The Starving Time at Jamestown

Faunal Analysis of
Pit 1, Pit 3, the Bulwark Ditch,
Ditch 6, Ditch 7, and Midden 1

James City County, Virginia

Report submitted to:

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Table of Contents

Table of Contents (cont'd)

Page

List of Figures

Page

List of Tables

Page

List of Tables (cont'd)

Page

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Introduction

Excavations in and around James Fort, site of the first permanent English settlement in North America, have produced what are arguably the most significant series of faunal assemblages ever recovered from this region. Dating from the earliest period—"The Starving Time" of 1609-1610—some of the Jamestown assemblages bear testimony to the hardships that the colonists faced during the initial years of settlement. Other assemblages dating to the second quarter of the seventeenth century show that by this time herds of cattle, swine, and goats had become sufficiently established that colonists could rely on domestic mammals as a major, if not primary, source of meat.

For generations, our knowledge of The Starving Time has reinforced our culture's belief that our people's resilience and ability to adapt to an untamed world and survive is in large part due to the abundant wildlife that nourished and sustained them. As the documentary records from Jamestown have shown, the effects of hunger and disease took such a toll on the colonists, that by the spring of 1610 when Sir Thomas Gates, Sir George Somers and others arrived with a small supply of provisions they had brought with them from Bermuda, they found the few remaining survivors near death. Archaeologically, however, we have been unable to provide any faunal data backing up what happened during this period. Until now, excavations have produced nothing dating to this very early period, and consequently it has been impossible to determine the extent to which the earliest colonists depended upon local resources.

Faunal Evidence

Our knowledge of early seventeenth-century (1620-1650) subsistence patterns is based on three decades of research, largely by Henry Miller, now chief archaeologist at St. Mary's City in Maryland, and by members of Colonial Williamsburg's Zooarchaeology Lab (Miller 1984, 1986; Brown 1989; Manning-Sterling 1994; Bowen 1992, 1994a, 1994b, 1995, 1996; Walsh et al. 1997). Synthesizing his work on a number of seventeenth- and early eighteenth-century faunal assemblages, Miller led the way in defining dietary trends, demonstrating that in the 1620-1650 period, wildlife made up a significant portion of the diet, anywhere from 20 to 30% of the meat diet (using a zooarchaeological measure called usable meat weight). But as tobacco plantations began to emerge from the wilderness, colonists began to rely upon domestic livestock, rather than wildlife, for as much as 90% of the total meat diet. Subsequent work by Bowen and others have amplified his work.

These more recent efforts base their relative dietary estimates on *biomass,* an analytical method developed after Miller completed his work (Reitz and Cordier 1983). Since both methods accurately rank the relative importance of mammals, the group that includes the large and relatively heavy domesticated animals, they both have the ability to show the progression in the *relative* dietary importance of wild and domestic species. Thus, both methods show a similar progression of the *ranked dietary importance* of domestic to wild sources of meat. But biomass estimates produce more accurate estimates of meat contributed by fish and other fauna that continue to grow throughout their life span. Since many of the early assemblages contain sizable quantities of fish, we chose to present the most recent data as seen in the biomass estimates. With them, we believe we have produced a more accurate picture of the relative importance of wildlife among colonists who settled throughout the region. For a more complete description of these methods, see Appendix A. Like with meat weight estimates, biomass estimates show that during the 1620-1660 period wildlife consumption ranged from 21% to as little as 6%, but by the late seventeenth century wildlife consumption dropped overall to 9 and 10%.

Until now, there has been no sample from a pre-1620 period, and therefore it has been impossible to measure the extent to which the earliest colonists depended upon wildlife. For the first time, the assemblages from James Fort demonstrate that in ca. 1610, wildlife contributed half of the colonists' meat diet.

Two very small assemblages dating to the second quarter of the seventeenth century show these settlers, like those who lived elsewhere in the colony, established their herds of cattle, pigs, and goats sufficiently that herds of livestock contributed anywhere from 43 to 75% to the total meat diet. See Figure 1. Data from Jordan's Journey, the Hampton University site, the Walter Aston site, Rich Neck Plantation, and the John Page site, each demonstrate the strength of the herds. In just a decade, there was a precipitous drop in wildlife consumption.

The bones recovered from ca. 1610 Jamestown show that early on, the colonists depended heavily on local resources—deer, small mammals, turtles, and fish, as well as herons, cormorants, gulls, and waterfowl. There are also species that are seldom, if ever, found in assemblages dating to the post-1620 period—porpoise, vipers, mud or musk turtles, and chopped-up horse bones. On the surface, this evidence confirms the documents describing how colonists staved off starvation by procuring wild resources and eating the stores of livestock they brought to establish their own herds.

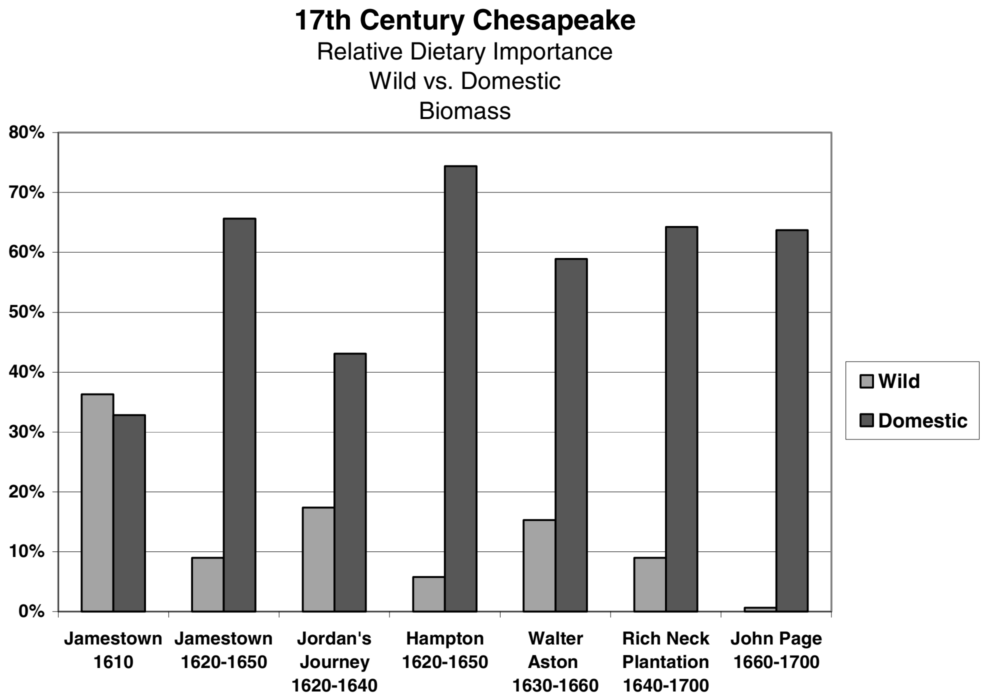

Figure 1.

Analysis of the c. 1610 assemblages, however, has been made difficult by two problems, first that only two assemblages from this period, Pit 3 (B) and Pit 1, are large enough to produce accurate diversity assessments. The second problem is that each of the archaeological features dating to ca. 1610 spans three phases of occupation—the initial occupation in 1607, "The "Starving Time," and the period afterward when Gates arrived in May 1610 with a new group of settlers and food supplies from Bermuda. Since sub-assemblages dating to these phases of occupation could not segregated adequately, and statistical analyses could be strengthened by combining evidence, the decision was made to aggregate data from all three periods into one large "early period" assemblage.

The post-Starving Time period is very important to the overall story. When Gates, Somers, and others, arrived in May, they discovered the colony at the point of collapse. They had not expected to find Jamestown colonists in bad shape, and the supplies they had brought with them did not go far. Nonetheless, supplies they had brought with them from Bermuda are a reminder of the interconnections existing between the various colonies. Present in the Jamestown assemblages are tropical fish, including groupers and snappers, species that do not occur locally. Even more symbolic of this connection is the presence of a species that is found *only* on the island of Bermuda, the cahow (or Bermuda petrel). Specific descriptions of these Bermuda species, and the connection they represent, is outside the scope of this section, but detailed accounts of these species and how British provisioned their colonies are included in Appendix A.

Like the early assemblages, the later sub-assemblages dating from 1620 to 1650 are small. Thus, they too were combined to form a macro-assemblage. Even so, this produced a sample size of only 1883 bone fragments, a quantity that permits only a general assessment of the relative importance of wild to domestic animals, and no accurate reading of the range of wildlife actually consumed. In addition to this problem, the later assemblage represents a relatively long period of time (1620-1650), a situation that limits any precision to our analysis of what happened as the settlement stabilized. Future work with recently excavated assemblages might help to refine our knowledge.

The interpretive section of this report will focus on one period during the early occupation, The Starving Time. Beginning from the viewpoint that colonists arrived in the New World with beliefs about which meats were delicacies, which were desirable, and which were less than desirable, we will look at the array of animals found in the "early period" assemblage to see how colonists selectively chose species from the vast number they encountered. We will learn from the range of species found in these early assemblages that they did not go far from their settlement. Deer is found in conspicuously small quantities, while animals that would have lived nearby, either in the woodlands or in the nearby river and marshlands, are found in abundance.

We will explore yet another level of selectivity. As noted anthropologist, Mary Douglas, has written, humans "make some choices that are not governed by physiological processes. They choose what to eat, when and how often, in what order, and with whom" (Douglas 1984:3). She goes on further to state that while individual choices are based on availability and a person's position in society, decisions are derived from a deep mental structure that categorizes the world and defines how humans interact with nature and each other (Douglas 1966, 1984). Such animals that are thought taboo are resources that are forbidden. Well known today is the Hindu rejection of beef, the Jewish rejection of pork, the Euro-American rejection of dog, horse, and insects, and the American's rejection of heads, feet, and other parts of the animal that resemble their live form.

To evaluate how various species were selected, we will consider high-style medieval food and cuisine. To determine the extent to which colonists suffered from famine, we consulted textbooks to distinguish meats that were desirable medieval foods from those that were taboo. We will see that the species that have been identified in the Jamestown assemblages reads like the "who's who list" in medieval cuisine. Yet, when their situation deteriorated through a combination of factors, including among others drought and disease, they starved, eventually consuming even undesirable or blatantly taboo resources.

The detailed evaluation of the faunal remains, the description of the various species, and description of the methods used in the analysis are relegated to the appendix. This is not to suggest that this data is somehow less essential; in fact, it is the fundamental basis of the conclusions presented here. It is important to realize, however, that the analysis of the animal bone is only one (albeit essential) component of a multi-disciplinary study of this aspect of a critical historical period. These bones provide in many ways an unparalleled window into the past.

A Study of Ca. 1610 Jamestown

For generations, our culture has believed the abundant wildlife found in a new and untamed world sustained and nourished the early colonists (Thomas 1941:7-15). The early assemblages bear testimony to this belief, but the presence of species not traditionally consumed reveals the hardships faced by the colonists during “The Starving Time”, and the presence of some species not found in this region confirms the connection colonists maintained with Bermuda.

The later assemblages are dramatically different—they contain less wildlife, fewer species, and proportionately much greater quantities of cattle. Do these show how and when colonists shifted their focus from hunting and fishing to herding? Unfortunately, we can’t tell yet; the faunal assemblages, even when combined, are statistically too small. To understand the full range of species exploited, more (and larger) assemblages dating to the post-Starving Time period are needed.

Medieval Cuisine

Quantitative evidence from the bone remains supports the common belief that wild animals were plentiful and the rivers were full of fish for the taking, and that during the initial years these sources sustained colonists. These assemblages also confirm, though in ways quantitative data does not reveal, that colonists’ medieval tastes guided their selection of wildlife from the tremendous variety of wildlife they encountered. At the turn of the seventeenth century, Englishmen valued species we do not consider edible today (Mead 1931; Drummond and Wilbraham 1939; Wilson 1974; Henisch 1976; Wheaton 1983; Paston-Williams 1993). As early as the thirteenth century cuisine was highly differentiated. While the poor consumed a diet composed of grains, cheese and other dairy products, salted fish and occasional meats, the nobility hunted and consumed a diet of primarily meat, with “fish days” devoted to a variety of fresh fish. In fact, the consumption of meats of all kinds and fresh fish signified social class. To protect their resource, they forbid the poor to hunt, enclosed wastelands to make parks for game, and built ponds to keep fish and to attract fowl. With music, dancing, and great flair, the great lords prepared banquets that included literally hundreds of animals, among them oxen, wild bulls, sheep, calves, swans, geese, capons, pigs, peacocks, small and large birds, deer, sturgeon, pikes, breams, porpoises, and seals. The paramount showpieces of the medieval banquet were roasted swan and peacock, skinned and roasted, then sewn back the skin, complete with feathers. With fitting ceremony, the feet and beak of peacocks were often were gilded with gold (Wheaton 1983).

At the end of the late fifteenth century, this high-style cuisine changed, first in Italy then later in France and England (Wheaton 1983; Mennell 1985; Paston-Williams 1993). Fewer exotic meats were served, and in their place were “made dishes,” delicately prepared dishes of single pieces of familiar butcher’s meats. In this new cuisine, pungent sauces made of spices, vinegar and fruit made way for rich sauces made from beef, veal, pork, and other meats. In the Elizabethan period yet another change occurred, this one in meal patterns. Now, the nobility took their meals more often in private, although banquets were still held for special occasions, and they continued to be conspicuously overwhelming displays of many dishes of meat.

No doubt, either through personal experience or through observation, the Jamestown colonists had knowledge of this cuisine. In the New World, they were surrounded by what were to them exotic, highly prized animals, there for the taking. Even if they did not know how to prepare the high style dishes, one would expect that, given an opportunity, they would have sought out the prized foods.

In many ways the early-period assemblage supports the interpretation that the first colonists sought out prized animals. Along with domestic livestock are many wild species, including those we no longer think of as food (among them crow, cormorant, ring-billed gull, and bottle-nosed dolphin). Other animals include deer, raccoon, beaver, cottontail, Canada goose, snapping turtle, and slider (Table 1).

In medieval England, highly valued “royal fish” included the sturgeon, porpoise, seal, and whale (Wilson 1974:31-48). By the late medieval period, whales virtually ceased to be eaten, and porpoises were gradually losing favor, though many still cultivated a taste for baked porpoise. It was the venison of fish day, boiled and served with frumenty, or baked with spices in a pasty. Still highly valued was the sturgeon, but as royalty often waived their ancient claim to them, commoners could occasionally catch them in the Severn or Thames.

Table 1.
Early Jamestown Assemblages, ca. 1610
Biomass Percentages

	Pit 1 (N=3,970)	Pit 3 (A) (N=189)	Pit 3 (B) (N=7,803)	Bulwark Ditch (A-C) (N=164)	Bulwark Ditch (D) (N=390)
	Biomass	Biomass	Biomass	Biomass	Biomass
FISH	**20.8**	**11.8**	**7.6**	**10.2**	**4.2**
Shark	xx	xx	>0.1	xx	xx
Skates/Rays	<0.1	>0.1	>0.1	xx	xx
Sturgeon	18.1	10.0	6.5	9.5	3.6
Gar	0.5	0.2	0.1	xx	xx
Herring	<0.1	0.1	<0.1	xx	xx
Shad	xx	0.5	<0.1	0.4	0.3
Sucker	0.5	0.3	0.1	xx	xx
Catfish	0.8	0.6	0.3	0.2	0.1
Pickerel	<0.1	xx	xx	xx	xx
Codfish	0.1	xx	<0.1	0.1	0.2
Sunfish	<0.1	xx	xx	xx	xx
White Perch	0.7	xx	0.1	xx	xx
Striped Bass	<0.1	xx	<0.1	xx	xx
Grouper	xx	xx	0.4	xx	xx
Yellow Perch	xx	xx	xx	xx	xx
Snapper	xx	xx	<0.1	xx	xx
Sheepshead	<0.1	xx	<0.1	xx	xx
REPTILES	**11.7**	**2.7**	**1.7**	**xx**	**1.1**
Snapping Turtle	0.2	1.9	0.4	xx	xx
Musk/Mud Turtle	1.0	xx	<0.1	xx	xx
Slider/Cooter Turtle	3.7	0.8	0.5	xx	0.7
Diamondback Terrapin Turtle	xx	xx	0.1	xx	xx
Box Turtle	3.4	0.8	0.7	xx	0.4
Sea Turtle	3.4	xx	xx	xx	xx
Snake	<0.1	xx	<0.1	xx	xx
Viper	<0.1	xx	<0.1	xx	xx
WILD BIRDS	**3.6**	**6.9**	**3.2**	**0.5**	**2.9**
Cormorant	0.2	xx	0.1	xx	xx
Bermuda Petrel	0.1	0.2	<0.1	xx	xx
Goose spp.	0.5	1.0	0.7	0.4	>0.1
Canada Goose	1.9	2.4	1.2	xx	0.4
Wild Ducks	0.6	xx	0.5	0.1	<0.1
Killdeer	<0.1	xx	xx	xx	xx
Ring-billed Gull	xx	xx	<0.1	xx	xx
Hawk	<0.1	xx	xx	xx	xx
Bald Eagle	xx	xx	0.2	xx	0.2
Turkey	0.2	3.2	0.4	xx	2.3
Owl	<0.1	xx	xx	xx	xx
Bobwhite	xx	xx	<0.1	xx	xx
Crow	xx	0.1	<0.1	xx	xx
Woodpecker	<0.1	xx	<0.1	xx	xx
WILD MAMMALS	**11.7**	**10.2**	**7.1**	**43.9**	**23.8**
Opossum	0.5	0.5	0.1	xx	0.7
Cottontail	xx	xx	<0.1	xx	x
Woodchuck	xx	xx	xx	xx	0.2
Grey Squirrel	0.3	0.9	0.2	0.1	0.4

Table 1 (cont'd).
Early Jamestown Assemblages, ca. 1610
Biomass Percentages

	Pit 1 (N=3,970)	Pit 3 (A) (N=189)	Pit 3 (B) (N=7,803)	Bulwark Ditch (A-C) (N=164)	Bulwark Ditch (D) (N=390)
	Biomass	**Biomass**	**Biomass**	**Biomass**	**Biomass**
MAMMALS (cont'd)					
Fox Squirrel	0.3	xx	0.1	xx	0.3
Beaver	0.4	xx	<0.1	0.6	0.8
Muskrat	<0.1	xx	0.2	0.1	0.1
Dolphin	3.7	xx	0.8	16.3	xx
Raccoon	0.9	2.7	0.5	0.3	1.9
River Otter	xx	xx	<0.1	xx	xx
Mink	xx	xx	<0.1	xx	x
Deer	5.6	6.1	5.1	26.5	19.4
COMMENSALS	**15.3**	**xx**	**0.2**	**7.2**	**5.6**
Black Rat	0.1	xx	0.1	xx	<0.1
Cat	0.2	xx	xx	xx	xx
Dog	0.6	xx	0.1	7.2	1.5
Horse	14.4	xx	xx	xx	4.1
DOMESTIC BIRDS	**0.3**	**2.2**	**0.2**	**xx**	**0.2**
Domestic Goose	0.2	1.5	0.1	xx	xx
Chicken	0.1	0.7	0.1	xx	0.2
DOMESTIC MAMMALS	**21.0**	**42.4**	**19.7**	**23.1**	**27.5**
Cattle	14.0	21.8	15.0	8.0	11.1
Pig	4.7	16.8	4.7	10.9	14.6
Sheep/Goat	2.3	3.8	xx	4.2	1.8
HUMANS	xx	xx	***	xx	xx

Note: ***=Present; not quantified.

Two of these species are in the early assemblage. One is the bottle-nosed dolphin, a highly intelligent mammal that today is a common entertainer in marine shows. In the Chesapeake, this dolphin is known to have frequented the inshore waters, rivers, and tidal creeks, where they fed on fish and squid. Several bone fragments, both from the cranium and vertebral column, show butchery marks, indicating most probably that they had been eaten.

Until the late sixteenth century, porpoise appeared on the tables of kings and lords. Even Queen Elizabeth had porpoises among her Friday diet (Mead 1931:95). Sometimes a pudding was made from their blood and grease, mixed with oatmeal, salt, pepper, and ginger. Placed in the gut of the animal and seethed (boiled) for a good while, the animal was then broiled and "served forth" (Mead 1931:95).

Sturgeon was found in the early assemblage. If numbers are any indication, the colonists must have pursued them enthusiastically. In the early assemblages, their remains account for 48% of all identified fragments and 10% of the biomass (Figure 2). An anadromous fish that lives in salt water, but migrates upstream in May to spawn in fresh water, sturgeon were seasonally plentiful. Encouraged by the Virginia Company to harvest them, in May colonists were waiting (Stachey in Haile 1998:684). But not only were they a possible incipient industry; they were also a potentially important source of food, as John Smith indicated when he wrote, "We had more sturgeon than could be devoured by dog and man" (Smith in Haile 1998:320). Knowing just what proportion represents food, and what proportion represents commercial activity, however, is problematical, since documents tell us that a certain number to be exported were boiled, cut into small pieces, salted, and packed into barrels (Brown 1890(1):386).

No doubt the scutes were tossed aside along with scutes from sturgeons that were consumed. Can we honestly assume our measure represents a realistic estimate of how much sturgeon contributed to the diet? The answer is never as easy as we would like it to be.

While zooarchaeologists would like their data to clearly reflect *dietary* consumption, in fact, their data includes the remains from animals that have been harvested for *commercial*—not food—purposes. Documentation is critical in identifying these species that were used for commercial purposes, and it is important to factor in this activity—a point that we will return to later.

The Starving Time

If analyzed thoughtfully, the early faunal assemblage can reveal important information about the famine described as the Starving Time. The first step in this analysis was to determine which foods were considered good to eat, and which were not. Every culture has deeply seated beliefs about animals that are taboo, and the English are no exception. By researching food history texts to learn what animals were taboo, and by comparing what was found in the early assemblages with later assemblages, it has been possible to create a list of animals that were taboo and only eaten in desperate times. As research progressed, it became quickly apparent that the list is very short—it includes the horse, dog, cat, rats, mice, raptors, and humans.

Telling strictly from the archaeology which animals were taboo is not a straightforward process, since many small vertebrates such as snakes, turtles, rodents, frogs, cats, dogs, horses are almost always found in very small numbers. They are what biologists refer to as "commensal"

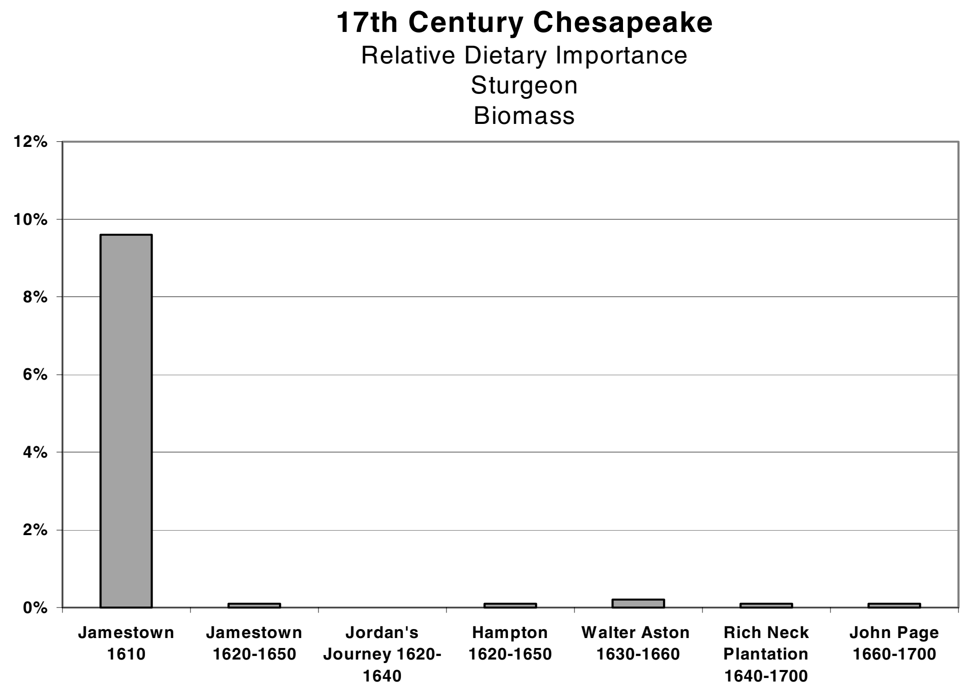

Figure 2.

species—animals that live with another, sharing food and resources, but neither are parasitic nor injured by the other. In some cases, small species such as snakes, frogs, rodents, and turtles live comfortably alongside humans, and when they die, their bones become part of the trash left by the site's occupants. Two other categories are work animals and pets, both of whom have been domesticated for purposes other than food. If the animal is relatively large (say larger than a dog), butcher marks may help tell whether they were eaten, but unfortunately many of these species are very small, and even if they were consumed, few would exhibit any sign of this activity.

To determine what species were consumed only during the Starving Time, species found in the early assemblage were compared against other species found in other historic-period faunal assemblages. We categorize as famine food those that have been defined as taboo on the basis of food history texts but are present in large numbers in the early assemblage and are either absent or present only in very small numbers in later assemblages. Since the very small animals leave only minimal remains, regardless of their use, the relative abundance measures are not reliable indicators of whether or not an animal was taboo. Snakes, rats, and mice are such examples. For these, we have relied upon documentation.

Fish

Medieval high-style cuisine incorporated a diverse diet of fish, both in quantity and in variety. Views on where this focus on fish originated include Simoons (1994), who writes that no fish species were taboo. In fact, he suggests that the valuing of fish as a food source has its origin in Christianity, which itself adopted the Levitican code. To the ancient Hebrews, fish was a symbol of good luck, a protection against the evil eye. In Christianity, fish became a symbol of the Messiah. On Fridays and during Lent, Catholics of pre-Reformation Europe were not permitted to eat meat, but fish was a convenient substitute.

C. Anne Wilson (1974:20-28) supports the view that high-style medieval cuisine has its roots in the ancient past, but she begins with the Roman invasion of Britain in AD 43. As the Romans constructed new towns and in the process transformed native farmhouses into Roman villas, they passed along their own ideas of food and cookery, a style of elite cuisine that endured in some ways for many generations. In Wilson's view Romans developed their love of fish from the Greeks, who from the third century BC became their chefs. In Britain, Romans sought out shellfish, in particular oysters that were transported inland live in water-tanks. They also sought out seafish, including mullet, sturgeon, turbot, as well as many other varieties (Wilson 1974:21).

With the Romans came a cuisine that set itself apart from local cuisine. Prior to their arrival a vernacular cuisine was based on natural resources, and the only distinction between the wealthy and poor was one of quantity. With the arrival of the Romans, the distinction became one of kind; the Greco-Roman cuisine drew upon native foods combined with imported flavorings. Whatever the origin of fish being an integral element in high style cuisine, surviving menus of British medieval estates reflect this past. There seem to have been few, if any, species turned down by the nobility.

Along the coast, fresh fish was readily available, but since most Englishmen lived too far from fishing ports to receive fresh marine fish regularly, from a very early period a long-distance trade brought dried and salted fish to the hinterlands. There, the poor consumed primarily salted fish (Wilson 1974; Paston-Williams 1993:24-27; Simoons 1994; Franklin 1997). For them fresh fish was a rarity, but for the wealthy, who caught fish from their own ponds, or purchased it from the local market, they consumed a diverse array (Mead 1931:93; Wilson 1974; Paston-Williams 1993). The roster includes fish familiar to us—herring, shad, cod, halibut, haddock, perch, carp, sole, sturgeon, pike, salmon, whiting, rockfish, mullet, and trout. Other species were also taken from the sea or inland rivers, among them eels, rays, lampreys, beavers (whose tail was a delicacy), sea mammals (whale, porpoise, and seal), shrimp, crayfish, crab, and shellfish (whelks, oysters, and mussels).

Records of the early Jamestown settlement indicate that colonists continued this tradition. John Smith states, “neither better fish, more plenty, nor more variety for small fish had any of us ever seen in any place so swimming in the Water than in the Bay of Chesapeack…” (Smith in Haile 1998:261). In the summer of 1607, according to Christopher Newport, “the mayne river (James) abounds with sturgeon, very large and excellent good; having also at the mouth of every brook and in every creek both store and exceeding good fish of divers kinds; in ye large sounds neere the sea are multitudes of fish, banks of oysters, and many great crabs rather better, in fact, that oures, are able to suffice 4 men…” (Newport in Pearson 1943:1). The presence of at least seventeen species in the early faunal assemblage attests to the variety they consumed.

Turtles

Simoons (1994) reports no aversion to turtle in the English culture, yet oddly enough, Mead (1931), Drummond and Wilbraham (1939), and Henisch (1976) make no reference to this group of animals. Wilson (1974:225) and Paston-Williams (1993:211-212) suggest that the consumption of turtles, prepared as soup, was an innovation of the mid-eighteenth century, when green turtles could be successfully imported from West India live in tanks of fresh water. Made in the “West India fashion”, a turtle of sixty to one hundred pounds made enough to provide, by itself, the first course. Wilson describes that procedure:

> Its belly and back were boiled and baked respectively, and laid out at the top and bottom of the table, the fins and guts were stewed in rich sauces to provide corner dishes, while a tureen of turtle soup, made from the head and lights, had the place of honour in the center (Wilson 1974:225).

Although turtles did not hold a place of honor on the medieval and Elizabethan table, Strachey remarked that the colonists at Jamestown noticed the tortoises as large as those they had seen in the Bermudas. He claimed they did not eat these, although they did take and “eat daily” of the smaller land tortoises (Strachey in Haile 1998:683-684). Archaeologically, evidence shows several carapace fragments from sea turtles (Family Chelonidae), the family to which the loggerhead belongs. While these bones may represent those caught locally, they also may be among the animals imported from Bermuda, since marine turtles are a common sight in Bermuda.

Certainly there is an impressive list of land turtles in the early assemblage. They include the snapping turtle, slider or cooter, box turtle, and diamondback terrapin, all of which are commonly found in very small numbers in historic faunal assemblages. Broken, sometimes butchered, and always intermixed with the butchered remains of the large domesticates, they were no doubt food.

However, also present in these early assemblages are numerous specimens from the family of stinkpots, mud turtles, musk turtles (Family Kinosternidae). Seldom are any members of this family found in historic faunal assemblages from this region, a sign that generally speaking they were not considered to be a particularly desirable food source (Alderton 1988:142-144). Since all species in this family have two pairs of musk glands, from which they exude an offensive secretion whenever threatened, they were probably taken only during the Starving Time.

Snakes

The vertebrae of snakes and vipers were found in the early assemblages. The absence of diagnostic haemal spines on the ventral portion of fourteen vertebrae indicate they were from the non-poisonous family Colubridae, a family that includes among many others corn and rat snakes. But vipers were also present, either the copperhead, a species that prefers wooded hillsides or rocky outcrops near water, or the cottonmouth, a species that is found in swamps, lakes, and rivers.

On one hand, the presence of a relatively large number of snakes and vipers (presumably used as food) might simply indicate famine, but texts on culinary history demonstrate vipers held a place in English cuisine and medicine (Stead 1995:11-14). One preparation was viper broth, an antacid that was thought to be nutritive, restorative, and invigorating. A second preparation was viper wine, which they thought would bring "new lust and youthful flames." In the culinary tradition, vipers held a place as dinner-table fare, viper soup, which was made from vipers skinned alive, with their heads cut off, their bodies cut into pieces, then boiled with their hearts in water with salt, pepper, wine, and spices.

Colonists may have used them in this manner, but records indicate that the consumption of snakes was an act of desperation. George Percy wrote that after colonists had eaten all the "quick things," some had eaten snakes or adders (Percy in Haile 1998:445-446). On another occasion he reported that they were forced to search the woods and to feed upon serpents and snakes (Percy in Haile 1998:505). It appears that they first consumed the larger animals, and only when all they were gone and desperation had set in, did they search out this resource. While there is clearly dread and disgust evident in Percy's words, colonists may, on some level, have been ambivalent towards them, particularly since these reptiles held a place in their cuisine and in their world as a cure and aphrodisiac.

Even today, modern Americans generally have a strong aversion to them, while at the same time, our culture retains rattlesnake meat as an exotic food. Many of us have heard such fare tastes like chicken, but few have tasted it, and even fewer care to have the opportunity. A quote by Sam Arnold summarizes the modern view:

> Rattlesnake eating isn't all that difficult. It's just that lots of people have a problem with eating snake. Many people fear all snakes, and wouldn't touch 'em with a ten foot snake pole. Truth is, the meat is rather like chicken, and after being braised for 90 minutes, it comes away from the bones in flakes, not unlike lump crab. I guess it's the thought of it that turns people off, but surprisingly, it's number one of all the appetizers at my restaurant, The Fort, near Denver. We serve some 200 snake portions a week, and 1200 pounds of rattlesnake meat a year (Arnold 1996:22).

