitants of the Jordan's Landing village.

The "open air" nature of Feature 1 granted dogs, weather, and other taphonomic agents prolonged access to the materials thrown into the ditch. Consequently, certain ungulate bone parts are underrepresented in the Feature 1 assemblage. As stated previously, there is no reason to interpret any missing deer bone parts as evidence of cultural selectivity in preparation or disposal of the carcass. A more dramatic effect that taphonomic agents have had on the assemblage is the selective removal of certain taxa whose bones are less durable than those of large mammals. The bones of small mammals and fish are often completely destroyed by taphonomic agents (see below) leading not only to distorted patterning in quantitative analyses but also to important omissions in taxonomic listings for assemblages. The fact that this sample was not fine-screened has undoubtedly contributed to the bias against smaller taxa (see below). Feature 1 contrasts with the other features (see Figure 3.2) in having a majority of bone fragments belonging to white-tailed deer. This pattern reflects in part the fact that the ditch was open for an extended period of time and consequently subjected to greater taphonomic pressure. It is also likely, given the diversity of weathering stages observed on mammal bones, that materials deposited in Feature 1 spent some period of time on the surface in the village before eventually ending up in the ditch.

Taphonomic Processes and Small Mammals, Birds, Fish, and Mussels

Features 21, 41, and 43 all contain a great majority of fish bone compared with the other vertebrate classes, there being 82 percent fish (percentages calculated with NISP, proportional to all bone fragments identified at the class level) in Feature 21, 89 percent fish in Feature 41, and 70 percent fish in Feature 43 (see Figure 3.3). Freshwater mussels were also abundantly represented in these three features, but it was impossible to tabulate them in comparable numbers since the shell was largely reduced to rubble. Feature 1 contains 22 percent fish and 49 percent mammal of which at least 22 percent is white-tailed deer. The incidence of canid gnaw marks is lower in the latter three features than in Feature 1, a fact most likely attributable to the closed nature of Features 21, 41, and 43. It is likely that the contents of the small pits were deposited in single events after meals. This practice would effectively limit access by dogs once the pits were covered over. (The few gnawed bone fragments recovered from the pits are most likely incidental inclusions from the midden through which the pits were dug).

Payne and Munson (1986) have pointed out that smaller mammal skeletons (rabbit size or smaller) can be dramatically affected when consumed by dogs; indeed, small mammals are typically ingested in their entirety leaving evidence of the animal only in the feces. Jones (1986) suggests a similar effect for fish when consumed by man, pigs, or dogs. Nicholson (1992) has subjected the bones of a variety of small mammal, amphibian, and fish taxa to sedimentary abrasion and trampling and found that boiled bones are generally more prone to destruction than fresh and that fish bones are more fragile than mammal. The implications of their findings for the assemblages of concern here are that any medium-to-small mammals and fish that were consumed in their entirety by dogs (and people?) in the village would not be represented in the features unless the dogs defecated in the pits. Further, it is predicted that Feature 1 should contain proportionally fewer medium mammals, small mammals, and fish than the other three features, which were relatively inaccessible to dogs. This does not necessarily mean that the ditch originally contained the same proportion of the smaller animals as the other pits, but rather that Feature 1 is more strongly biased against there being representation of the number of individual small animals deposited there or in the village originally. Further bias against representation of smaller animals in the ditch results from the sampling procedures in the field, which included the use of 1/4-inch screens for the sample included in this study.

Another biological agent of attrition in the four assemblages is the rodent. Table 3.1 shows that all four features contain fragments that were gnawed by rodents. While rodents are not considered to have seriously damaged the bones on which their gnaw marks appear, the possibility that small bones were carried away should be considered.

Bone Density and Differential Survivorship of Fish Bones

Once the three pits that are now Features 21, 41, and 43 were covered in soil several hundred years ago canids as agents of attrition were effectively eliminated and the bone and shell fragments within the pits became part of the chemical environments within the features. The soil is generally acidic, which can have a corrosive effect on bone as well as shell. Indeed, most of the shell in these features is in a highly fragmented, often powdered state. Some valves, however, have persisted in excellent condition. These virtually

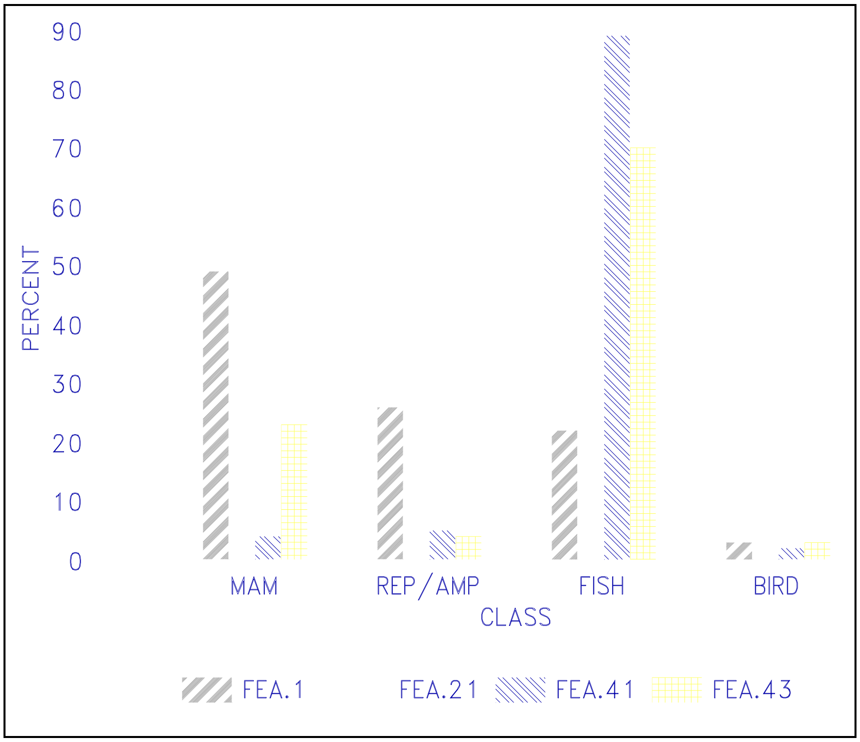


Figure 3.3. Relative abundances of the vertebrate classes as measured by percentage of total NISP.

unharmed valves were seated in locations approximately centered relative to the bulk of shell material and were consequently shielded from surrounding hostile chemical reactions. The condition of fish bone fragments is also variable and may be partly affected by their proximity to corroding shell. How many bones and of what taxa can we expect to have been destroyed in these features?

Expectations of which bone parts will survive in the archaeological record can be developed by measuring the inherent physical properties of the bone parts and identifying the characteristics that increase the likelihood that a given part will survive various abuses. There have been studies of various properties of bone alleged to be related to the differential survivorship seen in the fossil and archaeological records. Many researchers have cited a correlation between survivorship and bone density (Behrensmeyer 1975; Brain 1976; Binford and Bertram 1977; Lyman 1982, 1984, 1994) and some have tried to show a causal relationship between bone density and survivorship (Lyman 1982; 1984; 1994). It will be argued here that bone density does not, however, offer a satisfactory explanation for the ability of certain bones and bone parts to persist during processes of attrition when others do not. In the following section bone density models of differential survivorship will be examined and an alternative model proposed. It is hoped that such a model might clarify the taphonomic history of fish remains deposited in the features under study.

Bone Density Models and Bone Survivorship

Brain (1976) has noted that the proximal and distal ends of goat bones have drastically different capacities to resist crushing, as from the jaws of canids. The proximal

Figure 3.4. The humerus of a white-tailed deer split into halves revealing the bone structure within. The proximal end is at the top and the distal end is at the bottom of the pictures. Note the massiveness of the distal end.

humerus is wide, thin-walled, and spongy while the distal end is narrow and compact (see Figure 3.4). He states that such qualities can be quantified by measuring the specific gravity of each end. Brain describes his method for estimating specific gravity of the opposing ends of the humerus as first cutting the bone in half at a right angle to its axis, and weighing each end. The two ends are next dipped in plasticine to seal off the cavities and any other openings on the shafts and then submerged in water to measure the volume. Specific gravity is then calculated as the ratio of mass to volume (Brain 1976). Brain reports specific gravity estimates for the humerus, radius and ulna, femur, and tibia, all with proximal and distal ends separate and all apparently from a single goat. When the specific gravity estimates of these bone parts are matched against the data from the Hottentot village assemblage, a correlation is observed (Brain 1976).

Lyman (1982, 1984) has pointed out, however, that Brain's density measures are not a true specific gravity measure. The addition of the plasticine introduces error into the volume, a measurement that is certainly limited in its precision with or without the plasticine. The use of only one representative for each element precludes any understanding of individual variation in density for respective bone parts. Binford and Bertram (1977) estimated bone density for three sheep and a caribou. Their method is very similar to that described by Brain (1976), notable exceptions being that here paraffin was used in lieu of plasticine and for paired elements both were measured for each individual and average values reported. Binford and Bertram's methods are as imprecise as those of Brain.

Lyman (1982, 1984) reported results of an extensive study of the relationship between bone density and survivorship for ungulates, and included a review of previous attempts to measure the density of bones and bone parts. Lyman observes that Brain's density measures are actually a hybrid of true density, the density of the bone material minus any pore space, and bulk density, the density of the bone including pore space. Binford and Bertram's density estimates are an approximation of bulk density with the volume of the paraffin coating unaccounted for (Lyman 1982, 1984). Both Brain's and Binford and Bertram's density data show correlations with survivorship in the Hottentot village goat sample (Lyman 1982, 1984) and Lyman argues that any measure that approximates bulk density will suffice for predicting survivorship. The problem with techniques for measuring density such as those employed by Brain and Binford and Bertram is the difficulty in obtaining consistent, comparable measurements. Lyman's answer to this shortcoming is to measure bone density via photon absorptiometry. He asserts that the photondensitometer can provide consistent, well-defined measures of certain properties of bones. Lyman's measure that is comparable to bulk density is "VD", which, as predicted, shows significant correlations with survivorship in many cases (Lyman 1982, 1984).

The frequent attainment of significant correlations between bulk densities and survivorship suggests that there is a relationship between these two variables. However, the exact theoretical nature of this relationship proves to be elusive. Binford and Bertram (1977:112–113) have formulated an equation that models the destruction of bone as a function of time. They state that the rate of bone destruction is inversely proportional to density, directly proportional to the surface area-to-volume ratio, and directly proportional to the strength of the agent of attrition (soil pH, size of jaw, mass of overburden, etc.) as

$$dD/dt = a(-S/V)/D \qquad (1)$$

where S = surface area, V = volume, D = density, and a = strength of the agent of attrition. In this form the model seems to be an acceptable representation of attrition, though necessarily simplified as most models are. Binford and Bertram go on to combine "S/V" with "a" as a constant in the first order approximation:

$$dD/dt = -A/D \qquad (2)$$

The reason given for this alteration is that the "surface-to-volume ratio is approximately constant for most bones" (Binford and Bertram 1977:113). This statement is surprising since the surface area-to-volume ratio is one quality of bone elements that can vary dramatically, such as with the astragulus versus the scapula of an ungulate. Perhaps Binford and Bertram were tailoring their model to long bones, which tend to be roughly cylindrical. In any event, the ratio S/V cannot be reasonably ignored.

Lyman (1982, 1984) proposes a much simpler model relating bone density to survivorship. The model's simplistic form, basically identifying survivorship as a function of density, is necessary given the purpose for which it was derived: to explore the role of bone density in promoting survival. Though he suggests that bone part density mediates to some degree bone part survivorship, Lyman acknowledges the surface area-to-volume ratio as being an important factor and calls for examination of this property (Lyman 1982, 1984).

Several researchers have commented on the importance of microarchitecture and design in a bone's ability to resist attrition (Chave 1964; Guthrie 1967; Brain 1976). The shape of a bone, partly genetically predetermined, is greatly influenced during an animal's life by the bone's function (Lanyon and Rubin 1985). The relative amounts of collagen and mineral are also related to function (Lanyon and Rubin 1985). Thus, it is no surprise that many load- bearing bones in tetrapods are variations of a common geometric shape, the cylinder, and vary in response to the particular stresses and strains with which they must contend. In bones bearing "usual loads," the material properties of the tissue are fairly constant (Lanyon and Rubin 1985), whereas bones that have radically different functions, such as deer antlers or the auditory bulla of a whale, may be more variable in their mineral content (Lanyon and Rubin 1985). Adaptive response to stress in what Lanyon and Rubin (1985) call the "traditional" components of the skeleton is "achieved primarily by the regulation of tissue mass and by the adjustment of tissue architecture" (Lanyon and Rubin 1985). There is no reason to expect dramatic variations in density of the tissue among most skeletal elements in an animal and probably not between comparable elements among many mammals. What does vary is the relative massiveness of bone parts and the manner in which that mass is distributed.

