COASTAL WEEDEN ISLAND SUBSISTENCE ECONOMY AND OCCUPATION: A ZOOARCHAEOLOGICAL ANALYSIS OF STRANGE'S RING MIDDEN (8By1355), BAY COUNTY, FLORIDA

by

MARAN ELAINE LITTLE

(Under the Direction of Elizabeth J. Reitz)

ABSTRACT

Subsistence economy, occupation, and seasonality of sites have been major research trajectories for many coastal southeastern sites. A unit was excavated at Strange's Ring Midden (8By1355) in Bay County, Florida in order to further investigate these subjects. The site is part of a Weeden Island village complex located on an expansive estuarine bay system. Most village sites in this area and time period seem to be year-round occupations with mixed resource acquisition strategies. The zooarchaeological remains recovered from the excavation show that the occupants of the site practiced a mixed subsistence strategy with an emphasis on resource location instead of resource type. Occupation of the Strange's site during this period is at least multi-seasonal if not year-round.

INDEX WORDS: zooarchaeology, Florida Gulf Coast, subsistence, ring midden

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MARAN ELAINE LITTLE

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MARAN ELAINE LITTLE

Major Professor:	Elizabeth J. Reitz
Committee:	Jennifer Birch
	Laurie Reitsema

Electronic Version Approved:

Julie Coffield
Dean of the Graduate School
The University of Georgia
April 2015

DEDICATION

This work is dedicated to my maternal grandfather, William David McKillip, Ed.D. His fascination with archaeology and his passion for sharing it with his weird little granddaughter has stayed with me all of my life.

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CHAPTER ONE: INTRODUCTION

INTRODUCTION

Studies of subsistence economies, settlement patterns, and seasonality of resource use are major research trajectories for many coastal southeastern sites (Cook 2013, Reitz et al. 2013, Thompson and Turck 2010). Resource use and occupation scheduling of villages varies widely throughout the Weeden Island cultural area (Milanich 2002:160), which includes parts of southern Alabama, Georgia, and northwest Florida (Figure 1). Much of this variation is rooted in coastal versus inland occupations, but even within coastal sites a wide range of lifeways are represented. However, most village sites in this area and time period seem to be year-round occupations with mixed resource acquisition strategies evident. This thesis is focused on the Strange's Ring Midden site (8By1355), a component of a larger settlement on the Gulf Coast of northwest Florida.

Strange's Ring Midden is a component of one of several Weeden Island phase (Table 1) occupations on a 30-km long peninsula in northwest Florida (Figure 2). The site is located between a large estuarine bay system and the Gulf of Mexico. Northwest Florida is defined as "the panhandle west of the Aucilla River" (Milanich 2002:357). Located near the present-day town of Mexico Beach, the Strange's site is on Tyndall Air Force Base (TAFB) and has been investigated most recently by the National Park Service's Southeastern Archeological Center (SEAC). The ring midden is part of a small Late Woodland-period occupation which also includes a burial mound (8By26) and a largely ceramic artifact scatter (Figure 3). When discussing the entire village complex, the term “the Strange’s site” refers to the occupation as a whole as opposed specifically to the Strange’s Ring Midden site.

The people inhabiting the Strange’s site had established the occupation by at least A.D. 600, but possibly up to a century earlier. While the assemblage discussed in this thesis can reliably be dated to the Late Woodland period, the Strange’s site was occupied for a long period, and through multiple cultural “events”. The village was constructed in a circular pattern with an open central plaza similar to the earlier Swift Creek peoples of the area, suggesting that they may have been direct descendants as opposed to migrants from another region (Russo et al. 2011:124).

Strange’s Ring Midden itself is a relatively uniform mix of utilitarian ceramics and kitchen debris, suggesting that its shape and distribution is a result of the discard of household refuse throughout the village as opposed to a purposefully constructed shell ring monument. The subsistence strategy used at the site is thought to include only those resources that could be acquired from the surrounding area in each season, with no evidence of farming present. While there are areas of higher artifact concentration within the ring, these are interpreted as activity or higher usage areas rather than of a hierarchical distribution of resources; however, more investigation of the site as a whole is needed to gain a more complete picture of the site’s social structure (Russo et al. 2011:125).

There are at least five other sites similar to Strange’s on the peninsula (i.e., burial mound adjacent to ring-shaped village with midden) occupied around the same period of time. While it is not possible to prove absolute contemporaneity of habitation at these sites, it is possible that they represent a moiety, a type of extended kin group into which a tribe or community is divided (Driver 1969:247). Different sections of a moiety community may display specialization or preference different to that of the other members, which may explain some of the intra-site differences discussed in Chapter Five.

In-depth zooarchaeological analysis has not been attempted at most coastal Weeden Island sites due to general time and budgetary constraints; however, such research is integral to the interpretation of these coastal communities. Although both lithic and ceramic artifacts were recovered from the unit reported here, my analysis focuses on the invertebrate and vertebrate faunal remains. The analysis completed for this thesis targets two main research topics: (1) the subsistence economy during this period at the Strange's site, including the diversity/equitability of species represented and procurement strategies, and (2) evidence for the theory that the Woodland Gulf Coast was an environment in which these strategies fostered residence on more than a strictly seasonal basis.

Throughout the text, I use a number of terms to describe specific environments in the area adjacent to Strange's Ring Midden, including estuarine, marine, freshwater, and terrestrial biomes. These are described in more detail in Chapter Two.

The zooarchaeology research tests a number of hypotheses. These hypotheses and their implications are presented as follows:

Hypothesis 1

H_1: Invertebrate and vertebrate analysis will indicate a reliance on both taxonomic groups.

H_0: Invertebrate and vertebrate analysis will indicate a strong preference for one taxonomic group or the other.

Implications

I_1: A broad subsistence strategy was practiced at the site, with no evidence of either dietary or cultural bias for mollusc or vertebrate use.

I_2: A narrow subsistence strategy was implemented, with potential evidence of some level of resource choice bias.

Hypothesis 2

$H_{1:}$ Data analysis from MNI and biomass estimates will show preferential use of certain animals over others.

$H_{0:}$ No evidence of preferential use of certain animals will be evident.

Implications

I_1: Focus on specific taxa over others suggests some level of a targeted subsistence strategy involving “staple” resources and “incidental” resources.

I_2: No evident focus suggests that no obvious strategy for resource acquisition was implemented at the site.

Hypothesis 3

H_1: Analysis of the preferential habitats of groups of animals will show primary use of groups of taxa based on their preferred environment.

H_0: No evidence for preferential use of groups of taxa based on environmental preference will be evident.

Implications

I_1: Focus on specific groups of taxa suggests preferential use of certain biomes (i.e. estuary over marine).

I_2: No evident targeting of specific environments suggest that all biomes were evenly exploited.

Hypothesis 4

H_1: Analysis of the element distribution of white-tailed deer (*Odocoileus virginianus*) will show presence of both high- (Forequarter, Hindquarter) and low-utility portions of the carcass (Head, Feet).

H_0: Only high-utility portions or low-utility portions of the carcass will be present.

Implications

I_1: Elements from all carcass portions indicate that the entire animal was brought back to the site for processing and deer were likely obtained locally.

1_2: Element distribution from either only high- or only low-utility portions indicates specialized use.

Hypothesis 5

H_1: Diversity, equitability, richness, and trophic level estimates will provide evidence for a wide range of taxa exploited, but with certain taxa targeted over others.

H_0: Diversity and equitability estimates will indicate a narrow range of taxa exploited evenly.

Implications

I_1: A mixed subsistence strategy of low-yield/high-reliability resources (i.e., oyster) and high-yield/low-reliability resources (i.e., deer) was implemented.

I_2: A narrow subsistence strategy focusing on one type of resource was implemented.

Hypothesis 6

H_1: A wide range of gathering/fishing/hunting technologies were used to procure both invertebrate and vertebrate faunal resources.

H_0: A limited number of resource procurement strategies were implemented.

Implications

I_1: Using a wide range of procurement technologies allow for the use of many different groups of taxa and biomes.

I_2: A limited number of strategies will limit the resources acquired to specific types.

Hypothesis 7

H_1: Taxa recovered from the site will represent the same suite of taxa extant in the area today.