Birds

Falconry was an ancient skill in Egypt and the Middle East. Adopted by the Romans, who took it with them as they spread throughout Europe. When they occupied Britain, the local upper classes adopted falconry (Wilson 1974:117). It was a means of procuring food, but it also was sport, and even after the Norman Conquest, it became increasingly popular. By then different species of falcons were allotted to men according to their social rank. The king's bird was the gerfalcon (a large falcon), an earl's the peregrine, the yeoman's the goshawk, the priest the sparrow-hawk, the lady the small merlin, and commoners the kestrel. Larger falcons, including the peregrine, were flown at larger birds such as the heron, bittern, or curlew, while the smaller goshawk was flown at cranes, geese, pheasants, and partridges. Kestrels were flown at small birds and partridges, and the small hobby (a small falcon) was flown at larks.

At Jamestown when colonists first arrived, did they seek out the highly valued birds—maybe even train the bald eagle, red-tailed hawk, or the great horned owl to take wild fowl for them? The presence of a small number of bald eagle, hawk, and owl bones in the early assemblages hints that they might have done so. The following passage by Strachey indicates they may have been used to take birds, but further documentation is needed.

> Of birds the eagle is the greatest devourer, and many of them there. There be divers sort of hawks, spar[row]hawks, lannerets, goshawks, falcons, and ospreys. I brought home from thence this year myself a falcon and a tassel [tercel], the one sent by Sir Thomas Dale to His

> Highness the Prince and the other was presented to the Earl of Salisbury—fair ones, what the proof of them may be I have not learned. They prey most upon fish (Strachey in Haile 1998:682).

While documentation for falconry, or the utilitarian equivalent, in the colonial Chesapeake is scarce, every early seventeenth-century faunal assemblage contains the remains of bald eagles, hawks, and owls. Secondary food history texts are absolutely clear that raptors were hunters—not food—and thus colonists may well have trained raptors to retrieve fowl for them. This interpretation is strengthened by the fact that raptors are found *only* in the early and mid-seventeenth century, after which time in England guns had eclipsed falconry as a means of hunting (Wilson 1974; Thomas 1983).

In medieval society birds reigned supreme on aristocratic tables. Wilson (1974-114-137) summarizes their position in high-style cuisine. During dinners meats were served in two main courses, and during feasts meats were served in three courses. In these events many, even hundreds, of birds were served, but which ones? Early menus read like nature guide books, for with the exception of the raptors, almost every other bird is listed. Among them were capons, hens, swans, pheasants, herons, peacocks, cranes, bitterns, egrets, curlews, partridges, pigeons, quails, snipes, ducks, geese, gulls, crows, woodcocks, blackbirds, sparrows, robins, finches, greenbirds, and sand thrushes. Among the larger birds, the swan was the most expensive, while among the small birds, the blackbird was the most expensive (Wilson 1974:118-119). Stewed in pottages, baked in pies, or roasted on meat- or bird-spits, they were considered fine dishes. At times they were sewn back into their skins, or served with their own special sauces, made from garlic, verjuice, or offal.

By the mid- to late sixteenth century, fowl remained as important as ever in high-style cuisine, but the less palatable of the wild birds, the seabirds and some freshwater birds, began to lose their appeal. By the eighteenth century gulls, cranes and herons had become neglected, for their flavor was thought too fishy, and the range of acceptable land birds also narrowed. Though still prized in the 1690s, by the 1750s bustards, (buzzard, or possibly *Otis tarda*, the largest European game bird now extinct), were reduced to the "curious fare" section of some cookbooks, and by the 1780s they had become scarce in markets (Wilson 1974:127). Nonetheless, throughout the seventeenth and eighteenth centuries, some birds retained a special importance as fine fare. Swans, ever the elite dish, continued to appear at feasts and on the tables of the gentry, but fewer small wild birds were served. Still, larks were enjoyed, and sparrow dumplings were not unknown, but blackbirds, thrushes and finches were losing their appeal (Wilson 1974:128).

Birds found in the early assemblage include the domestic goose, Canada goose, dabbling duck (*Anas* spp.), diving duck (*Aythya* spp.), wood duck, chicken, and turkey—all of them desirable to this day. Less desirable nowadays are crow, cahow (or Bermuda petrel), cormorant, gull, bobwhite, killdeer, woodpecker, and other small perching birds. While the latter all appear on medieval menus, the faunal list hardly reads like the who's who of high cuisine. Where is the swan, the most prized of all fowl? Hamor (Haile 1998:817) indicates they were truly impressed with the profusion of species as they witnessed flocks that thickened the clouds, and Strachey (Haile 1998:683) describes the fineness of turkey meat and men shooting partridges (bobwhites?), but whether they actually hunted and ate them is less clear.

Sampling variation may be one reason for the absence of some species that might be expected. While the total number of Minimum Number of Individuals is 86 in the largest assemblage, and 16 in the smallest, many species are often represented by only one or two bone fragments. Further excavation will no doubt recover additional species not represented in these two assemblages.

Mammals

Medieval high-style cuisine focused on an astonishing variety of birds and fish, as well as substantial quantities of domestic mammals. But, comparatively speaking, the variety of wild mammals consumed by British gentry pales in comparison to the variety of fish and birds they consumed. In fact, some of what we now know to be mammals were then classified as fish. Beaver's tail, whale, seal, and porpoise (known by the Saxons as "sea swine" and by the ecclesiastics of the Middle Ages as *porco-marino*) were all thought of as fish that could be eaten on Fridays and during Lent.

Do their choices reflect cultural preference, possibly surviving Roman ideas of food and high-style cuisine that became established among the gentry class? Wilson (1974) believes this to be true, and a comparison of Roman foods with the list of foods on medieval menus shows a remarkable similarity existed between the two. But, from a biological standpoint, the relative absence of mammal species reflects that of nature, particularly if one subtracts those traditionally not eaten—rats, mice, and carnivores—from the menu. The classes of birds and fish are themselves more diverse than mammals. Did their choice of animals reflect availability in the woodlands? Records show that over hundreds of years hunting brought about the demise of the bear, wild boar, and wild cattle, and what wildlife survived was in large part because the gentry provided them protection from open-season hunting by the poor. Had the gentry not protected deer, their favorite wild mammal, they too might have gone extinct.

In Italy animal husbandry had been the basis of the Roman economy for hundreds of years, and it was no different in Britain, where Romans established villas on British farms (Wilson 1974:69-73). As in Rome, it was an agrarian economy where livestock formed the basis of their diet. To enclose the larger game animals, Romans created game parks, where they could protect the red and roe deer, wild oxen and pigs, and, in some remote parts of Wales and in the Caledonian forest, bear. Romans also introduced some smaller mammals. Rabbits were bred in hare gardens, dormice of the continental European species (known as the "fat dormouse") were enclosed and fed acorns and chestnuts, and snails, still popular in France and Italy, were kept on land entirely surrounded by water to prevent them from wandering away.

In the centuries following the Roman occupation, the same domestic animals were kept, and hunting provided an integral supplement to their diet (Wilson 1974:76-85). Among the Saxon aristocracy, hunting became a major sport, and in later centuries the wealthy established game parks, much like those of Western Europe. By the turn of the twelfth century, in the lowland zone of Britain there were thirty-one parks and seventy hays (places where nets were set up into which the hunters and their dogs drove their quarry). In Celtic areas, hunting was a noble pastime, and Welsh kings had professional hunters. Regulations assigning special seasons to particular species, restricted hunting stags from midsummer to early winter, and hunting wild swine afterwards, and hinds (female deer) from February to midsummer.

Throughout the Saxon period hunting was an important activity for all, wealthy and poor, each having the right to hunt on his own land (Wilson 1974:78-84). But Norman kings and their successors restricted access to all forest lands and to the game that lived within them. Laws were repealed for awhile, but by the late sixteenth century waste lands were turned into restricted parks where deer were protected. Warrens protected rabbits (coneys) that had been reintroduced from France, and as forests receded and predators decreased in number, escapees from the warrens bred on the outside to create a large wild population.

By then, parks had preserved some of the large mammals, but others had become extinct. Native bears had disappeared, though in their place continental bears were used for bear-baiting. Wild cattle, referred to as "wild oxen" in menus, lived in the woods around London in the twelfth century, but by Queen Elizabeth's time, these cattle could be found only in the remote parts of Wales and Scotland. And wild boars, which were common until the fifteenth century, had by the seventeenth century been extirpated. As the game of the nobility, deer were protected and hare were protected in parks.

Also popular were some smaller mammals. Known as a dish for the lord, red squirrels were put into pottages containing partridges and coneys, although by Tudor times they had lost favor among the gentry. In 1747 Dr. Moufet wrote

> squirrels are much troubled with two diseases, choler and the falling-sickness; yet their hinder-parts are indifferent good whilst they are young, fried with parsley and butter: but being no usual nor warrantable good meat, let me skip with them and over them to another tree… (Wilson 1974:84).

The diversity of wild mammals appearing on tables of the British nobility pales in comparison to the diversity of wild mammals found in the Jamestown assemblages. In addition to the large and small mammals listed on noble menus, deer, rabbit, beaver, and squirrel, is the raccoon, opossum, mink, muskrat, otter, and woodchuck. Did they eat them, or were they the remains of other activities? Even if they were used for other purposes, they probably were also eaten, since all parts of the body, particularly cranial and main weight-bearing long bones are amply represented in the faunal remains. Ralph Hamor's narrative indicates these animals served as an important source of food:

> …beavers, otters, foxes, *racounes* (almost as big as a fox; as good meat as a lamb), hares, wildcats, muskrats, squirrels flying and other of three or four sorts, *apossumes* (of the bigness and likeness of a pig of a month old, a beast of as strange as incredible nature…Of each of these beast the lion excepted, myself have many times eaten, and can testify that they are not only tasteful but also wholesome and nourishing food… (Hamor in Haile 1998:817).

Though they provided food, these animals may also have provided furs, an activity encouraged by the Virginia Company. In 1610 instructions to the colonists requested that beaver skins and beaver cods (scrota) be sent from Virginia (Haile 1998:25). Later John Smith wrote in his *General History* that in their search for furs, they found a few beavers, otter, bears, martens, minks, luswarts (lynxes), and sables (Smith in Haile 1998:261-262). Strachey speaks to the fact that they traded trifles with Indians for otter, beaver, *rakoone*, and bear skins.

Commensal Mammals

While remains of mice are not present in the faunal assemblages analyzed, their bones are so small that they may well be found in the flotation samples that have yet to be examined. However, remains of the larger rats are present in Pit 3, Sequence B, and comparison of these bones with specimens housed in the National Museum of Natural History demonstrated they are remains of *Rattus rattus* (the European black rat)—not any of the native species. Clearly, this rat dominated the island very quickly. Like its cousin *Rattus norvegicus* (the Norway or brown rat), the black rat was originally a native of Asia. Both came to Europe over land and by ship, then later migrated to the Western Hemisphere with Europeans on explorer and merchant vessels (Earnest and Oulahan 1978:62).

Both black and brown rats tend to congregate in large groups, and both are nest builders, but the black rat is a climber, enabling it to construct its nest in trees or in the upper levels of buildings. The brown rat is a burrower, enabling it to set up house under floors, in walls, or in the ground. Of the two, the black rat was the superior seagoer, and it was this species that came first. According to one source, the brown rat did not arrive until around 1775, when this large and fierce animal gradually drove the smaller black rat from much of its range (Webster et al. 1985). Whenever the brown rat did come, our faunal assemblage contains only the remains of the black rat, a demonstration that the larger and more aggressive rat was not on the ship with the first colonists.

For centuries rats have been associated with filth and disease in Europe, where the only good rat was a dead one. Colonists agreed with this condemnation, for John Smith remarked that after arriving they found that rats on board their ships had multiplied to many thousands that consumed their casked corn (Smith in Haile 1998:319). Later, Strachey informs us of the continuing problem presented by these rodents, when he reported on their attempt to produce silk,

> …surely the worms prospered excellently well until the master workman fell sick, during which time they were eaten with rats… (Strachey in Haile 1998:677).

Two species that served to control rodents, hunt, and possibly provide companionship, are the domestic dog and cat. Pit 1 contains remains of both, while Pit 3, and the Bulwark Ditch contain only the dog. These species were both were traded by Captain Newport to local Native Americans; in particular, John Smith traded a white greyhound to Powhatan, who accepted it as a confirmation of friendship (Hamor in Haile 1998:837; Smith in Haile 1998:166). (It is not clear whether in fact the archaeological remains are those of a greyhound or other British variety, or are aboriginal dogs; these remains need to be examined by a zooarchaeologist specializing in canines). That Jamestown colonists knew of native dogs is made clear by this statement of Peter Wyn,

> As concerning your request of bloodhounds, I cannot learn that there is any such in this country; only the dogs which are here are a certain kind of curs like our warrener's hey-dogs in England, and they keep them to hunt their land fowls, as turkeys and suchlike, for they keep nothing tame about them (Wyn in Haile 1998:204).

Whatever their purpose, and whatever their origin, during the Starving Time, after the horses and other "beasts" had been eaten, colonists turned to vermin, "as dogs, cats, rats, and mice..." (Percy in Haile 1998:505). In the end, they like all other animals were eaten.

Remains of the horse, ass, mule (*Equus* spp.) are present in the early assemblage. If remains had been relatively complete, it might be possible to take this identification to species, but the remains are so highly fragmented, we have left the identification to genus. Documents, however, suggest that the horse (*Equus cabellus*) is the likeliest source.

Domesticated by circa 4000 BC in various parts of Europe where grassland supported large populations of wild horses, horses provided transportation. After they were no longer useful for transportation and draught purposes, the animals were eaten, in some cases as a sacrificial food (Clutton-Brock 1992:55-56; Simoons 1994:168). In Greece and Rome, horse sacrifice was practiced, but its flesh was ignored, except for medicinal purposes. In fact, Romans were disgusted at the thought of eating horseflesh. The Catholic Church took on this belief, and as Christianity spread throughout Europe, efforts were made to stamp out pagan rituals, including the eating of horseflesh. In Ireland, among other places, the eating of horseflesh continued, although by the end of the seventeenth century horseflesh had come to be regarded as a low class food. Only starvation brought many Europeans to eat it.

In Jamestown, the importance of horseflesh as famine food is irrefutable. Present in relatively large quantities and butchered in ways that are identical to the manner in which cattle bones are butchered, there is little doubt colonists consumed them. In the early assemblage, horse contributed 12% of the biomass, both in comparison to the proportion of cattle in the assemblage and what is present in other seventeenth-century faunal assemblages (Figure 3). In all other faunal assemblages, horse is represented by only one or two fragments from the cranium or foot. On the basis of this evidence it is clear that the earliest colonists ate horseflesh. As their hunger deepened, they crossed lines—and the animal they brought for transportation became a significant part of the diet.

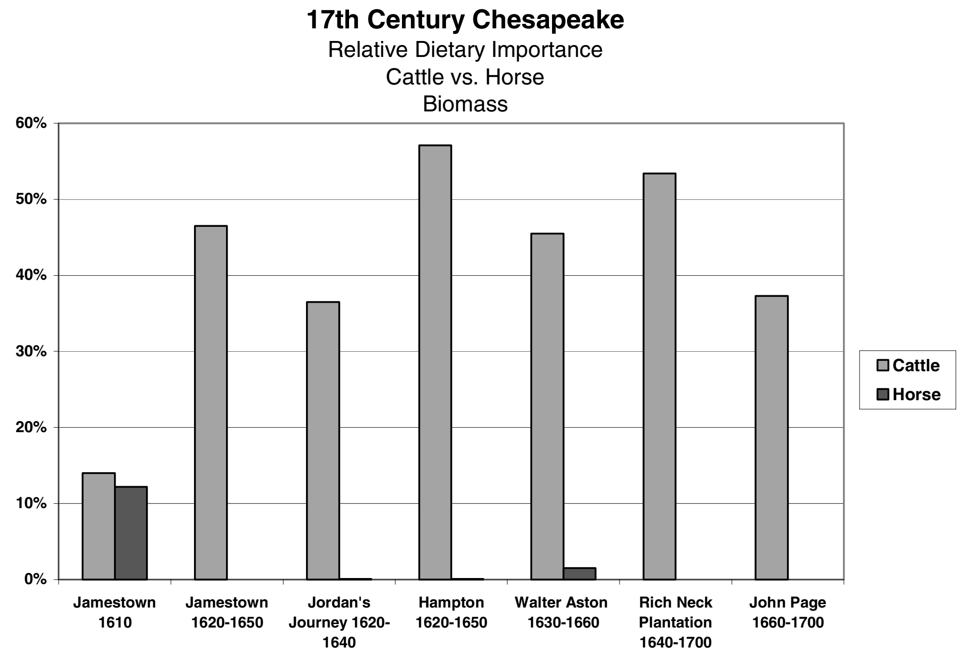

Figure 3.

Famine

As hunger deepened, all at Jamestown began to

> feel that sharp prick of hunger, which no man truly describe but he which hath tasted the bitterness thereof. A world of miseries ensued… Then having fed upon horses and other beasts as long as they lasted, we were glad to make shift with vermin, as dogs, cats, rats, and mice. All was fish that came to net to satisfy cruel hunger, as to eat boots, shoes, or any other leather some could come by. And those being spent and devoured, some were enforced to search the woods and to feed upon serpents and snakes and to dig the earth for wild and unknown roots, where many of our men were cut off and slain by the savages. And now famine beginning to look ghastly and pale in every fact that nothing was spared to maintain life and to do things which seem incredible, as to dig up dead corpse out of graves and to eat them, and some have licked up the blood which hath fallen from their weak fellows… (Percy in Haile 1998:505).

From the faunal remains it is clear taboo foods were eaten in the Starving Time, but how could this have happened in the midst of plenty, when reports describe waters being so full of fish that they literally jumped into fishing boats? Scholars have suggested several reasons, including the colonists' fear of the Native Americans (thus inhibiting long-range hunting or fishing expeditions), their lack of hunting and fishing skills, and the disease that plagued them. One has suggested the location of the island was part of the problem. Located at the confluence of brackish and fresh waters, during summers the brackish waters were trapped, causing a back-up during the summers. Then, the only water they had to drink was salty, and it contained their own waste (Earle 1979). Recent tree ring studies by Dennis Blanton and others have added yet another perspective. On the basis of this evidence, it is clear that from 1606 to 1612 the region experienced a severe draught that reduced ground water and increased salinity levels in the river (Stahl et al. 1998; Blanton, in press). For the colonists this all added up to salty drinking water, made deadly during the summer.

Documentation indicates there was yet another way their well-being was compromised. On July 8, 1609, a Third Supply of 500 new settlers set sail for Virginia, but during their voyage, they encountered a hurricane, and the ships became scattered. The *Sea Venture*, which carried the leaders, Sir Thomas Gates, Sir George Somers, and Captain Christopher Newport, ran aground off the coast of Bermuda. But 8 ships limped on to Jamestown. Arriving there in mid-August 1609, the 200-300 survivors were famished, and within three days a field of corn, the main food supply that would have helped the colony survive the winter (McCartney 1997:35; McCartney 2000:25-26).

Surviving the Famine

Clearly, the colonist's situation was dire. Colonist George Percy reported, "There were never Englishmen left in a forreigne Countrey is such miserie as wee were in this new discovered Virginia." They died of "meere famine" (Percy in Shirley 1949:234). John Smith vividly describes their plight, when he writes

> Though there be fish in the sea, fowls in the air, and beasts in the woods, their bounds are so large, they are so wild, and we so weak and ignorant, we cannot much trouble them (Smith in Wharton 1957:6).

This is a telling statement, for their famine was more than the lack of food. When ships arrived with supplies they managed, but when supplies were gone, they depended upon the wild sources, their hunting and fishing skills, along with the beneficence of the surrounding Native populations (Shirley 1949:234). When the shipments were gone, the combined effects of fear, isolation, draught, inadequate food and water supplies, disease, and maybe other things contributed to their situation.

Famine is a complex phenomenon. Armelagos and Farb (1980:211-213) report "starvation affects every system in the human body: it produces diarrhea and other disturbances of the digestive tract; hypertension and eventual collapse of the circulatory system; a sharp decrease in the intake of oxygen; a decrease in strength and control over limb movements; and increasing vulnerability to changes in temperature."

The social fabric of the community is also stressed, and seeking food becomes the primary activity. Three stages have been identified. At the onset of famine, people intensify their activities. The search for food brings people together, particularly kin who cooperate by pooling resources, but political unrest develops, where some blame the leadership. In the second stage, the immediate threat of starvation becomes the focus, and with the exception of their immediate family, people turn away from social cooperation. Most taboos are ignored, and everything potentially edible is sought. Competition and aggression increase, people begin to hoard food, and as desperation grows, the family ceases to function as a food-sharing unit. The death rate increases fourfold, most notably among the very old and the very young. In the final stage virtually all are exhausted, and social interactions all but cease. Members of the same household compete with each other, people sit silently at home, and social, political or religious institutions exist only on minimal levels. But in known instances, the most hallowed food taboos are still generally observed, and cannibalism is not practiced.

William McIntosh (1996:159-173) summarizes the literature on famine. For famine to occur there has to be more than a food shortage that results in hunger; more deaths than normal have to be related to malnutrition. Thus famine results from insufficient food, a sharp increase in mortality, along with some severe form of social disruption. Generally there are multiple causes, including climatic events that disrupt food production, years of drought, flooding, plant disease, insects, or a deteriorating environment.

Population pressures can add stress to available food supplies, but scholars tend to believe this to be insufficient cause. Almost always, political disarray or economic circumstances conspire with the situation to bring extreme distress, and more often than not, people have lost their "right" to food. Rights to valued resources are never equal, and in societies where commercial trade and hired labor supersedes reciprocal exchange labor, those dependent upon others are at risk. At its worst, victims accept their fate because of their lack of entitlement.

In Third World countries, where economies are under transition and capitalism has transformed "moral economies," cash crops are exported and people become dependent on commercially-produced foods, where before they were self-sufficient in food production. Famine can even be politically induced. Certain regions, ethnic groups, or urban areas can benefit from economic development, while others suffer, sometimes out of benign neglect or callous disregard. As the world witnessed in post-Selassie Ethiopia, food policies pursued by the government can induce famine.

What happened in Jamestown? Gentlemen, scholars, artisans, and tradesmen arrived first in April 1607, hungry and with only meager food supplies. Many died, and subsequent arrivals fared little better than the first. From the outset, the new immigrants were ill-prepared to feed themselves (McCartney 1997:29-37). By April 1608, Captain John Smith forced them to begin growing corn, but whether or not livestock came with them on the first ships is not clear. Possibly there were none until after the first supply in January 1608. Records show that by 1609 there were at least six mares, a horse, 500-600 swine, and as many chickens, some goats, and some sheep (Barbour 1986 V.I:273; Dandoy 1997: 12-13).

Early on, when the first group of colonists' situation became dire, they hunted and fished to supplement food supplies, and Indians gave them food. Until then it appears they kept famine at the door, but in subsequent years, a constellation of events conspired to bring on famine. Increasingly poor relations with their neighbors made them fearful of leaving the fort, a fact that is documented both in the written record as well as the species found in the early assemblage. One species not found in the immediate area, the bear, is absent, and another, the deer is present in only small quantities. Alternatively, the commensal species, and those whose natural habitat was at their doorstep, are present. As relations deteriorated even further, records indicate they would not even venture from the fort.

Theirs was a highly stressed situation. Whether individuals had come from cities, where they were probably dependent upon market produce, or whether they had come from rural areas, where moral economies provided the safety net of reciprocal relationships, everyone left the social and economic structure they had known in England. Most came without their wives, parents, and other relatives, resulting in a situation where they were isolated. Men were fearful and had only their leaders to provide direction and support. In this situation Captain John Smith emerged as their effective leader, and history has credited him for his ability to deal with Native leaders and his skill in the wilderness. Surely he had an ability to keep men calm, and this played a large part in staving off famine. In May 1609, Sir Thomas Gates began as their interim leader, but it is unclear how effective he was. And what about Powhatan, and the leadership among the Natives?

Their own political events conspired to create their situation. In August 1609, newly arrived and starving immigrants devoured corn that would have helped them through the winter. Nature did not help, in that the location they chose to settle provided very poor, even deadly water supplies, but the drought may have been the element that could not be surmounted by any leadership. It was difficult to grow their own corn, even to obtain it from the Indians, who also were suffering its effects.

As hunger deepened, they ate animals they did not normally eat—snakes, horses, rats, mice, musk turtles, cats, and dogs. Did they eat raptors, maybe the bald eagles that are present in the early assemblage? Did they eat human flesh? Possibly, since the early assemblage includes one cranial bone from a young adult. Supportive evidence is found in documentary records describing some colonists digging up dead corpses out of graves and eating them, and others licking up the blood which had fallen from their weak fellows (Percy in Haile 1998:505). Another, better known story is about Collines, who dismembered his wife. Some references claim he ripped a child from her womb, disposed of it in the river, then chopped her into pieces and salted her for food (Percy in Haile 1998:505). Some believed he actually consumed her, although Thomas Gates reported that the one who murdered his wife initially claimed hunger made him do it, but that when his house was searched they found a good quantity of meal, oatmeal, beans, and peas. Only then did he confess to murder and he was hanged for his crime (Strachey in Haile 1998:473-474).

Thinking about the situation from an analytical perspective, it appears colonists behaved much as the anthropologists and evolutionary theorists describe in optimal foraging theory, where humans first exploit the most efficient animals, then they move on to those that require more energy to exploit. Percy's description confirms that was exactly what the colonists did (Percy in Haile 1998:505). First they "fed upon horses and other beasts as long as they lasted," then shifted to "vermin," dogs, cats, rats, and mice. Only then did they begin searching the woods for serpents, snakes, and wild and unknown roots. They did not kill their own, but finally, they fed upon dead corpses and licked the blood of their dead. The records are clear in their descriptions of starvation and famine.

After the winter, survivors faced more difficulties. As spring emerged from winter they were living "from hand to mouth" (Strachey in Haile 1998:419). Many were facing imminent death, and therefore energy levels were extremely low, but nonetheless finding food was a problem, for it was not yet time to plant, and all fourteen of their nets had been left to spoil over the winter. These gone, "all help of fishing (in the nearby river) perished" (Strachey in Haile 1998:441).

Nature dealt them another blow. As spring emerged from the long winter, they expected to see the anadromous sturgeon that provided a welcome source of protein. Generally, sturgeon began their run upriver in large numbers in May, though sometimes they began running as early as March.

During good years, reports indicate colonists took anywhere from 52 to 68 at a single draught. Afterwards, from late May until the end of June, they took a few young individuals between two feet and a yard long. From then on until September, they took a few sturgeon two or three yards long. After that, few were taken (Smith in Pearson 1942(22)3:215).

This year the sturgeon never appeared (Strachey in Haile 1998:419, 425, 441). He remarked "there was not one eye of sturgeon yet come into the river" (Strachey in Haile 1998:419). He continued describing the length colonists went to find them,

> Besides that the Indian thus evil entreated us, the river, which were wont before this time of the year to be plentiful of sturgeon, had not now a fish to be seen in it. And albeit we labored and haul'd our net twenty times day and night, yet we took not so much as would content half the fishermen. Our governor therefore sent away his longboat to coast the river downward as far as Point Comfort, and from thence to Cape Henry and Cape Charles and all within the bay, which after a seven nights' trial and travail returned without any fruits of their labors, scarce getting so much fish as served their own company (Strachey in Haile 1998:425-426).

Was this shortage related to the drought? Probably not, according to some ichthyologists. The drought probably impacted salinity levels and the temperature of the water, the effect of which might have been to shift breeding grounds and inhibit eggs from maturing, but it could not have prevented the sturgeon run that year. For reasons that are not totally understood, anadromous fish do not return every single year. George Washington, who depended upon the herring runs in the Potomac to feed his slaves, knew that sometimes they would not come, and he shifted his provisioning activities in the years in which they did not come.

This is a topic that needs further research. For purposes of this report, a brief description of possible reasons why species do not return is summarized (Baker 1981:95-98). Throughout their lifetimes, fish become familiar with their surroundings, and anadromous fish such as the salmon and sturgeon spawn and spend some of their early life in fresh water. At some point, the older fish migrate to the sea, where they feed for many years until they are sexually mature and ready to spawn, at which point they return to fresh water. Sturgeon is anadromous—meaning as adults they feed in the deep waters of the Atlantic, but then generally move upriver to spawn in fresh water. In spring, large numbers enter the rivers, where females migrate upstream, using the tidal tributaries as a nursery. There, sticky eggs become attached to the bottom (Murdy et al. 1997:54).

With changes in ocean temperatures and currents, fish can extend their existing migration circuits northward, or they can develop completely new ones to take advantage of the change.

> When adult salmon fail to return to their natal stream but instead spawn in another one, according to the modern view they do so not because they are lost but because they have opted for a new stream that is more suitable for spawning than the old one (Baker 1981:97-98).
>
> [Research on salmon shows] young fish are aware of how chemicals carried in water change between the upstream spawning grounds and the point of entry into the sea. The olfactory signature of river water—the characteristics that the fish recognizes through its sense of smell—are probably peculiar not only to each river system but also to each tributary and remain relatively unchanged over a number of years. When an adult salmon arrives back at the coast after its feeding and maturation phase, it locates the position where fresh water with a familiar olfactory signature enters the sea. It then swims upcurrent, passing by a familiar series of smell signposts until it reaches its spawning grounds. It literally smells or tastes its way home (Baker 1981:104-105).

All seemed lost, and those living at the fort were at the point of death, when in May 1610 Sir Thomas Gates, George Somers and 100 or so new settlers reached Virginia in two ships that had been fashioned from Bermuda's native cedar wood. Gates opted to remove them to Newfoundland, and all were packed up to return, when Lord De La Warr arrived from England. With new hope, they turned around to start over, but even with food, three men who were beyond help died (Somers in Haile 1998:446).

Conclusion

Not all of the colonists starved. When George Percy had recovered from his sickness, he undertook a journey to Algernon's Fort, where he found some of his people,

> in good case and well liking, having concealed their plenty from us above at James Town, being so well stored that the crab fishes wherewith they had fed their hogs would have been a great relief unto us and saved many of our lives. But their intent was for to have kept some of the better sort alive and with their two pinnaces to have returned to England, not regarding our miseries and wants at all… (Percy in Haile 1998:506).

Clearly, as Armelagos, Farb, and McIntosh have indicated, politics played a part in The Starving Time.

The Starving Time is a fascinating period of our country's past, one that invokes cultural mythology about natural abundance and starvation. But the story is not complete. Those familiar with the physiology of starvation need to consider the symptoms colonists described. Those familiar with the emotional factors need to take a specific look at the social organization, and what impact famine had on the group and their leadership. More needs to be done with animal behavior to consider the drought's impact on native wildlife, both terrestrial and marine life, the life cycles of such species as the sturgeon, and livestock that arrived in a less hospitable world than has been thought.

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Appendix A. Description of the Faunal Remains

Methods

In 1997, faunal remains from Jamestown were submitted to Colonial Williamsburg's Zooarchaeology Laboratory for analysis. Based on initial inspection, bones from all of the features appeared to be extremely well preserved. It appears that the bones had not been exposed for an extended length of time to the sun, rain, or extreme temperature changes. Based on the excellent preservation, the lack of major recovery bias, and the large percentage of identifiable bones, it was agreed that all the bones would be analyzed. In total, 14,400 bones were sorted, numbered, and identified from six different features (see Table 2).

Recovery Bias

The first, most basic step in zooarchaeology analysis is to evaluate bone preservation, taphonomic factors, and recovery technique. The bones from the Jamestown assemblages were predominately from soil that had been screened through one-quarter-inch mesh. Quarter-inch screening is a standard technique used on historic-period Virginia sites, although there are some sites that are not screened at all. It has been shown (Thomas 1969) that screening has an enormous positive influence on the recovery of bone, particularly the recovery of smaller or more fragile elements. The smaller the screen size, the better, but the practical cost in time and manpower must be considered as well. One-quarter-inch screening is a sound and responsible compromise, and allows comparison with a large number of sites that have been excavated similarly. A small amount of wet screened material from ER 124F was submitted for analysis. This included one hundred thirty identifiable bones and three hundred eighty-three unidentifiable bones.

It appears that the overall rate of faunal recovery was very good. The high number of fish, small mammal, and bird bones suggests that a fair sample of the original "death assemblage" have been recovered. As usual, however, the more durable elements, such as teeth and long bone shafts, were most commonly found, but few element types were completely absent from any of the assemblages**.** It may be significant to note that there were a few bones from immature animals. Since these bones degrade fairly quickly, it appears that the sample is not fatally biased toward the larger and more durable elements.