It is clear that massiveness and design are the inherent properties of bones that we should examine in the attempt to explain differential survivorship. How can such properties be expressed and quantified? Another look at Binford and Bertram's model (Equation 1) reveals one possible solution. If we can consider D in this model to be an approximation of bulk density (Lyman 1982, 1984) then it can be reexpressed as the mass-per-unit volume ratio for the bone part. The model equation might be rewritten as

$$dD/dt = a(-S/V)/(m/V) \qquad (3)$$

where m = mass and all other characters are as defined above. In this form it is clear that volume cancels out, leaving the rate of bone destruction being inversely proportional to mass and proportional to the strength of the agent and the surface area, expressed as

$$dD/dt = a(-S/m) \qquad (4)$$

This equation has greater potential to approximate the effects of varying distribution of mass in bones or bone parts. Consider that two objects can have equal mass and equal volume and thus equal densities, yet their mass can be distributed in space in dramatically different ways. For example, a glassmaker might make a window pane with a certain quantity of glass, and then take the same quantity and make a marble. The marble will clearly have a significantly greater ability to resist various abuses, though both objects have equal densities. The rate of chemical reaction between agents in the soil and bone, as well as the susceptibility of bone to mechanical destruction, is closely related to surface area (Von Endt and Ortner 1984:252; Lyman 1994:239).

If density is not a property that is of interest in the destruction of bone, then the correlations often seen between bone part density values and survivorship (Brain 1976; Binford and Bertram 1977; Lyman 1982, 1984, 1994) need explanation. Part of the answer lies in the relationship between surface area and volume. Table 3.3 lists formulae for surface area and volume of some common geometric shapes. For every shape, there is a relationship between surface area and volume that allows surface area to be expressed as a function of volume. Thus, to be related to surface area of a given shape is to be related to volume. It is notable, however, that the strength of this relationship differs for each of the different shapes in the table and would for any other shapes as well. It is also interesting that at very small values in one dimension, the surface area-to-volume ratio can become quite large, as in the case with cylinders where as they become more disklike (shorter length, flatter shape) the surface area assumes values that are greater and greater relative to the volume. At larger values of the variable, the surface area-to-volume ratio is smaller. What is of relevance to the issue of bone density as a predictor of survivorship is that for

Table 3.3. Some Properties of Common Geometric Shapes.

Shape	Properties	
Sphere	Surface area = $4\pi r^2$	where r = radius
	Volume = $4/3\pi r^3$	
	Surface area = $3/rV$	where V = volume
Cylinder	Surface area = $2\pi rL + 2\pi r^2$	where r = radius L = length
	Volume = $\pi r^2 L$	
	Surface area = $2(1/r + 1/L)V$	where V = volume
Right Circular Cone	Surface area = $\pi rL + \pi r2$	where r = radius L = length
	Volume = $1/3\pi r^2 h$	where h = height
	Surface area = $[3(1 + r)/rh]V$	where V = volume

bone parts that are of approximately the same shape, for example long bones that are roughly cylindrical, a bulk density measure will be closely related to the mass/surface area ratio. This partly explains why significant correlations are seen between bulk density measures and survivorship.

The exact manner in which surface area is related to volume for specific shapes varies and undoubtedly some variation in the strength of correlations between bulk density and survivorship is attributable to the varying shapes of bones. Recall that artiodactyl ribs have a mean bulk density (0.40) that is approximately equal to that of the distal humerus (Lyman 1985:227). Yet it is obvious that the distal humerus is more robust than a rib and frequently shows greater survivorship in bone assemblages (see Table 3.2). The significant difference between these two bone elements is shape, and the shape of the rib is characterized by far greater surface area. Another important factor is the inclusion of pore space in the bulk density measures. The more pore space there is within a bone part the greater the surface area relative to mass within, and, consequently, the less its durability. However, bone parts with more pore space also have lower bulk density values, and it is unclear to what degree the inner architecture of bones affects the utility of the bulk density measure.

Measurement of Bone Density in Three Fish Species

Bulk density has been shown to have merit as a predictor of a bone or bone part's ability to resist attrition when applied to certain mammalian species (Brain 1976; Binford and Bertram 1977; Lyman 1982, 1984) despite the fact that it does not explain differential survivorship of bone parts. The greater shortcomings of models employing bone density measures are revealed when attempts are made to apply such models to bones from other nonungulate mammalian species (Lyman 1994:253–254) or from other vertebrate classes. These shortcomings should be particularly severe in those taxa whose bones do not have the hollow cavities typical of most large mammal bones. To illustrate this point, density measures were taken on specimens of fish from three species in two superorders. The longnose gar (*Lepisosteus osseus*) was chosen as a representative of the superorder Holostei, which have what can be considered more robust skeletons, while the gizzard shad (*Dorosoma cepedianum*) and the river herring (*Alosa chrysochloris*) represent Teleostean species with fragile skeletons. There are obvious differences in the abilities of certain gar and herring bones to survive various forms of attrition. Therefore, if bone density is a useful measure, we should expect to observe variety in the density values of those bones.

A technique for measuring specific gravity of objects designed by J. W. Byrd (formerly of the Department of Physics and Astronomy at Appalachian State University and now of Mt. Olive College) was employed for obtaining density measures for the fish bone specimens. While density is conceptually defined as the ratio of mass to volume, taking precise and accurate measures of the volume of bones is unreasonably difficult (see Lyman 1982, 1984). To avoid such problems here specific gravity was measured by recording the dry mass of a bone as well as the apparent mass (its mass when submerged in distilled water) and calculated as the ratio of the dry mass to the difference between the dry mass and the apparent mass. Specific gravity is a measure of true density (Lyman 1982; 1984). Note that most fish bones have relatively little to no pore space, which makes the specific gravity also a good estimate of bulk density.

Some practical considerations for the technique used in measuring specific gravity are as follows. Since the denominator in the above ratio calls for differences in mass measures, it is imperative that a very precise balance be employed. For fish, which typically have individual bones weighing less than 1.0g, a balance reading to 0.0001g is necessary. The technique requires that bones be submerged in water so that mass can be recorded. Any suspensory apparatus must be accounted for in the model, which might include estimating the effects of surface tension on this apparatus if it is sufficient to introduce an appreciable degree of error. The water must be distilled and its temperature recorded (the formula relates the density of the material to the density of water at 21.0 degrees celcius). Any air that is trapped in the specimens must be forced out before the apparent mass is measured since air pockets can alter the apparent mass readings.

The balance employed in this analysis was a Mettler HE10 electronic balance, which reads to 0.0001g. Accuracy of the balance was checked repeatedly throughout the analysis with secondary standard masses ranging from 0.0505g to 1.0000g, and it was found to provide consistent readings. A platform was placed underneath the balance (but above the pan) on which a beaker of distilled water could sit without disturbing the readings. Apparent mass measures were accomplished by suspending a wire and a clip holding the specimen from the hook on the balance into the water. The apparent mass of the wire and clip had to be measured and negated in the model. The model, including the apparent mass of the wire and clip, is as follows:

$$\text{specific gravity} = \frac{M_{act}}{M_{act} + M_{ap} - M'_{ap}} \qquad (5)$$

where M_{act} is the dry mass of the bone, M_{ap} is the apparent mass of the clip and wire, and M'_{ap} is the apparent mass of the clip, wire, and bone. The copper wire used to suspend the clip was threadlike, rendering surface tension negligible. Care was taken never to touch the specimens with bare hands for fear of leaving oils on the bone or clip.

For every measure of mass, wet and dry, at least three readings were recorded and average values calculated for use in the formula. Multiple readings of the apparent mass of the wire and clip were taken intermittently during the analysis, and an average value used for M_{ap}.

Initial experimentation with this technique showed that it is a reliable method for obtaining specific gravity estimates for many materials. A disk of pure aluminum was found to have a density of 2.65 at 23.0 degrees celcius, which compares favorably with the value of 2.69 at 21.0 degrees celcius reported in the Handbook of Chemistry and Physics (Weast 1969). An error of 1.5 percent, part of which is attributable to the difference in temperature, is acceptable.

Early attempts at obtaining the apparent mass measures for bone specimens met with some difficulty. When the bone was suspended in the beaker, the mass readings began to increase steadily for seconds, sometimes as much as a minute. It was ascertained that air was trapped on and possibly in the specimens. The problem was remedied (the apparent mass readings no longer increased) by soaking the bones in distilled water for a number of minutes before attempting measurement. Trapped air must be reckoned with as a potential source of error when applying this technique to bones.

Another potential source of error is variation in the processing of the fish skeletons used. All specimens measured had been macerated in jars of water and their dried skeletons stored in metal cabinets in the Zooarchaeology Laboratory, Department of Anthropology, University of Tennessee, Knoxville. The length of time spent in jars is unknown, but all specimens have been housed in the cabinets for years.

Results of the experiment are reported as raw data in Table 3.4 with summary statistics in Table 3.5 (see Figure 3.5). Examination of the variation in the raw data reveals some interesting characteristics of density. First, density measures for particular bone elements must be presented as average values rather than single, absolute values that are used to represent an entire taxon. Comparisons between many bone elements and/or taxa using the density data should be done statistically since many have values that overlap.

An analysis of variance was done (Kleinbaum and Kupper 1978; Zar 1984) to test for significant differences between selected bone elements and taxa. Table 3.6 lists results of the statistical analyses. It is apparent that there are no statistically significant differences between the species when data from all available elements are considered collectively. Within the species, significant differences are noted among the elements for shad and herring. Gar show no significant difference among the frontal, opercular, and cleithrum but consistently show smaller values for the vertebrae.

The issue of whether the species or elements measured exhibit statistically significant differences or not is actually of little importance in the face of the many larger issues: Does density mediate the resistance of fish bone to attrition? Can a measure of density predict the survivorship of fish bone in archaeological contexts? The specific gravity data clearly indicate that the answer to both of these questions is no. The shad and herring vertebrae are significantly less dense than their associated skull plates but are clearly more durable. It is unlikely that an alternative means of measuring the density of fish bones will produce a more promising result since most fish bones have very little pore space. The clear implication is that there is very little in the density of fish bones that is useful in understanding or predicting survivorship.

Table 3.4. Density Values for Fish Bone Specimens.

Catalog Number	Frontal	Opercular	Cleithrum	Vert.(2)
Lepisosteus osseus				
LoDr7	1.81	1.62	1.91	1.30
LoDr5	1.86	1.89	1.84	1.20
LoDr26	1.82	1.82	1.84	1.47
LoDr30	1.81	1.86	1.82	1.49
LoDr28	1.61	1.84	1.85	1.39
LoWb31	1.86	1.78	1.87	1.21
LoDr55	1.81	1.84	1.81	1.33
998	1.98	1.95	1.66	1.29
LoDr70	1.83	1.80	1.84	1.43
2660	2.02	1.88	1.72	1.17
LoDr2	1.89	1.92	1.96	1.17
LoDr3	2.04	1.97	1.95	1.41
LoDr40	1.91	1.77	1.90	1.38
Dorosoma cepedianum				
332	-	1.94	1.81	1.54
337	-	1.97	1.81	1.30
336	-	1.97	1.75	1.83
335	-	1.97	1.68	1.67
334	-	1.84	1.66	1.34
234	-	1.95	1.74	1.65
Alosa chysochloris				
1023	-	1.89	1.54	1.63
1906	-	1.82	1.43	1.46
6486	-	1.80	1.37	1.23
1730	-	1.97	1.84	1.67

Table 3.5. Summary Statistics for Fish Bone Density Data.

Statistic	Frontal	Opercular	Cleithrum	Vert.
Lepisosteus osseus (N=13)				
Mean	1.87	1.84	1.84	1.33
Standard Deviation	0.11	0.09	0.08	0.11
Range	0.43	0.35	0.30	0.32
Dorosoma cepedianum (N=6)				
Mean	-	1.94	1.74	1.56
Standard Deviation	-	0.05	0.06	0.20
Range	-	0.13	0.15	0.53
Alosa chrysochloris (N=4)				
Mean	-	1.87	1.55	1.50
Standard Deviation	-	0.08	0.20	0.20
Range	-	0.17	0.47	0.44

Table 3.6. Analysis of variance results.