H_0: Taxa recovered from the site will be markedly different from those in the area now.

Implications

I_1: The environment surrounding the site has not changed significantly enough to disrupt the species composition.

I_2: The environment surrounding the site has changed significantly since the Woodland period.

Hypothesis 8

$H_{1:}$ Seasonal indicator taxa will indicate site use either during specific seasons of the year or evidence for year-round occupation.

H_0: No seasonal indicator taxa will be present.

Implications

I_1: Seasonality of site occupation will be observed.

I_2: Seasonality of site occupation will not be observed.

These hypotheses provide a framework to test and interpret the zooarchaeological data from Strange's Ring Midden, and make inferences about the lifeways of the occupants of similar sites. Many of these questions are unanswerable through other avenues of research. Although the site has been extensively studied by various individuals and institutions, zooarchaeological analysis provides invaluable understanding of how the site was used by the people living there.

I expect most results to conform to the primary hypothesis. Seasonal occupation and resource use have been investigated in this general area numerous times with the same general results: most village sites in this area and time period seem to be year-round occupations with mixed resource acquisition strategies evident. The only hypothesis for which I expect to see a null result is Hypothesis 8, since, as stated, strictly seasonal camps in this time and place seem to be the exception, not the rule (Russo et al. 2009). In particular, village complexes like the Strange's site, which includes a burial mound, would not be a transitory encampment, but a place where people had set down roots, at least enough to have a monument in which to inter their dead. This is not a marker of a seasonal fishing/gathering camp, but of a year-round settlement.

PREVIOUS ARCHAEOLOGICAL RESEARCH

The burial mound at the Strange's site was first excavated by Clarence Bloomfield Moore during his tour of Florida archaeological sites in 1902 (Russo et al. 2011:31). A trench was dug through the eastern side of the mound to avoid a previously dug "looters' trench." The artifacts Moore reported were primarily whole ceramic vessels and effigy figures, items he perceived as "high status" grave goods. Five burials also were recorded from within the mound, two of which were topped with a layer of oyster shells (Moore 1999:192-198). Willey's (1949) typology of Moore's collected artifacts placed mound construction and use in the Weeden Island phase.

Although some survey work was conducted in the late 1970s by Gary Knudsen, systematic surveys and extensive excavations were not initiated until 2003 when SEAC was contracted by Tyndall Air Force Base to assess the number and size of archaeological sites located on the property. Surveys and excavations have been ongoing at the Strange's site since that time, as well as at other sites located on the large base. GPR (ground penetrating radar) and electrical resistance surveys of the area west of Strange's Bayou were conducted in conjunction with Victor Thompson's 2007 field school with the University of West Florida. These surveys identified several slight rises or "midden mounds" in the area, but found no suggestion of subsurface features such as structures or additional burials (Thompson and Laracuente 2007).

More recent SEAC excavations of the Strange's site included intensive shovel testing covering a large portion of the Ring Midden and ceramic scatter, and more limited testing near the burial mound. In areas with high artifact density, 170 shovel tests and 6 1-x-1 m excavation units were dug into the Ring Midden (Russo et al. 2011:57). Despite the fact that many of these contained faunal artifacts, identification to species was conducted on the 1/4-in fraction of only one of the shovel tests (ST44) due to time constraints. As will be discussed in Chapter Three, the screen size used, though appropriate for the scope of the project, adds an additional layer of bias.

Strange's Ring Midden is unique in that it is one of the least-disturbed sites of its kind in this area of Florida. This offers an opportunity to test various zooarchaeological methods and for additional analysis to contribute to the interpretation of the Strange's site. Although the site has been studied by several groups, in-depth zooarchaeological analysis has not been possible up to this point. How the occupants of the Strange's site adapted to both the natural and cultural environment of the area is an important research trajectory which adds further dimensions to our understanding of coastal Weeden Island occupations in northwest Florida.

CHAPTER TWO: CULTURAL AND ENVIRONMENTAL CONTEXT

CULTURAL CONTEXT

Across its broad reach, people sharing the Weeden Island cultural complex varied widely, and "differed greatly in their use of other pottery, subsistence regimes, settlement patterns, and social complexities" (Milanich 1994:155). However, the middle and late Woodland periods in the northwestern portion of Florida seem to be characterized much more by stasis than by change. This stands in contrast to the larger regional trend of diverse environmental adaptations (Milanich 2002:354). In the northwest coastal region of Florida during this time there is little evidence of variation from directly previous periods in economy, subsistence strategies, and village organization. Much of the discrimination among Weeden Island phase sites in the cultural region is based on distribution and relative frequency of ceramic styles rather than on any concrete differences in social or cultural structure. The Swift Creek, Weeden Island I, and Weeden Island II phases are described in further detail below. Dates assigned to the phases follow those used by Russo et al. (2011).

Swift Creek

The Swift Creek phase dates from A.D. 0 – 400 (Russo et al. 2011:26), ending with a gradual shift from Swift Creek ceramic assemblages to Weeden Island assemblages (Milanich 1994:144). Swift Creek style ceramics, however, continue to be produced and used throughout the Southeast long after A.D. 400. Most coastal Swift Creek sites appear to conform to a similar pattern of village arrangement, with living areas bounded by either circular or horseshoe-shaped middens. Many villages have burial mounds associated with them. Subsistence economies at the sites located near tidal marsh zones appear to be almost entirely based on the environments directly adjacent to each site (Milanich 1994:145).

Weeden Island I

The dates of the Weeden Island I (A.D. 300 – 750) component overlap briefly with those of Swift Creek (Russo et al. 2011:28). Swift Creek and Weeden Island phases share many attributes. These include the continuation of an estuarine-based subsistence economy and the presence of shell rings composed mainly of oysters and marsh clams, accompanied by burial mounds. It is likely that these similarities represent a cultural continuum (Milanich 1994:166). Ceramic styles are generally one of the only markers distinguishing between Weeden Island I contexts and either antecedent Swift Creek or subsequent Weeden Island II (Wakulla) contexts.

Weeden Island II (Wakulla)

The appearance and subsequent dominance of the ceramic type known as Wakulla Check Stamped is the defining characteristic of the Weeden Island II phase (A.D. 750 – 1000) (Russo et al. 2011:28). During the late "terminal Woodland" period, habitation sites tend to be smaller in size but more numerous, often using different locations than sites from previous phases. Milanich (1994:152-154) argues that this may be a response to increasing population pressures and potentially greater competition and territoriality relating to coastal resources. The earliest presence of maize kernels also occurs during this phase at an inland site in the eastern panhandle directly east of the Apalachicola River (Milanich 2002:362).

ENVIRONMENTAL CONTEXT

Geology and Climate

Strange's Ring Midden is located in Bay County on the eastern end of a roughly 30-km-long peninsula in northwest Florida (Figure 2). Bay County is located in the central portion of the Florida panhandle and includes coastal as well as inland environments. The site borders East Bay, part of an expansive estuarine system near the present-day town of Mexico Beach. This region has experienced repeated advances and retreats of sea level since the Miocene epoch (Myers and Ewel 1990:106-107). Tidal activity is described as "low energy" and rarely reaches more than 0.5 m amsl (NOAA 2012). Soils on the southeastern portion of the peninsula are the Rutlege-Allanton-Pickney association. This association is characterized by broad, low, relatively flat areas with poor drainage closely associated with a wetland environment. Soil pH reactivity ranges from 4.5 to 6.0 (Duffee et al. 1984:58).

Climate in the research area is generally mild and humid. Average annual temperature in the area is 20.5°C and average annual rainfall is 147.3 cm (Bradley 1978:223). Although temperatures vary seasonally, the climatic pattern is similar throughout the panhandle. The dry season (October/November through May) displays a wider range of temperatures and low rainfall, while the wet season (June through September/October) displays more stable temperatures and high rainfall (Myers and Ewel 1990:13).

Several different types of environments are found near the Strange's site, and are broadly classified as: estuarine, marine, freshwater, and terrestrial. The estuarine bay system north of the Strange's site is technically a salt marsh, which "occupies intertidal zones and [is] at least occasionally inundated with salt water" (Myers and Ewel 1990:481). Salt marshes and estuaries have one of the highest net primary productivity levels of any environment (Myers and Ewel 1990; Whittaker 1975).