Lab Techniques

The study of animal bones from archaeological sites has become a burgeoning field that is still developing new analytical techniques that will influence how faunal assemblages are interpreted. Initially, the

Table 2.
Assemblages Analyzed

Assemblage	Date	Unident Bone	Identifiable Bone	Total Bone
Pit 1	ca. 1610	616	3,354	3,970
Subpit A	ca. 1610	0	1	1
Pit 3				
Sequence A	ca. 1610	81	108	189
Sequence B	ca. 1610	6,155	1,648	7,803
Bulwark Ditch				
Sequences A, B, C	ca. 1610	48	116	164
Sequence D	ca. 1610	268	122	390
Ditch 7	ca. 1620	116	51	167
Ditch 6	Post 1630	41	50	91
Midden 1	2nd qtr 17th c.	1,029	596	1,625
TOTALS		**8,354**	**6,046**	**14,400**

pioneers of zooarchaeology concentrated on producing "species lists," simply naming the various species that were represented on an archaeological site. By counting the bone fragments from each specific species, zooarchaeologists attempted to estimate the importance of some animals over others. Fortunately, zooarchaeological research has evolved more complex and discriminating methods through time (Chaplin 1971; Davis 1987). Different analysts use different methods, though the goals are generally the same; the following section explains some of the standard procedures used by Colonial Williamsburg's Zooarchaeology Laboratory that affect the study of the Jamestown assemblages.

The initial processing phase included sorting the faunal fragments into "identifiable" and "unidentifiable" categories. The unidentifiable bone—that which could not be taken at least to the taxonomic level of Order—was then further sorted into broad taxon groupings such as bird, fish, small mammal, medium mammal, and large mammal. Finally, within their taxon groupings, the bones were sorted into broad element categories such as long bones, teeth, ribs, and skull fragments. All of the unidentifiable bones were then counted, weighed, and examined for evidence of burning, butchering, or other types of modification. This data was then entered into a custom-designed microcomputer program developed by Greg Brown and Dr. Joanne Bowen for Colonial Williamsburg's Department of Archaeological Research.

Each of the identifiable bones was assigned a "unique bone number" which was affixed to the bone using an acid-free label with the site and ER (excavation register) number. If the bone was too small to be labeled, it was placed into a plastic bag with an acid-free bone label. By working with the comparative collection, which was created and currently is maintained by Dr. Joanne Bowen of Colonial Williamsburg's Zooarchaeology Lab, the "identifiable" bone fragments were identified to the lowest taxonomic level possible. The taxon, bone element, symmetry (side), location, weight, fusion state, tooth type and wear, relative age, butchering marks, and evidence of burning, weathering, and chewing were recorded and entered into the computer program. Once the data was entered, they were manipulated to provide the summary information described later.

Once these steps were completed, the bones were laid out to determine the minimum number of individuals. MNIs were calculated for each assemblage separately by pairing comparable rights and lefts, taking into account size, state of fusion, tooth eruption, and general morphology. Before the bones were put away, evidence of butchery and chewing marks was recorded on diagrams of individual bones, and osteological measurements of the major domesticates (pig, cow, and sheep/goat) and deer taken using the standards defined in von den Dreisch (1976). Summary diagrams of butchery patterns can be found in Appendix E, and the osteological measurements for the Jamestown assemblages can be found in Appendix F.

Analytic Techniques

Relative Dietary Estimates

There are four generally recognized measures of taxonomic abundance—Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), Usable Meat Weights, and Biomass. The most common goal of these analyses is to identify the relative dietary importance, but zooarchaeologists have long debated their relative strengths and weaknesses. In our view, each measure provides a different measure of relative importance, and therefore we regularly compute all four estimates, a step that allows us to take advantage of the strengths of each, as well as to make the broadest possible comparisons of our data with the work of others.

NISP

The first and most direct calculation of the relative abundance of any species within a faunal assemblage is to determine the Number of Identified Specimens. After identification, all bones within each species are added together to determine the frequency of fragments for each animal. Though still perhaps the most frequently used measure of abundance, this method has several shortcomings, most notably its assumption that the bones being counted are representative of the sampled population, and that each item is independent of every other item. There is no way, however, to demonstrate which bone fragments came from different individuals across an entire faunal sample. Other problems with this method include the unequal numbers of bones in different classes, differential preservation rates, uneven fragmentation rates that occur with different classes and sizes of animals, and misrepresentation of complete skeletons that are often intermixed with fragmented pieces from an indeterminate number of individuals (Grayson 1984).

From an interpretive standpoint, NISP represents only the number of fragments identified to taxon. It does not directly consider the differences in size and meat weight between various classes of animals. For this reason, as well as the potential biases described above, many zooarchaeologists have come to the conclusion that this technique alone cannot provide an accurate assessment of the relative dietary importance of various species.

Minimum Number of Individuals

One popular alternative for estimating species abundance is the Minimum Number of Individuals (MNI). While NISP calculates the maximum number of individuals on a site, this method establishes the minimum number of animals by estimating the smallest number of animals that are represented in the recovered faunal assemblage. For each taxon, the rights and lefts of each of the main elements are carefully matched, taking into consideration differences in age, sex, and size. Once completed, the individual MNI for each element is considered, and by taking into consideration gross size and age differences, a figure representing the entire animal is derived.

The MNI effectively corrects for the differential number of bones found in bird, mammal, and fish skeletons, as it also corrects for the presence of complete skeletons. But the thoroughness of the analyst, the units of aggregation, and the sample size all affect the interpretation of an MNI figure. Accurate estimations of dietary importance based on MNI require a large number of bones, since infrequently-occurring animals are over-represented in small assemblages. As Grayson (1984) pointed out, MNI values are intimately tied to units of aggregation, and therefore, in small samples the least common species on a site will be overemphasized.

While this problem is greatly diminished in larger samples, the MNIs, no matter how well executed, do not provide a true dietary estimate. Since large and small taxa are given equal weight, this method produces a skewed picture of the relative dietary importance. For example, one pig and one cow are seen as equally important in dietary terms, despite the differences in pounds of meat (Grayson 1984).

Usable Meat Weight

In the 1950s Theodore White introduced to the field a method that would translate MNIs into dietary estimates. To obtain a rough estimate of the relative importance of different taxa, the MNI for a given taxon was multiplied by the average amount of usable meat derived from an estimate of meat yield. Average values used in this study are based on the average weight of modern wild birds, mammals, turtles, and rough estimates for the more variable fish. Domestic livestock weights are based on colonial figures from historic records and from “historic breeds” research, and are far more realistic than modern livestock weights. Averages used for this study are largely those developed by Henry Miller in his 1984 dissertation (Miller 1984).

A critical bias undermining this method is that estimates are based on the “average” weight of a given taxon. Since fish and other cold-blooded vertebrates grow continually throughout their lives, there is no single average weight. Thus, with faunal assemblages, as those from slave sites in the Chesapeake, the Southeast, and Caribbean, where assemblages are frequently dominated by fish, the usable meat weight estimates are totally unrealistic. However, in the Chesapeake, where non-slave sites tend to contain a predominance of large domesticates, this problem is less significant.

Since this method relies on MNI directly, usable meat weight estimate suffer from the same problems inherent in the MNI method. In small assemblages, particularly those where even the more frequently occurring taxa are represented by only one or two MNI, the least frequently occurring taxa are grossly inflated. While some claim a minimum of 200 MNI is needed to produce reliable estimates, we have followed Katherine Cruz-Uribe's (1988) statistical analysis, which shows assemblages having a minimum MNI of 25 produce are adequate for diversity assessments.

Biomass

The fourth measure known as "biomass" or "skeletal mass allometry" is quickly becoming a standard in zooarchaeological analysis. Unlike other methods, this method is based on the biological premise that the weight of bone is related to the amount of flesh is supports. Since two dimensions of an animal grow in a relatively predictable exponential curve, an equation relating the two can be derived. Developed for zooarchaeology by Elizabeth Reitz and other scholars, this method is based on firm biological ground. Body size and body weight can then be determined from the size of a bone element, since a specific quantity of bone represents a predictable amount of tissue (Reitz and Cordier 1983; Reitz and Scarry 1985). This estimate, therefore, provides a balance to the NISP and MNI methods. It successfully counters the problem of interdependence, since it accounts for the presence/absence of partial and complete skeletons. It does not rely on thoroughness or assemblage composition, and fragmentation is not a problem. It does, however, require that each bone (or set of bones) is weighed individually.

In a later section, where relative dietary estimates are used to show trends over time, biomass estimates have been used, despite the fact that all of the early analyses by Miller, Bowen, and others are based on usable meat weight. However, recent research by Bowen and others have shown biomass estimates to be far more consistent than meat weight estimates (Bowen in Walsh et al. 1997). In general, it allows the weight of the fragments identified only to class to become part of the dietary estimates, it avoids the idiosyncracies of the MNI method, and it circumvents the "averaging" problem that plagues any assemblage containing a large proportion of fish.

Taphonomy

There are many physical, chemical, and biological processes that can modify the appearance of bones and affect the faunal interpretation of an archaeological site. The study of these mechanisms is known as "taphonomy," or the study of environmental phenomena and processes that affect organic remains after death (Efremov 1940). The determination of which cuts of meat are represented in a faunal assemblage begins with the careful analysis of taphonomic modifications. Identifying alterations resulting from natural processes such as temperature variation that can dry out, split, or otherwise degrade bone, carnivores and rodents that chew bone, and human feet that can further fragment bone, is the important first step. Equally important is identifying modifications that are the result of cultural activities such as butchering with an ax, cleaver or saw. Modifications resulting from percussion tools look to the unschooled and unwary much like stress fractures resulting from temperature variation (Gifford 1981; Lyman 1987b; Bonnichsen and Sorg 1989; Johnson 1985).

During the identification phase of this project, burn stains, chew marks, weathered appearance, and butchering evidence were recorded (see Tables 4-9, later). Bones were recorded as “burned” only if they exhibited distinctive charring or scorched marks. Experiments on cooking bones, by either roasting or boiling, has shown that it often takes extreme temperatures to produce burn marks on a bone. The size and density of the bone, combined with the temperature and type of cooking, influences the appearance of burn marks on bones (Pearce and Luff 1994). For this reason, there may have been other bones in the assemblages which were burned and cooked but were not recorded as having burn marks.

Evidence of the bones being chewed was apparent from puncture holes made by canine teeth or by specific gnawing patterns left on the surface of the bone. Carnivores such as dogs will typically chew on the soft ends of long bones to create channels that allow them to get at the marrow. Smaller bones belonging to fish, birds, and small mammals are easily broken and digested by carnivores, so there is rarely any evidence of carnivore chewing on these bones. Chew marks left by rodents were recorded separately from carnivore marks and are distinguished by a characteristic pattern made by their incisor teeth.

A weathered appearance on the surface of a bone can occur if bones are left in the open and are exposed to extreme temperatures and the changing elements. Usually if bones are left exposed for a period of time, they are also susceptible to chewing by animals and fragmentation due to the trampling of feet. Bones were recorded as having a weathered appearance if the surface of the bone was fragile and flaking.

Finally, butchering leaves the most obvious taphonomic sign on the bone. The majority of the butchered elements from the Jamestown site were long bones that had been hacked by an ax or cleaver, leaving irregular fractures and V-shaped cuts. Wherever the cut was placed, the resulting piece of meat generally would have included almost half the element and therefore carried on it substantial amounts of meat. All of the butchered bones were recorded on drawings for each feature (see Appendix E), and a more detailed discussion of the butchering is included in a later section.

Age Data

Zooarchaeologists can also determine the age at which an animal was slaughtered. In general terms, "kill-off" patterns are determined by several aging techniques, including evaluating the relative size and characteristics of the bone, tooth wear, and the degree of fusion of the long bone epiphysis.

Essential for any study of animal husbandry, evidence for the age of slaughter is based on individual bone that can “aged,” i.e., a long bone that has one or more epiphyseal ends or a mandible having either the fourth premolar and one or more molars. Once the “age” has been determined for each individual bone, then they are aggregated to form the demographic structure of the dead herd, known as “kill-off,” or slaughter patterns. As with so many other techniques in zooarchaeology, these methods require assemblages with large numbers of ageable bones and/or teeth.

Unfortunately, neither of the Jamestown assemblages contained sufficient numbers to reconstruct kill-off patterns from mandibular tooth wear for any of domesticated mammals. Lone bong data is almost as weak, and it is insufficient to provide any information on either cattle or caprines (sheep or goats) for any time period. Data for swine is a bit stronger, but only the early assemblage contains sufficient numbers of ageable long bone to produce any evidence. With only nineteen long bones, even it is very weak.

While faunal remains has the potential of providing evidence essential in reconstructing animal husbandry patterns, these assemblages are too small, and therefore discussions include only a brief description of epiphyseal fusion aging. For a more complete discussion on the various methods, see Appendix 3 in *Provisioning Early American Towns. The Chesapeake: A Multidisciplinary Case Study* (Walsh et. al. 1997).

Briefly, the process of epiphyseal fusion aging is based on developmental morphology. There are three growth areas in a typical mammalian long bone: the shaft or diaphysis and epiphyses on either end, separated by cartilage that is progressively ossified as the epiphyses “fuse” to the shaft. The rate at which these epiphyses fuse varies, on either end of the same bone and among different elements. By noting which epiphyses are fused and which are not in animals of known age, the sequence of bone fusion can be determined. This sequence appears to be fairly consistent for a species, but can vary within different breeds of the same species and can be influenced by diet and environmental factors.

Even though the exact age at which these bones fuse can vary, the process and sequence of bone fusion remains the same and thus can serve as a guide to relative age. Following Raymond Chaplin, as outlined in *The Study of Animal Bones from Archaeological Sites*, the fused or unfused condition of the epiphyses of the limb bones from the Jamestown assemblages were recorded whenever possible for cattle, caprines, and swine (Chaplin 1971).

Taxa Identified

The following section provides a detailed description of each of the taxa found in one or more of the Jamestown assemblages. There were a total of 6,046 identifiable bones recovered from the various assemblages, with the bulk of this material coming from Pit 1 and Pit 3. A total of seventy-two different species were identified, including eighteen fish species, eight reptile/amphibian species, twenty-four bird species, and twenty-two mammal species. A list of each species by taxonomic and common name can be found in Table 3.

Before progressing to a detailed discussion of relative dietary importance, meat cuts, taphonomic processes, and husbandry patterns, it is necessary to briefly describe the habitat, availability, and economic importance of each animal. More in-depth information is available in the field guides, traveler's accounts, and wild game and livestock management texts listed in the bibliography.

Crustaceans

Blue Crab. Three calcined pincers from blue crabs (*Callinectes sapidus*) were identified in Pit 1. The blue crab is distributed along the Atlantic coast, and is most prevalent in the Chesapeake area (Lippson and Lippson 1984). Their remains, mostly calcined claws, have been recovered from most colonial-period sites throughout the Chesapeake Bay region. Due to the fragile quality of the claws, crab remains typically survive only if they have been burned. Crabs were harvested from the water primarily during the summer months, but also on a limited basis during spring and fall; during the winter months they become dormant, burrowing into the sandy bottom. John Smith remarked in his *General History* that the inhabitants of Jamestown lived on crabs and sturgeon from May to September 1607 while they waited for their first shipment of supplies (Smith in Barbour 1986). Again, since crab claws usually survive only when they have been burned, the presence of only three calcined pincers should not be considered an indicator of abundance

Bermuda Fish

Present in Pit 3 are numerous elements from species belonging to the Serranid and Lutjanid families. Although a few species from these families are found in the Chesapeake region, the large size of the remains indicates they came from a more southern region, probably Bermuda where they are very common. Strachey wrote in his description of Bermuda that they daily hooked many kinds of fish, including angelfish, salmon, peal (small salmon), bonitos, stingray, cavally (horse mackerel), snappers, hogfish, sharks, dogfish, pilchards, mullets, and rockfish, of which be divers kinds" (Strachey in Haile 1998:397). Dried, salted, and barreled in brine, fish taken in Bermuda could be easily made were ready for export.

Serranidae. Fifteen elements belonging to the sea bass family (Family Serranidae) came from Pit 3. Members of the sea basses and groupers are typically large-mouthed, robust bottom dwellers that can range in length from several inches to several feet. The species in this family feed on crustaceans and fish and can inhabit a variety of habitats from the shoreline to depths of 660 feet or more. The family, which primarily lives in tropical and temperate seas, includes approximately four hundred fifty species, of which three are known to seasonally inhabit the Chesapeake Bay. While the jewfish (*Epinephelus itajara*) and the

Table 3.
Taxa Identified

Taxonomic Name	Common Name
CRUSTACEANS	
Callinectes sapidus	Blue Crab
FISH	
Order Rajiformes	Skates or Rays
Order Lamniformes	Typical Sharks
Class Osteichthyes	Bony Fish
Acipenser spp.	Sturgeon
Lepisosteus spp.	Gar
Family Clupeidae	Herring
Alosa sapidissima	American Shad
Family Catostomidae	Sucker
Family Ictaluridae	Freshwater Catfish
Esox niger	Channel Pickerel
Family Gadidae	Codfish
Lepomis spp.	Sunfish
Morone americana	White Perch
Morone spp.	Temperate Bass
Morone saxatilis	Striped Bass
Family Serranidae	Sea Bass
Perca flavescens	Yellow Perch
Family Lutjanidae	Snapper
Archosargus probatocephalus	Sheepshead
AMPHIBIANS/REPTILES	
Order Testudines	Turtle
Chelydra serpentina	Snapping Turtle
Family Kinosternidae	Musk or Mud Turtle
Chrysemys spp.	Slider or Cooter
Malaclemys terrapin	Diamondback Terrapin
Terrapene carolina	Box Turtle
Family Cheloniidae	Marine Turtle
Family Colubridae	Snake
Family Viperidae	Vipers
BIRDS	
Class Aves	Bird
Class Aves/Mammalia III	Bird/Small Mammal
Phalarcrocorax auritus	Double-Crested Cormorant
Pterodroma cahow	Bermuda Petrel
Goose spp.	Goose
Anser spp.	Goose
Anser anser	Domestic Goose
Branta canadensis	Canada Goose
Duck spp.	Duck
Anas spp.	Dabbling Duck
Anas platyrynchos	Domestic Duck or Mallard
Anas rubripes	Black Duck
Aix sponsa	Wood Duck
Oxyura jamaicensis	Ruddy Duck
Aythya spp.	Pochard
Aythya collaris	Ring-Necked Duck
Charadius vociferus	Killdeer
Larus delwarensis	Ring-Billed Gull
Family Accipitridae	Hawk or Eagle
Haliaeetus leucocephalus	Bald Eagle

Table 3 (cont'd).
Taxa Identified

Taxonomic Name	Common Name
BIRDS	
Meleagris gallopavo	Turkey
Gallus gallus	Chicken
Colinus virginianus	Bobwhite
Family Strigidae	Typical Owls
Order Piciformes	Woodpeckers
Order Passeriformes	Perching Bird
Corvus brachyrhynchos	American Crow
MAMMALS	
Class Mammalia	Mammal
Class Mammalia I	Large Mammal
Class Mammalia II	Medium Mammal
Class Mammalia III	Small Mammal
Didelphis virginiana	Opossum
Sylvilagus floridanus	Eastern Cottontail
Marmota monax	Woodchuck
Sciurus carolinensis	Eastern Grey Squirrel
Sciurus niger	Eastern Fox Squirrel
Castor canadensis	Beaver
Rattus spp.	Rat
Ondatra zibethica	Muskrat
Rattus rattus	Roof Rat
Tursiops truncatus	Bottle-Nosed Dolphin
Felis domesticus	Domestic Cat
Canis familiaris	Domestic Dog
Procyon lotor	Raccoon
Lutra canadensis	River Otter
Mustela vison	Mink
Equus spp.	Horse/Ass
Oder Artiodactyla I	Sheep, Goat, Deer, or Pig
Order Artiodactyla II	Sheep, Goat, or Deer
Sus scrofa	Domestic Pig
Odocoileus virginianus	White-Tailed Deer
Bos taurus	Domestic Cattle
Ovis aries/Capra hircus	Domestic Sheep or Goat

gag (*Mycteroperca microlepis*) have occasionally been caught in the waters of the Chesapeake, the black sea bass (*Centropristis striata*) is common in the mid-lower Chesapeake Bay from spring to late autumn, inhabiting rocky bottoms near pilings, wrecks, and jetties (Murdy et al. 1997). However, the remains found in the Jamestown assemblage were of much larger fish, similar to the species which frequent Bermuda. At least fifteen species are currently found in Bermuda waters, including the harlequin bass (*Serranus tigrinus*), the coney (*Cephalopholis fulva*), the black grouper (*Mycteroperca bonaci*), the yellowmouth grouper (*M. interstitialis*), the tiger grouper (*M. tigris*), the yellowfin grouper (*M. venenosa*), the gag grouper (*M. microlapis*), the red grouper (*Epinephelus morio*), the Nassau grouper (*E. striatus*), the red hind (*E. guttatus*), and the rock hind (*E. adscensionus*) (Sterrer 1986).

Lutjanidae. One element from Pit 3 was identified as a member of the snapper family (Family Lutjanidae). As with the sea basses, snappers are mainly confined to tropical and subtropical marine waters where they are found near reefs and other underwater structures. Although two species of snapper have been documented in the Chesapeake Bay, the gray snapper (*Lutjanus griseus*) and the cubera snapper (*Lutjanus cyanopterus*) are such a rare sight in the Bay that the element probably represents a fish that was imported. Several species of snapper can be found around the waters of Bermuda, including the gray snapper (*Lutjanus griseus*), the lane snapper (*Lutjanus synagris*), the silk snapper (*Lutjanus vivanus*), and the yellowtail snapper (*Ocyurus chrysurus*) (Sterrer 1986).

Jamestown Fish

The identification of fish in the assemblages is not surprising due to Jamestown's proximity to the James River and the Chesapeake Bay. Fishing has long been important in the Tidewater region and in his description of Virginia, Captain John Smith wrote that:

> *Of fish we were best acquainted with Sturgeon, Grampus, Porpus, Seales, Sting-graies, whose tailes are very dangerous. Bretts, Mullets, White Salmonds, Trowts, Soles, Plaice, Herrings, Conyfish, Rockfish, Eeles, Lampreys, Catfish, Shades, Pearch of three sorts, Crabs, Shrimps, Crevises, Oysters, Cocles, and Muscles (Smith in Barbour 1986, 2:111).*

The seasonal presence of fish in the Chesapeake is influenced by several factors, including habitat, water salinity, water temperature, the amount of oxygen, and sources of food. Keeping all of these factors in mind, there are six main categories of fish that inhabit the Chesapeake—freshwater, estuarine, marine, anadromous, semi-anadromous, and catadromous. Generally freshwater fish can be found in waters with a salinity as high as 10%, while estuarine fish typically live in tidal waters with salinities that range from 0% to 30% and marine fish live in oceanic waters that have a salinity that is greater than 30%. Anadromous fish include those species that migrate from ocean waters to freshwater to spawn and semianadromous fish move from waters of higher salinity to waters of lower salinity to spawn. Finally, catadromous species are rare in the Chesapeake and include fish that migrate from freshwater habitats to the ocean for spawning (Murdy et al. 1997).

The majority of the fish identified in the Jamestown assemblage prefer to live in low-salinity habitats that are consistent to the upper regions of the James River. During various time of the year, though some species are more prevalent in the James due to the temperature of the water and spawning habits. These species which were identified in the assemblages and are more common in the spring through autumn months include sturgeon, skates/rays, herring, shad, white perch, striped bass, and sheepshead (Murdy et al. 1997). As described by Alexander Whitaker, the colonists were also aware of the seasonal abundance of some fish and depended on their presence at various times of the year to supplement their diet:

> *The sea fish come into our rivers in March and continue until the end of September; great schools of herrings come in first; shad of a great bigness and rockfish follow them; trouts, bass, flounder, and other dainty fish come in before the other be gone; then come multitudes of great sturgeon...(Whitaker in Haile 1998:743).*

Skates or Rays. Dentary elements from Pit 1 and Pit 3 were identified as belonging to the Order Rajiformes. Rays and skates feed chiefly on crustaceans, shrimp, mollusks, squid, and small fish and can be found along the Atlantic coast from Florida to New England (Hildebrand and Shroeder 1972). While skates and rays are typically found in deep ocean waters, there are some species of rays that prefer shallow water and even can be found in freshwater areas. In the waters of the Chesapeake they are commonly caught in nets or by rod and reel, although they are not usually utilized for human consumption (Murdy et al. 1997).

One anecdote in *The General History* describes Captain John Smith's encounter with a stingray while fishing for fish with his sword:

> *But it chanced our captain taking a fish from his sword, not knowing her condition, being much of the fashion of a thornback, but with a long tail like a riding rod, whereon the middest is a most poisoned sting or two or three inches long, bearded like a saw on each side, which she struck into the wrist of his arm near an inch and a half. No blood nor wound was seen, but a little blue spot. But the torment was instantly so extreme that in four hours had so swollen his hand, arm, and shoulder and part of his body as we all with much sorrow concluded his funeral and prepared his grave in an island, as himself directed. Yet, it pleased God by a precious oil Doctor Russell at the first applied to it when he sounded with probe [that] ere night his tormenting pain was so well assuaged that he ate of the fish to his supper, which gave no less joy and content to us than ease to himself, for which we called the island 'Stingray Isle' after the name of the fish (Smith in Haile 1998:262).*

Typical Sharks. A total of eight vertebrae from Pit 3 and Midden 1 were identified to the Order Lamniformes (typical sharks). Sharks are typically found in the Chesapeake area during the summer and fall. While some species prefer deep-water habitats, other species such as the sand tiger (*Odontaspis taurus*) inhabit shallow estuaries and coastal waters feeding on small fish, crustaceans and squid. Other sharks such as the bull shark (*Carcharhinus leucas*) are known to frequent brackish waters as well as low-salinity rivers and lakes. Bull sharks feed on bony fish, crustaceans, turtles, and mammals and have been recorded as far north as the Paxtuxent River (Murdy et al. 1997).

Sturgeon. Of all the fish elements identified in the Pit 1, Pit 3, and the Bulwark Ditch assemblages, scutes from sturgeon were the most numerous, accounting for 48% of the total identified bones. Sturgeon are among the most easily identified of fish species due to their hard bony "scutes" which lie in five rows along their bodies. The sturgeon is a bottom-dwelling anadromous fish that lives in diverse habitats. The large species, the Atlantic sturgeon (*Acipenser oxyrhynchus),* is found in shallow waters along the continental shelf, sometimes entering larger rivers to spawn. The other main species, the shortnose sturgeon (*Acipenser brevirostrum*), is more commonly found in river mouths, tidal rivers, estuaries, and bays. Living up to fifty years, they can become enormously large, averaging six to eight feet in length. They were and are today important commercially; their roe is made into high-quality caviar, their flesh is eaten smoked or fresh, and isinglass is made from their swim bladders (Robbins et al. 1986).

The 1609-10 Council of Virginia also realized the importance of sturgeon and instructed the early colonists that "Once the ships are unloaded at Jamestown, the sailors shall be put to work fishing for sturgeon, etc." (Haile 1998:25). Sturgeon were so plentiful in the James River that John Smith remarked that while they were waiting for provisions, "We had more sturgeon than could be devoured by dog and man, of which the industrious by drying and pounding, mingled with caviar, sorrel, and other wholesome herbs, would make bread and good meat" (Smith in Haile 1998:320).

The early attempts to export sturgeon to England failed since the products did not keep well on the long voyage back. In 1610, instructions were sent concerning the proper methods of pickling sturgeon flesh and utilizing the other parts of the fish:

> *Sturgeon which was last sent, came ill conditioned, not beinge well boyled; if it were cut in small peeces, and powdered, put up in caske, the heads pickled by themselves, and sente hither, it would doe farre better… Rowes of the said Sturgion make Cavearie according to instructions formerlye given… Soundes (air-bladder) of the said Sturgion will make Isinglasse according to the same instructions (Brown 1891, 1:386).*

After the sturgeon fishing expeditions of 1610, there appear to be no records indicating further shipments of sturgeon were exported from Virginia until 1620. Although there are no records of sturgeon being exported during this time, Governor Thomas Dale established regulations in 1612 to control overfishing:

> *All fishermen, dressers of sturgeon, or such like appointed to fish or to cure the said sturgeon for the use of the Colony, shall give a just and true account of all such fish as they shall take by day or night, of whatsoever kind, the same to bring unto the Governor. As also all such kegs of sturgeon or caviar as they shall prepare and cure upon peril for the first time offending herein of losing his ears, and for the*

second time to be condemmed a year to the galleys, and for the third time offending to be condemmned to the galleys for three years (Wharton 1957:17).

English interests in establishing a sturgeon fishery in Virginia continued into the 1620s. By 1626, however, records of the General Court of Virginia noted that the "Sturgeon fishery here costs adventurers 1700 £ but no accounts of their profit begun…" (Pearson 1943a:4). This apparent lack of success in the sturgeon industry was best defined by the Dutch traveler David De Vries, who wrote:

When the English first began to plant their colony here, there came an English ship from England for the purpose of fishing for sturgeon; but they found that this fishery would not answer, because it is so hot in summer, which is the best time for fishing, that the salt or pickle would not keep them as in Muscovy whence the English obtain many sturgeon and where the climate is colder than in the Virginias (De Vries in Pearson 1943a:4).

Today the sturgeon population has again been reduced due to overfishing, pollution, and dam construction. In the Chesapeake Bay, fishing for the Atlantic sturgeon peaked in 1890, after which the fishery rapidly declined with each passing year. In 1938, a law was passed in Virginia that prohibited the removal of sturgeon less than four feet long. By 1974, it became "unlawful to take or catch and retain possession of any sturgeon fish" in Virginia, so presently there is no sport fishery for Atlantic sturgeon. This law and other conservation regulations may be the reason that limited spawning of sturgeon has once again been occurring in the James and the York rivers. For now however, controlled sturgeon fisheries in New York and Canada provide high-quality caviar and other commercial products for export purposes (Murdy et al. 1977).

Gar. At least one hundred sixty-one elements from Pit 1 and Pit 3 indicated the presence of gar (*Lepisosteus* spp.) in the early Jamestown diet. The gar belongs to an ancient group of predatory fish that are distinguished by their elongated, cylindrical body that is covered with diamond-shaped scales. Gars are also noted for having long beaklike jaws that contain sharp teeth of various sizes (McClane 1965). Only one species, the longnose gar (*Lepisosteus osseus*), is reported to still exist in the waters of the Chesapeake Bay. This gar can reach a length of six feet and may have once been a common sight in the waters of the James River (Hildebrand and Schroeder 1972). Today, it is not considered a good eating fish, although its remains are frequently found in prehistoric and colonial faunal assemblages.

Herring. A total of eight fish elements from Pit 3 and one hundred and thirty-six elements from Pit 1 were identified as belonging to the herring family (Family Clupeidae). The biology and the ecology of clupeids is varied: some species live predominately in freshwater, and some only enter fresh water to feed or spawn. There are ten species of herring that are known to inhabit the Chesapeake Bay region, with the alewife (*Alosa pseudoharengus*), the American shad (*Alosa sapidissima*), the Atlantic menhaden (*Brevoortia tyrannus*), and the Atlantic herring (*Clupea harengus*) being the most common. The alewife and Atlantic herring spawn from late March through April in locations of large rivers and small streams, returning to the ocean by summer. The springtime presence of herring in the tributaries of the Chesapeake was described by Robert Beverly in 1705:

> *In the Spring of the Year, Herrings come up in such abundance into their Brooks and Foards, to spawn, that is almost impossible to ride through, without treading on them. Thus do those poor Creatures expose their own Lives to some Hazard, out of their Care to find a more convenient Reception for their Young, which are not yet alive (Beverly in Pearson 1942a:218).*

The American shad also prefers to spawn in fresh to low-salinity waters of the tributaries during the spring months, while the Atlantic menhaden spawn during the early spring and again in the fall in the shelf waters off the bay. All of these species are considered important food fish, while some are also valued for their roe and oil (Murdy et al. 1997).

American Shad. A member of the herring family, the American shad (*Alosa sapidissima*) was identified by fifteen elements found in Pit 3, the Bulwark Ditch, and Midden 1. As mentioned earlier, the shad enters bays and rivers along the Atlantic coast in the spring to spawn in the fresh waters. They prefer to spawn in shallow flats in rivers near the mouths of creeks and return to salt water when cool weather returns (Hildebrand and Schroeder 1972). Being plentiful in the Tidewater region, shad was described by William Strachey in 1612 as being "a yard long and for sweetness and fatness a reasonable food fish; he is only full of small bones, like our barbels in England" (Strachey in Wharton 1957:15).