Species	Source	F value	Prob>F
Lepisosteus osseus	Between frontal, opercular, and cleithrum	0.24	0.78
Dorosoma cepedianum	Between opercular, cleithrum, and vertebrae	13.78	0.00
Alosa chrysochloris	Between opercular, cleithrum, and vertebrae	5.50	0.03
All	Between all species, all elements	0.79	0.46

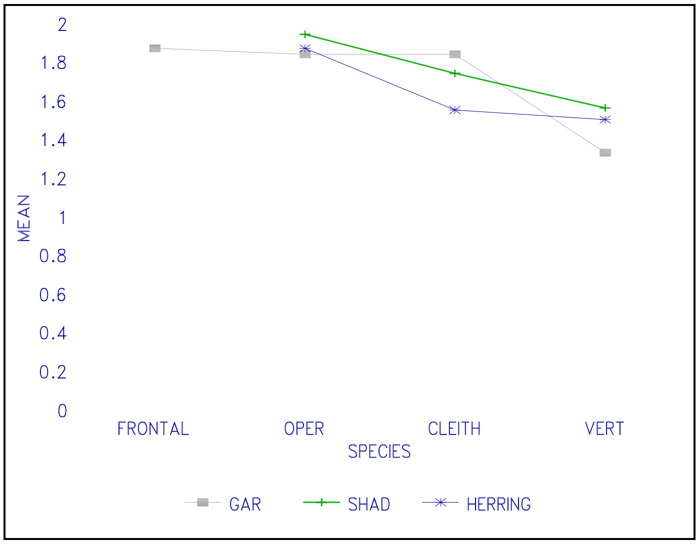


Figure 3.5. Mean density values for selected elements from gar, shad, and herring.

The Mass/Surface Area Ratio and Fish Bone Survivorship in the Jordan's Landing Assemblage

Density of bones has been argued above not to be a mediating factor in a given bone's resistance to attrition. The success of models employing bone part bulk densities or hybrids between true and bulk densities (Brain 1976; Binford and Bertram 1977; Lyman 1982) is attributable to the nature of the bones examined, all being hollow and/or porous and usually cylindrical. These design characteristics create a strong, definable relationship between volume and surface area. For bones that do not have large cavities and/or pore spaces, however, it is expected that density will not prove useful in deriving models that predict survivorship. The density data for fish reported above serve as a case in point. If we force a comparison of mean values for the opercular (see Table 3.5), it is seen that the clupeids' bones have higher densities than those of the gar.

Table 3.7. Mass/surface Area Estimates for Gar and Clupeid Specimens.

	Mass/Surface Area (mg/mm^2)			
Species	Opercular	Vert.	Frontal	Total Length (cm)
Dorosoma cepedianum	0.143	0.233	-	19.7
	0.173	0.431	-	24.0
	0.280	0.474	-	27.6
Alosa chrysochloris	0.204	0.798	-	43.0
	0.196	0.647	-	38.0
Lepisosteus osseus	0.331	-	0.367	18.0*
	0.339	-	0.386	18.0*
	0.459	-	0.495	25.5
	0.768	-	1.005	117.0
	0.631	-	0.781	94.0

* Length is an estimate, not based on actual measure of live fish.

Surface area is a characteristic of bones and bone parts that should be explored as a variable in taphonomic models. But actually obtaining accurate values of surface area for objects with complex shapes is problematic and an efficient, accurate means of measuring this characteristic is currently unknown. To explore the importance of the mass/surface area ratio in understanding survivorship, surface area values were estimated for selected bone elements of clupeids and gar. The operculars of both groups and the gar frontal were chosen because of their relatively flat shapes. Five specimens from each group were laid on graph paper graduated in millimeters, their outlines traced on to the paper, and surface area estimated by doubling the area within this perimeter. The surface area of the clupeid vertebral centra were estimated by treating them as cylinders and measuring the radius and length and used in the formula for surface area of a cylinder (see Table 3.3). The centra are not actually round, but more elliptical with concavities on each end. The radius measure was taken on the long axis with the intent of obtaining the largest possible value, hopefully compromising the error caused by not accounting for undulations on the surface. At best these measures are rough estimates that are believed to be close enough to reality to permit comparison. Table 3.7 lists the values obtained in this analysis. Note the trend of increasing values with increasing total length of each fish.

The results in Table 3.7 are useful in understanding the relative frequencies of Clupeid fragments and gar fragments in the Jordan's Landing assemblages. Gar is well represented in all of the features, reflecting in part the abundance of gar in the waterways around the site. The strong representation of gar by a large variety of elements suggests, at least in part, that the gar elements are relatively robust. Clupeids, in contrast, are represented only in Features 21 and 41 (see Figures 3.6a and 3.6b), and only by vertebral centra (see Figures 3.7a and 3.7b). This is unusual given that out of 15 species of fish represented in Feature 41, only two have no skull fragments present (the other species is sturgeon, which have few ossified elements). Feature 21 has 14 species of fish of which only two have no skull bones represented (again, the other species is sturgeon). Figures 3.7a and 3.7b show the relative representation of gar skull bones and vertebrae. Skull bones

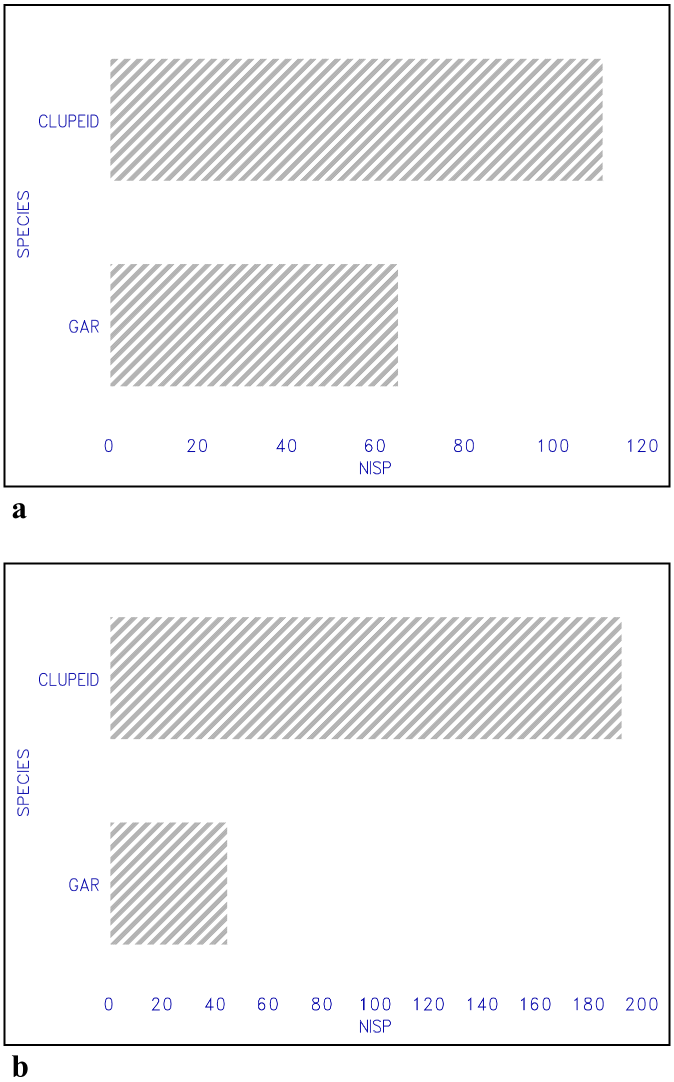
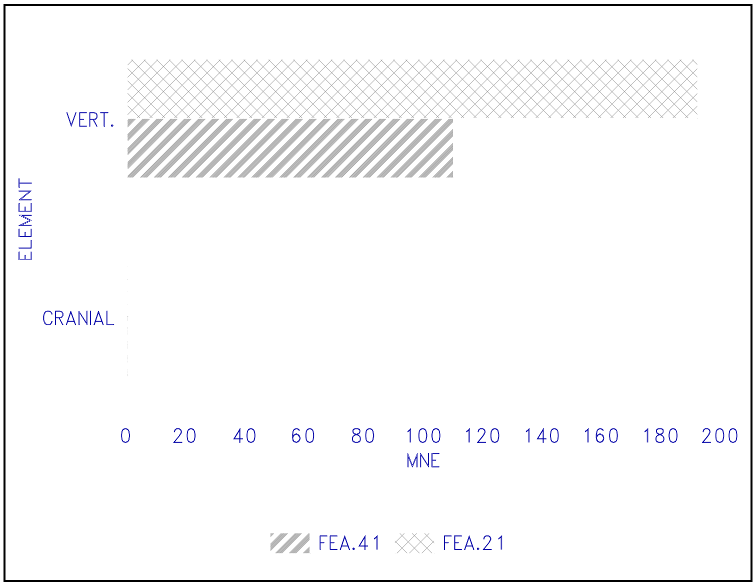


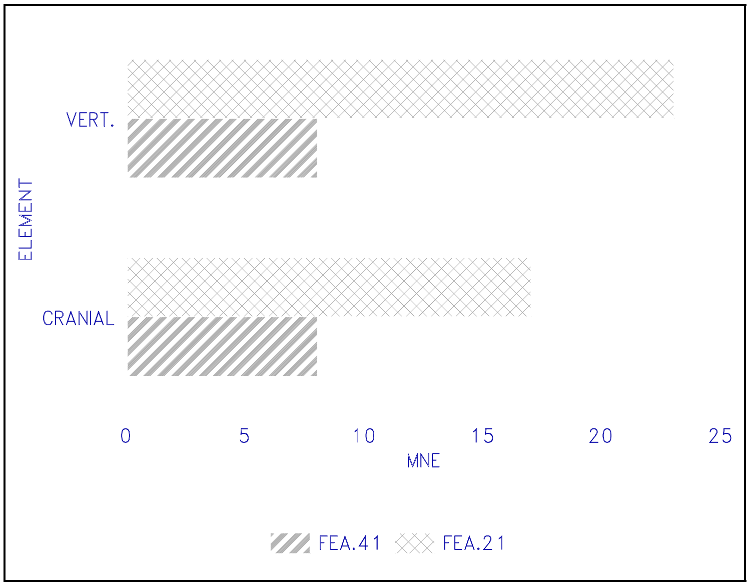
Figure 3.6. Relative abundance of gar and clupeids in Features 41 (a) and 21 (b).

from the gar seem to be as resistant to attrition as the vertebrae. Examination of Figures 3.8 and 3.9 reveals that gar operculars have substantially higher values of mass/surface area than those of the clupeids. Interestingly, Figure 3.9 shows that clupeid vertebrae have substantially higher mass/surface area ratios than the operculars. Figure 3.10 indicates that clupeid vertebrae are comparable to gar frontals and operculars in this measure.

If we, not unreasonably, predict that other Clupeid skull bones have low mass/surface area values and that other gar skull bones have high values, then it is apparent that the mass/surface area ratio has great predictive power in the survivorship of fish bone. It is indeed correlated with the bone part representations in Features 21 and 41. Further, it is conceivable that the distribution of mass relative to surface area has some explanatory power as well. Future attempts to "reconstruct" ravaged assemblages (see Lyman 1994:283–287 for discussion) should rely upon the relationship between mass and surface area, particularly where multiple vertebrate classes are to be included in the analysis.



a



b

Figure 3.7. Bone element frequencies for clupeids (a) and gar (b) in Features 21 and 41. (MNE = minimum number of elements)

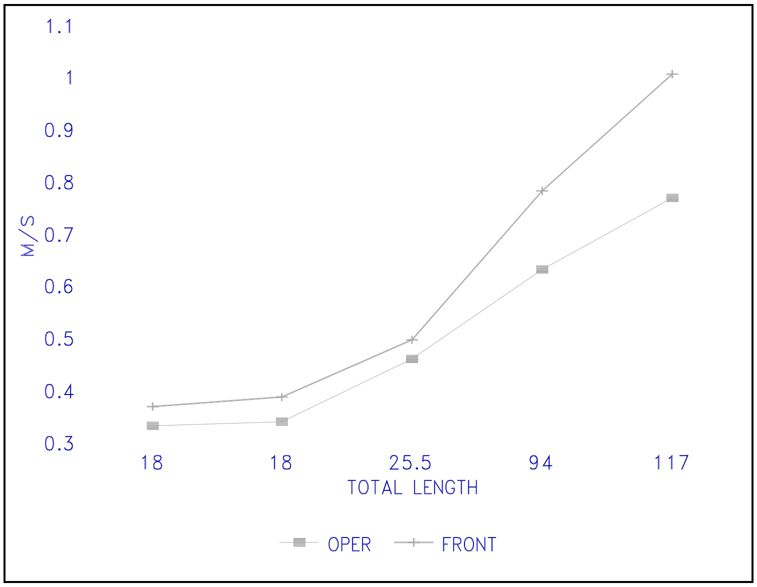


Figure 3.8. Mass/surface area values (see text) for gar plotted against total length.