The portion of East Bay on which the Strange's site is located is approximately 20 km from the nearest saltwater inlet, at least today. It supports more pockets of low-salinity environments than do marshes closer to the Gulf itself. Dahlberg (1975) describes two zones within an estuary with accompanying salinity data. These include the lower reaches closer to the marine input, and middle and upper reaches farther from the marine input. The lower reaches have salinity levels averaging roughly 27‰ and water temperatures averaging around 20°C. The middle and upper reaches have salinity levels averaging between 5‰ and 21‰ and water temperatures averaging 21°C (Dahlberg 1975:113). Although these data are from the estuarine system of St. Catherine's Island on the southern Georgia coast, they are loosely comparable to the bay system studied for this thesis.

As used here, the marine environment is considered more or less strictly high salinity, characteristic of the Gulf of Mexico. Areas near the coast such as East Bay are occasionally inundated by freshwater, particularly runoff from rain, but they retain higher salinity levels due to tidal activity. In this case, I consider the "marine" area to be St. Andrew Sound and the Gulf of Mexico directly south of the peninsula.

Freshwater is technically described as water with no salinity. However, due to Florida's geology, most bodies of water are brackish to some degree (Reitz 2015, personal communication). Although several taxa described in this thesis are categorized as "freshwater" species, all can tolerate very low levels of salinity. It is likely that these low salinity environments are found in the many small tributaries and creeks which are a part of the East Bay system, and it is assumed that these taxa were acquired within these areas.

The terrestrial environment includes all areas back from the estuary and beyond the normal high tide; essentially, it includes all the surrounding "land" in the simplest terms. Many taxa are in this category, including box turtles, other reptiles, and all birds and mammals. While these species may have used or been acquired in the other environments (particularly estuarine), they require dry land for a significant portion of their life cycle.

Flora and Fauna

The vegetation present at the site today is dominated by water-tolerant species. Arboreal vegetation includes cypress (*Taxodium distichum*), pond pine (*Pinus serotina*), sweetbay (*Magnolia virginiana*), water oak (*Quercus nigra*), and blackgum (*Nyssa sylvatica).* Understory plants include native shrubs such as saw palmetto (*Serenoa repens*), wax myrtle (*Morella cerifera*), and gallberry (*Ilex coriacea*) (Myers and Ewel 1990:110 - 116). The modern vegetative community probably differs greatly from the vegetation during the occupation period of the site. It is thought that in the past, the area was chiefly longleaf pine (*Pinus palustris*), with magnolia (*Magnolia grandiflora*), hickory (*Carya* spp.), and oak (*Quercus* spp.) stands present in the hammocks (Braun 1950:283). Historic land clearing for logging and agriculture is the most likely reason these plant communities were so severely disrupted (Russo et al. 2011:21).

Anticipating the results reported here, the conjunction of terrestrial, marine, and estuarine environments observed in the area today also existed when the site was occupied. Common terrestrial mammal species include opossums (*Didelphis virginiana*), rabbits (*Sylvilagus* spp.), squirrels (*Sciurus* spp.), raccoons (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*). Prior to European contact, apex predators such as the black bear (*Ursus americanus*) and cougar (*Puma concolor*) may have been present in greater numbers. The area supports a large number of bird species, including ducks (*Aix* sp.; *Anas* spp.; *Aythya* spp.), bobwhite quails (*Colinus virginianus*), wild turkeys (*Meleagris gallopavo*), and many wading and song birds. Passenger pigeons (*Ectopistes migratorius*) were once common, but pronounced extinct in the wild in 1911 due to massive over-harvesting (Smith 2011:437). Of the many reptiles in the area, alligators (*Alligator mississippiensis*) and pond turtles (Emydidae) continue to be harvested for food now as in the past. There is also a relatively high concentration of both non-venomous (Colubridae) and venomous (Elapidae; Viperidae) snakes in the area.

The aquatic environments surrounding the Strange's site support a great many species of fishes. Common in the estuaries and the near-shore waters of the Gulf are sea catfishes (*Ariopsis felis, Bagre marinus*), mullets (*Mugil* spp.), sheepsheads (*Archosargus probatocephalus*), and pinfishes (*Lagodon rhomboides),* as well as numerous drums and croakers (Sciaenidae). Freshwater species include gars (Lepisostidae), bowfins (*Amia calva*), freshwater catfishes (Ictaluridae), and sunfishes (Centrarchidae). Although gars and freshwater catfishes will both venture into estuaries, their primary habitat is very low salinity freshwater. Because many of the "marine" fishes use estuaries as hatcheries and spend the early part of their life cycle in them, the estuarine/marine divide is porous. With marine fishes, a small individual captured is assumed to be from the estuary, while a full-sized adult is assumed to be a marine capture due to the nursery role of estuaries in the lifecycle of many fishes. Adult fishes will also sometimes return to the estuaries to feed on the young fishes.

Although there is a significant amount of variation within the Weeden Island cultural area as a whole, the Strange's site seems to be fairly consistent both in overall subsistence strategy and cultural attributes such as village organization and ceramic type assemblage. The driving force behind the differences between Strange's and adjacent sites is likely linked to the specific habitat and resources available in the area in which they are located. The zooarchaeological methods and analysis presented aim to confirm this inference.

CHAPTER THREE: METHODS AND MATERIALS

Strange's Ring Midden was chosen as a study site for several reasons. First and foremost, the relatively long period of occupation, from the middle Woodland into the late Woodland, lends a unique advantage for studying continuity and change in coastal lifeways in northwest Florida. Although the Strange's site has been studied extensively by several groups, particularly by the Southeastern Archeological Center, so far in-depth zooarchaeological analysis at this site or sites in the immediate area is rare. The excavation of another unit in the area with the express purpose of conducting zooarchaeological research begins to fill in the gaps in this area's archaeological record.

FIELD METHODS

Field work for this thesis was conducted in December 2012. The study site is bounded by large thickets of saw palmettos on the southern and western edges; however, the site boundaries are completely mapped (Russo et al. 2011). Firebreaks cut through the hammock have not disturbed the midden, and following them provided the most convenient path to the site. Once the site was located, a ground probe was used to search for an area of high shell density. The calcium carbonate which leaches into the soil from the shell aids in the preservation of vertebrate faunal remains (Claassen 1998:60; Reitz and Wing 2008:141). Probing was limited to areas of the ring adjacent to Thompson's 2007 datum. This survey area had a very large percentage of contiguous positive shovel tests with high artifact density (Russo 2012, personal communication).

Once a high shell density area was located in the southeast portion of the midden, a 1-x-1 m excavation unit (Figure 3) was opened. The unit was excavated in arbitrary 10 cm intervals until a sterile level was reached between 40-50 cmbd. A roughly 30-x-30 cm "shovel test" was excavated in the southwest corner of the unit to 90 cmbd to confirm that a sterile level had indeed been reached. The soil profile was too uniform for use of natural stratigraphy to guide excavation levels (Figure 4). The matrix was screened through a nested stack consisting of a 1/8-in box screen with window screen on the bottom level of the stack. Although 1/4-in screen was used in previous excavations at the site, it was anticipated that many smaller species, especially fishes, were not recovered during those earlier studies (Reitz and Wing 2008:147-150). The material from the 1/8-in and 1/16-in fractions were bagged separately in the field in order to facilitate lab work. Proveniences included in this study are listed in Appendix A. Ceramics and lithics from the 1/8-in fraction were bagged separately as well and returned immediately to SEAC for analysis. These are temporarily curated at SEAC, awaiting final curation at Eglin Air Force Base. Diagnostic ceramics and key species noted in the field were recorded on excavation unit forms to aid in lab analysis.

Although bags were labelled with site number and unit provenience on-site, field specimen (FS) numbers were not assigned until all material had been returned to the field house and could be properly organized and inventoried. While in the field, the placeholder designation of EU(1) was used for the unit in lieu of the official SEAC unit number. The unit reported here was eventually designated EU7.