Sucker. Ninety-four elements from Pit 1 and Pit 3 were identified as belonging to the sucker family (Family Castostomidae), close relatives of carp and minnows. The suckers comprise a large family of freshwater fishes that can occasionally be found in brackish waters. They typically ascend small creeks in the spring where they prefer to spawn in swiftly flowing waters. Although suckers are quite bony fish, they are considered to be fairly good eating (Hildebrand and Schroeder 1972).

Catfish. A total of one hundred seventy-one fish elements from Pit 1, Pit 3, the Bulwark Ditch, Ditch 6, and Midden 1 were identified to the freshwater catfish family (Family Ictaluridae). Freshwater catfish are abundant in all Chesapeake Bay tributaries and can be found in lakes, rivers, ponds, streams, and estuarine waters where they feed on a variety of insects, fishes, and crustaceans. The most common species of freshwater catfish found in the Chesapeake include the white catfish (*Ictalurus catus*) and the channel catfish (*Ictalurus punctatus*). During spring and early summer, both species move upstream to spawn where they lay eggs in large, saucer-shaped nests. They are both praised as fine fish for eating due to their lack of small bones (Murdy et al. 1997).

Channel Pickerel. The channel pickerel (*Esox niger*) was identified from five elements excavated from Pit 1. Typically found in brackish or salt waters, the channel pickerel is the smaller species of the pickerel family. Pickerels are noted for their elongated body and their long snouts, which allows them to hide among the weeds when feeding on smaller fish. They migrate to shallow waters for spawning in early March to mid-April and return to deeper waters in winter (Hildebrand and Schroeder 1972).

Codfish. Surprisingly, there were at least six fish elements from Pit 1, Pit 3, the Bulwark Ditch, and Ditch 7 that were identified as belonging to the cod family (Family Gadidae). Although pollock (*Pollachius virens*) and the Atlantic cod (*Gaus morhua*) have been caught in the Chesapeake Bay region on rare occasions, they are more typically found in large numbers off the waters of New England and their remains have appeared in most if not all New England historic faunal assemblages. The habitat of the Atlantic cod can be found within a fathom of the sea bottom, generally in temperatures ranging between 32 and 55 degrees. In the summer and early fall adult cod congregate in the polar waters around Labrador, withdrawing in later fall and winter to the south or into deeper water. Thus, in the modern period on the New England coast, cod are taken commercially only in fall, winter, and early spring. They usually appear in southern Massachusetts in mid-October, and migrate northward in early May. Younger cod, and others less sensitive to water temperature, remain in shoals and river mouths, usually on rocky bottoms, year-round (Bigelow and Schroeder 1953).

The presence of cod in the Jamestown assemblages raises the question of whether these bones are the remains of imported cod or were they procured from nearby waters. As mentioned, cod are not typically found in the Chesapeake region, but some early historic references suggest that cod may have been locally available to the Jamestown inhabitants. For example, Captain Christopher Newport wrote in 1607:

> *And within sight of land into the sea we expect at time of year to have a good fishing for cod, as both at our entering we might perceive by palable conjectures, seeing the cod follow the ship… as also out of my own experience not far off to the northward the fishing I found in my first voyage to Virginia (Newport in Wharton 1957:8).*

A year later, during his first expedition up the Bay, Captain John Smith also made a reference to cod being in the Chesapeake Bay when he commented:

> *Neither better fish, more plenty, nor more variety for small fish had any us ever seen in any place so swimming in the water than the Bay of Chesapeack… Some small cod also we did see swim close by the shore by Smith's Isles, and some as high as Riccard's Clifts, and some we have found dead upon the shore (Smith in Barbour 1986, 2:168).*

While cod may have been available in limited quantities to the Jamestown colonists at certain times of the year, records indicate that the majority of their cod was imported. As early as 1610, efforts were made by the colony to supply themselves with cod that they fished for in the waters off the coast of New England. But due to the lack of sea-worthy fishing vessels and skilled fishermen, Jamestown became dependent on English interests for their supply of cod that was brought from New England and Canada. Salted codfish, as well as other cured fish, became a staple in the early colonists diet and by 1624-25, the Virginia Census recorded that 58,000 pounds of fish was being stored in fifteen settlements near the James River (Pearson 1943a:6).

Temperate Bass. The assemblages from Pit 1, Pit 3, and Midden 1 contained at least four fish bones that could only be identified as temperate bass (*Morone* spp.). Members of the temperate bass family include moderate to large-sized fish that occur in marine, brackish, and freshwater habitats. The two species found in the Chesapeake Bay include the white perch (*Morone americana*) and the striped bass (*Morone saxtilis*). The individual habitats of these two species are discussed below.

White Perch. White perch (*Morone americana*) was identified from four hundred fifty-five elements excavated from Pit 1, Pit 3, and Midden 1. Tolerating a wide range of salinities, the white perch is an abundant year-round resident found in all tributaries of the Chesapeake Bay. Preferring level bottoms of silt, sand, mud, or clay, white perch migrate to fresh or low-salinity waters of large rivers to spawn from April through June. After spawning, adults move back downstream toward the Bay to spend the summer feeding in richer waters, while the young gradually move down to join them. Due to their value as a food fish, white perch have long been one of the most important recreational and commercial fishes in the Chesapeake Bay (Murdy et al. 1997).

Striped Bass. Five elements from Pit 1, Pit 3, and Midden 1 were identified to the species striped bass (*Morone saxtilis*). During summer and winter, striped bass are found in deep channels of the bay, while in the fall they are more concentrated in the lower reaches of rivers. In the spring they return to the sand or mud bottoms of freshwater to spawn. They are carnivorous, feeding on various kinds of animal life such as fish, crustaceans, worms, and insects. Also called rockfish, the striped bass has long been a favorite saltwater fish for food (Hildebrand and Schroeder 1972).

Yellow Perch. One element from Midden 1 was identified as belonging to yellow perch (*Perca flavescens*). The yellow perch is common in most tributaries of the Chesapeake Bay and can sometimes be found in brackish water at river mouths. They prefer to inhabit the upper portions of estuaries and migrate even further upstream to spawn in small shallow streams in late February (Lippson and Lippson 1984).

Sheepshead. At least five fish elements from Pit 1 and Pit 3 were identified as sheepshead (*Archosargus probatocephalus*). As a summer visitor to the lower Chesapeake Bay, sheepshead can be found near jetties, wharves, pilings, shipwrecks, and other structures that become encrusted with barnacles, mussels, and oysters, their main prey. Sheepshead are regarded as excellent food fish and are often mentioned in early descriptions of fish in the Chesapeake (Murdy et al. 1997). One of these descriptions was by Thomas Glover when he wrote in 1676 that:

> *In the Rivers are great plenty and variety of delicate Fish; one kind whereof is by the English called a Sheepshead, from the resemblance the eye of it bears with the eye of a Sheep: This fish is generally about fifteen or sixteen inches long, and about half a foot broad; it is a whole-some and pleasant fish, and of easie digestion (Glover in Pearson 1942a: 217).*

Reptiles/Amphibians

Each of the identified turtle and snake species that are discussed below are commonly found in the eastern region of Virginia and therefore would have been accessible to the occupants of the Jamestown settlement. While sea turtles are more common in the Chesapeake waters from May through November, the other identified turtles are typically active from March through October. Snakes and vipers are also more active in the warmer months and tend to hibernate by November (Mitchell 1994).

Bermuda Turtles

Fragments from the carapace of what may be members of the Chelonidae family were found in Pit 1 and Midden 1, possibly representing shipments of food from Bermuda. Unfortunately, since the range of marine turtles is so broad, *and* it includes both Bermuda as well as the Chesapeake region, it is impossible to say for sure where this particular turtle was captured.

Chelonidae. At least eight carapace elements from Pit 1 and Midden 1 have been identified as marine turtles (Family Cheloniidae). The most frequently seen marine turtles in the Chesapeake region include the loggerhead turtle (*Caretta carretta*), Kemp's ridley turtle (*Lepidochelys kempii*), and the leatherback turtle (*Dermochelys coriacea*). All of these species have paddlelike limbs and can be found in the coastal bays, lagoons, estuaries and the open waters of the Chesapeake Bay. They typically use the Chesapeake as a summer feeding area, where they consume various prey including crabs, shellfish, fish, squid, shrimp, and seaweed. The only marine turtle known to nest in Virginia is the loggerhead, which mates in shallow waters off nesting beaches and comes ashore to lay a hundred or more eggs in deep holes dug with their hind feet (Mitchell 1994).

Although the loggerhead turtle frequents the Virginia shoreline, and the remains may very well be from local turtles, sea turtles also are a common sight in Bermuda, and at least for a time they were captured for export. In his description of sea turtles on the island of Bermuda in 1610, Silvester Jourdain remarked that "I have seen a bushel of eggs in one of their bellies, which are sweeter than any hen egg; and the tortoise itself is all very good meat and yieldeth great store of oil, which is as sweet as any butter; and one of them will suffice fifty men a meal, at least…"(Jourdain in Wright 1964:11). William Strachey wrote of the turtles of Bermuda,

> *The tortoise is reasonable toothsome, some say wholesome meat. I am sure our company liked the meat of them very well. And one tortoise would go further amongst them than three hogs. One turtle, for so we called them, feasted well a dozen messes, appointing six to every mess. It is such a kind of meat as a many can neither absolutely call fish nor flesh, keeping most of what in the water, and feeding upon sea grass like a heifer in the bottom of the coves and bays, and laying their eggs (of which we should find five hundred at a time in the opening of a she-turtle) in the sand by the shore side, and so covering them close, leave them to the hatching of the sun, like the manatee at Saint Dominique which made the Spanish friars, at their first arrival, make some scruple to eat them on a Friday because in color and taste the flesh is like to morels of veal. Concerning the laying of their eggs and hatching of their young, Peter Marty writeth thus in his* Decades of the Ocean*: "At such time as the heat of nature moveth them to generation, they came forth of the sea, and making a deep pit in the sand, they lay three or four hundred eggs therein. When they have thus emptied their bag of conception, they put as much of the same again into the pit as may satisfy to cover the eggs, and so resort again unto the sea, nothing careful of their succession. At the day appointed of nature to the procreation of these creatures, there creepeth out a multitude of tortoises as it were pismires out of an anthill, and this only by the heat of the sun, without any help of their parents. Their eggs are as big as geese eggs; and themselves grown to perfection, bigger than great round targets" (Strachey in Haile 1998:400-401).*

Jamestown Turtles

In the various assemblages are found a variety of turtles, almost all of whom are found locally in and around the island.

Snapping Turtle. Thirty-eight bones from Pit 1, Pit 3, and Midden 1 were identified as snapping turtle (*Chelydra serpentina*). The snapping turtle inhabits areas of permanent freshwater, but may enter brackish waters at times. They often bury themselves in mud, exposing only their eyes and nostrils. More active at night during the warmer months, most enter hibernation by late October, burrowing into mud bottoms, beneath logs or vegetable debris, where they remain until spring. They feed on insects, crabs, shrimp, clams, earthworms, fish, frogs, toads, small turtles, snakes, as well as plant material (Ernst and Barbour 1972). Considered to be delicious, turtle meat is eaten throughout its range.

Musk or Mud Turtle. At least eighty elements from Pit 1 and Pit 3 were identified as a musk or mud turtle (Family Kinosternidae). Preferring fresh or brackish waters, all musk or mud turtles have two pairs of musk glands beneath the border of the carapace. The secreations are very offensive, so they are also commonly called "stinkpots" (Behler and King 1979).

Slider/Cooter. A total of seventy-six elements from sliders or cooters (*Chrysemys* spp.) were found in Pit 1, Pit 3 and Bulwark Ditch. These turtles typically inhabit sluggish rivers, shallow streams, marsh areas, lakes, and ponds with aquatic vegetation. Some prefer soft bottom habitats while others can be found in areas that support overhangs for sunning (Ernst and Barbour 1972).

Diamondback Terrapin. Eleven carapace bones from Pit 3 were identified as diamondback terrapin (*Malaclemys terrapin*). Distinguished by the deep growth rings on the carapace, diamondback terrapins can be found in salt-marsh estuaries, tidal flats, and lagoons where they feed on marine snails, clams, and worms (Behler and King 1979). The early colonists at Jamestown probably ate the terrapin prepared in the Indian fashion, roasted whole in hot coals and opened at the table where the meat was extracted by fingers. Due to its delicious meat, the diamondback terrapin quickly gained fame and became an indispensable course on menus designed for royalty and the elite (Wharton 1957).

Box Turtle. Pit 1, Pit 3, and the Bulwark Ditch assemblages produced a total of one hundred and eighty-five bones that belonged to box turtles (*Terrapene carolina*). The box turtle is a small terrestrial turtle that normally inhabits open woodlands, but can also be found in pastures and marshy meadows. They forage during the cooler times of the day and avoid the heat by hiding under rotting logs, in mud, or shallow pools. As the temperature begins to drop in the fall, box turtles begin hibernation by burrowing into loose soil, sand, vegetation, or animal burrows. Omnivores, they consume roots, stems, leaves, fruit, seeds, mosses, insects, fish, frogs, toads, and carrion. They have also be known to consume mushrooms poisonous to man, which habit has killed many a human who has eaten their flesh (Behler and King 1979).

Snakes and Vipers

There were twelve vertebrae from Pit 1 and Pit 3 that could only be identified as snake (Family Colubridae) and at least fourteen distinctive vertebrae from Pit 1 and Pit 3 that were identified as vipers (Family Viperidae). By far the largest family of living snakes, colubrids contain approximately 1,500 species, which inhabit every possible ecological niche (Linzey and Clifford 1981: 37-117). The thirty species of nonpoisonous snakes that are found in Virginia can be found in a variety of habitats including trees, on the ground, beneath the ground, and in the water. As diverse as is the habitats is their food. Some species specialize in certain prey, while others are generalists, eating almost anything small enough to be swallowed. Possible species present on the island include water snakes (*Nerodia* spp.), semi-aquatic reptiles that can be found in water, basking in the sun, or in tree branches. Another possible group represented is *Elaphe* spp. (rat snakes), large powerful constrictors that kill their prey by wrapping their bodies around it. One, the back rat snake (*Elaphe obsoleta*) crawls along the woodland floor, scaling trees in search of food.

The viper family includes poisonous snakes that have curved, retractable, hollow fangs near the front of the upper jaw. Along the eastern coast of Virginia, the most common vipers are the copperhead (*Agkistrodon contortrix*) and the cottonmouth (*Agkistrodon piscivorus*). While the copperhead prefers wooded hillsides or rocky outcrops, the cottonmouth can be found in swamps, lakes, rivers, and irrigation ditches (Mitchell 1994). Although the snakes and vipers may have been just visitors to the site, George Percy wrote that during the starving period, "…some were enforced to search the woods and to feed upon serpents and snakes…" (Percy in Haile 1998:505).

Bermuda Birds

Several fragments of the cahow found in the early assemblages are proof that the Jamestown colonists were supplied animals from Bermuda.

Cahow. The discovery of Bermuda cahow (*Pterodroma cahow*) bones at Jamestown has opened up new avenues concerning the economic relationship between Jamestown and Bermuda. So far, nine elements (at least two individuals) from Pit 1 and Pit 3 have been identified and confirmed by staff at the Smithsonian Institution. Two similar elements from the wing region and two long bone elements suggest that cahows were imported as a food source. The bones have been broken in a similar fashion, suggesting that the meat-bearing elements may have been salted, preserved and sent as provisions. The history of the cahow as a food source in the early 1600s and their Bermuda habitat suggests that these specimens from Jamestown came directly from Bermuda.

The legendary Bermuda cahow is a diving petrel belonging to the order Procellarriformes, which also includes albatrosses, shearwaters, and storm petrels. As with other species in this order, the cahow has large nostrils enclosed in a prominent tube along the hook-tipped beak. They typically have a thirty-five-inch wingspan with grayish-black plumage above and white plumage below. They spend their youth and summers on the open ocean and only return to land to breed. Under the cover of night, the cahows return in October to nest in shallow burrows and rock crevices. Both the male and female may occupy the burrow night and day until late December when they leave to feed at sea. They are usually gone two weeks before returning to lay and incubate their single egg. For the next seven weeks the male and female take two week turns sitting on the egg, while the other is looking for food. Except for the first few days of its life, a newly hatched chick is left alone in the burrow except when being fed (Schreiber et al. 1987).

Although they are now making a comeback from near-extinction, the cahow has had a turbulent history not much different than the history of Jamestown. In 1603, a Spanish sea captain sought shelter from a storm on an unknown island in the western Atlantic. According to legend, the sailors were horrified when millions of shrieking, winged shapes swirled around the masts of the ship in the dark night. The sailors later sought their revenge on the birds by eating them in the thousands. They named the bird “cahow” after their loud call (Schreiber et al. 1987).

At one time the cahow had large breeding colonies on the Bermuda islands, but they were quickly destroyed by early British colonists and the pigs they brought with them. An early text by William Strachey beautifully describes these island birds that knew no fear of predators:

> *A kind of web-footed fowl there is, of the bigness of of an English green plover, or sea mew, which all the summer we saw not, and in the darkest nights of November and December (for in the night they only feed) they would come forth, but not fly far from home, and hovering in the air and over the sea, made a strange hollow and harsh howling. Their color is inclining to russet, with white bellies, as are likewise the long feathers of their wings russet and white. These gather themselves together and breed in those islands which are high, and so far alone into the sea that the wild hogs cannot swim over them; and there in the ground they have their burrows, like conies in a warren, and so brought in the loose mould, though not so deep; which birds with a light bough in a dark night, as in our lowbelling (rung to stupefy the birds who were then netted), we caught. I have been at the taking of three hundred in an hour, and we might have laden our boats. Our men found a pretty way to take them, which was by standing on the rocks or sands by the seaside, and holloing, laughing, and making the strangest outcry that possibly they could, with the noise whereof the birds would come flocking to that place, and settle upon the very arms and head of him that so cried, and still creep nearer and nearer, answering the noise themselves; by which our men would weigh them with their hand, and which weighed heaviest they took for the best and let the other alone; and so our men would take twenty dozen in two hours of the chiefest of them; and they were a good and well-relished fowl, fat and full as a partridge. In January we had great store of their eggs, which as great as an hen’s egg, and so fashioned and white-shelled, and have no difference in yolk nor white from an hen’s egg. There are thousands of these birds, and two or three islands full of their burrows, whither at any time in two hours’ warning we could send our cockboat and bring home as many as would serve the whole company; which birds, for their blindness (for they see weakly during the day) and for their cry and hooting, we called the ‘sea owl’. They will bite cruelly with their crooked bills (Strachey in Haile 1998:398-399).*

By 1609, the settlers had devastated the cahow population on the main island of Bermuda, so when a plague of introduced rats caused a famine, the islanders looked to the cahows who still existed on the smaller surrounding islands (Halliday 1978). Finally, fearing the demise of the cahow, the Governor of Bermuda issued proclamations in 1616 and 1621 to stop "the spoyle and havock of the Cahowes." Unfortunately, the proclamations were not effective and the cahow was not seen in the Bermuda islands for over 300 years (Halliday 1978).

In 1951, a systematic search for the species revealed that a few nests—about 18 pairs—were located on tiny offshore islands where many tropical birds nest. On these rocky islands where it has been forced to breed due to human presence on the main island, the cahow cannot burrow into the hard ground but inhabits natural holes. This has put the cahow into competition with the long-tail tropical bird, which also nests in rocky crevices. Long-tails were destroying defenseless cahow chicks left in the nest, so they could take over the rocky holes for their own nest. With the help of Bermuda's conservation department, artificial burrows were made and protective covers, which only cahows could squeeze into, were placed over nest holes. These measures helped to increase the cahow population, but in the 1960s a new threat was evident. Eggs were failing to hatch and chicks were dying due to DDT residues the cahows had picked up from the ocean environment. Legislation has finally controlled the use of DDT in North America, and the cahows are making a comeback once again. As of 1985, the cahows had increased their population to 35 pairs (Schreiber et al. 1987).

Jamestown Birds

The Chesapeake Bay is the largest estuary in North America and the primary destination of literally millions of migratory waterfowl during the winter months. Some of the bird species that were identified in the Jamestown assemblages are considered to be migratory fowl although certain environmental conditions can affect their presence and absence in an area. Birds such as the black duck, the ruddy duck, the ring-necked duck, and the ring-billed gull would have probably been available to the colonists in larger amounts during several months of the year. The seasonal availability of certain birds was accounted by John Smith in his descriptions of Virginia:

> *In Winter there are great plentie of Swans, Cranes, gray and white with blacke wings, Herons, Geese, Brants, Ducke, Wigeon, Dotterell, Oxeies, Parrats, and Pigeons. Of all those sorts great abundance, and some other strange kinds, to us unknowne by name. But in sommer not any, or a very few to be seene (Smith in Barbour 1986:111).*

Other identified fowl in the Jamestown assemblages could have been year-round supplements to the diet of the inhabitants of Jamestown. Some of these species include cormorants, Canada geese, mallards, hawks, eagles, owls, turkeys, crows, and perching birds.

Double-Crested Cormorant. Pit 1 and Pit 3 contained nine bird bones that were identified as a double-crested cormorant (*Phalacrocorax auritus*). As a water bird, the cormorant can be found on rocky coasts, beaches, inland lakes, and rivers. They are identified by their dark body, set-back legs, and hooked bills. They typically dive from the surface for fish and may swim submerged to the neck (National Geographic Society 1983).

Goose. Seventy bones from Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, and Midden 1 could be identified as goose (Goose spp.), although there were not enough distinguishing attributes to determine the specific species. These bones are probably from one of the following: the Canada goose (*Branta canadensis*), the brant (*Branta bernicla*), or the domestic goose (*Anser anser*).

Canada Goose. Pit 1, Pit 3, the Bulwark Ditch, Ditch 6, and Midden 1 produced a total of seventy-four bones that were identified as Canada goose (*Branta canadensis*). The Canada goose is the most common and familiar wild goose, preferring to breed in open or forested areas near water. When they migrate, the flocks usually fly in a V-formation, and stop to feed in wetlands, grasslands, or cultivated fields. The Canada goose is a common visitor to the James River and can be found in the Chesapeake region year-round (National Geographic Society 1983).

Domestic Goose. Three bones from Pit 1 and Pit 3 were identified as domestic goose (*Anser anser*). It is not certain when the first domestic goose was brought to Jamestown, but poultry arrived as early as June 1610 (Gray 1958), and geese had been domesticated in England for centuries. The three bones were clearly from domestic geese, as they are not only smaller than their cousin the Canada geese but their bones are morphologically distinct.

Duck spp. A total of thirty-seven bones from Pit 1, Pit 3, the Bulwark Ditch, and Midden 1 could only be identified as duck. The bones were predominately fragmented so that there were not enough distinguishing features to identify the species. The Chesapeake Bay region and the environment surrounding Jamestown, are primary wintering areas for a large variety of duck species because of its size, habitat diversity, and waterways with significant submerged vegetation and shellfish.

Dabbling Duck. Three bones from Pit 3 were identified to the genus of dabbling ducks (*Anas* spp.). The dabbling or surface-feeding ducks feed by tipping tail-up to reach aquatic plants, seeds, and snails. They can be found primarily in freshwater shallows, but in winter they can also be found in salt marshes. Some of the more common dabbling ducks include the mallard (*Anas platyrhynchos*), the American black duck (*Anas rubripes*), the gadwall (*Anas strepera*), the green-winged teal (*Anas crecca*), and the American widgeon (*Anas penelope*). All of these species, with the exception of the mallard, are typically winter inhabitants of the Chesapeake (National Geographic Society 1983).

Domestic Duck or Mallard. Nineteen bird bones from Pit 1 and Pit 3 were identified as domestic duck or mallard (*Anas platyrhynchos*). The mallard ranges throughout much of the Northern Hemisphere. They prefer shallow brackish waters, but some will inhabit bay and coastal marshes, estuarine rivers, or other environmental niches. Their diet includes pondweed, wild rice, bullrushes, martweed, and a variety of other submerged or emergent plants. Although “tipping-up” is their common way of feeding, mallards will dive at times to obtain their food (National Geographic Society 1983).

Black Duck. Three bones from Pit 3 were from a black duck (*Anas rubripes*). As a dabbling duck species, the black duck feeds on aquatic plants, seeds, and snails by tipping their tails up in the water. They typically nest in Canada along woodland lakes, streams, and freshwater or tidal marshes. During the winter months the black duck can be found as far south as North Carolina (National Geographic Society 1983).

Wood Duck. At least four bird bones from Pit 3 were from a wood duck (*Aix sponsa*), a year-round resident of the Chesapeake region. These are woodland ducks that feed in ponds or rivers and are equipped with sharp claws that allows them to perch on stumps or branches. The male wood duck has a striking, colorful plumage while the female can be distinguished by large, white, teardrop-shaped, eye patches. Nests are made in tree cavities or nest boxes (National Geographic Society 1983).

Pochard. Pit 1, Pit 3, and Ditch 6 also included at least five bones that could only be identified as a pochard (*Aythya* spp.). Pochards are diving ducks that have legs set far back and far apart which makes walking awkward. Their heavy bodies require them to have a running start on water for take-off. There are five species of pochards that can be found wintering in the Chesapeake area—the canvasback (*Aythya valisineria*), the redhead (*Aythya americana*), the ring-necked duck (*Aythya collaris*), the greater scaup (*Aythya marila*), and the lesser scaup (*Aythya affinis*) (National Geographic Society 1983).

Ring-Necked Duck. There were two bones from Pit 3 that were identified as a ring-necked duck (*Aythya collaris*). Distinguished by their peaked heads and bold white ring on their bill, the ring-necked duck is common in freshwater marshes, woodland ponds, small lakes, and coastal wetlands (National Geographic Society 1983).

Killdeer. One bone from Pit 1 was identified as a killdeer (*Charadius vociferus*), a year-round bird found in Virginia. As a member of the plover family, the killdeer is distinguished by their loud, piercing call: *kill-dee* or *dee-dee-dee*. They are typically found in meadows, farm fields, shores and riverbanks where they like to nest on open ground. Although they are generally seen singly or in pairs, in the winter they tend to form loose flocks (National Geographic Society 1983).

Ring-Billed Gull. There were two bones from Pit 3 that belonged to a ring-billed gull (*Larus delawarensis*). Considered a three-year gull, the ring-billed gull acquires a new and different plumage in each of the first three falls of its life. It is very common and can be found wintering along the east and west coasts (National Geographic Society 1983).

Hawk or Eagle. Pit 3 contained one bone that was identified to the Family Accipitridae, which includes both hawks and eagles. This is a large, geographically-dispersed family of birds of prey, equipped with hooked bills and strong talons. Pit 1 had two bones that had enough distinguishing characteristics so that they could be identified as members of the hawk family (*Buteo* spp). The red-shouldered hawk (*Buteo lineatus*) and the red-tailed hawk (*Buteo jamaicensis*) are the most common species that are found in the Tidewater area of Virgina (National Geographic Society 1983).

Bald Eagle. One bone from Pit 3 and one bone from the Bulwark Ditch were identified as bald eagle (*Haliaeetus leucocephalus*). The bald eagle is seen most often near seacoasts, rivers, and lakes, where they feed mainly on fish. Adult bald eagles are readily identified by their white head and tail feathers, and their large yellow bill and talons. They nest in tall trees or on cliffs and are often seen along the James River (National Geographic Society 1983).

Turkey. Fifteen bones from Pit 1, Pit 3, the Bulwark Ditch, and Ditch 7 were identified as turkey (*Meleagris gallopavo*). The turkey is essentially a woodland bird. When Europeans first colonized North America, the turkeys inhabited wide forests, preferring wooded swamps and mature hardwood forests. As the land became cleared they adapted to open fields, savannas, and meadows as they foraged for insects, berries, and other foods (Bent 1963). In his description of the wildlife in Virginia, William Strachey remarked that "Turkeys there be great store wild in the woods like pheasants in England, 40 in company, as big as our tame here, and it is an excellent fowl, and so passing good meat as I may well say it is the best of any kind of flesh which I have ever yet eaten there " (Strachey in Haile 1998:683). Prehistoric sites in Virginia commonly include turkey (Barfield and Barber 1992, and John Smith was impressed that "in March and April [local Indians] live much upon the fishing weares, and feed on fish, turkies, and squirrels…" (Smith in Barbour 1986:162).

Wild turkeys were taken to Europe, domesticated, and reintroduced to North America (Powell 1990). Since they continued to breed with their wild progenitor, it is not surprising that no osteological distinction can be made between wild and domestic animals. For the purpose of this analysis, they have been considered wild and therefore have been included with wild fowl in the relative dietary estimates.

Chicken. The only bird to be found in all of the assemblages was the domestic chicken (*Gallus gallus*), represented by twenty-nine elements. Chickens provided another source of fresh meat to the early colonists. In terms of the actual amount of meat, chickens were not nearly as important as wildfowl, wild mammals, domestic mammals, or fish, but they did provided a year-round source of fresh meat. Chickens and their eggs were prepared in a number of ways: roasted, boiled, fried, broiled, and minced (Noël Hume 1978).

Bobwhite. One bone from Pit 3 was identified as a bobwhite (*Colinus virginianus*). Bobwhites are mottled reddish-brown quails with short gray tails. They are commonly found in brushlands and open woodlands, where they feed and roost in coveys except during the nesting season (National Geographic Society 1983).

Typical Owls. One bone from Pit 1 was identified to the family of typical owls (Family Strigidae). These are distinctive birds of prey with immobile eyes and large heads. Many of the species hunt at night and roost during the day. In the Chesapeake area, typical owls include the great horned owl (*Bubo virginianus*), barred owl (*Strix varia*), and the Eastern screech owl (*Otus asio*) (National Geographic Society 1983).

Woodpeckers. At least one bone excavated from Pit 3 could be identified to the order of woodpeckers (Order Piciformes). In the Eastern part of Virginia this order includes species such as the red-bellied woodpecker (*Melanerpes carolinus*), the Northern flicker (*Colaptes auratus*), red-headed woodpecker (*Melanerpes erythrocephalus*), and the pileated woodpecker (*Dryocopus pileatus*). All of these species have strong claws, short legs, and stiff tail feathers that allow woodpeckers of climb tree trunks. Their distinctive sharp bill enables them to chisel out insects, to prepare holes for nests, and to tap out territorial signals to rivals (National Geographic Society 1983).

Perching Bird. Two bird bones from Pit 3 were from a perching bird (Order Passeriformes). The bones were not complete enough to identify a specific species of this huge group, which includes robins, sparrows, jays, crows, larks, wrens, swallows, and starlings.

American Crow. Three bones from Pit 3 were identified as American crows (*Corvus brachyrhynchos*). As one of the largest species in the crow family, the American crow is easily identified not only by its size but also by its distinctive and familiar *caw* call. They can be found in a variety of habitats throughout the United States and are very common in Virginia (National Geographic Society 1983).

Wild Mammals

All of the identified wild mammal species identified in the Jamestown features were native to Virginia in the seventeenth century and could have supplemented the diet throughout the year.

Opossum. In Pit 1, Pit 3, the Bulwark Ditch, and Midden 1 sixteen bones were identified as opossum (*Didelphis virginiana*). Opossums are known for their activity at night and for their frequency around swampy areas that are common along the shores of the East Coast. The seasonal abundance of food, water, and the availability of den areas (Gardner 1982) can influence their presence in these habitats. The meat of the opossum was described by William Hugh Grove, a Virginian, in 1732 as “resembling Hog flesh, exceeding fat and Lusious” (Barnett and Gilliam 1989).

Eastern Cottontail. The Eastern cottontail (*Sylvilagus floridanus*) was represented by two elements from Pit 3. The cottontail is usually found in brushy areas, cultivated fields, and woods, where they eat a variety of fruits, vegetables, crops, and leafy plants. They regularly inhabit the suburbs of most towns and cities and are apt to be encountered almost anywhere (Webster et al. 1985).

Woodchuck. One bone from the Bulwark Ditch was identified as a woodchuck (*Marmota monax*). Also referred to as a groundhog, the woodchuck is the largest member of the squirrel family that can be found in Virginia. They prefer to dig their burrows on the edges of forests that border along open land, stream banks, or grassy fields. It is believed that when the early colonists first came the woodchuck was probably a rare sight, but as land was cleared for farming suitable habitats were formed, increasing the woodchuck's presence in Virginia. Although woodchucks living in the mountains of Virginia go into hibernation by late October or November, woodchucks along the coastal region often remain active all year feeding on available plant material (Webster et al. 1985).