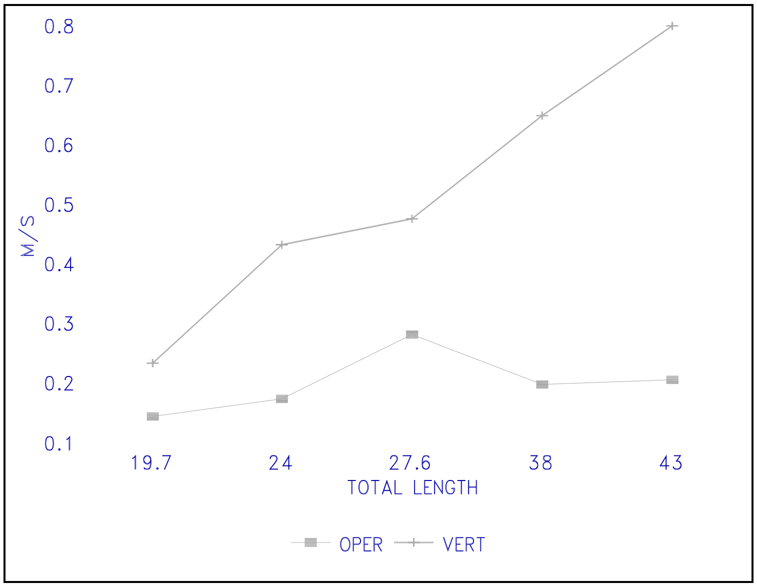


Figure 3.9. Mass/surface area values (see text) for clupeids plotted against total length.

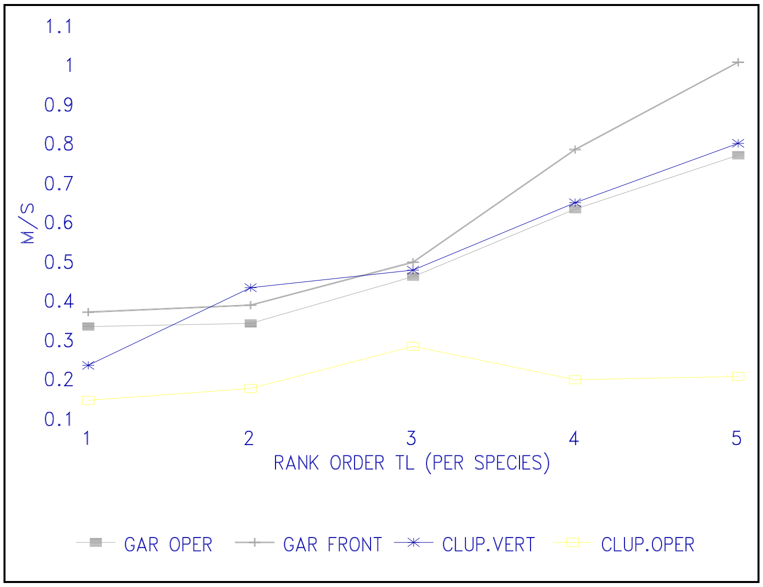


Figure 3.10. Mass/surface area values for gar and clupeids plotted against total length.

Summary and Conclusions

The purpose of conducting a taphonomic analysis of the Jordan's Landing assemblages was to isolate a priori any sources of bias introduced by taphonomic agents into the data that affect interpretations of that data. It is clear that due consideration of taphonomic biases has significantly changed the interpretation of the four assemblages. Because biases in faunal data are largely unseen unless they are searched for, taphonomic analyses should be a part of any zooarchaeological analysis.

Domestic dogs are a likely candidate for inflicting the damage seen on many bone fragments, particularly those in Feature 1. The damage inflicted by gnawing observed on ungulate elements (see Figure 3.1) resembles that seen in actualistic studies dealing with wolves (Klippel, Snyder, and Parmalee 1987) and domestic dogs (Brain 1976; Byrd n.d.). Feature 1 deer bone part frequencies are a classic example of the canid pattern of attrition as represented by the survivorship of the opposing ends of eight deer bone elements (see above). Interestingly, the data distributions seen in plots of bone part and complete bone survivorship on utility (FUI) appear to be reverse utility curves. These curves are often interpreted as evidence of the higher utility parts having been selectively removed by the humans who butchered the carcasses. Following this, then, we might interpret the Feature 1 assemblage as derived from a butchering station or a kill site. An alternative interpretation holds that the higher utility bone parts were selectively removed by canids. Byrd (n.d.) found that domestic dogs do prefer those parts with the highest utility and low bulk density. Further, it was shown (see above) that the bone part frequency data resulting from experiments where whole deer carcasses were fed to gray wolves also appear to be distributed as reverse utility curves. The plausible explanation for the bone part frequency patterns observed in Feature 1 is that whole deer carcasses were introduced into the village, butchered, cooked, and the remains offered to village pets and/or thrown into the open ditch where the dogs had further access to them. A clear canid pattern of attrition was not observed for Features 21, 41, and 43.

Small mammal remains are likely to be underrepresented in the Feature 1 sample due to the ability of humans and dogs to consume them entirely (Payne and Munson 1986) and to the lack of fine-screening. It is unclear what effects canids would have had on the medium mammal remains. Presumably, medium mammal bones are less likely to survive than large mammal bones simply because they are less massive. Dogs can be considered less a factor in Features 21, 41, and 43 as these pits were apparently closed soon after filling. It is reasonable to assume that a similar situation exists for reptile and amphibian remains.

Fish are abundantly represented in Features 21, 41, and 43, and moderately represented in Feature 1 (see Figure 3.3). The bone part frequencies of fish in the ditch should have been significantly affected by canids as they are known to consume fish in entirety (Jones 1986). The strong representation of gar skull fragments and clupeid vertebrae in Features 21 and 41 has been shown to be related to an inherent quality of those bones, the mass/surface area ratio. It is likely that the proportionally high NISP for the holostean fishes is related to their robusticity, while the poor representation of many teleostean fish bones (particularly the more easily identified skull fragments) is attributable to their more fragile nature. The specific taphonomic agent responsible for destroying these fragile bones is not identified, but strong possibilities are heat from cooking, crushing by humans in mastication, and chemical attrition in the soil. Human cooking and mastication are the most likely agents in the case of the clupeid skull bones in Features 21 and 41. They are one of the few groups missing skull bones entirely and have very low mass/surface area values for the opercular (Figure 3.11) and probably for other skull bones as well. Indeed, herring are consumed along the Roanoke River today bones and all since most elements become quite soft after cooking. This does not include the vertebrae, (Figure 3.11) which are swallowed whole or rejected. If the contents of Features 21 and 41 are the remains from stews, then the clupeid skull bones could have been simply boiled away. It is unlikely that humans consumed other fishes whole, particularly those with more massive bones such as the gar.

It is clear that clupeids will often be represented only by vertebrae (Figure 3.11). The lack of clupeid remains, including vertebrae, in the Feature 1 sample probably results from a combination of taphonomic agents destroying the skull plates and recovery methods employed in the field. The 1/4-inch screens used during the excavation of this sample will not catch most clupeid vertebrae. Conversely, the large, flat gar skull plates, which have approximately the same potential to survive attrition, do reliably catch in 1/4-inch screens. It is predicted that clupeid vertebrae will be found in future analyses of the fine-screen samples from the ditch. The absence of clupeids in Feature 43 is believed to reflect original absence; that is, no clupeids were ever introduced into that pit.

Some general conclusions resulting from the taphonomic analysis are as follows. The Feature 1 assemblage has been heavily biased by the activities of various taphonomic agents. These activities have left the assemblage dominated by those taxa and their respective bone parts that are most resistant to destruction. Therefore, the picture of subsistence practices offered by this assemblage—that hunting whitetail deer dominated the effort to exploit animal resources—is a distortion. It is also unlikely that holostean fishes were the most common group of fishes exploited. The smaller, more fragile taxa were very likely selectively removed before they could be recovered by archaeologists or missed due

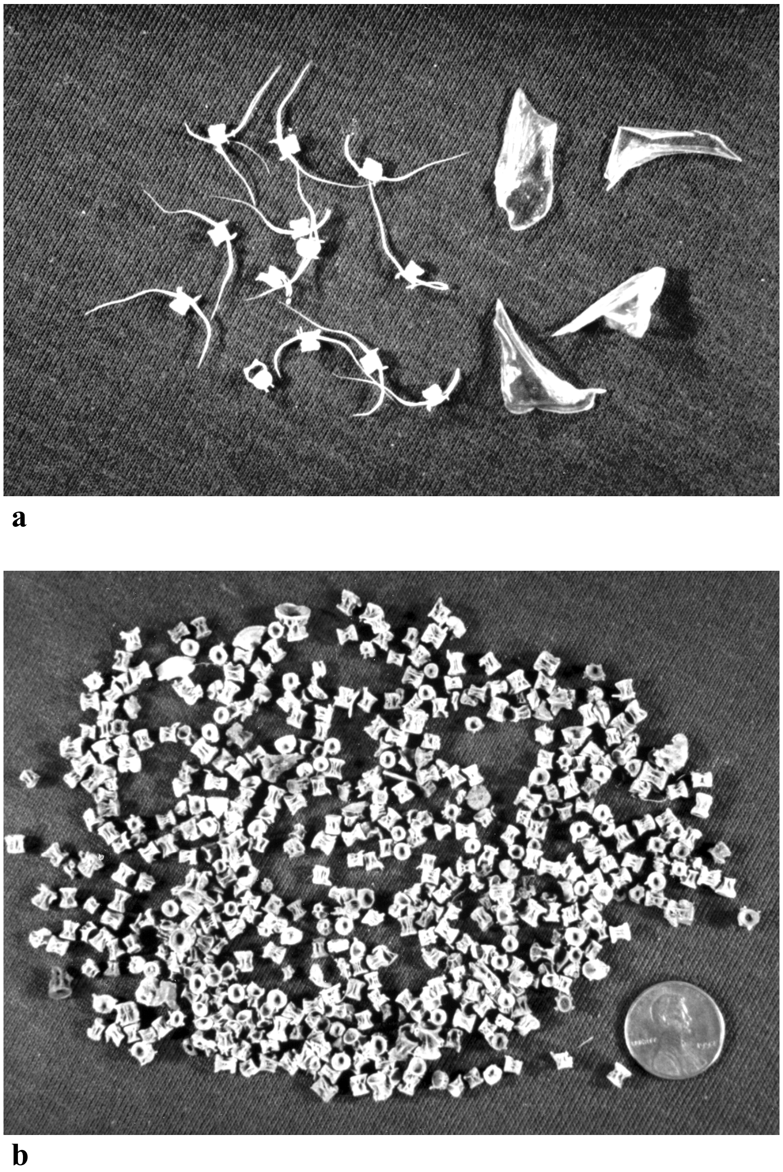


Figure 3.11. Modern clupeid skull elements and vertebrae (a) and clupeid vertebrae from Feature 21 (b). Note that only the vertebral centrum survives in archaeological context.

to recovery methods. If crawfish were regularly taken as in the historic period (see Chapter 1), then their fragile exoskeletons did not survive to be recovered archaeologically in the four assemblages.

The three small trash pits provide a less distorted glimpse of subsistence patterns of the Cashie phase villagers. They are all three dominated by the remains of teleostean fish. There are approximately equal numbers of large and medium size mammals. Thus, it is clear that subsistence strategies involved intensive efforts to exploit smaller animals such as raccoons, opossums, turtles, and fish. Birds were apparently an insignificant component in the diet. However, very little is known about the inherent qualities of bird bones that affect their ability to survive in the archaeological record.

Chapter 4

SPECIES DIVERSITY IN THE FOUR FEATURES

Diversity is a parameter of ecological communities that has received much attention from ecologists. This descriptive measure is composed of two basic components: richness, the number of species, and evenness, the respective species' relative abundances (Hill 1973; Putman and Wratten 1984). Generally, the more species per number of individuals in a community the more diverse it is; but the spread of individuals between species is a separate aspect of diversity that must also be considered.