ZOOARCHAEOLOGICAL METHODS

The first stage of lab work consisted of re-screening material from the 1/8-in fraction with a 1/4-in screen. This was done chiefly to separate invertebrate material with a higher likelihood of contributing to the MNI estimate from the many small mollusc fragments present in the sample. The materials were bagged and identified separately, but all fractions retained the same FS number. This analysis combines both 1/4-in and 1/8-in fractions. The material smaller than 1/8-in was floated to separate out botanical material, but was not identified or included in the zooarchaeology study. The unstudied botanical material was kept with the faunal material which will be curated at Eglin Air Force Base.

Both invertebrate and vertebrate remains were identified using standard zooarchaeological methods. All identifications were made by Maran E. Little using the comparative skeletal collection of the Zooarchaeology Laboratory, Georgia Museum of Natural History, University of Georgia. A number of primary data classes are recorded during identification. Specimens are identified in terms of elements represented, the portion recovered, and symmetry. The Number of Identified Specimens (NISP) is determined. Specimens that cross-mend are counted as single specimens. The only exceptions are in specimens attributed to UID Mollusc, UID Bivalve, and UID Vertebrate, which are not counted due to their highly fragmented condition. All specimens are weighed to provide additional information about the relative abundance of the taxa identified. Evidence for age at death, sex, and modifications are noted if observed. Measurements for molluscs are recorded following Reitz and Wing (2008:383). No bird or mammal specimens could be measured. The greatest anterior width of the fish atlas and the greatest dimensions of the fish otolith are recorded. Sea catfish otoliths are measured by greatest length, breadth, width, and thickness (Figure 5). Measurements are presented in Appendix B.

The Minimum Number of Individuals (MNI) is estimated based on paired elements, size, and age. Normally, MNI is estimated at the lowest possible taxonomic level, usually the species. However, occasionally a larger MNI estimate is suggested at a higher taxonomic level, such as genus or family. For example, more individuals might be estimated if all materials identified as Ariidae and *Ariopsis felis* are examined together rather than considering those specimens identified only *A. felis* for estimating MNI. In this case, the same element was used to calculate MNI for both Ariidae and *A. felis*, allowing for an additional six individuals to be identified. The Gastropoda category represents complete columella from 33 individuals, which allows them to be positively included in the MNI count, though they cannot be attributed to a lower taxonomic level.

Although MNI is a standard zooarchaeological quantification method, the measure has several well-known biases. For example, MNI emphasizes small species over larger ones. This can be demonstrated in a hypothetical sample consisting of five rabbits and one deer. Although five rabbits indicate emphasis on rabbit, one deer could, in fact, supply more meat. Further, some elements are more readily identifiable than others. The taxa represented by these elements may, therefore, be incorrectly perceived as more significant to the diet than animals with less distinctive elements. *A. felis* neurocrania, readily identified from very small fragments, exemplify this situation. Conversely, some taxa represented by large numbers of specimens may present few paired elements and hence the number of individuals for these species may be underestimated. Oysters and turtles are good examples of this last problem. MNI for these animals will usually be under-estimated relative to the number of specimens. Basic to MNI is the assumption that the entire individual was utilized at the site. From ethnographic evidence, it is known that this is not always true (Perkins and Daly 1968). This is particularly the case for larger individuals, animals used for special purposes, and where food exchange was an important economic activity (Thomas 1971; White 1953).

In addition to these primary biases, MNI is also subject to secondary bias introduced by the way samples are aggregated during analysis. The aggregation of archaeological samples into analytical units (Grayson 1973) allows for a conservative estimate of MNI, while the "maximum distinction" method, applied when analysis discerns discrete sample units, results in a much larger MNI. In estimating MNI for the Strange's Ring Midden assemblage, all faunal remains from the unit are grouped and analyzed together.

Biomass estimates attempt to compensate for some of the problems encountered with MNI. Biomass refers to the quantity of tissue which a specified taxon might supply. Predictions of biomass are based on the allometric principle that the proportions of body mass, skeletal mass, and skeletal dimensions change with increasing body size. This scale effect results from a need to compensate for weakness in the basic structural material, in this case bones and teeth. The relationship between body weight and skeletal weight is described by the allometric equation:

$$Y = \mathrm{a}X^{\mathrm{b}}$$

(Simpson et al. 1960:397). In this equation, X is specimen weight, Y is the biomass, b is the constant of allometry (the slope of the line), and a is the Y-intercept for a log-log plot using the method of least squares regression and the best fit line (Reitz et al. 1987; Reitz and Wing 2008:237-239). Many biological phenomena show allometry described by this formula (e.g., Gould 1966, 1971) so that a given quantity of skeletal material or a specific skeletal dimension represents a predictable amount of tissue or body length due to the effects of allometric growth. Values for *a* and *b* are derived from calculations based on data at the Florida Museum of Natural History, University of Florida, and the Georgia Museum of Natural History. Allometric formulae for biomass estimates are not currently available for amphibians or lizards so biomass is not estimated for these groups. The allometric formulae used here are presented in Appendix C.

The species identified from Strange's Ring Midden are summarized into faunal categories based on class. This summary contrasts the percentage of various groups of taxa in the collection. These categories are Bivalves, Gastropods, Crabs, Invertebrate commensals, Cartilaginous and bony fishes, Turtles, Birds, Deer, Other wild mammals, and Vertebrate commensals. In order to make comparisons of MNI and biomass estimates possible, the summary tables include biomass estimates only for those taxa for which MNI is estimated. For example, biomass for Kinosternidae is not included, while biomass for *Kinosternon* spp. is included in the summary tables.

Taxa also are summarized into categories based in the particular biome they inhabit. These categories are Estuarine taxa, Marine taxa, Freshwater taxa, Invertebrate mobile taxa, Indeterminate gastropod taxa, and Terrestrial taxa. Invertebrate mobile taxa includes species which move easily from one aquatic biome to another such as the blue crab (*Callinectes sapidus*). Indeterminate gastropod taxa includes both terrestrial and either estuarine or marine gastropod columella.

Taxa tentatively classified as commensal are animals that might be consumed, but that also are commonly found in close association with humans and their built environment as pets, work animals, or vermin seeking food or shelter in the site. Some commensal animals are ones that people either do not encourage or actively discourage. Just as some of the animals included in the commensal category might have been consumed at this site, or at other sites, either voluntarily or out of need, likewise some of the animals included in the non-commensal categories might have been commensal. Taxa tentatively classified as commensal are barnacles (*Balanus* spp.), frogs (Ranidae), colubrid snakes (Colubridae), and Hispid cotton rats (*Sigmodon hispidus*).

The presence or absence of elements in an archaeological assemblage provides data on animal use such as butchering practices and transportation costs. The artiodactyl elements identified at Strange's Ring Midden are summarized into categories by body parts. The Head category includes only skull fragments, including antlers and teeth. The atlas and axis, along with other vertebrae and ribs, are placed into the Vertebra/Rib category. It is likely the Head and Vertebra/rib categories are under-represented because of recovery and identification difficulties. Forequarter includes the scapula, humerus, radius, and ulna. Carpal and metacarpal specimens are presented in the Forefoot category. The Hindfoot category includes tarsal and metatarsal specimens. The Hindquarter category includes the innominate, sacrum, femur, and tibia. Metapodiae and podiae which could not be assigned to one of the other categories, as well as sesamoids and phalanges, are assigned to the Foot category.

The elements identified as deer (*Odocoileus virginianus*) are presented visually to illustrate their number and location in a carcass. Although the atlas and axis fragments are accurately depicted, other cervical, thoracic, lumbar, and caudal vertebrae, as well as ribs, are placed approximately on the illustration. The last lumbar location is used to illustrate vertebrae which could only be identified as vertebrae. Specimens identified only as sesamoids, metapodiae, podials, or phalanges are illustrated on the right hindfoot.