Eastern Gray Squirrel. One hundred nine elements from Pit 1, Pit 3, and the Bulwark Ditch came from the eastern gray squirrel (*Sciurus carolinensis*). The gray squirrel prefers a mature hardwood habitat with dense undergrowth. Its range may vary depending on food availability, population size, and age. They consume a diversity of foods including acorns, a variety of nuts, fruits, seeds, certain tree barks, fungi, and insects (Flyer and Gates 1982). Squirrels were and still are often hunted for their meat, which can be served boiled, stewed, or barbecued.

In his discussion of Virginia wildlife, William Strachey commented that "Squirrels they have and those in great plenty are very good meat. Some are near as great as our smallest sort of wild rabbits, some are blackish or black and white like those which are here called silver-haired, but the most are gray" (Strachey in Haile 1998:681).

Eastern Fox Squirrel. A total of sixteen bones from Pit 1, Pit 3, and the Bulwark Ditch came from the eastern fox squirrel (*Sciurus niger*). As the largest of the North American tree squirrels, the fox squirrel is distinguished by its gray body and its bluish gray or black face. Historically, fox squirrels could have been found throughout the mid-Atlantic region but today they are predominately found in the coastal areas of South Carolina, the southeastern coastal plains of North Carolina and the mountain regions of both North Carolina and Virginia. Their restricted distribution is due to the decline of their natural habitat that includes mature longleaf pine and hardwood forests. Although they will feed on a variety of fruits and seeds they prefer pine seeds, eating both green and mature cones (Webster et al. 1985).

Beaver. At least ten bones from Pit 1, Pit 3, the Bulwark Ditch, and Midden 1 belonged to the beaver (*Castor canadensis*). The beaver is found throughout most of the United States, wherever water and plant materials suitable for winter food are present. Remaining active throughout the year, the beaver lives in lakes, ponds, rivers, and streams, but prefers the relatively flat terrain of fertile valleys and lowlands. They are a nocturnal species that feed on bark and small twigs, and can be found leveling trees to construct dams and lodges (Webster et al. 1985).

At the time of initial European contact, the beaver population is estimated to have been 60,000,000 or more. Colonization and fur trapping significantly reduced the population, until the beaver almost became extinct in North America (Webster et al. 1985). Beavers were valued not only for their fur, but also for their long teeth that Native Americans would use for tools and weapons. As a food source, the beaver has long been a favored source of fat and protein, including their tail, which Strachey described as being "somewhat like the form of a racket, bare without hair, which to eat the savages esteem a great delicate" (Strachey in Haile 1998:681). Reintroduction and protection policies have resulted in the beaver reclaiming much of its former habitat

Muskrat. Pit 1, Pit 3, and the Bulwark Ditch produced twelve bones that were identified as muskrat (*Ondatra zibethica*). Described by William Strachey as "proportioned like a water rat" (Strachey in Haile 1998:681), the muskrat is a semiaquatic mammal that is abundant in the marshes surrounding the Chesapeake Bay. Their presence in an area is usually marked by the occurrence of their homes, large mounds of vegetation. However, when muskrats live in streams and ponds they tend to build their dens in tunnels into the surrounding banks. Like the beaver, the muskrat has long been valued for its pelt but their high rate of productivity has enabled them to prosper in areas where their habitat has been maintained (Webster et al. 1985).

Bottle-Nosed Dolphin. Twenty-five bones from Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, and Midden 1 were identified (using the collections of the Smithsonian) as bottle-nosed dolphin (*Tursiops truncatus*). Bottle-nosed dolphins are typically medium to dark gray on their dorsal side and pale gray to whitish on their underbelly. They have been known to measure up to twelve feet in length and can weigh as much as six hundred pounds. The bottle-nosed dolphin can be found along the Atlantic coast but is unique from other dolphins since they prefer to inhabit inshore waters and frequently enter sounds, rivers, and tidal creeks. They feed primarily on squid and fish but have also been known to eat shrimp and octopus (Webster et al. 1985).

Dolphins are known to have been taken in Virginia's coastal waters and John Fontaine, an English visitor to Virginia in 1715 considered it "a very dry fish and requires a great deal of sauce" (Alexander 1972). Francis Louis Michel, who also visited Virginia in the early eighteenth century, made a reference to porpoises in his report. Although the harbor porpoise (*Phocoena phocoena*) can also be found in the inshore waters and coastal bays of Virginia, Michel's description of porpoise is instructive, since they are close in appearance and can easily be misidentified. He reported:

> *A good fish, which is common and found in large numbers, is the porpoise. They are so large that by their unusual leaps, especially when the weather changes, they make a great noise and often cause anxiety for the small boats or canoes. Especially do they endanger those that bathe. Once I cooled and amused myself in the water with swimming, not knowing that there was any danger, but my host informed me that there was (Michel in Hinke 1916:34).*

Raccoon. Forty-three elements from Pit 1, Pit 3, and the Bulwark Ditch were identified as raccoon (*Procyon lotor*). The raccoon is a nocturnal carnivore that inhabits areas near water sources such as fresh and saltwater marshes, hardwood swamps, and flood plain forests. Omnivorous and opportunistic when it comes to finding food, it consumes both plants and animals. Since they are active throughout winter, these animals could have been hunted year-around (Webster et al. 1985). While they provided the colonists with a source of meat, the Native Americans also used their skins. John Smith accounted for this when he described a visit with Powhatan, "Before a fire upon a seat like a bedsted, he sat covered with a great robe, made of Rarowcun skinnes, and all the tayles hanging by" (Smith in Barbour 1986 2:150)

River Otter. A single bone from Pit 3 was identified as a river otter (*Lutra canadensis*). The river otter is a large, elongated, semiaquatic animal with webbed toes and short, dense fur. Historically, they have occurred along waterways from streams to lakes where there is a good food supply, clean water, and relatively low levels of human disturbance. They feed mainly on fish, but also on crabs, amphibians, and other aquatic organisms. They are extremely intelligent and inquisitive, and their populations have been greatly diminished due to trapping, pollution, and the destruction of habitats (Webster et al. 1985). As with the beaver and the mink, the river otter has been and is still valued for its pelt. Early accounts indicate that as the colonists became familiar with the Native Americans they would trade items such as knives, glasses, and combs for the skins of beavers, otters, and minks (Barbour 1986, 2:94).

Mink. One bone from Pit 3 was identified as a mink (*Mustela vison*). Captain John Smith remarked about minks in his description of Virginia by saying that "…Minkes we know they have, because we have seene many of their skinnes, though very seldome any of them alive" (Smith in Barbour 1986, 2:111). Although generally nocturnal, minks can be found over much of eastern North America and prefer to live near marshes, swamps, and along the borders of lakes, streams, and rivers. Their waterproof fur allows them to hunt for prey such as fish, frogs, crustaceans, small birds, and small mammals. Their soft fur has also made them a target of trappers, as their pelt has long been of value to the fur industry (Webster et al. 1985).

White-Tailed Deer. The white-tailed deer (*Odocoileus virginianus)* was identified by ninety-one bones found in Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1. White-tailed deer are herbivores that inhabit most environmental settings and consume a diversity of foods, selecting the most nutritional and tasty foods available. Their activity region depends on a number of factors, including population size, season of the year, and weather conditions (Webster et al. 1985).

During the initial settlement period deer were quite prevalent, and large numbers of deer remains are typically found in early historic sites. While deer may have been hunted in the surrounding woods of Jamestown, Captain John Smith also remarked on Native American traders who provided the colonists with venison. Impressed by their hunting skills, Smith wrote in detail how Native Americans hunted deer both in large groups and as a single hunter:

> *One Salvage hunting alone, useth the skinne of a Deere slit on the one side, and so put on his arme, through the neck, so that his hand comes to the head which is stuffed, and the hornes, head, eyes, eares and every part as artificially counterfeited as they*

> *can devise. Thus shrowding his body in the skinne by stalking, he approacheth the Deere, creeping on the groun from one tree to another (Smith in Barbour 1986, 2:118).*

Beginning in the mid-seventeenth century in the coastal region of the Chesapeake, deer populations declined, as evidenced by the decreasing number of bones found on archaeological sites from this time period (Miller 1984). Settlers looked to deer for subsistence and, to a lesser degree, for sport, which contributed to the decline of the deer population. The diminished deer population, coupled with the increasing utilization of pig and cattle, greatly curtailed the importance of deer in the diet.

Commensal Mammals

Commensal animals are those that live with another species and share its food, both animals possibly benefiting from each other through this association (Davis 1987). Three commensal species which live in close proximity to humans were found in the assemblages. Except in times of emergency, they are rarely eaten and are typically not considered food remains in normal zooarchaeological studies.

Rats. A total of seventeen elements from Pit 1, Pit 3, and the Bulwark Ditch could be identified to the broad category of rats (there were not enough distinguishing features to identify a specific species). Many species of rat that can be found in the eastern part of Virginia, including the marsh rice rat (*Oryzomys palustris*), the hispid cotton rat (*Sigmodon hispidus*), the Eastern woodrat (*Neotoma floridana*), the roof rat (*Rattus rattus*), and the Norway rat (*Rattus norvegicus*).

Roof or Black Rat. Pit 3 and Midden 1 produced twelve bones that were identified as roof rats (*Rattus rattus*). Also known as the black rat, the roof rat is basically an arboreal animal, preferring to live in trees, shrubs, vines, and the attics and walls of buildings. They feed on a variety of grains, fruits, and vegetables and are most active in the late afternoon and evening hours. A native of the Old World, the roof rat was introduced into North America by early explorers and colonists and quickly became distributed in the eastern portion of the United States (Jackson 1982). Captain John Smith remarked on their productivity when he wrote, “In searching our casked corn we found it half rotten and the rest so consumed with so many thousands of rats that increased so fast (but their original was from the ships) as we knew not how to keep that little we had” (Smith in Haile 1998:319). Later during the Starving Time, the colonists were forced to search for rats as a food source to satisfy their hunger. When the Norway rat reached North America around 1775, they gradually drove the roof rat from much of its range. Today they are likely to be found in the vicinity of shipping ports, such as Baltimore, Norfolk, Wilmington and Charleston (Webster et al.1985).

Cat. Three bones from Pit 1 were identified as cat (*Felis domesticus*). It is not surprising to find cats in the Jamestown assemblages since they were and still are often kept in homes and on farms to serve as mousers or ratters.

Dog. At least fifteen bones from Pit 1, Pit 3, and the Bulwark Ditch were identified to the category of dog (*Canis familiaris*). Although the skeletal remains suggest a large, robust dog, the exact species was not determined. It is recommended that an expert in canine skeletons be consulted to determine the species after taking precise measurements and comparing them to known specimens, including Native American dogs and English breeds.

Dogs are known to have been brought to Jamestown, and even Captain John Smith gave Powhatan a white greyhound as a gift. Dogs are also mentioned by William Strachey as being used for hunting wild pigs on the island of Bermuda and as a source of food during the starving period (Haile 1998).

Domestic Mammals

Brought over to the New World possibly with the first ship, but most certainly with the first shipment in early January 1608, livestock were present at Jamestown very early (Barbour 1986 V.I:273; Dandoy 1997:13-14). Records hint that horses, swine, goats, sheep, and chickens were among the earliest newcomers, but by June 1610, Lord De La Warr had brought milk cows, oxen, goats, hogs, and poultry. Thus from the earliest days they provided an important source of nourishment, so much so, that during the Starving Time all but possibly one hog was killed for food. Subsequent shipments of settlers also brought more livestock, and to protect them from hungry colonists in June 1611 Thomas Dale protected them by enacting a law "that no man shall dare to kill, or destroy any Bull, Cow, Calfe, Mare, Horse, Colt, Goate, Swine, Cocke, Henne, Chicken, Dogge, Turkie or any tame Cattel, or Poultry of what condition soeuer; whether his owne, or appertaining to another man, without leaue from the Generall… (Force 1947:14). As early as 1616, colonists claimed they could maintain themselves with meat from their livestock (Brown 1890 (I):776). By 1619, the census recorded 120 humans, 500 cattle, some horses and goats, and an "infinite" number of swine (Kingsbury 1933 (III):118). The mild climate, the fertile soil, and the presence of rivers were the reasons Captain John Smith gave for why the domestic animals would do well in Virginia: "Here will live any beasts, as horses, goats, sheepe, asses, hens, etc. as appeared by them that were carried thether" (Smith in Barbour 1986, 2:113).

Bermuda Swine. At least some of the swine were probably from Bermuda. Various accounts indicate that the colonists were capturing some of the wild boars while on the island of Bermuda and may have transported some of them to Virginia. Future analysis of either DNA samples or phytoliths surviving on the plaque remaining on pig teeth might help to determine whether these early hogs were from Bermuda.

As William Strachey wrote of Bermuda swine in 1610:

> *We had knowledge that there were wild hogs upon the island at first by our own swine preserved from the wrack and brought to shore. For they straying into the woods, an huge wild boar followed down to our quarter, which at night was watched and taken in this sort: One of Sir George Summers' men went and lay among the swine. When the boar being come and groveled by the sows, he put over his hand and rubbed the side gently of the boar, which then lay still, by which means he fast'ned a rope with a sliding knot to the hinder leg, and so took him, and after him in this sort two or three more.*
>
> *But in the end (a little business over), our people would be a-hunting with our ship dog, and sometimes bring home thirty, sometimes fifty boars, sows, and pigs in a week alive. For the dog would fasten on them and hold whilest the huntsmen made in. And there be thousands of them in the islands, and at that time of the year—in August, September, October, and November—they were well fed with berries that dropped from the cedars and the palms.. And in our quarter we made sties for them, and gathering of these berries served them twice a day, by which means we kept them in good plight… (Strachey in Haile 1998:399).*

Jamestown Swine. There were a total of four hundred two identified swine (*Sus scrofa*) elements from Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1. Although the ranking of pork among early diets may be argued by some, it is clear that the domestic pig was an important food source from the initial years of settlement on through the twentieth century. It was an efficient animal to raise. A prolific breeder that thrived on mast, roots, and tubers in an open woodland setting, they were born in the spring and by the next winter had grown to a good slaughter weight. In comparison to cattle that provided only about 50-60% of dressed meat per individual after slaughter, swine provided 65-80% and its flesh when salted was perfect for use as a year-round source of preserved meat (Reitz, Gibbs, and Rathbun 1985; Bowen 1990a, 1990b).

Archaeologically swine are omnipresent, and in every faunal assemblage their remains account for a substantial proportion, either in terms of NISP, MNI, usable meat weight, or biomass. From the early years, pork contributed 10% of the biomass, by 1620-50 anywhere from 6 to 17%, by 1660-1700 an average of 11%, and throughout the eighteenth century on rural plantations anywhere from 12 to 17% (Walsh et. al. 1997:351). This archaeological evidence, backed by historical accounts, demonstrate hogs did well in Virginia. Smith wrote, "Of three sows in eighteen months increased 60 and odd pigs…But the hogs were transported to Hog Isle, where also we built a blockhouse with a garrison…" (Smith in Haile 1998:319).

Cattle. Domestic cattle (*Bos taurus*) were identified in Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1. A total of three hundred fourteen bones, including both adult and immature (veal-sized) animals were identified. By 1608, and possibly earlier cattle arrived on Jamestown Island. They flourished in the woodland environment, and as early as the 1620s, herds had become so large that beef was able to become the mainstay of the colonists' diet, a pattern that stood firm throughout the colonial period (Miller 1984; Bowen 1990). Throughout the colonial period cattle provided primarily meat, but also some milk and dairy products, and beginning in the late-seventeenth and early-eighteenth centuries they were used to plow fields (Miller 1984; Bowen 1994). In terms of their contribution to the meat diet, in c. 1610 cattle contributed 14% of the total biomass, by 1620-1650 anywhere from 37 to 57%, by 1660-1700 47%, and throughout the eighteenth century on rural plantations anywhere from 34 to 56% of the total biomass (Walsh et. al. 1997:351). For a more complete discussion of cattle husbandry, see *Provisioning Early American Towns. The Chesapeake: A Multi-disciplinary Case Study* (Walsh et al. 1997).

Caprines. A total of twenty-six sheep (*Ovis aries*) or goat (*Capra hircus*) bones were identified from Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1. These species, despite their outward appearance, are usually lumped together by faunal analysts because they are almost skeletally indistinguishable. Using techniques developed by Middle Eastern faunal analysts, five bones from Pit 1 were identified as the remains of goat.

Starting in the mid-seventeenth century sheep were more commonly raised. While pigs and cows were allowed to roam free, sheep never became really profitable since they were unable to defend themselves from predators and would not freely reproduce (Reitz 1979). It was not until the 1690s that it became viable to raise sheep, because of the decline in the wolf population (Walsh 1988). While sheep were raised primarily for their wool, the by-product, mutton, remained a relatively small but important meat in the diet of individuals throughout the colonial period (Noël Hume 1978: Walsh et al. 1997).

Goats were introduced to the New World, possibly with the first arrivals, but certainly with the first supplies. Goats were hardy, they browsed on undergrowth, and they were better able to protect themselves from predators than sheep (Dandoy 1997; Walsh et al. 1997). With the first years of colonization, they supplied both milk and meat, but as fields were established and predators brought under better control, sheep were introduced in increasingly large numbers. By the mid-seventeenth century sheep had begun to replace most of the goats, though occasionally they still were raised primarily for their milk (Walsh et. al. 1997).

In terms of contribution to the meat diet, in c. 1610 caprines (sheep and goats combined) contributed 2.4% of the total biomass. By 1620-1650 they contributed anywhere from .7% to 4.3%, by 1660-1700 anywhere from 1 to 12.5%, and throughout the eighteenth century on rural plantations anywhere from 2 to 10% of the total biomass (Walsh et al. 1997:351).

Horse/Ass. Nineteen bones from Pit 1 and the Bulwark Ditch were identified as being from either a horse or an ass (*Equus* spp.). These animals are so similar osteologically that they are lumped together in the same grouping. Although these animals were typically used for draft purposes throughout the colonial periods, there are also accounts from the late seventeenth century of wild horses being trapped or hunted for their meat. Some of the horse bones from Jamestown are butchered, indicating that they were probably used as a food source. This is supported by accounts from William Strachey and George Percy who wrote that during the starving period horses and mares were some of the first animals to be killed for food (Haile 1989)

Humans

Human. A single cranial fragment from Pit 3 was identified by Doug Owsley, director of the Physical Anthropology Department at the Smithsonian Institution, as belonging to a young human (*Homo sapiens*).

Fishing and Hunting

When the promoters of the Virginia colony were trying to lure people to lay the groundwork for future settlements in the New World, the land and its resources were often portrayed in an overly favorable light. The descriptions of the wildlife and the accounts of plentiful sources of food were written by explorers who often visited the New World in the bountiful spring and summer. So when the colonists arrived in Virginia in 1607 they were ill prepared for the harsh winters and lacked the necessary skills needed to acquire food. In England, fishing and hunting had been considered leisure activities of the aristocrats, while in the New World these skills were crucial to their survival. The colonists came with little fishing equipment and the few guns they did bring were cumbersome, difficult to use, and not very accurate. As John Smith lamented in the early 1600s, “Though there be fish in the sea, fowls in the air, and beasts in the woods, their bounds are so large, they are so wild, and we so weak and ignorant, we cannot much trouble them” (Smith in Wharton 1957:6). As the settlers attempted to adapt their lifestyle to the new land, the progression of hunting and fishing techniques developed in conjunction with their relationship with the Native Americans. The following paragraphs summarize these relationships and how these techniques and equipment evolved as the colony changed.

As mentioned above, despite early descriptions of the New World that indicated that fish were plentiful in the waters along the coast, there are few accounts of fishing gear being brought to Virginia by the colonists in 1607. Within the first days of their arrival, colonists were put to work not only cutting down trees, pitching their tents, and making gardens, but also constructing nets for fishing (Smith in Arber 1910:91). Apparently not many fishing nets were used during their first summer since the men who survived lived mainly upon sturgeon and crabs that were easily taken in the shallow water with little effort and minimum equipment (Pearson 1942a:355).

As the winter approached, the Jamestown colonists were no better prepared to fish in the local waters, although they did make use of fish found in the frozen James River as accounted in a letter by Francis Perkins:

> *So excessive are the frosts, that one night the river froze over almost from bank to bank, in front of our harbour, although it was there as wide as that of London. There died from the frost some fish in the river, which were taken out after the frost was over, were very good and so fat that they could be fried in their own fat without adding butter or such thing (Perkins in Haile 1998:133).*

It was not until the spring of 1608, however, that Powhatan sent some of his people to teach the colonists not only how to sow the grain of the country but also how to make certain traps with which to fish. The most detailed accounts of Native American fishing techniques were written by Robert Beverley in 1705, who not only described the Native American fishing techniques of the early eighteenth century but also methods that were used before the English arrived in Virginia. Beverley wrote that the Native American would use carved bone for hooks and spears and the barks of trees, the skin of deer, and the local grass to weave fishing nets. Although fish in shallow water was easily taken with pointed sticks, fishing traps were used by the Native Americans to catch larger fish found in deeper water. One of these techniques was described by Beverley:

> *The larger Fish, that kept in deeper Water, they were put to a little more Difficulty to take; But for these they made Weyrs; that is, a Hedge of small riv'd Sticks, or Reeds, of the Thickness of a Man's Finger, these they wove together in a Row, with Straps of Green Oak, or other tough Wood, so close that the small Fish cou'd not pass through. Upon High-Water Mark, they pitched one End of this Hedge and the other they extended into the River, to the depth of Eight or Ten Foot, fastening it with Stakes, making Cods out from the Hedge on one side, almost at the End, and leaving a Gap for the Fish to go into them, which were contrived so, that the Fish could easily find their Passage into those Cods, when they were at the Gap, but not see their Way out again, when they were in; Thus if they offered to pass through, they were taken (Beverley 1705:38).*

Although the Native Americans may have shown the Jamestown colonists their techniques for fishing, these methods do not seem to have been readily put to use. Instead, some of the colonists used improvised methods and tools to catch fish as accounted by John Smith in the summer of 1608:

> *…we found… in diverse places, that abundance of fish lying so thicke with their heads above the water, as for want of nets, our barge driving amongst them*

we attempted to catch them with a frying pan; but we found it a bad instrument to catch fish with… Our captaine sporting himselfe to catch them by nailing them to the ground with his sword, set us fishing in that manner. By this devise, we tooke more in an houre then we all could eat (Smith in Barbour 1986:168).

The need for skilled fishermen and adequate supplies was finally addressed in February 1610, when a letter was sent to London requesting that tradesmen be sent to Jamestown including fishermen and net makers (Brown 1891:469). However, when the supply ship finally arrived in Jamestown there were few fishermen and "sturgeon dressers" on board and few nets were delivered to the colony. Acquiring fish for food continued to be precarious and in 1619 the Assembly permitted six Native Americans to live within the settlement if they engaged in fishing for the colonists (Wharton 1957:23). A similar arrangement probably continued until local disputes between the colonists and the Native Americans led to an uprising in 1622 which brought a renewed instability for English subsistence.

Around 1623 fishing gear ceased to be colony controlled and the colonists began to purchase their own fishing equipment and boats. The listing of estates soon began to include fishing lines and hooks, while seines became increasingly important to capture shad and herring in the local rivers. The fishing techniques of colonial Virginia continued to progress through the end of the eighteenth century when river plantation owners such as George Washington developed better fishing equipment to promote their own fishing industries (Pearson 1942b).

In terms of hunting, the early colonists were also influenced by a variety of factors. To begin with, the English brought with them ideas about wild animals and the social precepts of hunting. In the seventeenth century hunting in England was considered a recreation activity restricted to royalty, nobility, and the private gentlemen (Cox 1697). Since there were few large wild animals left in England at that time, the majority of the remaining animals were enclosed in deer parks, that were used exclusively by the nobility and the well-to-do. Although the lower class wanted the same access to wild game to supplement their diet, poaching by yeomen was punishable under forest laws (Thomas 1983). Coming from these laws and restrictions, few of the early Jamestown colonists were aristocrats and the majority of the settlers probably lacked experience in using firearms. The guns they did have were awkward, lacked accuracy, and therefore were often difficult to use in acquiring subsistence.

In the early writings from Jamestown there are few descriptions of the hunting techniques utilized by the colonists. Instead, the accounts from the Jamestown colony indicate that before the 1622 uprising, colonists relied heavily on trade with the Native Americans in acquiring wild game, especially deer. The Native Americans appeared to have been better equipped and experienced in hunting the land. John Smith commented on this in his descriptions of the Native Americans,

> *In their hunting and fishing they take extreame paines; yet is being their ordinary exercise from their infancy, they esteeme it a pleasure and are very proud to be expert therein. And by their continuall ranging, and travell, they know all the advantages and places most frequented with Deere, Beasts, Fish, Foule, Roots and Berries (Smith in Barbour 1986:118).*

After the uprising, the colonists had to rely upon their own hunting skills to supplement their diet. In response to their precarious relationship with their Native American neighbors, a hunting law was instituted that promised "severe censure of punishment by the Governor and Council" if anyone went out hunting without a sufficient number of well armed men (Wharton 1957:28). Other hunting laws and restrictions soon followed that dictated where people could hunt and occasionally what they could hunt. In a 1632 statute, hunting for wolves and game in the forests was encouraged so that the colonists would have training in the use of firearms, and help to keep the Native Americans at a distance (Hening 1823(1):199). Professional hunters were also being hired for the cost of powder, food, drink, and lodging. This practice of hiring hunters enabled some of the more wealthy landowners to focus their attentions on planting and developing the surrounding land (Miller 1986).

By the second half of the seventeenth century, the Native Americans had been pushed away from the prime hunting, fishing, and planting areas, as the English took over these areas for their own homes and plantations. With the increase of land ownership, social divisions and distinctions became more evident and the perception of the wilderness changed as the colonists adapted to their new land. Hunting and fishing began to be seen by the colonists as a sport and leisure activity again not as a means of survival. Domestic animals had become well established and were the primary source of meat, so that fish, fowl, and wild mammals were seen only as a supplement.

Taphonomic Analysis

This section briefly describe each of the taphonomic influences and how bones from Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1 have been modified.

Pit 1. A total of ninety domestic mammal and deer bones were examined from Pit 1 for taphonomic influences. Overall, the bones were in fair condition. One duck bone and one turtle carapace fragment showed signs of having being burned, and at least two hundred forty-five unidentifiable bones appeared to have been burned. A close inspection of the bones revealed limited evidence of chewing. Based on the appearance of puncture marks and specific chewing patterns, four domestic mammal bones (4.4%) appeared to have been chewed by a carnivore. Although they were not recorded in Table 4, there are also three duck bones that had holes in the shaft made by the canine tooth of a carnivore.

Table 4.
Pit 1.
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Cattle	17	1	5.9%	5	29.4%	0	0.0%	0	0.0%
Pig	26	0	0.0%	9	34.6%	0	0.0%	0	0.0%
Sheep/Goat	9	1	11.1%	0	0.0%	0	0.0%	0	0.0%
Horse	18	2	11.1%	9	50.0%	0	0.0%	1	5.5%
Deer	20	0	0.0%	2	10.0%	0	0.0%	0	0.0%
Total	**90**	**4**	**4.4%**	**25**	**27.8%**	**0**	**0.0%**	**1**	**1.1%**

Twenty-five domestic mammal and deer bones (27.8%) showed evidence of having been butchered with either an ax or a cleaver. Other butchered bones not noted in Table 4 include three cahow bones, four cormorant bones, eight duck bones, and three bottle-nosed dolphin elements. The location of the hack marks on the domestic mammal and deer bones from Pit 1 are recorded on drawings in Appendix E.

Pit 3. As with the other features, Pit 3 had very few bones that were affected by weathering or burning. While there were no domestic mammal or deer bones that have distinctive burn marks, one hundred thirty-four unidentifiable bones show signs of having been burned. Evidence of chewing on domestic mammal and deer remains is slight. Only one pig bone and one deer bone had been chewed by a carnivore, and two pig bones had been chewed by a rodent. Other chewed bones included two gray squirrel bones, one Canada goose bone, and one chicken bone.

Table 5.
Pit 3 (Sequence A and B)
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Cattle	37	0	0.0%	28	75.7%	0	0.0%	0	0.0%
Pig	39	3	7.7%	16	41.0%	0	0.0%	0	0.0%
Sheep/Goat	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Horse	0	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Deer	28	1	3.6%	9	32.1%	0	0.0%	0	0.0%
Totals	**110**	**4**	**3.6%**	**53**	**48.2%**	**0**	**0.0%**	**0**	**0.0%**

In Pit 3 remains, there are frequent butcher marks, seen in at least 48.2% of the domestic mammal and deer bones. were recorded as being hacked with an ax or cleaver in a manner that would have produced substantial amounts of meat on each bone. Other evidence of butchering came from bottle-nosed dolphin bones and a Canada goose bone. Drawings for each of the butchered domestic mammal and deer bones from Pit 3 are included in Appendix E.

Bulwark Ditch. A total of fifty-one domestic mammal and deer bones were analyzed for taphonomic influences. In this feature no weathered or burned identifiable bones are present, although nineteen unidentifiable bones had signs of being burned. Only ten deer bones show any indication that they had been chewed by a carnivore.

Table 6.
Bulwark Ditch (Sequence A, B, C, and D)
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Cattle	4	0	0.0%	2	50.0%	0	0.0%	0	0.0%
Pig	20	0	0.0%	3	15.0%	0	0.0%	0	0.0%
Sheep/Goat	3	0	0.0%	1	33.3%	0	0.0%	0	0.0%
Horse	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Deer	23	10	43.5%	9	39.1%	0	0.0%	0	0.0%
Total	**51**	**10**	**19.6%**	**15**	**29.4%**	**0**	**0.0%**	**0**	**0.0%**

The Bulwark Ditch had fifteen elements (29.4%) that show evidence of having been butchered. As with the other features, the butchered bones were recorded on drawings that can be found in Appendix E. Other butchered bones include a single opossum element and nine bottle-nosed dolphin elements.

Ditch 7. As the smallest of all the assemblages, Ditch 7 only had a total of thirty-five domestic mammal and deer bones. From this group, no bones appeared to have been burned or weathered, and only one pig bone has any evidence of carnivore chewing. At least two pig and two deer bones exhibit irregular fractures and V-shaped cuts indicating they had been hacked with either an axe or a cleaver. Wherever the cut was placed, the resulting piece of meat generally would have included almost half the element, which would carried on it substantial amounts of meat. All of the butchered bones for pig and deer can be found in Appendix E.

Table 7.
Ditch 7
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Cattle	13	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pig	16	1	6.3%	2	12.5%	0	0.0%	0	0.0%
Sheep/Goat	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Horse	0	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Deer	5	0	0.0%	2	40.0%	0	0.0%	0	0.0%
Total	**35**	**1**	**2.9%**	**4**	**11.4%**	**0**	**0.0%**	**0**	**0.0%**

Ditch 6. No domestic mammal or deer bones from Ditch 6 exhibit any sign of having been burned or chewed, and a single element from a cow

shows signs of have been weathered. As with the other features, the most frequently identified taphonomic influence present on the domestic mammal and deer bones is butchering. Seven pig, six cattle, one horse, and one deer bone were hacked, probably an ax or a cleaver. The butchered bones can be found in drawings in Appendix E.

Table 8.
Ditch 6
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	**No.**	**Pct.**	**No.**	**Pct.**	**No.**	**Pct.**	**No.**	**Pct.**
Cattle	23	0	0.0%	6	26.1%	1	4.3%	0	0.0%
Pig	17	0	0.0%	7	41.2%	0	0.0%	0	0.0%
Sheep/Goat	3	0	0.0%	1	33.3%	0	0.0%	0	0.0%
Horse	0	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Deer	2	0	0.0%	1	50.0%	0	0.0%	0	0.0%
Total	**45**	**0**	**0.0%**	**15**	**33.3%**	**1**	**2.2%**	**0**	**0.0%**

Midden 1. Bones from the largest assemblage are in excellent condition, exhibiting, among the 527 domestic mammal and deer bones, no signs of having been weathered or burned. Only four cattle and five pig bones show signs of having been chewed by a carnivore. The unidentifiable faunal remains, however, include at least one hundred twenty-one fragments with definite burning marks on the surface of the bone.