Diversity is of interest in ecological community studies because it can be related to stability, maturity, productivity, evolutionary time, predation pressure, and spatial heterogeneity (Hill 1973). For archaeological faunal assemblages, diversity has a separate purpose, being a parameter that describes the prey exploited by a single predator, humans. Archaeological theory holds that as hunter-gatherers become more culturally complex and populous, corresponding intensification in subsistence practices will include the exploitation of new species along with technological innovation and reorganization of labor (Price and Brown 1985). This process is often referred to as "diversification." Yellen (1986) provides grounding for this theory in the diet breadth model from ecology, noting that "as the number of items in the diet increase, the overall search time to find any one of them decreases accordingly" (1986:734–735). He goes on to add that a point is invariably reached where the cost of adding another species to the subsistence mix will outweigh the benefits (Yellen 1986:735). The addition of highly ranked items (low procurement costs, high return) such as domesticated animals should result in a number of lower ranked items being dropped from the list and an overall decrease in the diversity of prey (Yellen 1986:735). The results of Yellen's important study of Dobe !Kung subsistence indicate that this group of hunter-gatherers have maintained a consistent diversity of prey species in spite of seasonal fluctuations in resource availability and the adoption of domesticated animals. This is apparently done to minimize the risk of resource failure in an uncertain environment rather than to maximize short-term gain as predicted by the diet-breadth model (Yellen 1986:748).

A general trend toward the exploitation of an increasingly diverse set of resources has characterized many cultures throughout the world since the close of the Pleistocene Epoch (Hayden 1981). Christenson (1980) has argued that resource diversification increases for human groups experiencing population growth in the following manner: Richness and evenness of plant and animal species exploited are low at low population densities but rise as population density rises causing a corresponding drop in efficiency of labor. As efficiency of labor decreases, the use of domesticates becomes more favorable, they are adopted, and richness and evenness drop due to the new concentration on relatively few domesticated species. Where domesticated plant species only are adopted, the diversity of animal species exploited continues to rise. Since no known domesticated animal species were available to the late prehistoric inhabitants of the Jordan's Landing village, it is hypothesized that the faunal assemblages will reflect a high diversity of animal species exploited. This diversity will be characterized by a relatively large number of species that can be considered staples in the diet, but also by high evenness among the prey taxa, which indicates that there was not concentration on any one animal species.

The Measurement of Diversity in Faunal Assemblages

Hill (1973) has discussed several of the popular indices used as diversity measures and concluded that many belong to the same family of mathematical relations. The total number of species, Shannon's index H, and Simpson's index are all simply different powers of the same relation, differing in how they weight rare species. Diversity indices can be thought of as measures of how many species are effectively present when a sample is examined to a certain depth among its rarities (Hill 1973; Putman and Wratten 1984). The number of species exaggerates rare species by giving them weight equal to the more abundant groups. Simpson's index virtually ignores the rare species, giving appreciable weight only to the abundant, while Shannon's index H is intermediate between Simpson's index and the total number of species. Hill (1973) notes that Shannon's index H is somewhat ambiguous. Indeed, it is impossible to understand which component of diversity, richness or evenness, has contributed most to a particular value of Shannon's index. An index value of 0.5 results from a sample (N=6) with three species having equal numbers of individuals (two) in each or seven species with one including most of the individuals (17) in the sample (N=25). More interpretable measures of diversity are the number of species and the reciprocal of Simpson's index, which should be used together in the assessment of sample data (Hill 1973; Byrd 1997).

A formal analysis of the diversity of vertebrate species identified in the four Jordan's Landing assemblages has been reported by Byrd (1997). Three aspects of prey species diversity were examined: the regularity of the number of species consumed, the number of species consumed on a regular basis (provided such a number exists), and the way in which numbers of individual prey were distributed among the species exploited (evenness). It was argued that if there exists a number of species regularly exploited by the inhabitants of the site, whose remains were likely to survive and be recovered, then this number could be determined and taken as evidence of a consistent pattern of animal exploitation. This pattern of exploitation produces a statistical population with parameters of richness and evenness that can be estimated by analyzing sample data from archaeological sites. Archaeological samples should consist of faunal remains from deposits that are believed to have accumulated over a relatively brief interval of time (see Byrd 1997), such as trash pits or arbitrary levels in a midden (this assumes the midden debris accumulated gradually). It is expected that the richness of samples (N_s) will increase as sample size (N) increases up to a point, the population richness (N_t), after which sample size can continue to increase with no corresponding increase in sample richness.

The curvilinear distribution of data seen in a plot of N_s on N where the above conditions hold is one of limited growth. The method for finding an estimate of average richness employs the limited growth curve equation given in many mathematics textbooks as

$$y = c(1 - e^{-kt}) \quad (6)$$

where 'c' is the upper limit on the growth of the curve, 't' is typically time, and 'k' is an empirically derived constant. Inserting the variables of interest here we obtain

$$N_s = N_t(1 - e^{-kN}) \quad (7)$$

where 'k' is defined as

$$k = 1/(N_t)(N_t/1.5S)^{0.5LOGN} \qquad (8)$$

and 'S' is the reciprocal of Simpson's index (see Byrd 1995 for a complete account of the derivation of the above equations). The best estimate of N_t, interpreted as the number of species commonly exploited by the villagers, is obtained through a procedure referred to as the "minimum chi-square method" (Byrd 1997). This procedure involves entering the archaeological sample data into a spreadsheet, plugging N and S into equation (7), and then inserting values of N_t into the equation until the minimum chi-square value for goodness of fit between the N_s values and the values for N_s predicted by the equation is obtained. The N_t value that produces the lowest chi-square value (and thus, the best fit) is by definition the best estimate of the population N_t. Whether or not this estimate is acceptable is determined by the associated significance level, which should not indicate a poor fit of the model to the archaeological data (Byrd 1997). Variation in the number of species consumed on a regular basis or in the intensity of exploitation of specific species can prevent the sample data from plotting as a limited growth curve. Where it is impossible to obtain a close fit of a model to the sample data the conclusion must be that there was not a consistent pattern of animal exploitation by the site's inhabitants.

The Jordan's Landing faunal assemblages were divided into nine discrete samples. The three trash pit features were each counted as an individual sample. Arbitrary levels from the $2m^2$ unit in the ditch, Feature 1, were used for the other six samples. The justification for using levels from the ditch as samples is that it is apparent that the debris in the ditch accumulated gradually; thus, there is temporal ordering of these materials and it is reasonable to assume that bone specimens from a single level were deposited at approximately the same time. Conversely, it is clear that materials near the bottom of the ditch were deposited well before those close to the top. While some researchers may be uncomfortable relying on arbitrary levels as units of analysis, it is important to recall that the methodology employed here calls for samples to represent relatively brief time intervals. Trash pits are clearly the ideal provenience from which to draw samples. However, too few trash pits from the Jordan's Landing site have been analyzed to permit exclusion of the materials from the ditch.

The sample sizes (N) are measured by the MNI. The analysis can be done using other measures, but MNI offers the most interpretable results. NISP is a popular alternative to MNI in many quantitative analyses (see Grayson 1984), but its sensitivity to differential fragmentation renders it a poor choice for these purposes. Consider that white-tailed deer bones are usually fragmented (by humans seeking marrow and by canids) to a great degree in all the assemblages in the site but medium mammal bones are not. Bullhead catfish are most often represented by pectoral spines and cleithra alone while white-tailed deer have most skeletal elements represented by some number of fragments (see Chapter 3). The NISP greatly exaggerates the frequencies of certain taxa. Consequently, diversity indices calculated with NISP are measuring a confounded mix of relative abundance, differential preservation, and differential fragmentation.

The population evenness for vertebrates was estimated through visual examination of plots of S against N and S against N_s. It has been noted (Byrd 1997) that where population evenness is high, sample values of S will tend to gradually climb toward the population S value as N increases, but actually reach the population S value only at very high values of N. In these same populations sample S values tend to be approximately equivalent to the associated N_s values. Where population evenness is low the sample S values stabilize at the population value at relatively low values of N or N_s. It is important to remember that sample S values are determined by some complex rules of chance: thus, it is accurate to state that for samples drawn from a population with high evenness it is *likely* that the sample evenness will be high *relative to the sample size*. There will be occasional outliers (with low sample S values) that do not invalidate the patterns described above. In the case of the samples drawn from populations with low evenness, it is simply unlikely that a sample will be drawn with high evenness regardless of the sample size. Figure 4.1 shows sample S values plotted against N and against N_s for the Jordan's Landing samples. It is apparent that the population evenness is high. The population S was estimated to be approximately 18, though this value probably errs on the conservative side.

Archaeological sample values for N_s and N (vertebrates only) along with the estimate of the population S were entered into equations (7) and (8) and the minimum chi-square method used to obtain the estimate of 24 species for N_t (Byrd 1997). Figure 4.2 shows N_s plotted against N (archaeological data) along with the values of N_s predicted by equation (7) for the given values of N. It is apparent in the figure that the limited growth model provides a reasonable fit to the sample data. This impression is supported by the chi-square test statistic (X^2=1.7 v=9 p=0.999). It is also apparent that the curve plateaus at an N_s value of approximately 24. It is worth mentioning that the sample from the ditch probably excludes some taxa due to taphonomic effects (see Chapter 3), which makes the value of 24 species a low estimate and thus erring on the conservative side.

This estimate of 24 vertebrate species can be compared with what might be called a "baseline" number of species for the site environment. The results of a biological study of Company Swamp, Bertie County, North Carolina, by Laney et al. (1988) provide the figure of 261 vertebrate species present or likely to be present in that locality. The similarity of habitat in Company Swamp (e.g., gum-cypress and bottomland hardwood forests) to that of the site location, as well as its geographic proximity (less than 20 miles away), qualifies the assumption that a similar number existed in the village locality in the late prehistoric period. Clearly, the villagers were not attempting to exploit most of the species that were (technically) available to them. The particular species that were selected as food items were those that were considered palatable, nutritious, and worth pursuing, determinations that are usually culturally prescribed. It is not expected that any human group would exploit all species available in an environment as rich as that of the inner coastal plain of North Carolina. Lee (1979:226–227) reports that the !Kung San recognize 262 species of animals in their home range in the Kalahari Desert. Of these, 80 species are considered edible, 34 species are systematically hunted, and only 8 species account for the majority of meat in the diet. Similarly, Hill et al. (1984:128) report that the Ache name over 100 animal species in their forested South American homeland. The Ache were observed consuming (at least once) 52 different game species but obtained nearly all of their meat calories from only 7 species (Hill et al. 1984:128). The estimated N_t value of 24 is high in comparison to the 8 species regularly taken by the !Kung San and the 7 species eaten most often by the Ache.

The hypothesis proposed at the beginning of this chapter—that the Jordan's Landing villagers' subsistence practices incorporated the use of a wide variety of animal species—is supported by the diversity analysis. Approximately 24 vertebrate species were regularly exploited by the inhabitants of the village. Individual animals were very evenly distributed

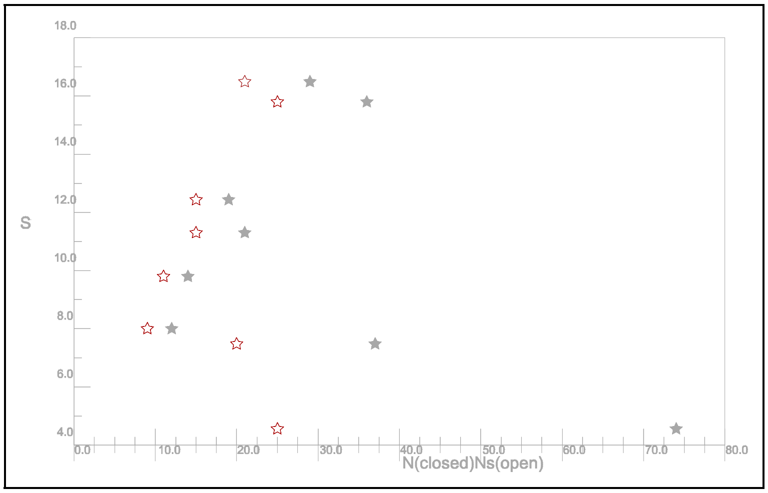


Figure 4.1. Sample evenness (S) plotted against sample size (N) and number of species (N_s).