Relative age of the deer is estimated based on observations of the degree of epiphyseal fusion for diagnostic elements. When animals are young their elements are not fully formed. The area of growth along the shaft, the diaphysis, and the end of the element, the epiphysis, is not fused. When growth is complete the diaphysis and the epiphysis fuse. Although environmental factors influence the actual age at which fusion is complete (Watson 1978), elements fuse in a regular temporal sequence (Gilbert 1980; Purdue 1983; Schmid 1972). During analysis, specimens are recorded as either fused or unfused and placed into one of three categories based on the age in which fusion generally occurs. Unfused elements in the early-fusing category are interpreted as evidence for juveniles; unfused elements in the middle-fusing and late-fusing categories are usually interpreted as evidence for subadults, though sometimes characteristics of the specimen may suggest a juvenile. Fused specimens in the late-fusing group provide evidence for adults. Fused specimens in the early- and middle-fusing groups are indeterminate. Clearly fusion is more informative for unfused elements which fuse early in the maturation sequence and for fused elements which complete fusion late in the maturation process than it is for other elements. An early-fusing element which is fused could be from an animal which died immediately after fusion was complete or many years later. The ambiguity inherent in age grouping is somewhat reduced by recording each element under the oldest category possible. Tooth eruption data (Severinghaus 1949) also are recorded.

The sex of animals is an important indication of animal use; however, there are few clear indicators of sex. Males are indicated by the presence of spurs on the tarsometatarsus of turkeys, antlers on deer, the baculum in those species that have one, and pelvic characteristics. Male turtles are indicated by a depression on the plastron to accommodate the female during mating. Females are recognized either by the absence of these features or by different shapes in these features. Female birds may also be identified by the presence of medullary bone (Serjeantson 2009). Another approach is to compare measurements of identified specimens for evidence of elements which fall into a male or female range, though there rarely are sufficient numbers of measurements to reliably indicate sex, as is the case for Strange's Ring Midden.

Modifications can indicate butchering methods as well as site formation processes. Modifications are classified as cut, burned, calcined, pathological, and worked. Although NISP for specimens identified as UID Vertebrate is not included in the species lists, modified UID Vertebrate specimens are included in the modification table.

Some modifications likely took place as the carcass was dismembered or as meat was removed from the bone before or after cooking. Cuts are small incisions across the surface of specimens. These marks were probably made by knives as meat was removed before or after the meat was cooked. Cuts may also be left on specimens if attempts are made to disarticulate the carcass at joints. Some marks that appear to be made by human tools may actually be abrasions inflicted after the specimens were discarded, but distinguishing this source of small cuts requires access to higher powered magnification than is currently available (Shipman and Rose 1983).

Experimental studies indicate that the color of bone may be a poor indicator of the type of modification because it is difficult to precisely describe color variations and other diagenetic factors may alter bone color (Lyman 1994:385). Burned specimens result from the carbonization of bone collagen and often are identified by their charred-black coloration (Lyman 1994:384-385). Burned specimens may result from exposure to fire when meat is roasted. Alternatively, burns may occur when specimens are intentionally or unintentionally burned after discard. Heating bone at extreme temperatures (≥ 600°C) can cause the specimen to become completely incinerated or calcined; calcined specimens are usually indicated by white or blue-gray discoloration (Lyman 1994:385-386).

Other modifications are noted when present. Pathologies occur when bone has been exposed to trauma, either biological or physical. Biological trauma includes disease or infection. Physical trauma includes broken bones. When these broken bones heal, a swollen area of additional bone, a traumatic osteoma, is present on the bone (Baker and Brothwell 1980; Greig 1931). Although there are many forms of identifiable pathologies, no attempt was made to identify them. Any pathology encountered is simply recorded as such. Worked specimens, such as grooved and snapped, flaked, or polished, show evidence of human modification for reasons probably not associated with butchery.

One method compares variety and degree of specialization by measuring the richness, diversity, and equitability of the species identified from a site. These estimates permit discussion of subsistence strategies in terms of the variety of animals used at the site (diversity) and the evenness (equitability) with which those species were used. Richness is the simple number of taxa in the collection. Diversity measures the number of individuals used in terms of the overall collection. Equitability measures the degree of dependence on the utilized resources and the effective variety of taxa used at the site based on the even, or uneven, use of individual species. Biases associated with these indices are discussed elsewhere (Grayson 1981; Hardesty 1975; Pielou 1966; Reitz and Wing 2008:235-246).

To measure diversity, the Shannon-Weaver Index is used. The formula for the index is:

$$H = = -\Sigma p_i log_e p_i$$

where p_i is the number of the *ith* species, divided by the sample size represented by MNI (Pielou 1966; Shannon and Weaver 1949:14). P_i is actually the evenness component since the Shannon-Weaver Index measures both how many species were used and how much each was utilized.

Equitability is calculated using the formula:

$$V= = H=/Log\ S$$

where $H=$ is the Diversity Index and $Log\ S$ is the natural log of the number of observed species (Pielou 1966; Sheldon 1969).

Interpreting the indices can be difficult. Diversity increases as both the number of species and the equitability of species abundance increases. A diversity index of 4.99 is the highest possible value. A sample with many species identified and in which the number of individuals slowly declines from most abundant to least abundant will be high in diversity. Diversity can be increased by adding a new taxon to the list, but if another individual of an already present taxon is added, diversity is decreased. A low diversity can be obtained either by having a few species or by having a low equitability, where one species is considerably more abundant than others. A low equitability value indicates that one species was more heavily used than other species in the sample. A high equitability index, approaching 1.0, indicates an even distribution of species in the sample following a normal pattern where there are a few abundant species, a moderate number of common ones, and many rare ones.

Diversity and equitability are estimated for both MNI and biomass. In the case of MNI, estimates of individuals were taken directly from the species lists. Biomass represents a different problem because biomass was estimated for more taxonomic levels than MNI. It was considered important to calculate biomass diversity and equitability using the same taxonomic units used to calculate these values for MNI. For this reason, only those biomass estimates for taxa for which MNI was estimated were included in the biomass diversity and equitability calculations. For example, in calculating biomass diversity and equitability, biomass for *Kinosternon* spp. was used rather than biomass for Kinosternidae. This ensures that when comparing biomass and MNI diversity results, exactly the same observations were used in both cases.

Trophic level is calculated using this formula:

$$TL_i = \Sigma(TL_{ij}) * (Biomass_{ij}) / (\Sigma Biomass)$$

Molluscan trophic level designations are based on those in Quitmyer and Reitz (2006). Adjustments were made to some species to reflect their higher trophic level (Hadden 2015). Trophic level is based primarily on the species' diet composition, dietary habits, and, to a lesser degree, dietary environment. Marine and estuarine fishes' trophic level designations are based on those in Froese and Pauly (1998). Trophic levels for these species are listed, summed together, and divided by richness to calculate a median trophic level for the assemblage.

Specimen count, MNI, biomass, and other derived measures are subject to several common biases (Casteel 1978; Grayson 1979, 1981; Wing and Brown 1979). In general, samples of at least 200 individuals or 1400 specimens are needed for reliable interpretations. Smaller samples frequently will generate a short species list with undue emphasis on one species in relation to others. It is not possible to determine the nature or the extent of the bias, or correct for it, until the sample is made larger through additional work.

These data also reflect the fact that elements of some animals are simply more readily identified than others and the taxa represented by these elements may appear more significant in terms of specimen count than they were in either the diet, or as a unit of economy as trade items.

If these animals are identified largely by unpaired elements, such as scales and cranial fragments, the estimated MNI for these taxa will be low. At the same time, animals with many highly diagnostic but unpaired elements will yield a high specimen weight and biomass estimate. Hence high specimen count, low MNI, and high biomass for some animals are artifacts of analysis. This source of bias is particularly critical to interpreting the role of sea catfishes and turtles in the subsistence strategies reflected in the Strange's Ring Midden assemblage.

Although this sample from Strange's Ring Midden is small compared to the midden as a whole, applying these methods in particular will give a more complete picture of the faunal assemblage at the Strange's site than previously was available. Using this mix of primary and secondary data will provide a more complete picture of the way in which faunal resources were used by the occupants of the site.

CHAPTER FOUR: RESULTS

Although sample size undoubtedly influences the results, a mixed strategy of targeting high-yield/low reliability subsistence sources and low-yield/high reliability subsistence sources conforms to the overall pattern observed in other coastal southeastern sites. The assemblage at Strange's Ring Midden suggests an emphasis not on resource type, but resource location, with most energy directed at those estuarine species which could be caught or collected in the bay.