Table 9.
Midden 1
Taphonomic Influences

		Chewed		Hacked		Weathered		Burned	
	Count	**No.**	**Pct.**	**No.**	**Pct.**	**No.**	**Pct.**	**No.**	**Pct.**
Cattle	219	4	1.8%	63	28.8%	0	0.0%	0	0.0%
Pig	284	5	1.8%	57	20.0%	0	0.0%	0	0.0%
Sheep/Goat	11	0	0.0%	1	9.1%	0	0.0%	0	0.0%
Horse	0	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Deer	13	0	0.0%	4	30.8%	0	0.0%	0	0.0%
Total	**527**	**9**	**1.7%**	**125**	**23.8 %**	**0**	**0.0%**	**0**	**0.0%**

Butchered bones include sixty-three cattle, fifty-seven pig, one sheep/goat and four deer bones. Making up 23.8% of the identified domestic mammal and deer bones, the majority of these bones are long bones that appear to have been hacked with either an ax or a cleaver. Drawings showing the butchered bones for domestic mammals and deer can be found in Appendix E.

Relative Dietary Importance

The following section discusses the relative dietary importance of each taxon based on each of the three main quantification methods mentioned earlier in the analytic techniques section. It must be realized that these are relative measures and they do not reflect anything absolute about the amount of meat provided. The complete tables for each feature that is discussed can be found in Appendix B.

Pit 1 (c. 1610). Excavations of Pit 1 from Jamestown produced a total of three thousand nine hundred and seventy bones, of which 85% of these were identifiable to at least fifty-one different species (Appendix B, Table 11). The high percentage of identifiable bones is due to the unusually high number of sturgeon scutes that made up 46.9% of the identifiable bones. The NISP figures reveal that besides sturgeon, white perch (9.6%), gar (3.4%), box turtle (3.3%), and mud/musk turtle (2.0%) were the most frequently identified species, contributing more bones than any other wild or domestic species. The remaining identified species each contributed less than 1% to the total NISP.

In terms of MNI, the wild species contributed the most individuals with seventy-five adults. With at least eleven freshwater catfish, six sucker, and eight white perch, the fish species make up 41.4% of the total MNIs. Wild birds are the second largest contributor with 19.5%, followed by reptiles/amphibians (13%), and wild mammals (13.8%). With only ten adult individuals represented in the assemblage, domestic mammals and birds are the smallest contributors to the MNI figures.

Although the domestic mammals from Pit 1 contributed the lowest amount to the NISP and the MNI percentages, overall they make up the greatest percentage (32%) of the usable meat weight. When looking at the species individually, bottle-nosed dolphin represent the greatest amount of usable meat (24.1%), followed by cattle and horse which each make up 19.3%. Other significant contributors are domestic pig (14.5%), sturgeon (4.3%), and beaver (1.2%).

The biomass figures for the assemblage show a slightly different picture. Overall, the wild species (51.3%) make up a larger percentage of the biomass than the domestic mammals and birds (24.3%). The high biomass percentage for the wild mammals is due to the significant amount of sturgeon, accounting for 18.1% of the biomass. Cattle (13.5%) and horse (11.1%) were the most important domestic meat providers in Pit 1, while most of the fish, bird, and small mammals made up less than 1%. It must be kept in mind that the domestic mammal and deer figures can be somewhat masked by the “other mammal” category, composed of indeterminate mammal bones that are almost certainly mostly cattle, pig, deer, and sheep/goat which were simply too fragmentary to identify to species. Unidentifiable large mammals made up 2.5% and medium mammals made up 3.5% of the biomass figures.

Pit 3, Sequence A (c. 1610). Sequence A of Pit 3 yielded one hundred and eighty-nine bones from contexts 69E and 124D. From the total count, 57.7% of the bones were identifiable to twenty-two different species, including fish, turtle, bird, and mammals (Appendix B, Table 12). By NISP, sturgeon bones (29.1%) were the most frequently identified species, followed by eastern gray squirrel (3.2%) and the domestic pig (3.1%). The remaining species each contributed less than ten bones and made up less than 2% of the total NISP number.

The MNI figures reveal only one adult individual for each species. Since there are so few bone fragments in this assemblage, the MNI figures represent more the sample size than any reality. Nonetheless, wild species dominate the assemblage, making up 71.4% of the MNIs. There were only six domestic species.

Unlike the NISP and the MNI, the meat weight calculations have the domestic species dominating the assemblage with 66.6%. Cattle contributed the most with 49%, followed by sturgeon, domestic pig, and white-tailed deer, each at 12.3%. Other significant contributors to the meat weight were sheep/goat (4.3%), raccoon (1.8%), and snapping turtle (1.2%).

The biomass percentages also showed cattle as the most important meat provider with 21.8% of the total. Not far behind cattle were domestic pig (9%), sturgeon (10.0%), and white-tailed deer (6.1%). In all, the domestic species made up 44.5% of the biomass, while wild species contributed 30.6%. As mentioned previously, the domestic mammal and deer figures can be somewhat masked by the "other mammal" category, composed of indeterminate mammal bones that are almost certainly mostly cattle, pig, sheep/goat, and deer which were simply too fragmentary to identify to species. Unidentifiable large mammals made up 14.3% and medium mammals made up 7.1% of the biomass figures.

Pit 3, Sequence B (c. 1610). Pit 3, Sequence B consisted of contexts 69F, 69G, 124E, 124F, 124J, 124N, 124P, and 124Q. Being the largest assemblage, there were a total of 7,803 bones, with 21.1% of the elements identifiable to fifty-nine different species (Appendix B, Table 13). The most frequently identified species were sturgeon (859 bones), followed by eastern gray squirrel (64 bones), and white perch (59 bones).

MNI calculations revealed that most of the species were represented by one adult individual, but white perch and eastern gray squirrel were each represented by four adults. Wild species dominated the MNIs with sixty-four individuals, while the domestic animals consisted of eight adults and one immature mammal.

In terms of the meat weight it is not surprising to find that the larger-sized species such as cattle, pig, white-tailed deer, beaver, bottle-nosed dolphin, sturgeon, and shark each contributed at significant amount. The remaining species each contributed less than 1% to the total meat weight percentage.

Cattle made up not only the greatest percentage of the meat weight but also contributed the largest amount (14.5%) to the biomass. Domestic pigs were the second largest contributors to the biomass with 4.7%, followed by white-tailed deer with 5.1%. The unidentifiable large mammal (24.6%) and the medium mammal (16.8%) fragments may mask the domestic mammal and deer percentages since they were too fragmentary to identify to species. In total, the domestic species made up 20% to the biomass, and the wild species made up 20.2%.

Bulwark Ditch, Sequence A, B, and C (c. 1610). Only one hundred sixty-four bones were submitted from Bulwark Ditch, Sequence A, B, and C—including contexts 82Q, 82R, 82S, 82V, 82W, 82X, 82Z, 86E, 105B, 105D, 87C, 87D, 104B, 104C, 104D, and 104N. Approximately 71% of the assemblage was identifiable to sixteen species, while only forty-eight bones were unidentifiable (Appendix B, Table 14). The high percentage of identifiable bones was due to the large number of sturgeon bones that dominated the NISP (40.8). Other significant contributors to the NISP were bottle-nosed dolphin (nine bones), white-tailed deer (eight bones), and domestic pig (six bones).

In MNI, each species was represented by one adult individual. Wild species totaled ten adults while the domestic species only consisted of three adults.

The wild species also dominated the meat weight percentages (57.9%) due to the presence of sturgeon, beaver, white-tailed deer, and bottle-nosed dolphin. The meat weight percentage for the domestic species was made up of cattle (30.8%), domestic pig (7.7%), and domestic sheep/goat (2.7%).

Wild species made up the highest percentage of the biomass figures, with bottle-nosed dolphin (16.3%), sturgeon (9.5%), and white-tailed deer (26.5%). Domestic species made up only 23.2% of the biomass. The unidentifiable mammal bones accounted for a total of 6.8%.

Bulwark Ditch, Sequence D (c. 1610). Consisting of contexts 81E, 81F, and 81G, the Bulwark Ditch, Sequence D had a total of three hundred ninety bones. As the summary chart shows, this assemblage contained two hundred sixty-eight unidentifiable bones (68.7%) and one hundred twenty-two identifiable bones, consisting of twenty-five different species (Appendix B, Table 15). Following the trend of many of the other assemblages, sturgeon were the most frequently identified species with forty-two bones. White-tailed deer were the second highest contributor to the NISP with fifteen bones, followed by domestic pigs (fourteen bones), and raccoon (seven bones).

Each species was represented by one adult individual, except for turkey, eastern gray squirrel, raccoon, and domestic pig (two each). Wild mammals made up the largest percentage of MNIs (71.0%), followed by domestic mammals (18.5%) and fish (14.8%). There was a wide diversity of species in the assemblage.

The domestic animals made up the majority of the meat weight, with horse (29.5%), cattle (29.5%), and pig (14.8%). Wild mammals (12.8%) primarily made up the meat weight for the wild species, while sturgeon also contributed a significant amount (7.4%).

There was only a 4.1% difference between the domestic and wild species in biomass. Individually, domestic pigs were the greatest contributor with 14.6%, followed by white-tailed deer (14.2%) and cattle (11.1%). Other notable contributors to the biomass included sturgeon (3.6%), turkey (2.3%), dog (1.5%), raccoon (1.9%), horse (4.1%), and domestic sheep/goat (1.8%). As mentioned previously, the domestic mammal and deer figures can be somewhat masked by the "other mammal" category, composed of indeterminate mammal bones that are almost certainly mostly cattle, horse, pig, sheep/goat, and deer which were simply too fragmentary to identify to species. Unidentifiable large mammals made up 11.7% and medium mammals made up 13.1% of the biomass figures. Finally, the remaining species each contributed 1% or less to the over biomass figures.

Ditch 7 (c. 1620). Ditch 7 was the smallest assemblage analyzed, with only ninety-one bones (Appendix B, Table 16). There were forty-one unidentifiable bones and fifty identifiable bones from ten different species. As with Ditch 6, domestic mammals were the most frequently identified species, with cattle contributing thirteen bones and domestic pigs sixteen. In terms of MNIs each species was represented by one adult individual.

When looking strictly at the meat weight, bottle-nosed dolphin contribute the most with 43.2% of the total percentage. However, when the weight of the bones is figured into the summary, cattle end up contributing the most to the overall diet with 42.3% of the biomass. Domestic pig followed cattle with 15.8% and white-tailed deer made up 9.2% of the total biomass. The unidentifiable bones consisted of five large mammal bones (4.5%) and three medium mammal bones (1.5%). If these bones had been identifiable to species they probably would have raised the biomass percentages of the domestic mammals and deer.

Ditch 6 (c. 1630). The faunal material from Ditch 6 totaled one hundred sixty-seven bones, with 30.5% of the assemblage identifiable to eight different species (Appendix B, Table 17). This assemblage is different than most of the previous features since no sturgeon bones were identified. This may reflect the laws that were established in 1612 by the Governor to protect sturgeon from being overfished. This assemblage is also different from Pit 1, Pit 3, and the Bulwark Ditch in that cattle dominate the NISP figures with twenty-three bones. Domestic pig contributed at least 10.2% to the NISP, followed by domestic sheep/goat (1.8%) and white-tailed deer (1.2%).

When the MNIs were examined each of the four wild species and each of the four domestic species contributed at least one adult. Domestic species did make up the majority of the usable meat weight with 83.1%.

Domestic mammals also dominated the biomass percentages, with cattle (49.9%) and domestic pig (14.6%) contributing more to the overall diet than any other species.

Midden 1 (c. 1625-1650). Midden 1 had a total of 1,625 bones, of which 36.7% were identified to twenty-one species (Appendix B, Table 18). Similar to other sites dating to the second half of the seventeenth century, Midden 1 was primarily made up of domestic species. Domestic pig was the most frequently identified specie with two hundred eighty-four bones, followed by cattle with two hundred twenty. While there were three sturgeon bones in the Midden 1 assemblage, their contribution to the summary was very minimal as compared to Pit 1, Pit 3, and the Bulwark Ditch.

Cattle contributed the most individuals with four adults and one immature animal. There were also at least four adult pigs, three catfish, and two chickens, while the remaining species each had one adult individual. Overall, due to the diversity in the assemblage, wild species contributed five more individuals than the domestic animals.

The presence of four adults and one immature individual account for cattle making up the greatest percentage of the usable meat weight with 65.5%. Bottle-nosed dolphin was second with 16.5%, followed by domestic pig with 15.9% and shark with 6.3%. The biomass figures show the overwhelming significance of domestic species, which contributed 69.0% to the overall diet. Cattle contributed the most with 47.4%, and domestic pig was the next largest contributor at 20.2%. Unidentifiable large mammals made up 11.3% and medium mammals made up 10.0% of the biomass figures.

Kill-Off Patterns

Aging methods were employed to help understand the husbandry techniques that underlay the availability of food. There is a direct relationship between the agricultural economy and how livestock are bred, raised, and slaughtered. In subsistence farming, animal husbandry focuses on raising livestock to serve multiple purposes. For example, a farmer might raise cattle for milk, meat, and draft uses, or sheep for both their wool and their meat. The farmers typically raise the livestock to provide for their own household's needs, and only after their needs are met is any surplus sold. On the other hand, specialized farming focuses on raising livestock to produce a product directly for market, and the focus shifts to carefully managing livestock to produce the greatest profit. Since this is best accomplished by focusing on a single product from an animal, commercially-oriented farming has developed very specialized farms with highly developed breeds that will most efficiently produce a product: dairy cows to produce milk, beef cattle to produce meat.

In the Chesapeake, the specialized production of livestock evolved directly out of the region's plantation economy, not long after the first settlement. Livestock first arrived with the earliest of settlers at Jamestown but by as early as the 1620s herds of cattle and swine were thriving within a protected woodland environment. Domestic herds were doing so well that in 1619 John Pory wrote that cattle "do mightily increase here, both kine, hogges and goates, and are much greater in stature, than the race of them first brought out of England " (Tyler 1946:213).

By the late seventeenth and early eighteenth century, the once lush environment was slowly disappearing. Forests, where cattle, swine, and horses once thrived, had been cut down to make way for tobacco and corn fields. Tobacco farming had begun to deplete soil. Some purchased lands to the west, but others shifted their focus to wheat, a crop that required plowing. Animal husbandry adapted to the new situation, and soon sheep, who thrived in enclosed pastures, began to appear in ever larger numbers. By the late seventeenth century references to domestic herds reflect the change by describing a decline in the health of their animals. New zooarchaeological evidence marks the significant shift in size came in the early eighteenth-century, but as early as 1688, John Clayton wrote in a letter that the cattle "have little or no Grass in winter, so that… [they] are pinned and starved, and many that are brought low and weak, when the Spring begins, venture too far into the Swamps after the fresh Grass, where they perish; so that several Persons lose ten, twenty or thirty heads of Cattle in a Year" (Force 1947:25-26; Arbuckle 1999).

By the early eighteenth century, more cattle, pigs, and sheep were raised for profit, and in response planters began to shift to more aggressive animal husbandry techniques that would hasten the time needed to fatten livestock. At least dairy cows and their calves were kept in pastures with sheep, fattening techniques were pursued, and in a more profitable period of time, livestock could be sent to the emerging urban and foreign markets.

Kill-off patterns from sites in the Chesapeake have reflected the changes that occurred in the animal husbandry techniques (Bowen 1994; Walsh et al. 1997). Slaughter ages of cattle from sites dating from the early seventeenth century have shown that typically 51% of the cattle population were killed when they were four years and older. By the late seventeenth century, the number of cattle being killed at greater than four years of age increased to 68%. This pattern has been attributed to grass feeding, where it takes about four years for cattle to reach their mature slaughter weight. As animal husbandry techniques were refined in the eighteenth century, cattle elements from faunal assemblages include larger percentages of younger individuals aged between 36-48 months. This probably reflects the more specialized form of cattle husbandry that allowed the cattle to mature to a slaughter weight at less than four years of age.

The kill-off patterns for pigs from sites from the seventeenth century show that during the first half of the century, almost half the population of slaughtered swine were less than a year old. Over the next hundred and fifty years, this number decreased until by the last half of the eighteenth century only 19-28% of the killed pigs were less than a year old. In contrast, pigs between the ages of 12-24 months increased from 11-17% in the seventeenth century to 31-38% in the late eighteenth century. Again, this change reflects a shift in pig husbandry patterns in response to the introduction of commercial markets and the increase of specialized farming (Walsh et al. 1997).

Finally, little is known about the slaughter patterns of caprines (sheep/goats) in the first half of the seventeenth century due to the fact that so few caprine bones have been excavated. Sites dating from the second half of the seventeenth century and the early half of the eighteenth century, however, have produced a substantial amount of sheep/goat bones for the purpose of kill-off analysis. Data from these sites indicates that caprines in the Chesapeake were being raised primarily for meat since most of the individuals were killed during their second and third years of age. As the century progressed, assemblages show a dramatic increase of older individuals, indicating that sheep were being increasingly raised for their wool (Walsh et al. 1997).

Based on what has been previously studied about animal husbandry patterns in the early to mid-seventeenth century, the kill-off patterns for the Jamestown assemblages should reflect the subsistence-oriented farming that was being practiced by the early colonists and later, by plantation owners. To accurately assess the kill-off patterns from an assemblage, large numbers of elements are needed in proportions that are roughly equal to that of a normal skeleton. Unfortunately, the majority of the features from the Jamestown site did not singly produce enough bones to make any conclusive statements about the kill-off patterns. In an attempt to achieve a larger database, the kill-off data from assemblages dating from the same time period were combined together. For example, the data from Pit 1, Pit 3, and the Bulwark Ditch were added together and the data from Ditch 7, Ditch 6, and Midden 1 were added together. But even when this was done, there was not enough data to accurately access the kill-off patterns for cattle or sheep. There were, however, nineteen pig bones in the combined assemblages of Pit 1, Pit 3, and the Bulwark Ditch (the "early" assemblage) and forty-four bones from Ditch 7, Ditch 6, and Midden 1 (the "later" assemblage) that could be analyzed for age data. Although this is a small number of bones, some generalizations have been made in the following paragraphs about the kill-off patterns for pigs. For the purpose of future comparative work, the epiphyseal fusion tables for Pit 1, Pit 3 (Sequence A), Pit 3 (Sequence B), Bulwark Ditch (Sequence A, B, and C), Bulwark Ditch (Sequence D), and Midden 1 are included in Appendix C, along with the tables showing the combined pig data from Pit 1, Pit 3, and the Bulwark Ditch and the combined data from Ditch 7, Ditch 6, and Midden 1 (Appendix C, Tables 19-44).

Pig Kill-Off Patterns. As mentioned above, the pig kill-off data from Pit 1, Pit 3, and the Bulwark Ditch were combined together since the three assemblages date to around 1610. Once combined the assemblages produced a total of nineteen pig bones that could be examined for kill-off patterns. As the table shows, 67% of the pigs were killed within the first year of age, 16% were killed within the second year of life, and finally, 16% were killed before they were two and a half (Appendix C, Table 43).

When the data from Ditch 7, Ditch 6, and Midden 1, were added together there were forty-four bones that could be used to assess kill-off patterns in the period 1620-1650. The summary chart for the combined features shows that the majority of the pigs were killed between one and two years of age (71.2%), followed by individuals less than one year of age (18.8%), and animals that were over three and a half years of age (10.0%) (Appendix C, Table 44).

As mentioned earlier, assemblages that date to the first part of the seventeenth century are dominated by pigs that were slaughtered within the first year of age. This changed in the second half of the century when the younger age groups decreased and the number of older swine increased. The kill-off charts from the earlier Jamestown assemblages reflect the pattern of killing the pigs within the first year of age, while the assemblages dating 1620-1650 seem to represent the beginnings of the transition. In the later assemblages, the pig age distribution is shifted from the 0-12 month group to the 12-24 month group, and at least 10% of the pigs fell in the older age category.

Element Distribution and Cuts of Meat

Many historical zooarchaeologists have focused their analysis of faunal remains on determining the social and economic status of households (Schulz and Gust 1983; Lyman 1987a; Crader 1984; Crader 1990; Reitz 1987; Bowen 1992). By looking at the presence or absence of various cuts of meat in an assemblage, they have concluded that the presence of feet and heads, which are considered less valuable cuts, are indicators of low social and economic status. Consequently, the presence of fleshier cuts of meat, indicated by body elements, are considered to be more valuable and an indicator of a household with high status (Crader 1984; Miller 1984). Bowen (1992, 1994), however, demonstrated that preferences for heads and feet as cuts of meat have changed from the pre-industrial period, and that until urban markets had grown and begun to control where butchery took place and to regulate which portions of the animals were to be sold, all portions of the animal were desirable. In fact, heads, particularly those of swine and calves, were considered to be delicacies.

In general, zooarchaeologists have not been able to identify distinctive characteristics of ethnic groups or high- and low-status diets (Bowen 1992; 1994). Particularly in seventeenth and eighteenth century assemblages, "low" and "high" quality cuts of meat are found intermingled in both high- and low-status assemblages. In his comparisons of known high-status and low-status seventeenth-century sites in Virginia, Henry Miller found very few differences in the distribution of particular elements. Similar species and cuts of meat were present in similar proportions on both types of sites, and in both, elements from "high-quality" cuts made up the majority of the bones (Miller 1984:360).

In studies of slave diet, where the assumption has been that slaves (presumably "low status") were provided the cuts of meat the white owners did not like, attempts have been made to demonstrate that "low-status" cuts such as the heads and feet were the cuts of meat most commonly consumed. Diana Crader looked for the presence of different cuts of meat to define the status of slave households associated with Monticello. In her comparative study of slave households associated with Thomas Jefferson's household and a slave household, she found a greater number "low-quality" cuts in the slave assemblage and a greater number of "high-quality" cuts in the main household assemblage. But like Miller, Crader found both high-quality cuts in the slave assemblage and low-quality cuts in the main household assemblage (Crader 1984, 1990).

To examine the proposition that meat cuts can be distinguished at Jamestown, element distribution tables were generated for Pit 1, Pit 3 (Sequence A), Pit 3 (Sequence B), Bulwark Ditch (Sequence A, B, and C), Bulwark Ditch (Sequence D), Ditch 7, Ditch 6, and Midden 1

(Appendix D, Tables 45-52). As with the kill-off data, the majority of the assemblages produced too few bones to give an accurate interpretation of the true element distribution. For this reason, two additional element distribution tables were made—one combining Pit 1, Pit 3, and the Bulwark Ditch, and the other Ditch 7, Ditch 6, and Midden 1 (Appendix D, Tables 53-54).

Besides comparing the Jamestown percentages to the normal element distribution percentages for each domestic mammal (to show deviations or skewed distributions suggesting favored cuts), Table 10 compares Jamestown to data compiled from seven rural Chesapeake sites dating from 1620 to 1660. The data from these sites was included in *Provisioning Early American Towns. The Chesapeake: A Multidisciplinary Case Study* (Walsh et. al. 1997) and includes the Hampton University site, Kingsmill Tenement, Bennett Farm, and three homesteads from Jordan's Journey.

Cattle. Cattle elements from the earlier Jamestown assemblages are predominately the body or meat-bearing elements (80.4%). Bones from the head made up only 5.3% of the element distribution, and 14.3% came from bones of the foot. It is surprising that so few cranial and foot bones were identified in these assemblages since those elements (especially teeth) are very dense and tend to survive even in acidic soil conditions. While at a first glance, the concentration of body elements may indicate a certain bias towards "high-quality" cuts of meat, this is unlikely since the early colonists were striving to find enough food and would have eaten all parts of the animal. The skewed element distribution may be the result of a small number of bones, although another equally plausible explanation is that these bones might possibly represent beef that had been barreled in Britain and brought over as supplies.

A total of 255 cattle bones from the Jamestown assemblage dating from 1620 to 1650 were analyzed. As the table shows, the distribution of cattle elements from these assemblages is almost identical to the normal skeletal distribution, indicating that the colonists were utilizing the entire animal.

Swine. As with cattle, there are a relatively small number of swine elements in the earlier Jamestown assemblage. While elements from the head (25.0%) are not far from the normal skeletal distribution, foot bones appear in less than normal proportions, making up only 14.0% of the elements. The body elements, on the other hand, are found in greater than normal proportions, making up 61.0%. Questions remain as to whether these remains are the remains of pigs that came from Britain live, barreled pork from Britain, or possibly live animals or barreled pork from Bermuda. Future research needs to be conducted, particularly on the Bermuda connection.

In the Jamestown assemblages dating 1620-1650, a total of three hundred seventeen bones were included for analysis. These assemblages differ from the earlier period in that the majority of the swine elements are from the head region (46.0%). This is similar to other Virginia sites, where 66.6% of the swine bones are from the head

Table 10.
Combined Features
Element Distribution

	Head		Body		Feet		
	No.	%	No.	%	No.	%	NISP
Cattle Normal		**29.7**		**42.2**		**28.1**	
Jamestown, c.1610	3	5.3	45	80.4	8	14.3	56
Jamestown,1620-1650	73	28.6	109	42.7	73	28.6	255
1620-1660 Sites		**50.1**		**28.9**		**20.9**	**1867**
Swine Normal		**28.2**		**34.5**		**37.3**	
Jamestown, c.1610	20	25.0	48	61.0	11	14.0	79
Jamestown, 1620-1650	145	46.0	107	34.0	65	20.0	317
1620-1660 Sites		**66.6**		**23.3**		**10.1**	**1271**
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	
Jamestown, c. 1610	2	25.0	6	75.0	0	0.0	8
Jamestown, 1620-1650	11	61.1	1	5.5	6	33.3	18
1620-1660 Sites		**33.1**		**37.5**		**29.5**	**275**

(largely because pig teeth are so durable and easily identified, but also presumably because pig's head was a delicacy).

Foot bones, on the other hand, are found in less than normal proportions both in the 1620-1650 Jamestown assemblage, as well as the other Virginia sites dating from 1620 to 1660. This consistency of low percentages of swine foot bones in seventeenth-century sites raises questions that need to be researched in greater detail. Since foot bones are quite dense and are likely to survive in faunal assemblages, lower numbers of swine foot bones from seventeenth-century sites can not be readily attributed to general preservation factors. Were these portions consumed in their entirety by canines? Were possibly they processed for gelatin, or some other use, then discarded elsewhere?

Horse. Invariably one or two equine bones appear in every colonial assemblage in this region. Usually a cranial or foot fragment, sometimes chopped, they have remained an enigma. Food remains, or not? The very small number and the fact that most often it is a foot has indicated they were not food remains.

In comparison to these remains, the equine remains found in the early assemblage include head, body parts, and feet, all equally well represented. From a total of nineteen bone fragments, seven are from the head, three from the feet, and the rest from the meaty portions, the hip, lower rear leg, backbone, and lower front leg. Thus body parts make up 47% of the assemblage.

Sheep/Goat. Finally, the small number of sheep/goats bones from the early Jamestown assemblage are primarily represented by body elements. Together they contributed 75.0% to the element distribution, while the remaining 25.0% are from the head region. No foot bones are present.

The eighteen sheep/goat bones from the 1620-1650 assemblages are primarily teeth (61.1%), followed by six foot bones and one body element. This differs from other Virginia sites, where the distribution of sheep/goat bones is closer to the normal skeletal proportions. The inconsistency is likely the result of sample size.

Butchering and Cuts of Meat

Although every zooarchaeologist must deal with butchery on a daily basis, few have dealt with butchery-related problems in print. With notable exceptions such as Lyman (1987b), Landon (1996) and Crader (1992), zooarchaeologists have tended to leave their observations as a laboratory function. Yet butchering data holds fascinating information on the transformation in foodways that occurred during the colonial period, along with the commercialization and industrialization of food production, distribution, processing, and consumption.

As faunal assemblages have come through Colonial Williamsburg's Zooarchaeology Laboratory, it has become apparent that a fundamental change occurred in butchering techniques during the seventeenth, eighteenth, and early nineteenth centuries. By working closely with the archaeologists to create tightly-dated assemblages, we have had the opportunity to observe when the butchering technique shifted from chopping to sawing and to formulate ideas on how and why this change occurred.

In his illustrative encyclopedia, Diderot (1978) depicts butchers in the seventeenth century with cleavers, knives, and broad axes, but no saws. Drawings of markets and butcher shops from eighteenth century London also shows broad axes and cleavers, not saws. Saws begin to appear only during the late eighteenth century or early nineteenth century. In fact, the earliest evidence of a saw is a 1799 drawing of Philadelphia, where a butcher is holding a saw (Bowen and Manning 1993).

Characteristic of seventeenth-century assemblages, the butchered bones from the Jamestown site are hacked with a chopping instrument. Drawings showing the butchered cuts for each domestic mammal and deer bone were compiled for Pit 1, Pit 3, the Bulwark Ditch, Ditch 7, Ditch 6, and Midden 1 and can be found in Appendix E.

As the drawings demonstrate, the bones from pigs, sheep/goat, and deer were chopped into similar forms as the butchering patterns found on the cattle bones. One major difference, however, is that long bones tended to be slightly more complete in the pigs, sheep/goats, and deer since their bones are relatively smaller in size. Given the fundamental similarity in approach to butchering, the following butchering descriptions have been generalized, with any exceptions noted.

Butchery evidence is presented in this report in a descriptive and visual form. Future research, where these patterns are combined with fragmentation studies, might lead to a better understanding of cookery methods. Was meat cooked in relatively complete pieces, possibly indicating roasting? Or were elements highly fragmented, and cooked as “one-pot” meals, either as pottages or other dishes that tend to be prepared in large pots? What cooking vessels can be correlated with the recovered bone remains?

While butchery research in zooarchaeology has been conducted for many decades, assumptions are based on what might seem to be rather naïve notions about nutrition, cooking methods, and economic well being. John Yellen’s research conducted during the 1970s showed the ¡Kung Bushmen chopped up bones to extract marrow, then all were placed in the pot to cook what have been referred to as “one-pot” meals (Yellen 1977). In fact, the size of the bone was directly related to the size of the pot. Others have taken this research and generalized it to conclude highly fragmented bones indicate individuals were so poor they wrenched all possible nutrition from the bones by extracting marrow (Otto 1984).

Horse Butchery. General observations of the Jamestown assemblages are that the horse remains are highly fragmented. Is this a sign they were breaking the bone for marrow? How does the degree of fragmentation seen in the horse remains compare to that in the cattle, swine, and caprines? More research exploring butchery patterns and the degree of fragmentation in the horse, cattle, swine, caprine and deer remains would help to identify how the colonists were preparing their meat. By extension this work would help determine whether or not bones were broken to extract the marrow. Lastly, comparisons between butchery patterns and degrees of fragmentation present in the early and later assemblages need to be conducted. If, for example, fragmentation indices derived for the early and later assemblages differ, and those from the Starving Time are found to be much more highly fragmented than those from the later period, it might be possible to infer they were indeed extracting all available nutrition from the bone.

All but one element, a mandible, came from Pit 1. There is little doubt these remains were butchered, in that these bones exhibit butchery marks identical in location to the cattle remains found in the assemblages. In addition, cervical vertebrae, innominate, tibiae, calcaneus, metatarsal, and others all exhibit chop marks and strike platforms on the surface where the bone is broken through. Visible *in* the break through compact bone are hinges, hairline fractures, and stress lines, all resulting from the force of the axe/cleaver used to strike the bone.

In comparison to bones seen in all seventeenth-century and later colonial faunal assemblages, these bones are highly fragmented, a condition that often produces many breaks that appear anomalous to the unschooled eye. However, the combination of signatures known to be related to chopping and the location of all breaks are sure signs the meat was butchered into small pieces—and probably the long bones were broken to extract marrow from their center.

Heads. Cranial bones that showed signs of being butchered predominately included mandible fragments. A total of seven butchered cattle mandible fragments were recorded from Ditch 6 and Midden 1 and one horse mandible was recorded as being butchered from the Bulwark Ditch. Butchered pig mandibles included two from Pit 3, one from the Bulwark Ditch, one from Ditch 6, and two from Midden 1. Finally, two butchered deer mandibles were recorded from the Bulwark Ditch. All of the mandibles were typically butchered perpendicularly to the axis with cuts on both the proximal and distal portions of the bone. Other butchered cranial elements included one pig maxilla from Midden 1 that had been hacked above the tooth row.

Vertebrae. A total of thirty adult cattle vertebrae from Pit 3, the Bulwark Ditch, Ditch 7, and Midden 1 were recorded as being butchered. A medieval form of butchering is to cut transversely through the centrum and main body of vertebrae (Maltby 1979). Most of these bones, however, exhibited a more modern method of butchering the carcass into two halves. Generally speaking, vertebrae were split with an ax or cleaver longitudinally along the axis, either along the center line or along either side of the centrum. The individual vertebrae are not shown in the drawings in Appendix E, but the raw data is available upon request.