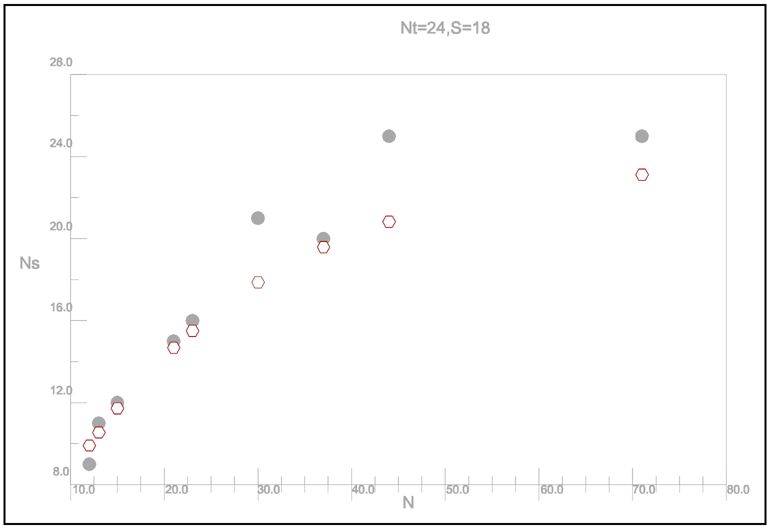


Figure 4.2. Sample number of species (N_s) plotted against sample size (N) along with limited growth model (open symbols).

among these prey species. Thus, it is clear that the villagers worked to maintain a steady, high diversity of prey species. These results are in line with the theory (Christensen 1980) that predicts that groups that have adopted plant horticulture but have no domesticated animals will exploit rather evenly a wide variety of animal species.

Chapter 5

SITE SEASONALITY OF THE JORDAN'S LANDING VILLAGE

Determination of the seasons in which the Jordan's Landing village was occupied is a fundamental goal of the zooarchaeological analysis. It is hypothesized that the village was occupied year-round, but this hypothesis is born out of expectations that agriculturalists would be sedentary and of observations such as the density of archaeological materials. Neither of these offer concrete evidence as to the seasons of occupation. Fortunately, evidence from faunal remains in the four assemblages can be used to address this issue.

The assemblage best suited for a seasonality assessment is that recovered from the ditch, Feature 1, as it contains food remains that were deposited over an extended period of time as opposed to the remaining three features, which were filled relatively quickly. A large number of trash pits containing faunal materials that had been analyzed would clearly be most desirable. While Features 21, 41, and 43 do contain materials that can be placed in a season, they alone cannot adequately represent four seasons. Test implications of the hypothesis simply call for the presence of animal remains deposited in all four seasons. Evidence of site seasonality can exist in a variety of forms including the age of young-of-the-year animals; dental annuli in mammals (Bourque et al. 1978); growth rings in fish scales, otoliths, and spines (Casteel 1976; Morey 1983); and presence or absence of deer antlers (Davis 1987), among other things. The four seasons defined here are winter (mid-December to February), spring (March to mid-June), summer (mid-June to mid-September), and fall (mid-September to mid-December).

Seasonality of Mammal Remains from Feature 1

Feature 1 contains remains from a number of juvenile individuals of various species. The age (in months) of each individual was used to determine the season of death by taking the month in which most individuals in the species are born and adding the age at death. Techniques for aging the animals were obtained largely from the wildlife biology literature. While no single technique is considered to offer extremely accurate results—they are no doubt compromised by factors such as geographic variation in ontogeny and reproductive cycle—all are assumed to be accurate enough to place age at death within the three-month period required by the test implications of the hypothesis.

Table 5.1 lists evidence from Feature 1, along with the season of death and references for the techniques used to assess that season. Birth periods for all species were obtained from Burt and Grossenheider (1976). Ages assigned to specimens appear in parentheses in the "evidence" section of the table.

Several of the specimens assigned to seasons require some clarification. The unfused distal femur of a deer is aged at <3 months, though Purdue (1983) can only place it at <23–24 months. Comparison of this specimen with comparative specimens reveals that it is of the size and state of development of a fawn, less than 3 months of age. The metacarpal and metatarsal fragments were aged similarly, though at 7–9 months. The raccoon right parietal can be aged at <8 months (Junge and Hoffmeister 1980) based on cranial suture obliteration, but this age can be refined somewhat by the size of the bone. A beaver right

Table 5.1. Evidence for Season of Occupation from Mammal Remains in Feature 1.

Season	Evidence	Reference
Odocoileus virginianus		
Fall/Winter	Antler fused to frontal fragment	Sevringhaus and Cheatum (1956)
Winter	Distal metacarpal, juvenile (7–9 months)	-
Winter	Distal metatarsal, juvenile (7–9 months)	-
Winter	Mandible with teeth, juvenile (7–9 months)	Sevringhaus (1949)
Winter	Calcaneum with half fused epiphysis (20–23 months)	Purdue (1983)
Late Spring/Summer	Medial phalange with unfused epiphysis (<4 months)	Purdue (1983)
Late Spring/Summer	Unfused distal femur, juvenile (<3 months)	-
Procyon lotor		
Summer	Left juvenile mandible (2 months)	Montgomery (1964)
Summer	Right juvenile mandible (2 months)	Montgomery (1964)
Summer	Left juvenile mandible (3 months)	Montgomery (1964)
Late Summer/Fall	Right juvenile parietal (4–8 months)	Junge and Hoffmeister (1980)
Spring	Maxillary fragment with teeth (12–14 months)	Montgomery (1964) Grau et al.(1970)
Late Winter/Early Spring	Fragmented skull with teeth (maxillary-premaxillary suture, tooth wear, 10–12 months)	Junge and Hoffmeister (1980) Grau et al.(1970)
Castor canadensis		
Spring	Right frontal, unfused but large size (11–13 months)	Robertson and Shadle (1954)

frontal is aged at <10–12 months (Robertson and Shadle 1954), but this age is refined according to its size relative to comparative specimens.

Conclusion

The evidence listed in Table 5.1 has representation of all four seasons. Given this result, the hypothesis that the village was not seasonally abandoned should be tentatively accepted, based on the seasonality of the mammal remains from Feature 1. Although evidence for winter occupation is more poorly defined than summer and spring, there is clear evidence of winter occupation. Note that five of the seven deer elements aged appear to have been late fall or winter kills. If the fused deer antler was from a winter kill rather than fall, there might be a void in evidence for fall occupation. Given the evidence of agriculture at the site (Phelps 1983:44–46), however, it is highly unlikely that the village would be abandoned before harvest in the fall and equally unlikely that it would be entirely abandoned for short time periods, as between the harvest and the onset of winter.

Analysis of the remaining features was not conducted in entirety. However, there are some obvious indications as to the seasons in which they were filled. Another fused deer antler was found in Feature 43, strong evidence of fall or winter season. Feature 41 contains a raccoon temporal bone fragment aged at 2–3 months (late spring/early summer) and a distal phalanx from a deer aged at 1–1.5 months (spring). Features 21 and 41 both

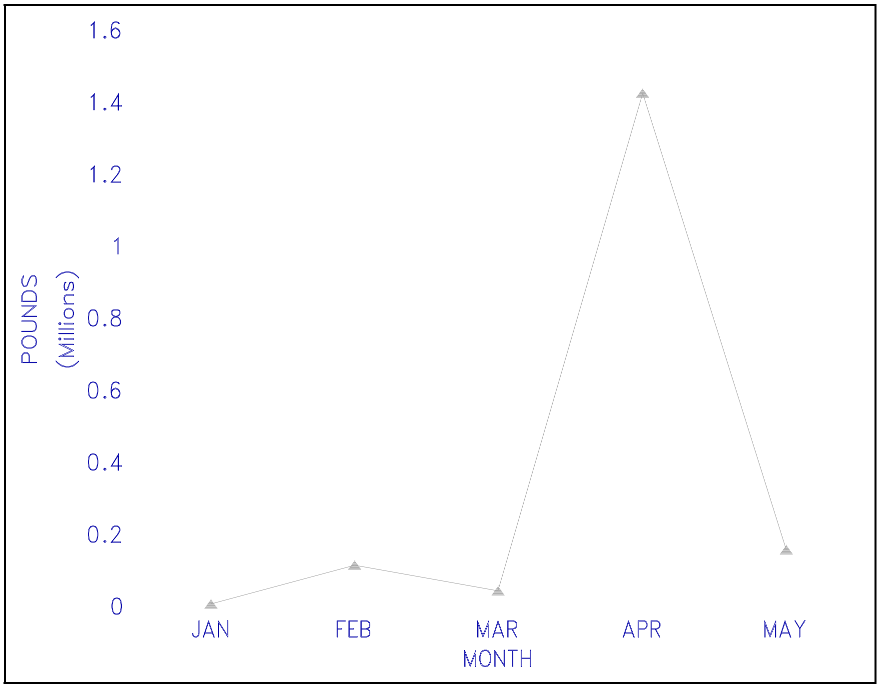


Figure 5.1. North Carolina commercial landings of the alewife in the Northern District by month in 1992. Source: North Carolina Division of Marine Fisheries.

contain anadromus fishes (clupeids, stripers, and sturgeon). Anadromous fish run the Roanoke River in large numbers in the spring, and the herring are noted for being particularly abundant and easy to catch. April is the peak month for the herring run (see Figure 5.1).

Chapter 6

SUBSISTENCE PRACTICES IN THE LATE PREHISTORIC PERIOD: THE VIEW FROM THE JORDAN'S LANDING SITE

In a review of Cashie phase research Phelps (1983:46) described the subsistence data from the Jordan's Landing site as:

> typical of a multiple adaptive pattern; maize and beans have been reclaimed from the ditch and hearths, along with charred hickory nutshells, a wide range of fauna including bear, deer, raccoon, opossum, rabbit, and other mammals; numerous fish; turtle and terrapin; and turkey and mussel. The wide variety of food resources clarifies the choice of site location where all of these natural foods were available, and arable land for agriculture was also adjacent [Phelps 1983:46].

At the time of that publication there had been no detailed analyses of faunal remains from any Cashie phase site, including Jordan's Landing. Consequently, only general statements were possible. This study is the first attempt to generate subsistence data that can be utilized to both answer basic questions about the village and provide a basis for the design of more sophisticated subsistence models for the Cashie phase. Phelps's initial impressions of subsistence practices have been confirmed, and it is now clear that the Jordan's Landing villagers were largely sedentary, relied heavily on aquatic animal resources as a source of protein, and exploited a wide variety of animal species regularly.

Table 2.1 lists the species observed in the four assemblages. Several of these, including deer, opossum, squirrel, snapping turtle, box turtle, gar, bowfin, white bullhead, yellow bullhead, striped bass, and mussels of the genus *Elliptio*, appear in all four features. The diversity analysis reported in Chapter 4 indicates that there was an appreciable degree of regularity in the high number of species consumed. The abundance and predictability of the species listed above would have contributed to that regularity. Most of these species were available year-round to the villagers, and it is hypothesized that they were staples in the diet.

The mammals exploited by the villagers could have been found in any of the terrestrial microhabitats surrounding the site. It is inferred that venison was in good supply for at least some periods, as evidenced by the occurrence of several whole deer long bones and a high count for phalanges. These would have been smashed by the villagers and chewed by their dogs in times of need (see Chapter 3). The deer populations could have flourished in the edge habitat created when the fields were cleared for planting as well as in old fields left to be reclaimed by forest. It is important to note, however, that large mammal species such as deer reproduce at a relatively low rate. Consequently, it would have been possible for a sedentary population of humans to hunt a local deer population to extinction (see Gramly 1977). The Tuscarora winter hunting party observed by Lawson (see Chapter 1) at the turn of the eighteenth century was probably on an extended hunting foray because deer and other large mammals were no longer available in sufficient numbers close to the home village. The fur trade of the seventeenth and eighteenth centuries no doubt exacerbated a problem that began when agriculture and sedentism led to increased population densities in the late prehistoric period.

Large mammal hunting was most reasonably done in the winter season because the animals' furs were most suitable for making clothing at that time but also because the attractiveness of alternative subsistence activities (i.e., fishing, farming, collecting turtles) was at a minimum during the coldest months. It is possible that extended large mammal hunting forays were a part of the yearly cycle at the Jordan's Landing village. Note that five of the seven deer elements that could be aged (see Chapter 5) were late fall or winter kills. However, there is no evidence suggesting that the village was entirely abandoned during the winter months. Further, most of the deer carcasses were transported to the village in their entirety, suggesting that deer hunters were not away from the village for an extended period of time. It is unlikely that winter hunting quarters of the size seen in the historic period were adopted until the fur trade began. Further steps in addressing this issue should include seasonality studies of other Cashie phase villages and the search for prehistoric seasonal hunting camps.