The faunal collection from this provenience of Strange's Ring Midden is moderate in size, consisting of 261 individuals from 61 taxa and 3,880 specimens **(**Table 2**)**. Invertebrate species dominate the individuals represented and comprise 68% of the individuals, 21% of the biomass. Vertebrate individuals are present in much lower numbers, but contribute 79% of the biomass (Table 3). Taxa in the results are grouped by biome (Table 4).

The Strange's Ring Midden assemblage is dominated by estuarine bivalve species, particularly eastern oysters (*Crassostrea virginica*). Oyster shell is ubiquitous in the matrix of the unit as well as throughout the midden. Unsurprisingly, the vast majority of specimens identified as UID Bivalve are oyster shell fragments, though no attempt was made to quantify these. Other estuarine invertebrate species represented are quahog clam (*Mercenaria* spp.) and crown conch (*Melongena corona*). These three taxa contribute 44% of the individuals and 12% of the biomass.

Marine molluscs have a higher level of species richness, but most are represented only by one or two individuals. Both bivalves and large-bodied gastropods are represented more or less equally. Lightning whelk (*Busycon sinistrum*) is most frequent in this category, followed by the Florida fighting conch (*Strombus alatus*), bay scallop (*Argopecten irradians*), cockle (Cardiidae), sunray venus (*Macrocallista nimbosa*), pearwhelk (*Busycotypus spiratus*), and horse conch (*Pleuroplaca gigantea).* These seven taxa contribute 4% of the individuals and 5% of the biomass.

Several aquatic species do not fit neatly into either estuarine or marine habitats or niches. Moonsnails (*Neverita* spp.), blue crabs (*Callinectes sapidus*), and barnacles (*Balanus* spp.) travel easily between the two environments and could have been obtained from either source. These three taxa contribute 15 individuals, 6% of the individuals and less than 1% of the biomass.

In addition, there are a number of specimens for which MNI can be confidently assigned, but for which identification past class level is not possible. Thirty-three individuals could only be identified as Gastropoda; which includes both unidentifiable large-bodied aquatic snails as well as smaller terrestrial snails. The only terrestrial snails attributed to lower taxonomic levels are two polygyrid (Polygyridae) terrestrial snails and one rosy wolfsnail (*Euglandina rosea*). Although it is possible these were consumed, the small size of terrestrial snails other than the wolfsnail makes this unlikely. Polygyrid snails are also drawn to midden areas to take advantage of the detritus available, and are interpreted as commensal. These three taxa contribute 36 individuals, 14% of the individuals and 3% of the biomass.

Estuarine fishes comprise the bulk of the Strange's vertebrate assemblage. Mullet (*Mugil* spp.) are the most abundant bony fish in the collection. Hardhead catfishes (*Ariopsis felis*), indeterminate sea catfishes (Ariidae), and toadfishes (*Opsanus* spp.) are also very common in the collection. Other estuarine fishes in the sample include pinfishes (*Lagodon rhomboides*), Atlantic croakers (*Micropogonias undulatus*), killifishes (*Fundulus* spp.), and sheepsheads (*Archosargus probatocephalus*). These eight taxa contribute 21% of the MNI and 44% of the biomass.

Marine fishes demonstrate a similar level of species richness as the estuarine fishes, but are far less abundant in the collection. Cartilaginous fishes are represented by a single stingray spine (Dasyatidae) and two cownose rays (*Rhinoptera bonasus*) vertebrae. Bony marine fishes include indeterminate jacks (Carangidae), pigfishes (*Orthopristis chrysoptera*), seatrouts (*Cynoscion* spp.), spots (*Leiostomus xanthurus*), red drums (*Scienops ocellatus*), southern flounders (*Paralichthys* spp.), burrfishes (*Chilomycterus* spp.), and common puffers (*Sphoeroides* spp.). Seatrouts and red drums are considered fully marine as adults but spend time in estuaries as juveniles, so these taxa could have been obtained from either source. The size of the specimens suggests adult individuals, thus a marine capture, though they could represent adults feeding on juvenile fishes. These ten taxa contribute 6% of the MNI and 16% of the biomass.

Freshwater species contribute a very small portion of the assemblage. Only one freshwater fish is present in the collection, a single gar (Lepisosteidae) represented by six ganoid scales. Two other predominantly freshwater taxa are present, an indeterminate frog (Ranidae) and mud turtles (*Kinosternon* spp.). All of these species tolerate low levels of salinity, but are far more likely to be encountered in areas with a large degree of freshwater accumulation. These three taxa contribute 1.5% of the MNI and 4% of the biomass.

Terrestrial species are present in much lower numbers than aquatic or semiaquatic taxa. These include reptiles, birds, and mammals. Box turtles (*Terrapene carolina*) and a non-venomous colubrid snake (Colubridae) are the only terrestrial reptiles present. A single bone shaft fragment represents an indeterminate bird (Aves) in the collection. One commensal mammal, a Hispid cotton rat (*Sigmodon hispidus*), was identified. Other wild mammals include opossums (*Didelphis virginiana*), cottontail rabbits (*Sylvilagus* spp.), raccoons (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*). These eight taxa contribute 3% of the MNI and 16% of the biomass, the majority of which are from deer.

A total of 16 deer specimens were identified in the collection, with teeth (N=11) representing the only cranial elements in the assemblage (Table 5, Figure 6). Forefoot (N=2), and Foot (N=3), were the only other portions represented. The only element which provided epiphyseal fusion data was one fused proximal metapodial (Table 6). Because this element is fused before birth in deer, it is not useful for aging an individual. However, the size of the deer elements recovered, as well as the dentition, suggests that both individuals were at least sub-adults. No indicators of sex were found for deer or any other taxa.

The most common modification in the Strange's assemblage is burning (N=320) (Table 7). An additional 89 specimens are calcined, which together suggests roasting as a common method of vertebrate food preparation or burning as a method of waste disposal. Other modifications recorded include cut marks (N=3), one pathological specimen, and one worked specimen. The pathological specimen is a malformed turtle neural. No direct cause for the malformation was evident, but the vertebrae are a common element for pathologies of this type to be manifest in turtles. The worked bone is a stingray spine (FS# 137) which has been shaped at the tip and polished.

Measurements could be taken of 97 oyster valves, three quahog clam valves, one sunray venus valve, one crown conch, and ten fish bones (Appendix B). Accounting for potential size differences due to age, all seem to be of average dimensions compared to the UGA reference collection.

Two specimens from EU7, one deer bone and one oyster, were sampled for both ^{14}C radiocarbon dating and $\delta^{13}C$ carbon analysis by the Center for Applied Isotope Studies (CAIS) at the University of Georgia. The collagen from the deer sample returns an uncalibrated date of 1190 ± 20 ^{14}C yr, with a calibrated age of A.D. 770 – 890 (UGAMS#13322; bone collagen; $\delta^{13}C$= -20.4). The shell sample returns an uncalibrated date of 1560 ± 20 ^{14}C yr, with a calibrated age of A.D. 749 - 906 (UGAMS#13323; shell; $\delta^{13}C$= -1.2). Shell dating is notoriously unreliable due to the marine reservoir effect (Bowman 1990:24-25). Oyster, in particular, is extremely problematic, with many variations in results both between and within specimens (Rick et al. 2012:207-209).

Other radiocarbon dates from SEAC's previous excavations at Strange's Ring Midden were also processed at CAIS. These include one date from a sooted Weeden Island Plain rim sherd and three dates from deer bone. The sherd sample (UGAMS#03288; ceramic; $\delta^{13}C$= -23.1) returns a date of 1320 ±25 ^{14}C yr, with a calibrated age of A.D. 650 – 770. The three deer samples ([UGAMS#13322; collagen; $\delta^{13}C$= -20.4] ; [UGAMS#13604; collagen; $\delta^{13}C$= -20.8] ; [UGAMS#13605; collagen; $\delta^{13}C$= -21.8]) return dates of 1190±20 (calibrated A.D. 770 – 890); 970±25 (calibrated A.D. 1020 – 1150); and 1170±20 (calibrated A.D. 770 – 940), respectively. Although the majority of these dates fit neatly with the age of the site, one of the deer shows a very late date. This will be addressed in Chapter Six.