Ribs. Axes or cleavers were also used to chop ribs from adult cattle in Ditch 6 (two bones) and Midden 1 (eight bones). The butchery evidence demonstrates that the ribs were hacked parallel to the vertebral column. There were some variations as to where the division took place and the size or the portions created by the cut. Many of the adult cattle rib bones were chopped through the vertebral end or the rib, either at or just below the articulation with the vertebra. This was probably done in order to separate the rib section from the vertebra. Other ribs were hacked so that a more substantial portion of the bone was left attached to the vertebra, which would have formed a rib roast cut (Landon 1996). As with the vertebra, the individual ribs are not shown in the butchering drawings in Appendix E, but are available upon request.

Scapulae. In all, there were fifteen cattle, ten pig, and two deer scapula that were recorded as being butchered. Generally, all the bones had been chopped either through the glenoid and neck, or through the blade itself. The goal of these two cuts seems to have been to sever the shoulder from the front leg, and secondly to bisect the shoulder itself. Since the flat bone of the blade is so fragile, there were many fragments that appeared to have been broken due to stress fractures.

Long Bones. Butchered humeri, radii, ulnae, femora, and tibiae were the most identified butchered elements from all of the domestic mammal and deer bones. In all, there were twenty-five cattle long bones, forty-one pig long bones, and nineteen deer long bones identified from all of the assemblages. The majority of the cattle long bones had been chopped, probably with the intention of separating the joints. More often the cut was made below the proximal epiphysis through the shaft or above the distal epiphysis through the shaft. There were also a few bones that had been butchered mid-shaft. Experiments conducted by students and staff members working in Colonial Williamsburg’s Zooarchaeological Lab have demonstrated the ease with which these cuts can be made. Two hits of a cleaver are enough to snap the long bone in two; one well-aimed hit of an axe will snap a joint in two. These cuts are part of the primary butchering process, not simply cuts made by those attempting to release marrow from inside the shaft.

An interesting observation was that the majority of the pig long bones were from the middle of the shaft with no proximal or distal epiphyses, resulting in substantial cuts of meat. Many of the deer bones were hacked in a similar fashion but there were also a small number of butchered deer long bones that contained the epiphyses.

Innominates. Innominates from domestic mammals and deer were found butchered from Pit 1, Pit 3, the Bulwark Ditch, Ditch 6, and Midden 1. These included nine cattle, seven pig, two deer, and one horse. Like the scapula, the pelvic bones are vulnerable to breakage, and once butchered, its soft cancellous bone that is covered by a thin layer of compact bone makes it an easy target for dogs and feet. By viewing the innominates as a group, it is evident that they were always butchered, generally on either side of the acetabulum, through the ilium, ischium, and sometimes the pubis.

Lower Leg. Metapodials from cattle (three bones), deer (two bones), and horse (one bone) were recorded as butchered from Pit 1, Pit 3, and Midden 1. Most of the butchered metapodials contained one of the epiphyses and were chopped through the middle of the shaft. This cut would have ensured a large amount of meat remained on the bone.

Appendix B. Summary Tables

Note: NISP= Number of identified specimens; MNI=Minimum number of individuals. "2/2" under MNI means 2 adult, 2 immature; "1" means 1 adult.

Table 11.
Jamestown, Pit 1
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Callinectes sapidus (Blue Crab)	3	0.1	1	1.1	0.2	<0.1		
Order Rajiformes (Skates or Rays)	12	0.3	2	2.3	8.0	0.4		
Class Osteichthyes (Bony Fish)	421	10.6					0.86	2.0
Acipenser spp. (Sturgeon)	1860	46.9	1	1.1	100.0	4.8	7.88	18.1
Lepisosteus spp. (Gar)	133	3.4	1	1.1	5.0	0.2	0.22	0.5
Family Clupeidae (Herring)	3	0.1	1	1.1	0.4	<0.1	0.01	<0.1
cf. Family Clupeidae (Herring)	1	<0.1					0.01	<0.1
Family Catostomidae (Sucker)	75	1.9	6	7.0	6.0	0.3	0.23	0.5
Family Ictaluridae (Freshwater Catfish)	91	2.3	11	12.6	22.0	1.1	0.36	0.8
cf. Family Ictaluridae (Freshwater Catfish)	1	<0.1					0.02	<0.1
Esox niger (Channel Pickerel)	5	0.1	1	1.1	2.0	0.1	0.02	<0.1
Family Gadidae (Codfish)	1	<0.1	1	1.1	4.8	0.2	0.05	0.1
Lepomis spp. (Sunfish)	3	0.1	2	2.3	0.8	<0.1	0.01	<0.1
Family Percichthyidae (Temperate Bass)	1	<0.1					<0.01	<0.1
Morone americana (White Perch)	381	9.6	8	9.2	8.0	0.4	0.31	0.7
cf. *Morone americana* (White Perch)	14	0.4					0.02	<0.1
Morone saxatilis (Striped Bass)	1	<0.1	1	1.1	7.5	0.4	0.01	<0.1
Morone spp. (Temperate Bass)	2	0.1					0.01	<0.1
cf. *Morone* spp. (Temperate Bass)	1	<0.1					<0.01	<0.1
cf. *Archosargus probatocephalus* (Sheepshead)	2	0.1	1	1.1	7.5	0.4	0.02	<0.1
Order Testudines (Turtle)	215	5.4					0.51	1.2
Chelydra serpentina (Snapping Turtle)	4	0.1	1	1.1	10.0	0.5	0.08	0.2
Family Kinosternidae (Musk or Mud Turtle)	71	1.8	2	2.3	0.8	<0.1	0.34	0.8
cf. Family Kinosternidae (Musk or Mud Turtle)	8	0.2					0.07	0.2
Chrysemys spp. (Slider or Cooter)	15	0.4	1	1.1	3.0	0.1	1.49	3.4
cf. *Chrysemys* spp. (Slider or Cooter)	6	0.2					0.13	0.3
Terrapene carolina (Box Turtle)	130	3.3	5	5.7	1.5	0.1	1.46	3.4
Family Cheloniidae (Marine Turtle)	7	0.2	1	1.1	1.6	0.1	1.49	3.4
Family Colubridae (Snake)	2	0.1	1	1.1			<0.01	<0.1
Family Viperidae (Viper)	7	0.2	1	1.1			0.02	<0.1
Class Aves (Bird)	78	2.0					0.67	1.5
Class Aves/Mammalia III (Bird/Small Mammal)	29	0.7					0.05	0.1
Phalacrocorax auritus (Double-Crested Cormorant)	5	0.1	1	1.1	5.0	0.2	0.08	0.2
cf. *Phalacrocorax auritus* (Double-Crested Cormorant)	1	<0.1					<0.01	<0.1
Phalacrocorax spp. (Cormorant)	1	<0.1					0.01	<0.1
Pterodroma cahow (Bermuda Petrel)	7	0.2	2	2.3	3.0	0.1	0.05	0.1
cf. *Charadius vociferus* (Killdeer)	1	<0.1	1	1.1	1.0	<0.1	<0.01	<0.1
Goose spp. (Goose)	14	0.4					0.17	0.4
cf. Goose spp. (Goose)	3	0.1					0.04	0.1
Anser spp. (Goose)	1	<0.1					0.05	0.1
cf. *Anser* spp. (Goose)	3	0.1					0.04	0.1
cf. *Anser anser* (Domestic Goose)	1	<0.1	1	1.1	6.0	0.3	0.02	<0.1
Branta canadensis (Canada Goose)	31	0.8	2	2.3	12.0	0.6	0.85	1.9
Duck spp. (Duck)	14	0.4					0.09	0.2
cf. Duck spp. (Duck)	2	0.1					0.01	<0.1
Anas platyrhynchos (Domestic Duck or Mallard)	9	0.2	3	3.4	6.0	0.3	0.16	0.4
cf. *Anas platyrhynchos* (Domestic Duck or Mallard)	1	<0.1					0.01	<0.1
cf. *Oxyura jamaicensis* (Ruddy Duck)	2	0.1	1	1.1	1.0	<0.1	0.01	<0.1
Aythya spp. (Pochard)	1	<0.1	1	1.1	1.0	<0.1	0.01	<0.1
Buteo spp. (Hawk)	2	0.1	2	2.3	5.0	0.2	0.01	<0.1
Meleagris gallopavo (Turkey)	1	<0.1	2	2.3	15.0	0.7	0.07	0.2
Gallus gallus (Chicken)	3	0.1	1	1.1	2.5	0.1	0.03	0.1
cf. *Gallus gallus* (Chicken)	1	<0.1					0.01	<0.1

Table 11 (cont'd).
Jamestown, Pit 1
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Family Strigidae (Typical Owl)	1	<0.1	1	1.1	2.0	0.1	0.01	<0.1
Order Piciformes (Woodpeckers)	1	<0.1	1	1.1	0.6	<0.1	<0.01	<0.1
Class Mammalia (Mammal)	9	0.2					0.26	0.6
Class Mammalia I (Large Mammal)	34	0.9					1.07	2.5
Class Mammalia II (Medium Mammal)	43	1.1					1.53	3.5
Class Mammalia III (Small Mammal)	2	0.1					0.07	0.2
Didelphis virginiana (Opossum)	6	0.2	2	2.3	16.0	0.8	0.20	0.5
Sciurus carolinensis (Eastern Gray Squirrel)	23	0.6	3	3.4	3.0	0.1	0.14	0.3
cf. *Sciurus carolinensis* (Eastern Gray Squirrel)	10	0.3					0.02	0.1
Sciurus niger (Eastern Fox Squirrel)	4	0.1	2	2.3	1.6	0.1	0.08	0.2
Castor canadensis (Beaver)	4	0.1	1	1.1	25.0	1.2	0.19	0.4
Ondatra zibethica (Muskrat)	2	0.1	1	1.1	2.0	0.1	0.02	<0.1
Rat spp. (Rats)	7	0.2					0.03	0.1
cf. Family Delphinidae (Ocean Dolphins)	1	<0.1					0.03	0.1
Tursiops truncatus (Bottle-Nosed Dolphin)	7	0.2	1	1.1	500.0	24.0	1.38	3.2
Order Carnivora (Carnivore)	5	0.1					0.20	0.5
Canis spp. (Dog or Wolf)	1	<0.1					0.13	0.3
Canis familiaris (Dog)	1	<0.1					0.11	0.3
Procyon lotor (Raccoon)	13	0.3	1	1.1	15.0	0.7	0.31	0.7
cf. *Procyon lotor* (Raccoon)	6	0.2					0.07	0.2
Felis domesticus (Domestic Cat)	3	0.1					0.10	0.2
Equus spp. (Horse or Ass)	15	0.4	1	1.1	400.0	19.2	4.82	11.1
cf. *Equus* spp. (Horse or Ass)	3	0.1					1.46	3.3
Order Artiodactyla I (Sheep, Goat, Deer, or Pig)	3	0.1					0.14	0.3
Order Artiodactyla II (Sheep, Goat, or Deer)	3	0.1					0.20	0.5
Sus scrofa (Domestic Pig)	24	0.6	3	3.4	300.0	14.4	1.94	4.5
cf. *Sus scrofa* (Domestic Pig)	2	0.1					0.10	0.2
Odocoileus virginianus (White-Tailed Deer)	18	0.5	1	1.1	100.0	4.8	2.16	5.0
cf. *Odocoileus virginianus* (White-Tailed Deer)	2	0.1					0.27	0.6
Bos taurus (Domestic Cow)	14	0.4	1	1.1	400.0	19.2	5.85	13.5
cf. *Bos taurus* (Domestic Cow)	3	0.1					0.24	0.5
Capra hircus (Domestic Goat)	5	0.1	1	1.1	35.0	1.7	0.78	1.8
Ovis aries/Capra hircus (Domestic Sheep or Goat)	3	0.1	1	1.1	35.0	1.7	0.16	0.4
cf. *Ovis aries/Capra hircus* (Domestic Sheep or Goat)	1	<0.1					0.02	0.1
Bos taurus/*Equus* sp. (Domestic Cow, Horse, or Ass)	2	0.1					0.44	1.0
cf. *Bos taurus*/*Equus* sp. (Domestic Cow, Horse, or Ass)	2	0.1					0.90	2.1
Fish	3008	75.8	36	41.4	172.0	8.3	10.05	23.1
Reptiles/Amphibians	0	0.0	0	0.0	0.0	0.0	0.00	0.0
Turtles	456	11.5	10	11.5	16.9	0.8	5.57	12.8
Wild Birds	64	1.6	17	19.5	51.6	2.5	1.29	3.0
Wild Mammals	101	2.5	12	13.8	662.6	31.8	5.07	11.6
Domestic Birds	9	0.2	2	2.3	8.5	0.4	0.15	0.3
Domestic Mammals	52	1.3	6	6.9	770.0	37.0	9.09	20.9
Commensals	38	1.0	3	3.4	400.0	19.2	6.57	15.1
Wild	3638	91.6	76	87.4	903.3	48.4	22.32	51.3
Domestic	65	1.6	8	9.2	778.5	37.4	10.58	24.3
Identified	3354	84.5	87	100.0	2081.8	100.0	39.02	89.6
Unidentified	616	15.5					4.51	10.4
Totals	3970	100.0	87	100.0	2081.8	100.0	43.53	100.0

Table 12.
Jamestown, Pit 3, Sequence A
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Order Rajiformes (Skates or Rays)	2	1.1	1	4.5	8.0	1.0	0.00	0.0
Class Osteichthyes (Bony Fish)	26	13.8					0.07	1.2
Acipenser spp. (Sturgeon)	55	29.1	1	4.5	100.0	12.3	0.57	10.0
Lepisosteus spp. (Gar)	2	1.1	1	4.5	5.0	0.6	0.01	0.2
Family Clupeidae (Herring)	1	0.5					0.01	0.1
Alosa sapidissima (American Shad)	3	1.6	1	4.5	3.2	0.4	0.03	0.5
Family Catostomidae (Sucker)	2	1.1	1	4.5	1.0	0.1	0.02	0.3
Family Ictaluridae (Freshwater Catfish)	3	1.6	1	4.5	2.0	0.2	0.03	0.6
Class Reptilia (Reptile)	1	0.5						
Chelydra serpentina (Snapping Turtle)	3	1.6	1	4.5	10.0	1.2	0.05	0.8
cf. *Chelydra serpentina* (Snapping Turtle)	3	1.6					0.07	1.1
Chrysemys spp. (Slider or Cooter)	2	1.1	1	4.5	3.0	0.4	0.02	0.4
Terrapene carolina (Box Turtle)	2	1.1	1	4.5	0.3	<0.1	0.04	0.8
Class Aves (Bird)	10	5.3					0.11	1.9
Class Aves/Mammalia III (Bird/Small Mammal)	4	2.1					0.02	0.4
Pterodroma cahow (Bermuda Petrel)	1	0.5	1	4.5	1.5	0.2	0.01	0.2
Goose spp. (Goose)	1	0.5					0.06	1.0
Anser anser (Domestic Goose)	1	0.5	1	4.5	6.0	0.7	0.09	1.5
Branta canadensis (Canada Goose)	1	0.5	1	4.5	6.0	0.7	0.05	0.9
Meleagris gallopavo (Turkey)	2	1.1	1	4.5	7.5	0.9	0.19	3.2
Gallus gallus (Chicken)	3	1.6	1	4.5	2.5	0.3	0.04	0.7
Corvus brachyrhynchos (Common Crow)	1	0.5	1	4.5	1.0	0.1	0.01	0.1
Class Mammalia (Mammal)	1	0.5					0.02	0.3
Class Mammalia I (Large Mammal)	19	10.1					0.82	14.3
Class Mammalia II (Medium Mammal)	20	10.6					0.40	7.1
Didelphis virginiana (Opossum)	1	0.5	1	4.5	8.0	1.0	0.03	0.5
Sciurus carolinensis (Eastern Gray Squirrel)	4	2.1	1	4.5	1.0	0.1	0.04	0.7
cf. *Sciurus carolinensis* (Eastern Gray Squirrel)	2	1.1					0.01	0.2
Procyon lotor (Raccoon)	2	1.1	1	4.5	15.0	1.8	0.15	2.7
Sus scrofa (Domestic Pig)	5	2.6	1	4.5	100.0	12.3	0.80	13.9
cf. *Sus scrofa* (Domestic Pig)	1	0.5					0.17	2.9
Odocoileus virginianus (White-Tailed Deer)	2	1.1	1	4.5	100.0	12.3	0.35	6.1
Bos taurus (Domestic Cow)	1	0.5	1	4.5	400.0	49.0	0.98	17.2
cf. *Bos taurus* (Domestic Cow)	1	0.5					0.26	4.6
Ovis aries/Capra hircus (Domestic Sheep or Goat)	1	0.5	1	4.5	35.0	4.3	0.22	3.8
Fish	94	49.7	6	27.3	119.2	14.6	0.74	12.9
Reptiles/Amphibians	1	0.5	0	0.0	0.0	0.0	0.00	0.0
Turtles	10	5.3	3	13.6	13.3	1.6	0.18	3.1
Wild Birds	5	2.6	4	18.2	16.0	2.0	0.26	4.5
Wild Mammals	11	5.8	4	18.2	124.0	15.2	0.58	10.1
Domestic Birds	4	2.1	2	9.1	8.5	1.0	0.13	2.3
Domestic Mammals	9	4.8	3	13.6	535.0	65.6	2.43	42.3
Commensals	0	0.0						
Wild	121	64.0	16	72.7	272.5	33.4	1.76	30.6
Domestic	13	6.9	6	27.3	543.5	66.6	2.56	44.5
Identified	109	57.7	22	100.0	816.0	100.0	4.31	75.0
Unidentified	80	42.3					1.44	25.0
Totals	189	100.0	22	100.0	808.0	100.0	5.75	100.0

Table 13.
Jamestown, Pit 3, Sequence B
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Order Lamniformes (Typical Shark)	7	0.1	1	1.4	160.0	6.8	0.00	0.0
Order Rajiformes (Skates or Rays)	49	0.6	1	1.4	8.0	0.3	0.00	0.0
Class Osteichthyes (Bony Fish)	539	6.9					1.20	1.0
Acipenser spp. (Sturgeon)	859	11.0	1	1.4	100.0	4.3	7.61	6.5
Lepisosteus spp. (Gar)	29	0.4	1	1.4	5.0	0.2	0.12	0.1
cf. Family Clupeidae (Herring)	7	0.1					0.01	<0.1
Alosa sapidissima (American Shad)	7	0.1	1	1.4	3.2	0.1	0.06	<0.1
Family Catostomidae (Sucker)	17	0.2	2	2.7	2.0	0.1	0.09	0.1
Family Ictaluridae (Freshwater Catfish)	60	0.8	3	4.1	6.0	0.3	0.35	0.3
Family Gadidae (Codfish)	2	<0.1	2	2.7	9.6	0.4	0.05	<0.1
Morone americana (White Perch)	59	0.8	4	5.4	4.0	0.2	0.09	0.1
Morone saxatilis (Striped Bass)	2	<0.1	1	1.4	7.5	0.3	0.01	<0.1
cf. *Morone saxatilis* (Striped Bass)	1	<0.1					0.01	<0.1
Morone spp. (Temperate Bass)	1	<0.1					0.01	<0.1
cf. *Morone* spp. (Temperate Bass)	1	<0.1					0.01	<0.1
Family Serranidae (Sea Bass)	14	0.2	3	4.1	27.0	1.1	0.41	0.4
cf. Family Serranidae (Sea Bass)	1	<0.1					0.02	<0.1
Family Lutjanidae (Snapper)	1	<0.1	1	1.4	4.0	0.2	0.02	<0.1
Archosargus probatocephalus (Sheepshead)	3	<0.1	1	1.4	7.5	0.3	0.03	<0.1
Class Reptilia (Reptile)	85	1.1						
Chelydra serpentina (Snapping Turtle)	20	0.3	1	1.4	10.0	0.4	0.43	0.4
cf. *Chelydra serpentina* (Snapping Turtle)	2	<0.1					0.04	<0.1
Family Kinosternidae (Musk or Mud Turtle)	1	<0.1	1	1.4	0.4	<0.1	0.01	<0.1
Chrysemys spp. (Slider or Cooter)	46	0.6	2	2.7	6.0	0.3	0.44	0.4
cf. *Chrysemys* spp. (Slider or Cooter)	5	0.1					0.10	0.1
Malaclemys terrapin (Diamondback Terrapin)	11	0.1	1	1.4	0.6	<0.1	0.16	0.1
Terrapene carolina (Box Turtle)	51	0.7	3	4.1	0.9	<0.1	0.87	0.7
Family Colubridae (Snake)	10	0.1	1	1.4			0.02	<0.1
Family Viperidae (Viper)	7	0.1	1	1.4			0.02	<0.1
Class Aves (Bird)	265	3.4					1.43	1.2
Class Aves/Mammalia III (Bird/Small Mammal)	358	4.6					2.30	2.0
Phalacrocorax auritus (Double-Crested Cormorant)	3	<0.1	1	1.4	5.0	0.2	0.12	0.1
Pterodroma cahow (Bermuda Petrel)	1	<0.1	1	1.4	1.5	0.1	0.01	<0.1
Goose spp. (Goose)	32	0.4					0.74	0.6
cf. Goose spp. (Goose)	7	0.1					0.17	0.1
Anser spp. (Goose)	1	<0.1					0.08	0.1
Anser anser (Domestic Goose)	1	<0.1	1	1.4	6.0	0.3	0.03	<0.1
Branta canadensis (Canada Goose)	32	0.4	3	4.1	18.0	0.8	1.36	1.2
cf. *Branta canadensis* (Canada Goose)	5	0.1					0.08	0.1
Duck spp. (Duck)	13	0.2					0.13	0.1
cf. Duck spp. (Duck)	4	0.1					0.06	0.1
Anas spp. (Dabbling Duck)	3	<0.1					0.08	0.1
Anas platyrhynchos (Domestic Duck or Mallard)	9	0.1	2	2.7	4.0	0.2	0.11	0.1
Anas rubripes (Black Duck)	3	<0.1	1	1.4	2.0	0.1	0.07	0.1
Aix sponsa (Wood Duck)	4	0.1	1	1.4	1.2	0.1	0.03	<0.1
Aythya spp. (Pochard)	2	<0.1					0.05	<0.1
Aythya collaris (Ring-Necked Duck)	2	<0.1	2	2.7	2.0	0.1	0.02	<0.1
Larus delawarensis (Ring-billed Gull)	2	<0.1	1	1.4	4.0	0.2	0.01	<0.1
cf. Family Accipitridae (Hawk or Eagle)	1	<0.1					0.02	<0.1
Haliaeetus leucocephalus (Bald Eagle)	1	<0.1	1	1.4	7.5	0.3	0.18	0.2
Meleagris gallopavo (Turkey)	8	0.1	1	1.4	7.5	0.3	0.42	0.4
Gallus gallus (Chicken)	8	0.1	2	2.7	5.0	0.2	0.15	0.1
cf. *Gallus gallus* (Chicken)	2	<0.1					0.01	<0.1
Colinus virginianus (Bobwhite)	1	<0.1	1	1.4	0.5	<0.1	0.01	<0.1
Order Passeriformes (Perching Bird)	2	<0.1					0.01	<0.1
cf. Family Corvidae (Ravens and Crows)	1	<0.1					<0.01	<0.1
Corvus brachyrhynchos (Common Crow)	2	<0.1	1	1.4	1.0	<0.1	0.05	<0.1

Table 13 (cont'd).
Jamestown, Pit 3, Sequence B
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Family Picidae (Woodpecker)	1	<0.1	1	1.4	0.6	<0.1	<0.01	<0.1
Class Mammalia (Mammal)	3039	38.9					14.84	12.7
Class Mammalia I (Large Mammal)	489	6.3					28.77	24.6
Class Mammalia II (Medium Mammal)	1245	16.0					19.69	16.9
Class Mammalia III (Small Mammal)	135	1.7					1.78	1.5
Didelphis virginiana (Opossum)	5	0.1	1	1.4	8.0	0.3	0.11	0.1
Sylvilagus floridanus (Eastern Cottontail)	2	<0.1	1	1.4	2.0	0.1	0.03	<0.1
Sciurus carolinensis (Eastern Gray Squirrel)	39	0.5	4	5.4	4.0	0.2	0.26	0.2
cf. *Sciurus carolinensis* (Eastern Gray Squirrel)	25	0.3					0.05	<0.1
Sciurus niger (Eastern Fox Squirrel)	9	0.1	2	2.7	1.6	0.1	0.12	0.1
Castor canadensis (Beaver)	1	<0.1	1	1.4	25.0	1.1	0.02	<0.1
Ondatra zibethica (Muskrat)	7	0.1	1	1.4	2.0	0.1	0.23	0.2
Rattus rattus (Roof Rat)	11	0.1					0.06	0.1
Rat spp. (Rats)	9	0.1					0.02	<0.1
Tursiops truncatus (Bottle-Nosed Dolphin)	3	<0.1	1	1.4	500.0	21.2	0.93	0.8
Canis spp. (Dog or Wolf)	2	<0.1					0.22	0.2
Canis familiaris (Dog)	1	<0.1					0.07	0.1
Procyon lotor (Raccoon)	12	0.2	1	1.4	15.0	0.6	0.54	0.5
cf. *Procyon lotor* (Raccoon)	1	<0.1					0.05	<0.1
Lontra canadensis (River Otter)	1	<0.1	1	1.4	17.0	0.7	0.02	<0.1
Mustela vison (Mink)	1	<0.1	1	1.4	1.0	<0.1	0.02	<0.1
Order Artiodactyla II (Sheep, Goat, or Deer)	1	<0.1					0.12	0.1
cf. Order Artiodactyla II (Sheep, Goat, or Deer)	1	<0.1					0.03	<0.1
Sus scrofa (Domestic Pig)	31	0.4	2/1	4.1	250.0	10.6	5.18	4.4
cf. *Sus scrofa* (Domestic Pig)	2	<0.1					0.32	0.3
Odocoileus virginianus (White-Tailed Deer)	24	0.3	3	4.1	300.0	12.7	5.72	4.9
cf. *Odocoileus virginianus* (White-Tailed Deer)	2	<0.1					0.22	0.2
Bos taurus (Domestic Cow)	33	0.4	2	2.7	800.0	34.0	16.99	14.5
cf. *Bos taurus* (Domestic Cow)	2	<0.1					0.61	0.5
Homo sapiens (Human)	1	<0.1	1	1.4				
Fish	1659	21.3	22	29.3	343.8	14.6	10.10	8.6
Reptiles/Amphibians	85	1.1	0	0.0	0.0	0.0	0.00	0.0
Turtles	136	1.7	8	10.7	17.9	0.8	2.05	1.8
Wild Birds	83	1.1	17	22.7	54.8	2.3	2.64	2.3
Wild Mammals	132	1.7	17	22.7	875.6	37.2	8.32	7.1
Domestic Birds	12	0.2	3	4.0	11.0	0.5	0.27	0.2
Domestic Mammals	68	0.9	4/1	6.7	1050.0	44.6	23.10	19.8
Commensals	40	0.5	2	2.7	0.0	0.0	0.41	0.4
Wild	2095	26.8	64	85.3	1292.1	54.9	23.11	19.8
Domestic	80	1.0	7/1	10.7	1061.0	45.1	23.37	20.0
Identified	1650	21.1	74/1	100.0	2353.1	100.0	46.94	40.1
Unidentified	6155	78.9					70.01	59.9
Totals	7805	100.0	74/1	100.0	2353.1	100.0	116.95	100.0

Table 14.
Jamestown, Bulwark Ditch, Sequences A, B, and C
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Class Osteichthyes (Bony Fish)	6	3.7					0.03	0.3
Acipenser spp. (Sturgeon)	66	40.2	1	6.3	100.0	7.7	0.76	9.2
cf. *Acipenser* spp. (Sturgeon)	1	0.6					0.02	0.3
Alosa sapidissima (American Shad)	1	0.6	1	6.3	3.2	0.2	0.03	0.4
Family Ictaluridae (Freshwater Catfish)	1	0.6	1	6.3	2.0	0.2	0.02	0.2
Family Gadidae (Codfish)	1	0.6	1	6.3	4.8	0.4	0.01	0.1
Class Reptilia (Reptile)	7	4.3	1	6.3				
Class Aves (Bird)	3	1.8					0.13	1.6
Class Aves/Mammalia III (Bird/Small Mammal)	1	0.6					0.01	0.1
Anser spp. (Goose)	1	0.6	1	6.3	7.0	0.5	0.01	0.1
Duck spp. (Duck)	1	0.6	1	6.3	2.0	0.2	0.01	0.1
Goose spp. (Goose)	2	1.2					0.03	0.4
Class Mammalia (Mammal)	14	8.5					0.20	2.4
Class Mammalia I (Large Mammal)	2	1.2					0.05	0.6
Class Mammalia II (Medium Mammal)	15	9.1					0.32	3.8
Sciurus carolinensis (Eastern Gray Squirrel)	2	1.2	1	6.3	1.0	0.1	0.01	0.1
Castor canadensis (Beaver)	2	1.2	1	6.3	25.0	1.9	0.05	0.6
Ondatra zibethica (Muskrat)	1	0.6	1	6.3	2.0	0.2	0.01	0.1
cf. Family Delphinidae (Ocean Dolphins)	4	2.4					0.15	1.8
Tursiops truncatus (Bottle-Nosed Dolphin)	5	3.0	1	6.3	500.0	38.6	1.19	14.5
Canis spp. (Dog or Wolf)	4	2.4					0.26	3.2
cf. *Canis* spp. (Dog or Wolf)	2	1.2					0.07	0.8
Canis familiaris (Dog)	3	1.8					0.78	9.4
Procyon lotor (Raccoon)	2	1.2	1	6.3	15.0	1.2	0.02	0.3
Sus scrofa (Domestic Pig)	5	3.0	1	6.3	100.0	7.7	0.57	6.9
cf. *Sus scrofa* (Domestic Pig)	1	0.6					0.33	4.0
Odocoileus virginianus (White-Tailed Deer)	6	3.7	1	6.3	100.0	7.7	1.62	19.7
cf. *Odocoileus virginianus* (White-Tailed Deer)	2	1.2					0.56	6.8
Bos taurus (Domestic Cow)	1	0.6	1	6.3	400.0	30.8	0.66	8.0
Ovis aries/Capra hircus (Domestic Sheep or Goat)	2	1.2	1	6.3	35.0	2.7	0.35	4.2
Fish	76	46.3	4	25.0	110.0	8.5	0.87	10.5
Reptiles/Amphibians	7	4.3	1	6.3	0.0	0.0	0.00	0.0
Turtles	0	0.0						
Wild Birds	0	0.0						
Wild Mammals	24	14.6	6	37.5	643.0	49.6	3.61	43.7
Domestic Birds	1	0.6	1	6.3	7.0	0.5	0.01	0.1
Domestic Mammals	9	5.5	3	18.8	535.0	41.2	1.91	23.1
Commensals	9	5.5	0	0.0	0.0	0.0	1.11	13.4
Wild	110	67.1	12	75.0	751.0	57.9	4.52	54.7
Domestic	10	6.1	4	25.0	535.0	41.2	1.92	23.2
Identified	116	70.7	15	93.8	1297.0	100.0	7.52	91.0
Unidentified	48	29.3	1	6.3			0.74	9.0
Totals	164	100.0	16	100.0	1297.0	100.0	8.26	100.0