Phelps (1983:46–47) has noted that the Thorpe site (31NS3) is a reasonable candidate for one of these winter camps. Features containing Cashie ceramics and hickory nuts suggest that the site was occupied during the late fall and/or early winter during the late prehistoric period (Phelps 1980). The most abundant animal taxon represented is deer (Phelps 1980). The faunal materials from this important site should be formally analyzed and site seasonality determined since it is possible that the plant remains were stored for some period of time before being deposited in the features. A cursory look at the faunal materials from the Thorpe site has been made by the author, and it was noted that those deer remains that could be aged were consistent with a winter season of death. The bone fragments are generally in such poor condition that taphonomic bias might explain the large proportion of deer bone fragments. Nevertheless, the faunal evidence from the Thorpe site, such as it is, is consistent with expectations for a winter hunter's camp (e.g., large proportion of deer bones in assemblage, winter season of death for animals).

Expectations for patterning in deer hunting during the late prehistoric period are as follows. There should exist a trend during the Cashie phase of decreasing exploitation of the white-tailed deer (relative to population) as human population densities rise. This decreasing exploitation would be the result of increasing costs associated with having to range further and further out from the home area to locate deer populations dense enough to offer the hunter reasonable odds of success. Winter deer hunting by men became standard in Cashie culture because the collection of hides for making clothing became the primary goal of the hunting forays and because this was the season in which hunting did not interfere with other, more productive subsistence endeavors. Test implications for this hypothesis include decreasing proportions of deer (taking into account taphonomic variables) through time in Cashie phase faunal assemblages along with more intensive processing of each deer carcass, as evidenced by the degree of bone smashing. The majority of deer remains in later Cashie assemblages should be winter kills.

Bird remains in the Jordan's Landing assemblages consisted mainly of turkey. Wild turkey are common in the site vicinity today and prefer the lowland forested areas, usually on Chewacla Series soils (U.S. Department of Aqriculture 1990). With the exception of a single bobwhite quail bone, medium and small size birds are entirely lacking in the assemblages. The scarcity of waterfowl remains could be surprising to some since winter waterfowl populations are high in the Roanoke River watershed today and were presumably so in the past. However, waterfowl are very difficult to exploit with primitive weapons and were probably determined to be not worth the effort, given an abundance of low-cost alternatives (medium-sized mammals, fish, turtles, etc.). It is also likely that the winter season focus on deer hunting for hides precluded any serious attempts at taking waterfowl. The possibility of unknown treatment of the waterfowl carcass or another taphonomic agent being to blame for the lack of waterfowl remains must be considered. Nevertheless, it is hypothesized that waterfowl were not heavily exploited during the Cashie phase. The primary test implication is the low frequency of waterfowl remains in Cashie phase deposits. It must be demonstrated that waterfowl remains were not selectively removed by taphonomic agents in the deposits under consideration before negative evidence can be taken seriously.

The aquatic species observed in the site are the most diverse and the most numerous (as measured by numbers of individuals). Reptiles include snapping turtles, cooters, water snakes (genus *Nerodia*), and cottonmouth moccasins. Amphibians are represented by the bullfrog. Fish species include a strong representation of the holostean gar and bowfin. The large proportion of bone fragments recovered belonging to these two species has been shown to be at least partly related to their robusticity (see Chapter 3). However, the relatively high MNI estimates must also result from the large number of individuals introduced into the features. It is likely that gar and bowfin were available to the villagers in abundance, particularly in the summer when anaerobic conditions in the shallow waters of the swamps would drive most other species into deeper waters. Gar and bowfin are able to gulp air from the surface. Such behavior would make them easy targets for gigs. Teleostean fishes that are well represented include several ictalurids (white bullhead, yellow bullhead, brown bullhead), clupeids(herring and shad), white perch, striped bass, pickerel, largemouth bass, sunfish, and American eel. There is a large number of the estaurine Atlantic croaker in Feature 21, somewhat unusual for that stretch of the river (30 miles from Albemarle Sound). It is unclear whether these Atlantic croakers were obtained in trade or caught in the Roanoke during a dry spell, when they might have made their way unusually far up the river. The abundance of anadromous fishes in the feature with the Atlantic croaker remains suggests that these were deposited in spring (see Chapter 5). Since spring is typically a time of high precipitation in the site locale, it is more plausible to interpret the estaurine fish as trade items.

The location of the village next to the intersection of a small stream with the river (a pattern common to many of the Cashie phase sites) may be related to the abundant aquatic resources that cluster near the confluence of such streams with rivers. Other important qualities of a stream junction include the presence of cleaner drinking water in the creek, more abundant fauna in the river, and the ability to set up fish traps in the shallower, more protected waters of the creek.

The heavy emphasis on aquatic resources by the villagers was related at least partly to three significant characteristics that make these taxa attractive to sedentary hunters as a food resource. The first is that aquatic resources are relatively easy to locate given an understanding on the part of the hunter of what lies below the water's surface. Mussels are largely sedentary and tend to live in large clusters where habitat is suitable. To locate one mussel is to locate many. Many species of fish and turtles are potentially highly mobile but will usually position themselves in certain microhabitats such as next to submerged stumps and branches. When a specific location is overfished, new individuals will often replace those taken after some period of time. Thus, prehistoric hunters of fish and turtles could identify "hot spots" on which to concentrate their efforts just as modern fisherman do today.

The second characteristic of aquatic taxa is their great abundance. A river system such as the Roanoke is host to a large number of animal taxa *that can be exploited by humans*. The biomass supported by the river is not proportionally (per unit area) greater than that of the adjacent uplands; however, most of the biomass in the uplands consists of taxa that are not edible for humans, such as trees. What matters to human hunters is the edible animal biomass supported per unit area, which is suggested here to be considerably higher in the Roanoke River near the Jordan's Landing site than in the adjacent uplands. Developing estimates of the edible biomass that would have been available in the river and on land in the past is unfortunately beyond the scope of this analysis.

A third important characteristic of the aquatic taxa is that they are relatively easy to catch and process. Mussels are simply plucked off the bottom and heated until the shells pop open. Both turtles and fish can be taken with hook and line but the most productive methods for taking these vertebrate taxa involve the use of nets, baskets, and a variety of traps. These latter methods involve some initial costs in having to construct the devices. However, the returns can easily be large enough to justify the efforts. In addition, the use of special devices to take fish and turtles greatly reduces the uncertainty inherent in hook-and-line fishing. No direct evidence for the presence of these special devices has been recovered from the Jordan's Landing site, though bone fish hooks have been. The large quantities of herring provide indirect evidence for the use of traps insomuch as they are not known for being readily catchable on hook and line. Further, the sizes of the hooks recovered in the site are too large to catch herring. Both fish and turtles are relatively easy to process. Indeed, both could have been simply tossed into the stew pot whole or processed in any number of simple ways.

The information obtained through this study makes possible the formulation of several hypotheses concerning subsistence during the Cashie phase. It is hypothesized that the location of Cashie phase settlements was generally on arable land (sandy loam ridges) near the confluence of a stream with a river or other stream. This setting was chosen because of its agricultural potential as well as its proximity to excellent habitat for taking aquatic prey species. The shallower creeks may also have been necessary for the construction of weirs and/or the setting of traps and for obtaining cleaner drinking water. The relatively high diversity of the species exploited by the villagers suggests that a variety of animals were eaten, most of which were accessible in the site locality. It is expected that similarly high diversity values for prey species will characterize other Cashie phase village sites. It is hypothesized that the annual cycle during the Cashie phase was not marked by the movement of whole villages to hunting quarters in the winter, though temporary deer hunting forays were common in the winter season.

There are two major aspects of the subsistence data from Jordan's Landing that assume key roles in a model of Cashie phase subsistence. The first is the importance of agriculture which offered dependable, storable sustenance and encouraged sedentism. The second is the orientation toward the aquatic resources that are so abundantly represented in the Jordan's Landing assemblages. Like the agricultural products many of the aquatic species were easy to collect, especially given the technology dof fish traps, weirs, hooks, etc. (see above). They were also available to some degree in every season of the year. In short, aquatic resources were a reliable source of protein and other nutrients for a sedentary population. While the terrestrial species such as the white-tailed deer were clearly of importance as well, it is suggested here that the exploitation of aquatic resources was a more influential factor in Cashie culture. An example of this influence is the placement of villages in locations ideal for taking fish, turtles, and so on as discussed above. Sedentary peoples have by becoming sedentary partly forsaken the hunting of large mammals as a primary subsistence focus.

No direct evidence of food storage in the Jordan's Landing site was discovered during this study. The apparent complexity of Cashie phase culture suggests that food storage was practiced by the villagers (see Chapter 1) and it appears quite likely that corn and beans were stored in the fall to last until the next harvest. It is clear that the dramatic runs of anadromous fishes in the spring were taken advantage of. Herring, strongly represented in Features 21 and 41 as well as other features not formally analyzed to date, were caught in great numbers and possibly smoked and dried so that they could be stored for later use. Sturgeon and striped bass could have been stored as well but were not taken in numbers comparable to the herring. The archaeological visibility of fish storage technology could be very low but might include the recovery of storage pits containing fish, features containing anadromous fish that are demonstrably not from spring season depositions, or differential depositional patterns for certain fish bone parts (i.e., fish heads only in certain trash pits). Future studies will hopefully clarify this issue of fish storage.

The expectations for Cashie phase subsistence outlined in the opening chapter appear to have been met with perhaps one important exception. Food storage is now inferred but has not been in any way demonstrated. Nevertheless, there are reasons to propose that Cashie phase people were sedentary, regularly consumed a wide variety of animal species, and focused their hunting efforts on aquatic animal species. These interpretations are largely based on limited samples from a single site. It is likely that there was temporal and spatial variation in subsistence within the phase and this variation must not be swept under an intellectual rug by making generalizing assumptions with the results reported here that are treated as conclusions. The purpose of this study was to initiate zooarchaeological research of the Cashie phase. This now done, it is time to move forward. Recommendations for further research include analysis of additional faunal materials from the Jordan's Landing site to test certain of the hypotheses proposed above; excavation of other Cashie phase village sites with good faunal and floral preservation; analyses of faunal remains from other Cashie phase villages to assess seasonality and diversity to compare with that of the Jordan's Landing site, an assessment of Cashie phase site types to explore possibilities of seasonal activities such as winter hunting forays; and analysis of faunal remains from nonvillage sites that are candidates for winter hunting quarters or camps.

REFERENCES CITED

Arnold, J. E.

1996 Understanding the evolution of intermediate societies. In *Emergent Complexity: the Evolution of Intermediate Societies*, edited by J. E. Arnold. International Monographs in Prehistory, No. 9.

Barnwell, J.

1908 The Tuscarora expedition: letters of Colonel John Barnwell. *South Carolina Historical and Genealogical Magazine* 9(1):28–54.

Behrensmeyer, A. K.

1975 The taphonomy and paleoecology of plio-pleistocene vertebrate assemblages east of Lake Rudolf, Kenya. *Bulletin of the Museum of Comparative Zoology* 146(10):473–578.

1984 Taphonomy and the fossil record. *American Scientist* 72(6):558–566.

Binford, L. R.

1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

1981 *Bones: Ancient Men and Modern Myths*. Academic Press, New York.

Binford, L. R., and J. B. Bertram

1977 Bone frequencies—and attritional processes. In *For Theory Building in Archaeology*, edited by L. R. Binford, pp. 77–153. Academic Press, New York.

Bourque, B. J., K. Morris, and A. Speiss

1978 Determining the seasons of death of mammal teeth from archaeological sites: a new sectioning technique. *Science* 199:539–531.

Boyce, D. W.

1975 Did a Tuscarora confederacy exist? In *Four Centuries of Southern Indians*, edited by C. Hudson. University of Georgia Press, Athens.

1978 Iroquoian tribes of the Virginia–North Carolina Coastal Plain. In *Handbook of North American Indians: Northeast Volume XV*, edited by B. G. Trigger, Smithsonian Institution, Washington.

Brain, C. K.

1976 Some principles in the interpretation of bone accumulations associated with man. In *Human Origins: Louis Leakey and the East African Evidence,* edited by G. L. Isaac and E. R. McCown, pp. 96–116. Staples Press, Menlo Park, California.

1981 *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*. University of Chicago Press, Chicago.

Burt, H. B., and R. P. Grossenheider

1976 *A Field Guide to the Mammals: North America North of Mexico*. Houghton Mifflin Co., Boston.

Byrd, J. E.

n.d. Archaeological interpretation gone to the dogs: preliminary results of taphonomic experiments with domestic dogs. Unpublished manuscript, Department of Anthropology, University of Tennessee, Knoxville.

1995 An archaeological inventory of sites within the City of Greenville ETJ with site descriptions and predictive model. Report submitted to the City of Greenville, Planning and Community Development Office, Greenville, North Carolina.

1996a Preliminary report of the archaeological survey of the Contentnea Creek Drainage. Report submitted to the Office of State Archaeology, North Carolina Division of Archives and History, Raleigh.