Diversity, equitability, and richness indices indicate that sources of biomass in the collection were moderately diverse (2.918) but highly even (0.776) (Table 8). These indices are further separated into specifically invertebrate and specifically vertebrate categories which indicates that vertebrate diversity and equitability is higher than invertebrate diversity and equitability (Tables 9, 10). Although the pattern represents a subsistence strategy using a wide variety of resources located either on-site or from other areas of the peninsula, biomass from four taxa is much more abundant than others: oysters, mullets, sea catfishes, and deer. A richness of 45 taxa is not huge for such an ecologically diverse area. However, given the limited size of the analytical unit it is a useful value for understanding the relationships between diversity and equitability indices.

Aquatic trophic level indices for the taxa in the assemblage give the result of a median trophic level almost exactly in the middle of the scale (Table 11). This is not surprising given that the assemblage contains very high-tropic-level taxa (i.e., gars and catfishes) and very low-trophic-level taxa (i.e., oysters and mullets), as well as many "in-between" species.

Strange's Ring Midden displays a mixed strategy of targeting both high- and low-energy return faunal resources with a focus on estuarine species over either marine, freshwater, or terrestrial species. The age of the two deer recovered could not be determined, but were at least sub-adults at the time of death, and lack of high-utility portions of carcass suggest specialized use of deer. The number of burned specimen suggests roasting as a common method of food preparation for vertebrate taxa, but other methods cannot be ruled out for invertebrate taxa. Radiocarbon dating suggests that the site was occupied in some capacity during the Late Woodland period. The faunal analysis suggests a subsistence strategy in which people targeted locally available, reliable staple resources, and supplemented their diet with incidental taxa.

CHAPTER FIVE: DISCUSSION

Interpreting subsistence strategies at coastal communities during the Weeden Island phase has much to gain from intensive zooarchaeological analysis. The study of remains from Strange's Ring Midden is guided by two main research questions: (1) evidence of the subsistence economy at this site compared to other sites in the same spatial and temporal region, and (2) providing further evidence of prolonged site use on a year-round basis, as opposed to a strictly seasonal occupation. The research done at Strange's Ring Midden and at the nearby sites of Hare Hammock Ring Midden and Harrison Ring Midden (Hadden 2015) resolves some of the enduring questions about the lifeways of the people living at these sites during this time. These questions are addressed below following the hypotheses presented in Chapter One.

EVALUATION OF HYPOTHESES

> *Hypothesis 1*: Primary hypothesis: Invertebrate and vertebrate analysis indicates a reliance on both taxonomic groups.

A broad subsistence strategy was practiced at the site, with no evidence of either dietary or cultural preference for invertebrate over vertebrate taxa use, or vice-versa. Much of the difference between the two groups appears to be related to the taxa most readily available near the site, or ones that offered a large caloric return. This same pattern is evident at the nearby sites of Hare Hammock Ring Midden and Harrison's Ring Midden (Hadden 2015).

Although mollusc, crustacean, and vertebrate taxa were valuable resources during the occupation of the site, the large amount of invertebrates present in this assemblage and the ring midden as a whole suggests use of the local mollusc population as a stable and reliable resource.

> *Hypothesis 2*: Primary hypothesis: Data analysis from MNI and biomass estimates will show preferential use of certain animals over others.

Although the subsistence strategy implemented at the Strange's site incorporates a wide range of local species, some species were used more heavily than others, most notably oysters, mullets, sea catfishes, and deer. This suggests a subsistence strategy that targeted "staple" resources with "incidental" resources as supplements. Staple resources comprised the bulk of food resources available. These staple resources are animals which are available more or less year-round or occur at predictable intervals.

Incidental resources supplemented the main diet, providing a welcome addition to the day-to-day fare. These probably were hunted or gathered by chance encounter as people moved about the landscape, though some may have been specifically targeted. Some examples of incidental resources in the assemblage are several species of marine gastropods, including horse conchs, and turtles. These also were additional sources of essential nutrients. Turtle meat in particular contains high levels of vitamin C (Watt and Merrill 1975:64), a difficult vitamin to come by during much of the year in the natural environment, as it is primarily acquired from fruits.

While sample size bias influences results (Reitz and Wing 2008:151), the mixed strategy of targeting both low-yield/high reliability resources and high yield/low reliability resources conforms to the overall subsistence pattern observed in other coastal southeastern sites (Hadden 2015; Russo et al. 2009; Thomas 2014). A low yield/high reliability resource is one which may not give a high caloric return, but can be gathered in large numbers with little energy expenditure (i.e., oysters). High yield/low reliability resources give a high caloric return, but may be scattered across the landscape and require a much higher energy expenditure to obtain (i.e., deer). MNI for oyster is very high with a low biomass, likely due to the ease of estimating MNI for the species. Fishes as a whole contribute more biomass than deer, but deer contributes the highest biomass of any single taxon.

> *Hypothesis 3*: Primary hypothesis: Analysis of the preferential habitats of groups of animals will show primary use of groups of taxa based on their preferred environment.

The faunal assemblage at Strange's Ring Midden suggests an emphasis on resource type defined by location instead of by species. Most of the energy used to acquire animals is directed at those estuarine species which could be obtained from the bay directly adjacent to the site. Estuaries are ideal environments for humans to exploit for resources, but also are attractive to many terrestrial species, such as small mammals and deer. Such terrestrial taxa do not *require* an estuarine environment, but may be drawn to the area during the course of their own resource acquisition or other behaviors.

Although it is impossible to say whether or not these taxa were taken from areas directly adjacent to the site, there is a distinct likelihood that this was the case. Low-salinity areas of the bay today tend to be highly localized and occur in patches. This pattern was likely present during the Late Woodland, though the locations of these resource patches have probably changed. This presumes that the overall estuarine environment has not changed much since the Woodland period. Although this seems to be the case based on the suites of taxa present, additional research is required to say this with certainty.

This emphasis on estuarine species is characteristic of a subsistence strategy utilizing an array of locally available resources. Kelly's (1995:133-136) central-place foraging model describes an inverse relationship between distance traveled in the procurement of resources and the net caloric return of said resources; the further afield one must travel (thus expending energy) the lower the eventual return. The Strange's site is situated within minutes of the estuary, making it the most energy-efficient location from which to acquire estuarine resources.

> *Hypothesis 4*: Null hypothesis: Only high-utility portions or low-utility portions of the carcass will be present.

Deer is sometimes a major resource in coastal southeastern assemblages. Examining the element distribution present in a collection provides information on butchery habits at specific sites. Because deer are such large mammals, it is assumed that an assemblage containing a high percentage of high-utility elements (those with the largest amount of available meat) indicates off-site butchery with only choice cuts transported back to the site.

Conversely, an assemblage with a high amount of low-utility elements (those with small amounts of available meat) indicates several possibilities, including a low-status assemblage or on-site butchery, with the entire carcass brought back to the site. The fact that no high-utility elements are present in the assemblage can be interpreted as evidence that entire carcasses were brought to the site for processing. If this was the case, we can infer that deer were likely hunted nearby, from the area directly surrounding the site, or were acquired from further afield and brought back to the site in watercraft, which would reduce the transportation costs.

Another explanation for the types of element distribution seen at Strange's Ring Midden is that deer were used primarily for hides and/or bone tools as opposed to a protein source. The specimens present in the assemblage are classic examples of skinning refuse: head and foot elements. Deer elements are also scarce at the adjacent sites of Hare Hammock Ring Midden and Harrison Ring Midden (Hadden 2015). This raises the possibility that within the larger community living on the peninsula, deer were not highly valued for their meat, but rather for raw materials. If this is the case, it also may be that deer or deer hides were acquired through trade with other groups, rather than by hunting, but more research is required to make this determination.

> *Hypothesis 5*: Primary hypothesis: Diversity, equitability, richness, and trophic level estimates will provide evidence for a wide range of taxa exploited, but with certain taxa targeted over others.