Table 15.
Jamestown, Bulwark Ditch, Sequence D
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Class Osteichthyes (Bony Fish)	21	5.4					0.09	0.6
Acipenser spp. (Sturgeon)	42	10.8	1	3.7	100.0	7.4	0.59	3.6
Alosa sapidissima (American Shad)	1	0.3	1	3.7	3.2	0.2	0.05	0.3
Family Ictaluridae (Freshwater Catfish)	1	0.3	1	3.7	2.0	0.1	0.02	0.1
Family Gadidae (Codfish)	1	0.3	1	3.7	4.8	0.4	0.03	0.2
Class Reptilia (Reptile)	5	1.3						
Chrysemys spp. (Slider or Cooter)	2	0.5	1	3.7	3.0	0.2	0.12	0.7
Terrapene carolina (Box Turtle)	2	0.5	1	3.7	0.3	<0.1	0.07	0.4
Class Aves (Bird)	4	1.0					0.04	0.3
Goose spp. (Goose)	1	0.3					0.01	<0.1
Branta canadensis (Canada Goose)	1	0.3	1	3.7	6.0	0.4	0.06	0.4
Duck spp. (Duck)	1	0.3	1	3.7	2.0	0.1	<0.01	<0.1
Haliaeetus leucocephalus (Bald Eagle)	1	0.3	1	3.7	7.5	0.6	0.03	0.2
Meleagris gallopavo (Turkey)	2	0.5	2	7.4	15.0	1.1	0.38	2.3
Gallus gallus (Chicken)	2	0.5	1	3.7	2.5	0.2	0.03	0.2
Class Mammalia (Mammal)	119	30.5					0.77	4.7
Class Mammalia I (Large Mammal)	21	5.4					1.92	11.7
Class Mammalia II (Medium Mammal)	78	20.0					2.16	13.1
Class Mammalia III (Small Mammal)	20	5.1					0.16	1.0
Didelphis virginiana (Opossum)	3	0.8	1	3.7	8.0	0.6	0.11	0.7
cf. *Marmota monax* (Woodchuck)	1	0.3	1	3.7	5.0	0.4	0.03	0.2
Sciurus carolinensis (Eastern Gray Squirrel)	4	1.0	2	7.4	2.0	0.1	0.06	0.4
Sciurus niger (Eastern Fox Squirrel)	2	0.5	1	3.7	0.8	0.1	0.04	0.2
cf. *Sciurus niger* (Eastern Fox Squirrel)	1	0.3					0.01	0.1
Castor canadensis (Beaver)	2	0.5	1	3.7	25.0	1.8	0.13	0.8
Ondatra zibethica (Muskrat)	2	0.5	1	3.7	2.0	0.1	0.02	0.1
cf. Rat spp. (Rats)	1	0.3					<0.01	<0.1
Canis spp. (Dog or Wolf)	4	1.0					0.25	1.5
Procyon lotor (Raccoon)	7	1.8	2	7.4	30.0	2.2	0.32	1.9
Equus spp. (Horse or Ass)	1	0.3	1	3.7	400.0	29.5	0.67	4.1
Order Artiodactyla II (Sheep, Goat, or Deer)	4	1.0					0.55	3.3
Sus scrofa (Domestic Pig)	13	3.3	2	7.4	200.0	14.8	2.33	14.2
cf. *Sus scrofa* (Domestic Pig)	1	0.3					0.06	0.4
Odocoileus virginianus (White-Tailed Deer)	15	3.8	1	3.7	100.0	7.4	3.18	19.4
Bos taurus (Domestic Cow)	3	0.8	1	3.7	400.0	29.5	1.82	11.1
Ovis aries/Capra hircus (Domestic Sheep or Goat)	1	0.3	1	3.7	35.0	2.6	0.30	1.8
Fish	66	16.9	4	14.8	110.0	8.1	0.78	4.8
Reptiles/Amphibians	5	1.3	0	0.0	0.0	0.0	0.00	0.0
Turtles	4	1.0	2	7.4	3.3	0.2	0.19	1.2
Wild Birds	4	1.0	4	14.8	28.5	2.1	0.47	2.9
Wild Mammals	37	9.5	10	37.0	172.8	12.8	3.90	23.8
Domestic Birds	2	0.5	1	3.7	2.5	0.2	0.03	0.2
Domestic Mammals	18	4.6	4	14.8	635.0	46.9	4.51	27.5
Commensals	6	1.5	1	3.7	400.0	29.5	0.93	5.6
Wild	116	29.7	20	74.1	314.6	23.2	5.34	32.5
Domestic	20	5.1	5	18.5	637.5	47.1	4.54	27.6
Identified	122	31.3	27	100.0	1354.1	100.0	11.28	68.7
Unidentified	268	68.7					5.14	31.3
Totals	390	100.0	27	100.0	1354.1	100.0	16.42	100.0

Table 16.
Jamestown, Ditch 7
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Class Osteichthyes (Bony Fish)	10	11.0					0.04	0.4
Family Gadidae (Codfish)	1	1.1	1	10.0	4.8	0.4	0.02	0.2
Class Reptilia (Reptile)	2	2.2	1	10.0				
Class Aves (Bird)	5	5.5					0.07	0.8
Goose spp. (Goose)	2	2.2	1	10.0	7.0	0.6	0.06	0.7
Meleagris gallopavo (Turkey)	2	2.2	1	10.0	7.5	0.6	0.15	1.7
Gallus gallus (Chicken)	1	1.1	1	10.0	2.5	0.2	0.02	0.3
cf. *Gallus gallus* (Chicken)	1	1.1					0.03	0.3
Class Mammalia (Mammal)	10	11.0					0.16	1.8
Class Mammalia I (Large Mammal)	5	5.5					0.40	4.5
Class Mammalia II (Medium Mammal)	3	3.3					0.13	1.5
Class Mammalia III (Small Mammal)	6	6.6					0.06	0.6
Tursiops truncatus (Bottle-Nosed Dolphin)	1	1.1	1	10.0	500.0	43.2	0.51	5.9
Order Artiodactyla I (Sheep, Goat, Deer, or Pig)	1	1.1					0.07	0.8
Order Artiodactyla II (Sheep, Goat, or Deer)	6	6.6					1.13	12.9
Sus scrofa (Domestic Pig)	16	17.6	1	10.0	100.0	8.6	1.38	15.8
Odocoileus virginianus (White-Tailed Deer)	5	5.5	1	10.0	100.0	8.6	0.81	9.2
Bos taurus (Domestic Cow)	12	13.2	1	10.0	400.0	34.6	3.51	40.1
cf. *Bos taurus* (Domestic Cow)	1	1.1					0.19	2.2
Ovis aries/Capra hircus (Domestic Sheep or Goat)	1	1.1	1	10.0	35.0	3.0	0.02	0.3
Fish	11	12.1	1	10.0	4.8	0.4	0.06	0.7
Reptiles/Amphibians	2	2.2	1	10.0	0.0	0.0	0.00	0.0
Turtles	0	0.0						
Wild Birds	2	2.2	1	10.0	7.5	0.6	0.15	1.7
Wild Mammals	6	6.6	2	20.0	600.0	51.9	1.32	15.1
Domestic Birds	2	2.2	1	10.0	2.5	0.2	0.05	0.6
Domestic Mammals	30	33.0	3	30.0	535.0	46.2	5.10	58.2
Commensals	0	0.0						
Wild	21	23.1	5	50.0	612.3	52.9	1.53	17.5
Domestic	32	35.2	4	40.0	537.5	46.5	5.15	58.8
Identified	50	54.9	9	90.0	1156.8	100.0	7.90	90.2
Unidentified	41	45.1	1	10.0			0.86	9.8
Totals	91	100.0	10	100.0	1156.8	100.0	8.76	100.0

Table 17.
Jamestown, Ditch 6
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Class Osteichthyes (Bony Fish)	3	1.8					0.01	0.1
Family Ictaluridae (Freshwater Catfish)	1	0.6	1	12.5	2.0	0.3	0.01	0.1
Class Aves (Bird)	1	0.6					0.02	0.1
Branta canadensis (Canada Goose)	1	0.6	1	12.5	6.0	0.9	0.05	0.4
Aythya spp. (Pochard)	1	0.6	1	12.5	1.0	0.2	0.01	0.1
Gallus gallus (Chicken)	1	0.6	1	12.5	2.5	0.4	0.01	<0.1
Class Mammalia (Mammal)	49	29.3					0.45	3.6
Class Mammalia I (Large Mammal)	30	18.0					1.86	14.9
Class Mammalia II (Medium Mammal)	25	15.0					0.82	6.6
Class Mammalia III (Small Mammal)	8	4.8					0.13	1.0
Order Artiodactyla II (Sheep, Goat, or Deer)	2	1.2					0.06	0.5
Sus scrofa (Domestic Pig)	17	10.2	1	12.5	100.0	15.5	1.82	14.6
Odocoileus virginianus (White-Tailed Deer)	2	1.2	1	12.5	100.0	15.5	0.75	6.0
Bos taurus (Domestic Cow)	19	11.4	1	12.5	400.0	61.9	4.88	39.3
cf. *Bos taurus* (Domestic Cow)	4	2.4					1.31	10.6
Ovis aries/Capra hircus (Domestic Sheep or Goat)	3	1.8	1	12.5	35.0	5.4	0.26	2.1
Fish	4	2.4	1	12.5	2.0	0.3	0.02	0.2
Reptiles/Amphibians	0	0.0						
Turtles	0	0.0						
Wild Birds	2	1.2	2	25.0	7.0	1.1	0.06	0.5
Wild Mammals	2	1.2	1	12.5	100.0	15.5	0.75	6.0
Domestic Birds	1	0.6	1	12.5	2.5	0.4	0.01	0.1
Domestic Mammals	43	25.7	3	37.5	535.0	82.8	8.27	66.4
Commensals	0	0.0						
Wild	8	4.8	4	50.0	109.0	16.9	0.83	6.7
Domestic	44	26.3	4	50.0	537.5	83.1	8.28	66.5
Identified	51	30.5	8	100.0	646.5	100.0	9.16	73.6
Unidentified	116	69.5					3.29	26.4
Totals	167	100.0	8	100.0	646.5	100.0	12.45	100.0

Table 18.
Jamestown, Midden 1
Summary of Faunal Remains

	NISP		MNI		Meat Weight		Biomass	
	No.	Pct.	MNI	Pct.	Lbs.	Pct.	Kg	Pct.
Order Lamniformes (Typical Shark)	1	0.1	1	3.3	160.0	6.3	0.00	0.0
Class Osteichthyes (Bony Fish)	42	2.6					0.14	0.1
Acipenser spp. (Sturgeon)	3	0.2	1	3.3	100.0	4.0	0.12	0.1
Lepisosteus spp. (Gar)	1	0.1	1	3.3	5.0	0.2	0.01	<0.1
Family Ictaluridae (Freshwater Catfish)	13	0.8	3	10.0	6.0	0.2	0.10	0.1
Perca flavescens (Yellow Perch)	1	0.1	1	3.3	1.0	<0.1	0.01	<0.1
Family Percichthyidae (Temperate Bass)	1	0.1	1	3.3	1.0	<0.1	<0.01	<0.1
Morone americana (White Perch)	1	0.1	1	3.3	1.0	<0.1	<0.01	<0.1
Morone saxatilis (Striped Bass)	1	0.1	1	3.3	7.5	0.3	0.01	<0.1
Chelydra serpentina (Snapping Turtle)	6	0.4	1	3.3	10.0	0.4	0.15	0.2
Family Cheloniidae (Marine Turtle)	1	0.1	1	3.3	1.6	0.1	1.44	1.5
Class Aves (Bird)	16	1.0					0.17	0.2
Class Aves/Mammalia III (Bird/Small Mammal)	41	2.5					0.19	0.2
Goose spp. (Goose)	2	0.1					0.02	<0.1
Branta canadensis (Canada Goose)	1	0.1	1	3.3	6.0	0.2	0.21	0.2
cf. *Branta canadensis* (Canada Goose)	1	0.1					0.03	<0.1
Duck spp. (Duck)	2	0.1	1	3.3	2.0	0.1	0.01	<0.1
Gallus gallus (Chicken)	9	0.6	2	6.7	5.0	0.2	0.11	0.1
Class Mammalia (Mammal)	290	17.8					2.79	2.9
Class Mammalia I (Large Mammal)	145	8.9					11.03	11.3
Class Mammalia II (Medium Mammal)	453	27.9					9.73	10.0
Class Mammalia III (Small Mammal)	42	2.6					0.46	0.5
Didelphis virginiana (Opossum)	1	0.1	1	3.3	8.0	0.3	0.01	<0.1
Castor canadensis (Beaver)	1	0.1	1	3.3	25.0	1.0	0.05	0.1
Rattus rattus (Roof Rat)	1	0.1					<0.01	<0.1
cf. Family Delphinidae (Ocean Dolphins)	4	0.2	1	3.3	500.0	16.5	0.77	0.8
Order Artiodactyla I (Sheep, Goat, Deer, or Pig)	3	0.2					0.17	0.2
Order Artiodactyla II (Sheep, Goat, or Deer)	9	0.6					0.52	0.5
Sus scrofa (Domestic Pig)	268	16.5	4	13.3	400.0	15.9	17.78	18.3
cf. *Sus scrofa* (Domestic Pig)	16	1.0					1.89	1.9
Odocoileus virginianus (White-Tailed Deer)	11	0.7	1	3.3	100.0	4.0	1.46	1.5
cf. *Odocoileus virginianus* (White-Tailed Deer)	2	0.1					0.06	0.1
Bos taurus (Domestic Cow)	196	12.1	4	13.3	1600.0	63.5	41.80	43.0
cf. *Bos taurus* (Domestic Cow)	23	1.4					4.32	4.4
Bos taurus (Calf) (Domestic Cow (Calf))	1	0.1	1	3.3	50.0	2.0	0.22	0.2
Ovis aries/Capra hircus (Domestic Sheep or Goat)	11	0.7	1	3.3	35.0	1.4	1.01	1.0
cf. *Ovis aries/Capra hircus* (Domestic Sheep or Goat)	3	0.2					0.30	0.3
Bos taurus/*Equus* sp. (Domestic Cow, Horse, or Ass)	2	0.1					0.12	0.1
Fish	64	3.9	10	33.3	281.5	9.3	0.40	0.4
Reptiles/Amphibians	0	0.0						
Turtles	7	0.4	2	6.7	11.6	0.4	1.59	1.6
Wild Birds	2	0.1	1	3.3	6.0	0.2	0.24	0.2
Wild Mammals	19	1.2	4	13.3	633.0	20.9	2.35	2.4
Domestic Birds	9	0.6	2	6.7	5.0	0.2	0.11	0.1
Domestic Mammals	518	31.9	10	33.3	2085.0	69.0	67.32	69.2
Commensals	1	0.1						
Wild	92	5.7	17	56.7	932.1	30.8	4.58	4.7
Domestic	527	32.4	12	40.0	2090.0	69.1	67.43	69.4
Identified	596	36.7	30	100.0	3034.1	100.0	72.72	74.8
Unidentified	1029	63.3					24.51	25.2
Totals	1625	100.0	30	100.0	3034.1	100.0	97.23	100.0

Appendix C. Kill-Off Data

Table 19.
Jamestown, Pit 1
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	**Fused**	**Not Fused**
Age of Fusion - 0 to 12 Months		
Scapula	1	1
Innominate	0	0
Humerus - distal	0	2
Radius - proximal	0	0
Second phalange - proximal	0	0
	1	3
Percent of Age Range	25.0%	75.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	1
First phalange - proximal	0	0
Tibia - distal	1	4
	1	5
Percent of Age Range	16.7%	83.3%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	1
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=11; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 20.
Jamestown, Pit 3, Sequence A
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	1
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 21.
Jamestown, Pit 3, Sequence B
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	2
Femur - distal	1	1
Tibia - proximal	0	0
Fibula – proximal	0	2
	1	5
Percent of Age Range	16.7%	83.3%

N=7; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 22.
Jamestown, Bulwark Ditch, Sequences A, B, and C
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 23.
Jamestown, Bulwark Ditch, Sequence D
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	1	0
Humerus - distal	0	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 24.
Jamestown, Ditch 7
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	1
Metatarsal - distal	0	0
Fibula - distal	0	0
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 25.
Jamestown, Ditch 6
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	0	0
Humerus - distal	1	0
Radius - proximal	0	0
Second phalange - proximal	0	0
	2	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	0
First phalange - proximal	0	0
Tibia - distal	0	1
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	1	0
Metatarsal - distal	0	0
Fibula - distal	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	1
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	0	1
	0	2
Percent of Age Range	0.0%	100.0%

N=6; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 26.
Jamestown, Midden 1
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	**Fused**	**Not Fused**
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	4	0
Humerus - distal	3	1
Radius - proximal	0	1
Second phalange - proximal	5	1
	13	3
Percent of Age Range	81.3%	18.8%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	3
First phalange - proximal	0	0
Tibia - distal	1	5
	1	8
Percent of Age Range	11.1%	88.9%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	3
Metatarsal - distal	2	1
Fibula - distal	0	0
	2	4
Percent of Age Range	33.3%	66.7%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	1
Radius - distal	3	0
Ulna - proximal	0	2
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	1	2
	4	5
Percent of Age Range	44.4%	55.6%

N=40; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 27.
Jamestown, Pit 1
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 28.
Jamestown, Pit 3, Sequence A
Age Distribution Based on Epiphyseal Fusion
Bos taurus (Domestic Cow)

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 29.
Jamestown, Pit 3, Sequence B
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	**Fused**	**Not Fused**
Age of Fusion - 0 to 12 Months		
Scapula	2	0
Innominate	1	0
	3	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	2	0
Radius - proximal	1	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	3	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	1	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	1
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	1	1
Percent of Age Range	50.0%	50.0%

N=8; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 30.
Jamestown, Bulwark Ditch, Sequences A, B, and C
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 31.
Jamestown, Bulwark Ditch, Sequence D
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 32.
Jamestown, Ditch 7
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 33.
Jamestown, Ditch 6
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	0
Innominate	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Radius - distal	0	1
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Calcaneus	0	0
	0	1
Percent of Age Range	0.0%	100.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 34.
Jamestown, Midden 1
Age Distribution Based on Epiphyseal Fusion
***Bos taurus* (Domestic Cow)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	0	1
Innominate	8	0
	8	1
Percent of Age Range	88.9%	11.1%
Age of Fusion - 12 to 24 Months		
Humerus - distal	0	0
Radius - proximal	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	6	0
	6	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 24 to 36 Months		
Metacarpal - distal	1	0
Tibia - distal	2	0
Metatarsal - distal	1	0
Metapodial - distal	0	0
	4	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 36 to 48 Months		
Humerus - proximal	0	0
Ulna - proximal	0	1
Ulna - distal	0	0
Radius - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	2
Calcaneus	4	4
	4	7
Percent of Age Range	36.4%	63.6%

N=30; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 35.
Jamestown, Pit 1
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	2	0
Humerus - distal	0	0
Radius - proximal	0	0
	2	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=2; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979

Table 36.
Jamestown, Pit 3, Sequence A
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	1
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 37.
Jamestown, Pit 3, Sequence B
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	**Fused**	**Not Fused**
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
Percent of Age Range	0 0.0%	0 0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
Percent of Age Range	0 0.0%	0 0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Percent of Age Range	0 0.0%	0 0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 38.
Jamestown, Bulwark Ditch, Sequences A, B, and C
Age Distribution Based on Epiphyseal Fusion
Ovis aries/Capra hircus (Domestic Sheep/Goat)

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 39.
Jamestown, Bulwark Ditch, Sequence D
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 40.
Jamestown, Ditch 7
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	**Fused**	**Not Fused**
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 41.
Jamestown, Ditch 6
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	0	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=0; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 42.
Jamestown, Midden 1
Age Distribution Based on Epiphyseal Fusion
***Ovis aries/Capra hircus* (Domestic Sheep/Goat)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 6 to 10 Months		
Scapula	0	0
Innominate	0	0
Humerus - distal	0	0
Radius - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%
Age of Fusion - 12 to 36 Months		
Ulna - proximal	0	0
Ulna - distal	1	0
Metacarpal - distal	0	0
Femur - proximal	0	0
Tibia - distal	0	0
Metatarsal - distal	0	0
Metapodial - distal	0	0
Calcaneus	0	0
First Phalange - proximal	0	0
Second Phalange - proximal	0	0
	1	0
Percent of Age Range	100.0%	0.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
	0	0
Percent of Age Range	0.0%	0.0%

N=1; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 43.
Jamestown, Combined Data for Pit 1, Pit 3, and the Bulwark Ditch
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	2	2
Innominate	0	0
Humerus - distal	0	2
Radius - proximal	0	0
Second phalange - proximal	0	0
	2	4
Percent of Age Range	33.3%	66.7%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	1
First phalange - proximal	0	0
Tibia - distal	1	4
	0	5
Percent of Age Range	16.7%	83.3%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	0
Metatarsal - distal	0	0
Fibula - distal	0	1
	0	1
Percent of Age Range	0.0%	100.0%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	0
Radius - distal	0	0
Ulna - proximal	0	0
Ulna - distal	0	0
Femur - proximal	0	2
Femur - distal	1	1
Tibia - proximal	0	0
Fibula – proximal	0	2
	1	5
Percent of Age Range	16.7%	83.3%

N=19; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Table 44.
Jamestown, Combined Data for Ditch 7, Ditch 6, and Midden 1
Age Distribution Based on Epiphyseal Fusion
***Sus scrofa* (Domestic Pig)**

Bone and Epiphysis	Fused	Not Fused
Age of Fusion - 0 to 12 Months		
Scapula	1	0
Innominate	4	0
Humerus - distal	3	1
Radius - proximal	0	1
Second phalange - proximal	5	1
	13	3
Percent of Age Range	81.3%	18.8%
Age of Fusion - 12 to 24 Months		
Metacarpal - distal	0	3
First phalange - proximal	0	0
Tibia - distal	1	6
	1	9
Percent of Age Range	10.0%	90.0%
Age of Fusion - 24 to 30 Months		
Calcaneus	0	4
Metatarsal - distal	2	1
Fibula - distal	0	0
	2	5
Percent of Age Range	28.6%	71.4%
Age of Fusion - 36 to 42 Months		
Humerus - proximal	0	1
Radius - distal	3	1
Ulna - proximal	0	2
Ulna - distal	0	0
Femur - proximal	0	0
Femur - distal	0	0
Tibia - proximal	0	0
Fibula – proximal	1	3
	4	7
Percent of Age Range	36.4%	63.6%

N=44; Source of Fusion Ages: Silver 1963; Chaplin 1971; Maltby 1979.

Appendix D. Element Distributions

Table 45.
Jamestown, Pit 1
Element Distribution

	Head		**Body**		**Feet**		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	0	0.0	11	64.7	6	35.3	17
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	3	11.5	17	65.4	6	23.1	26
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	4	100.0	0	0.0	0	0.0	4
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	
Goat	0	0.0	5	100.0	0	0.0	5
Goat Normal		**29.7**		**42.2**		**28.1**	

Table 46.
Jamestown, Pit 3, Sequence A
Element Distribution

	Head		**Body**		**Feet**		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	0	0.0	2	100.0	0	0.0	2
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	1	16.7	5	83.3	0	0.0	6
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	0	0.0	0	0.0	1	100.0	1
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 47.
Jamestown, Pit 3, Sequence B
Element Distribution

	Head		**Body**		**Feet**		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	3	8.6	31	88.6	1	2.9	35
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	7	21.2	21	63.6	5	15.2	33
Pig Normal		**28.2**		**34.5**		**37.3**	

Table 48.
Jamestown, Bulwark Ditch, Sequences A, B, and C
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	0	0.0	0	0.0	1	100.0	1
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	2	33.3	4	66.7	0	0.0	6
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	1	50.0	1	50.0	0	0.0	2
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 49.
Jamestown, Bulwark Ditch, Sequence D
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	0	0.0	3	100.0	0	0.0	3
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	8	57.1	6	42.9	0	0.0	14
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	1	100.0	0	0.0	0	0.0	1
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 50.
Jamestown, Ditch 7
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	4	30.8	7	53.8	2	15.4	13
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	11	68.8	3	18.8	2	12.5	16
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	1	100.0	0	0.0	0	0.0	1
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 51.
Jamestown, Ditch 6
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	8	34.8	8	34.8	7	30.4	23
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	4	23.5	7	41.2	6	35.3	17
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	3	100.0	0	0.0	0	0.0	3
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 52.
Jamestown, Midden 1
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	61	27.9	94	42.9	64	29.2	219
Cow Normal		**29.7**		**42.2**		**28.1**	
Calf	0	0.0	0	0.0	1	100.0	1
Calf Normal		**29.7**		**42.2**		**28.1**	
Pig	130	45.8	97	34.2	57	20.1	284
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	7	50.0	1	7.1	6	42.9	14
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Table 53.
Jamestown, Combined Data for Pit 1, Pit 3, and the Bulwark Ditch
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	3	5.3	45	80.4	8	14.3	56
Cow Normal		**29.7**		**42.2**		**28.1**	
Pig	20	25.0	48	61.0	11	14.0	79
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	2	100.0	6	0.0	0	0.0	8
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	
Goat	0	0.0	5	100.0	0	0.0	5
Goat Normal		**29.7**		**42.2**		**28.1**	

Table 54.
Jamestown, Combined Data for Ditch 6, Ditch 7, and Midden 1
Element Distribution

	Head		Body		Feet		
	No.	**%**	**No.**	**%**	**No.**	**%**	**NISP**
Cow	73	28.6	109	42.7	73	28.6	255
Cow Normal		**29.7**		**42.2**		**28.1**	
Calf	0	0.0	0	0.0	1	100.0	1
Calf Normal		**29.7**		**42.2**		**28.1**	
Pig	145	46.0	107	34.0	65	20.0	317
Pig Normal		**28.2**		**34.5**		**37.3**	
Sheep/Goat	11	61.1	1	5.5	6	33.3	18
Sheep/Goat Normal		**29.7**		**42.2**		**28.1**	

Appendix E. Bucthering Charts

Appendix F. Osteological Measurements

Note: UBNo=Unique bone number; measurement descriptions are from von den Dreisch (1976).

Jamestown
Osteological Measurements

UBNo	ER#	Taxon	Element	Description	Measurement (mm)
Pit 1					
1914	2H	*Sus scrofa*	Scapula	SLC	20.9
1935	2H	*Sus scrofa*	Innominate	SB	13.7
2613	3BS	*Sus scrofa*	Tibia	Bd	32.6
				SD	13.6
Pit 3(A)					
10376	124D	*Odocoileus virginianus*	Ulna	DPA	39.4
				BPC	20.4
Pit 3(B)					
11529	124J	*Bos taurus*	Radius	Bp	79.6
10798	124f	*Sus scrofa*	Scapula	SLC	24.2
10821	124F	*Sus scrofa*	Scapula	SLC	23.5
10797	124F	*Sus scrofa*	Ulna	DPA	35.9
				BPC	24.8
10795	124F	*Sus scrofa*	Femur	Bd	45.2
10051	81F	*Odocoileus virginianus*	Ulna	BPC	16.9
10783	124F	*Odocoileus virginianus*	Radius	Bp	41.1
				SD	26.7
10288	124F	*Odocoileus virginianus*	Innominate	LA	49.4
10801	124F	*Odocoileus virginianus*	Tibia	SD	24.3
Bulwark Ditch (C)					
3709	87C	*Odocoileus virginianus*	Ulna	LO	50.5
				SDO	31.7
				DPA	33.9
				BPC	19.5
3710	87C	*Odocoileus virginianus*	Radius	Bp	33.1
Bulwark Ditch (D)					
10017	81E	*Sus scrofa*	Mandible	16b	37.9
3729	81G	*Sus scrofa*	Innominate	LA	37.2
				LAR	32.5
10013	81E	*Ovis aries/Capra hircus*	Cranium	21	48.0
10032	81F	*Odocoileus virginianus*	Innominate	LA	35.9
10047	81F	*Odocoileus virginianus*	Metacarpal	Bp	29.4
				SD	17.5
				Bd	30.8
Ditch 7					
4090	83G	*Bos taurus*	Scapula	SLC	50.1
Ditch 6					
10311	124C	*Bos taurus*	Phalanx 1	GL	61.6
				Bp	28.7
				SD	25.3
				Bd	26.4

Jamestown
Osteological Measurements

UBNo	ER#	Taxon	Element	Description	Measurement (mm)
3397	83V	*Bos taurus*	Phalanx 1	GL	60.2
				Bp	28.9
				SD	24.9
				Bd	26.9
10308	124C	*Sus scrofa*	Scapula	SLC	19.6
10310	124C	*Sus scrofa*	Tibia	SD	19.0
10313	124C	*Sus scrofa*	Metapodial	Bp	16.2
10328	124C	*Sus scrofa*	Calcaneus	GL	91.2
				GB	22.8
10309	124C	*Ovis aries/Capra hircus*	Calcaneus	GB	23.1

Midden 1

UBNo	ER#	Taxon	Element	Description	Measurement (mm)
3496	93L	*Bos taurus*	Tibia	Bd	57.9
3007	93M	*Bos taurus*	Metacarpal	Bp	60.7
				SD	39.3
10167	93Q	*Bos taurus*	Metacarpal	Bd	54.9
3300	83Q	*Bos taurus*	Calcaneus	GB	39.6
16	39/4G	*Bos taurus*	Radius	BFp	71.0
3153	93N	*Bos taurus*	Phalanx 1	GL	62.4
				Bp	28.8
				SD	25.1
				Bd	29.1
3083	93N	*Bos taurus*	Phalanx 1	GL	60.4
				Bp	32.6
				SD	29.1
				Bd	30.4
3144	93N	*Bos taurus*	Phalanx 1	GL	64.6
67	39/4H	*Bos taurus*	Phalanx 1	Bp	28.3
				SD	26.3
				Bd	26.2
3291	93N	*Bos taurus*	Phalanx 1	GL	62.4
				Bp	29.7
				SD	27.7
				BD	26.1
10125	93L	*Bos taurus*	Phalanx 2	GL	40.5
				Bp	32.4
				SD	26.5
3203	93K	*Bos taurus*	Phalanx 2	GL	42.4
				Bp	31.2
				SD	25.3
				Bd	25.5
10232	124B	*Bos taurus*	Phalanx 2	GL	38.3
				Bp	26.9
				SD	23.5
				Bd	23.7
3148	93N	*Bos taurus*	Phalanx 2	GL	40.8
				Bp	29.8
				SD	24.0
				Bd	24.4
3418	93G	*Bos taurus*	Phalanx 3	DLS	72.1
				Ld	59.1
				MBS	24.9

Jamestown
Osteological Measurements

UBNo	ER#	Taxon	Element	Description	Measurement (mm)
10242	124B	*Bos taurus*	Phalanx 3	DLS	83.8
				Ld	61.7
				MBS	27.7
3527	93L	*Bos taurus*	Phalanx 3	DLS	59.7
				MBS	19.6
3154	93N	*Bos taurus*	Phalanx 3	DLS	65.4
				MBS	23.8
10301	124B	*Sus scrofa*	Scapula	SLC	19.8
3205	93K	*Sus scrofa*	Scapula	SLC	26.2
3101	93N	*Sus scrofa*	Scapula	SLC	16.1
3498	93L	*Sus scrofa*	Ulna	SDO	18.9
				DPA	38.6
3156	93L	*Sus scrofa*	Radius	Bp	27.7
				SD	15.9
10117	93Q	*Sus scrofa*	Radius	SD	16.7
3152	93N	*Sus scrofa*	Humerus	Bd	40.1
				SD	16.4
3191	93K	*Sus scrofa*	Humerus	Bd	39.3
3250	93K	*Sus scrofa*	Innominate	LA	32.6
				LAR	30.2
3287	83P	*Sus scrofa*	Femur	SD	22.2
3511	93L	*Sus scrofa*	Tibia	SD	20.1
3345	93P	*Sus scrofa*	Astragalus	GLl	41.8
				GLm	39.3
				Dl	21.2
				Bd	25.8
3460	93L	*Sus scrofa*	Calcaneus	GB	22.2
10147	93N	*Sus scrofa*	Calcaneus	GB	19.8
3253	93K	*Sus scrofa*	Calcaneus	GB	24.4
10305	124B	*Sus scrofa*	Metapodial	GL	92.7
				Bp	17.1
				B	14.6
				Bd	17.8
3206	93K	*Sus scrofa*	Metapodial	Bp	20.4
				B	16.9
3252	93K	*Sus scrofa*	Metapodial	Bp	16.7
3489	93L	*Sus scrofa*	Metapodial	Bp	15.4
10292	124B	*Sus scrofa*	Metapodial	Bp	13.8
3004	93M	*Sus scrofa*	Metapodial	Bp	14.9
				B	15.4
10153	93N	*Sus scrofa*	Metapodial	Bp	14.9
3490	93L	*Sus scrofa*	Metapodial	Bp	14.9
10202	124B	*Sus scrofa*	Phalanx 1	SD	12.6
				Bd	14.2
10274	124B	*Sus scrofa*	Phalanx 1	GLpe	38.7
				Bp	15.0
				SD	11.9
				Bd	14.4
3493	93L	*Sus scrofa*	Phalanx 1	SD	12.5
				Bd	14.9

Jamestown
Osteological Measurements

UBNo	ER#	Taxon	Element	Description	Measurement (mm)
10102	83M	*Sus scrofa*	Phalanx 2	GL	23.2
				Bp	17.0
				SD	14.6
				Bd	15.8
10289	124B	*Sus scrofa*	Phalanx 2	SD	13.5
				Bd	16.1
3487	93L	*Sus scrofa*	Phalanx 2	GL	22.6
				Bp	15.4
				SD	14.6
				Bd	16.5
3123	93N	*Sus scrofa*	Phalanx 3	DLS	31.8
				Ld	27.9
				MBS	12.6
10127	93L	*Sus scrofa*	Phalanx 3	GL	22.6
				Bp	15.4
				SD	14.6
				Bd	16.5
3485	93L	*Ovis aries/Capra hircus*	Cranium	22	25.0
3499	93L	*Ovis aries/Capra hircus*	Metacarpal	Bp	25.2
				SD	14.7