1996b Disentangling the present condition: Iroquois and Algonkian history as revealed through interpretations of anthropometric, linguistic, and archaeological data. Paper presented at the Conference on Integrating Appalachian Archaeology, New York State Museum, Albany.

1997 The analysis of diversity in archaeological faunal assemblages: Complexity and subsistence strategies in the Southeast during the middle Woodland period. *Journal of Anthropological Archaeology* 16:49–72.

Casteel, R. W.
1976 *Fish Remains in Archaeology and Paleo-environmental Studies*. Academic Press, New York.

Chave, K. E.
1964 Skeletal durability and preservation. In *Approaches to Paleoecology*, edited by J. Imbrie and N. Newell, pp. 377–387. Wiley and Sons, Inc., New York.

Christenson, A. L.
1980 Change in the human food niche in response to population growth. In *Modeling Change in Prehistoric Subsistence Economies*, edited by T. K. Earle and A. L. Christenson. Academic Press, New York.

Cumming, W. P.
1955 *The Discoveries of John Lederer*. University Press of Virginia, Charlottesville.

Custer, J. F.
1988 Coastal adaptations in the Middle Atlantic Region. *Archaeology of Eastern North America* 16:121–135.

Davis, S. J. M.
1987 *The Archaeology of Animals*. Yale University Press, New Haven.

Drennan, R. D. and C. A. Uribe
1987 Introduction. In *Chiefdoms in the Americas*, edited by R. D. Drennan and C. A. Uribe. University Press of America, Lanham, Maryland.

Efremov, I. A.
1940 Taphonomy: a new branch of paleontology. *Pan-American Geologist* 74:81–93.

Etnier, D. A., and W. Starnes
1994 *The Fishes of Tennessee*. University of Tennessee Press, Knoxville.

Gifford, D. P.
1981 Taphonomy and paleoecology: a critical review of archaeology's sister disciplines. In *Advances in Archaeological Method and Theory*, Vol.4, edited by M.B. Schiffer, pp.365–438. Academic Press, New York and London.

Gramly, R. M.
1977 Deerskins and hunting territories: competition for a scarce resource of the northeastern woodlands. *American Antiquity* 42(4):601–605.

Grau, G. A., G. C. Sanderson, and J. P. Rogers
1970 Age determination of raccoons. *Journal of Wildlife Management* 34(2):364–372.

Grayson, D. K.
1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas.* Academic Press, New York.

Guthrie, R. D.
1967 Differential preservation and recovery of Pleistocene large mammal remains in Alaska. *Journal of Paleontology* 41:243–246.

Haag, W. G.
1948 An osteometric analysis of some aboriginal dogs. *University of Kentucky, Reports in Anthropology* 7(3):107–264.

Hayden, B.
1981 Research and development in the stone age: technological transitions among hunter-gatherers. *Current Anthropology* 22(5):519–537.

Hill, K., K. Hawkes, M. Hurtado, and H. Kaplan
1984 Seasonal variance in the diet of the Ache hunter-gatherers in eastern Paraguay. *Human Ecology* 12(2):101–135.

Hill, M. O.
1973 Diversity and evenness: a unifying notation and its consequences. *Ecology* 54(2):427–432.

Johnson, E.
1985 Current developments in bone technology. In *Advances in Archaeological Method and Theory*, Vol. 8, edited by M. B. Schiffer, pp. 157–235. Academic Press, New York.

Johnson, R. I.
1970 *The Systematics and Zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region.* Bulletin of the Museum of Comparative Zoology, Vol.140, No. 6. Harvard University, Cambridge, Massachusetts.

Jones, A. K. G.
1986 Fish bone survival in the digestive systems of the pig, dog and man: some experiments. In *Fish and Archaeology*, edited by D. C. Brinkhuizen and A. T. Clason. British Archaeological Reports International Series, No. 294, Oxford.

Junge, R., and D. F. Hoffmeister
1980 Age determination in raccoons from cranial suture obliteration. *Journal of Wildlife Management* 44(3):725–729.

Keeley, L. H.
1988 Hunter-gatherer economic complexity and "population pressure": A cross-cultural approach. *Journal of Anthropological Archaeology* 7:373–411.

Klein, R. G., and K. Cruz-Uribe
1984 *The Analysis of Animal Bones from Archaeological Sites*. University of Chicago Press, Chicago.

Kleinbaum, D. G., and L. L. Kupper
1978 *Applied Regression Analysis and Other Multivariable Methods*. Duxbury Press, Boston.

Klippel, W. E., L. M. Snyder, and P. W. Parmalee
1987 Taphonomy and archaeologically recovered mammal bone from southeast Missouri. *Journal of Ethnobiology* 7(2):155–169.

Laney, R. W., D. L. Stewart, G. R. McCrain, C. Mayes, and V. C. Bruton
1988 *Final Report on the North Carolina Department of Transportation Company Swamp Mitigation Bank, Bertie County, North Carolina*. U.S. Department of the Interior, Fish and Wildlife Service, Raleigh, North Carolina.

Lanyon, L. E., and C. T. Rubin
1985 Functional adaptation in skeletal structures. In *Functional Vertebrate Morphology*, edited by M. Hildebrand, D. M. Bramble, K. F. Liem, and D. B. Wake, pp.1–25. Belknap Press, Cambridge.

Lawson, J.
1967 *A New Voyage to Carolina*, edited by H.T. Lefler. University of North Carolina Press, Chapel Hill.

Lee, R. B.
1979 *The !Kung San: Men, Women, and Work in a Foraging Society*. Cambridge University Press, Cambridge.

Lyman, R. L.
1982 *The taphonomy of vertebrate archaeofaunas: bone density and differential survivorship of fossil classes*. Unpublished Ph.D. dissertation, University of Washington, Seattle.

1984 Bone density and differential survivorship of fossil classes. *Journal of AnthropologicalArchaeology* 3:259–299.

1985 Bone frequencies: differential transport, *In Situ* destruction, and the MGUI. *Journal of Archaeological Science* 12:221–236.

1994 *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

Metcalfe, D., and K. T. Jones
1988 A reconsideration of animal body-part utility indices. *American Antiquity* 53(3):486–504.

Montgomery, G. G.
1964 Tooth eruption in preweaned raccoons. *Journal of Wildlife Management* 28(3):582–584.

Morey, D. F.
1983 Archaeological assessment of seasonality from freshwater fish remains: a quantitative procedure. *Journal of Ethnobiology* 3:75–95.

Morey, D. F., and W. E. Klippel
1991 Canid scavenging and deer bone survivorship at an Archaic Period site in Tennessee. *Archaeozoologia* IV:11–28.

Nicholson, R. A.
1992 Bone survival: the effects of sedimentary abrasion and trampling on fresh and cooked bone. *International Journal of Osteoarchaeology* 2(1):79–90.

Noble, W. C.

1985 Tsouharissen's chiefdom: an early historic 17th century Neutral Iroquoian ranked society. *Canadian Journal of Archaeology* 9(2):131–146.

Olsen, S. J.

1985 *Origins of the Domestic Dog: The Fossil Record*. University of Arizona Press, Tuscon.

Parramore, T. C.

1982 The Tuscarora ascendancy. *The North Carolina Historical Review* LIX(4):309–326.

Payne, S., and P. J. Munson

1985 Ruby and how many squirrels? The destruction of bones by dogs. In *Paleobiological Investigations: Research Design, Methods, and Data Analysis*, edited by N. R. J. Fieller, D. D. Gilbertson, and N. G. A. Ralph, pp. 31–48. Symposia of the Association for Environmental Archaeology, No.5B, British Archaeological Reports International Series, No. 266, Oxford.

Peterson. R. T.

1980 *A Field Guide to the Birds*. Houghton Mifflin Co., Boston.

Phelps, D. S.

1980 *Archaeological Salvage of the Thorpe Site and Other Investigations Along the U.S. 64 Bypass, Rocky Mount, North Carolina.* Archaeological Research Report No. 1, Archaeology Laboratory, Department of Sociology and Anthropology, East Carolina University, Greenville.

1983 Archaeology of the North Carolina Coast and Coastal Plain: problems and hypotheses. In *The Prehistory of North Carolina: An Archaeological Symposium*, edited by M. A. Mathis and J. J. Crow, pp. 1–51. North Carolina Division of Archives and History, Department of Cultural Resources, Raleigh.

1984 *Archaeology of the Tillet Site: The First Fishing Community at Wanchese, Roanoke Island.* Archaeological Research Report No. 6, Archaeology Laboratory, Department of Sociology and Anthropology, East Carolina University, Greenville.

Price, T. D., and J. A. Brown

1985 Aspects of hunter-gatherer complexity. In *Prehistoric Hunter-Gatherers: the Emergence of Cultural Complexity*, edited by T. D. Price and J. A. Brown. Academic Press, Orlando.

Purdue, J. R.

1983 Epiphyseal closure in white-tailed deer. *Journal of Wildlife Management* 47(4):1207–1213.

Putman, R. J., and S. D. Wratten

1984 *Principles of Ecology*. University of California Press, Berkeley and Los Angeles.

Quinn, D. B.

1991 *The Roanoke Voyages 1584–1590*, Volume 1. Dover Publications, New York.

Redmond, W. H., A. C. Echternacht, and A. F. Scott

1990 *Annotated Checklist and Bibliography of Amphibians and Reptiles of Tennessee (1835 through 1989).* Miscellaneous Publications of The Center for Field Biology No. 4, Austin Peay State University, Clarksville, Tennessee.

Robertson, R. A., and A. R. Shadle

1954 *Osteologic criteria of age in beavers*. Journal of Mammalogy 35(2):197–203.

Robins, C. R., G. C. Ray, and J. Douglas
1986 *A Field Guide to Atlantic Coast Fishes of North America*. Houghton Mifflin Co., Boston.

Salley, A. S.
1911 *Narratives of Early Carolina*. Charles Scribner's Sons, New York.

Service, E. R.
1962 *Primitive Social Organization: An Evolutionary Perspective*. Random House, New York.

Sevringhaus, C. W.
1949 Tooth development and wear as criteria of age in white-tailed deer. *Journal of Wildlife Management* 13(2):195–216.

Sevringhaus, C. W., and E. L. Cheatum
1956 Life and times of the white-tailed deer. In *The Deer of North America,* edited by W. P. Taylor, pp. 57–186. Stackpole Co., Harrisburg, Pennsylvania.

Shipman, P., G. Foster, and M. Schoeninger
1984 Burnt bones and teeth: an experimental study of color, morphology, crystal structure, and shrinkage. *Journal of Archaeological Science* 11:307–325.

Smith, B. D.
1986 The archaeology of the southeastern United States: From Dalton to de Soto, 10,500–500 B.P. In *Advances in World Archaeology*, Volume 5, edited by F. Wendorf and A. Close. Academic Press, Orlando.

Snow, D.
1995 Migration in prehistory: the Northern Iroquoian case. *American Antiquity* 60:59–79.

1996 More on migration in prehistory: accommodating new evidence in the Northern Iroquoian case. *American Antiquity* 61(4):791–796.

Speth, J. D.
1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters*. University of Chicago Press, Chicago.

Steponaitis, V. P.
1986 Prehistoric archaeology in the southeastern United States, 1970–1985. *Annual Review of Anthropology* 15:363–404.

Stewart, M.
1990 Clemson's Island studies in Pennsylvania: A perspective. *Pennsylvania Archaeologist* 60:79–107.

Theobald, M. M.
1980 *The Indian Trade in Colonial Virginia.* Unpublished M.A. thesis, Department of History, College of William and Mary, Virginia.

Todd, V. H., and J. Goebel
1920 *Christoph Von Graffenried's Account of the Founding of New Bern.* Edwards and Broughton Printing Co., Raleigh.

Tuck, J. A.
1971 *Onondaga Iroquois Prehistory: A Study in Settlement Archaeology*. Syracuse University Press, Syracuse.

United States Department of Agriculture
1990 *Soil Survey of Bertie County, North Carolina*. Soil Conservation Service, U.S. Department of Agriculture.

Von Endt, D. W., and D. J. Ortner
1984 Experimental effects of bone size and temperature on bone diagenesis. *Journal of Archaeological Science* 11:247–253.

Weast, R. C.
1969 *Handbook of Chemistry and Physics*. The Chemical Rubber Co., Cleveland, Ohio.

Yellen, J. E.
1986 Optimization and risk in human foraging strategies. *Journal of Human Evolution* 15:733–750.

Zar, J. H.
1984 *Biostatistical Analysis*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.