The diversity of species represented at Strange's Ring Midden is moderate, falling into the middle range of values. This is characteristic of a subsistence strategy utilizing a wide array of locally available resources. Compared to the strategy at the nearby sites of Hare Hammock Ring Midden and Harrison Ring Midden (Hadden 2015), the diversity of species used at the Strange's site is notably higher, despite the disparity in richness (Strange's=45; Hare Hammock=79; Harrison=66). This not only exemplifies the complex relationship of diversity to richness (not a 1:1 correlation), but also may be evidence of slightly different subsistence strategies at each site, despite their proximity.

The equitability of species represented at Strange's Ring Midden is relatively high, which indicates a relatively even distribution of taxa exploited. However, a more in-depth evaluation of the data shows several outlier taxa which offset the low values of others. In the overall assemblage, oysters, mullets, sea catfishes, and deer contribute an overwhelming percentage of MNI and biomass compared to other taxa identified. While the inhabitants of the Strange's site used most resources more or less evenly, a few taxa were targeted as “staple” food sources and dominate the strategy. The remainder were “incidental” food sources.

Interestingly, though the equitability indices calculated for Hare Hammock and Harrison Ring Middens are very similar to Strange’s Ring Midden, the suite of “staple” invertebrate assemblages used at these three sites is vastly different (Hadden 2015). Although oysters dominate the invertebrate assemblage at the Strange’s site, the other ring midden sites are dominated by large-bodied marine gastropods and scallops. These differences are most likely due to the aquatic biome in which the sites are located; the Strange’s site is located directly on an estuary with brackish water ideal for stands of oyster. Hare Hammock and Harrison Ring Middens are located on the seaward shoreline of the peninsula, much closer to the marine habitats where large-bodied gastropods are abundant.

The trophic level for the aquatic species at Strange’s Ring Midden assemblage (Table 11) shows a mean value of 3.03. The trophic scale ranges between one and five, with “primary producers at the base with a trophic level of one, benthic herbivores and detritivores with a trophic level of two, and carnivores occupying levels three through five” (Quitmyer and Reitz 2005:806). Assuming a mean value for this habitat of around three, this is additional evidence of a subsistence strategy rooted in resources readily available as opposed to a strategy specifically targeting one species or niche over another, and a mix of low-yield/high reliability subsistence sources and high yield/low reliability sources.

> *Hypothesis 6*: Primary hypothesis: A wide range of gathering/fishing/hunting technologies were used to procure both invertebrate and vertebrate faunal resources.

All evidence indicates the inhabitants of the Strange’s site used several different strategies in food procurement. Gathering shellfish along either the estuary or marine coastline was obviously an important focus of resource procurement. Mass-capture of low-trophic-level fishes such as mullet using either seine nets or weirs in seagrass beds is also frequent. Higher level estuarine fishes could also have been obtained in this fashion, but were likely either incidental or bycatch instead of the target taxa. Burrfishes, in particular, inhabit areas similar to mullet, but their value as a food resource is questionable. It is unlikely that they were specifically targeted for meat, as there is very little to these fish other than innards and, in the case of females, abundant roe. There also remains the question of whether or not this taxon even *could* be consumed, as other members of their suborder (Tetraodontoidei) are known to be highly toxic.

Other high-level estuarine fishes such as sea catfishes were obviously specifically targeted based on the sheer abundance of these taxa in the assemblage, and adults may have been fished using technology such as chert or bone gorges on hand or trot lines. Juveniles of these species may have been caught using seine nets in estuarine nursery areas. Gorges or trotlines were likely also used for the large marine individuals, such as seatrouts and red drums.

Semi-aquatic and terrestrial species could have been acquired in a variety of ways as well. Small amphibians and reptiles may have been acquired incidentally in the course of the day as they were happened upon, or (in the case of frogs and mud turtles) could have been caught using traps set along the waters' edge, a technique still used in many rural areas in the south. Gigging could also have been used to acquire both frogs and flounders. This method, which is still practiced, involves hitting the target with a cudgel until the animal is dead or at least incapacitated.

The mid-sized mammals, opossums, rabbits, and raccoons, may have been chance finds taken opportunistically. It is worth noting, however, that all three mammals are crepuscular and/or nocturnal, and may be purposefully acquired through trapping. While it is possible to use snare traps to acquire deer, it is much more likely that this species was purposefully hunted using a projectile technology.

> *Hypothesis 7:* Primary hypothesis: Taxa recovered from the site will represent the same suite of taxa extant in the area today.

Any archaeological analysis relies on inferences based on present-day observations, and zooarchaeology is no different. Describing the environment of the site and surrounding areas as unchanged since the Woodland period would be unjustified without additional evidence, particularly since the terrestrial plant community is known to have changed significantly. However, a comparison of the fauna recovered from Strange's Ring Midden and the present-day taxa inhabiting the area suggests that little environmental change has occurred in the area, at least in terms of the overall animal composition. The Gulf of Mexico is regarded as a relatively stable environment compared to the Atlantic coast (Myers and Ewel 1990:439-440), and the Strange's site is insulated further by its location on a back bay away from the Gulf proper. The violent hurricanes common in late summer would have less of an impact on the site than on other sites located closer to the Gulf of Mexico, but would still have been near enough to give the residents prior warning to its occurrence.

Hypothesis 8: Null hypothesis: No seasonal indicator taxa will be present.

No direct evidence either for or against a strictly seasonal occupation of the site was observed in the faunal assemblage. Specific markers such as the age of certain mammals which mate and raise young in predictable seasons or the presence of sex-specific elements such as antlers (fully developed in male deer during the late summer and fall) are not present in this collection. In addition, taxa present only during specific seasons, such as bluefishes (*Pomatomus salatrix*) in the winter, were also absent.

All species represented in the collection are present either throughout most of the year or staggered in such a way that resource scarcity was not a driving force behind the occupation schedule of the site. The presence of a cownose ray grinding plate could indicate a spring/summer capture, as this species aggregates in large numbers during this time during their migration in the Atlantic coast (Weinand et al. 2000). This seasonality, however, is only thoroughly documented on the Atlantic coast; Gulf coast populations of cownose ray have not been shown to follow the same strict scheduling.

Coastal occupation patterns have been bitterly debated for many years, with one theory being that sites in the coastal Southeast are non-permanent seasonal camps that were abandoned during large portions of the year (Crook 1984; Percy and Brose 1974). More recent research into Woodland coastal communities in the Southeast suggests that this was not the case, at least not as a widespread settlement strategy (Anderson and Sassaman 2012**;** Thomas 2014). The mainly sedentary settlement strategy is also not limited to the general area and time discussed in this paper. Many prehistoric coastal groups are thought to have been highly sedentary and reliant on the local shellfish population. Residents of the Mississippi drainage from the Archaic onward (Parmalee and Klippel 1974), the Calusa of south Florida (Marquardt and Walker 2013), and the Jomon of Japan (Kusaka et al. 2010) all exhibit a sedentary, shellfish-reliant settlement strategy. This lifeway extends to modern groups, such as the Gidjingali Australian Aboriginal communities studied by Meehan (1982).

Based on the sheer biodiversity and richness of the environment surrounding Strange's Ring Midden, the residents of the site could occupy the area throughout the year, as all seasons would have had ample resources available to sustain the group. Although there are times of relative scarcity of certain taxa, this likely was overcome either by means of dietary diversity or by cultural means, such as reciprocal exchanges with people at neighboring sites. Russo et al. (2011:121) propose a reciprocal relationship between the Strange's site residents and those of the adjacent communities, either in terms of hosting/feasting activities or aid in times of hardship. As mentioned in the introduction, it is also a possibility that the villages on the peninsula represent lineages or segments of semi-related lineages with even closer ties, including spousal exchange (Milanich et al. 1997:188).

FUTURE RESEARCH

Further faunal analysis of Strange's Ring Midden, as well as other Weeden Island coastal sites, is needed for a more complete picture of resource use and occupational seasonality to be developed. The single unit reported here is not representative of the midden as a whole, and other areas of the ring should be further investigated. Many sites display considerable inter-site variability (Colannino 2010; Reitz et al. 2013), especially between features.

Ideally, large excavations using small-screening techniques would be implemented in other areas of the site, such as the center "plaza" area. Although evidence of habitation tends to be lost due to the type of building materials likely used, as well as the sandy matrix, the areas immediately surrounding the midden would be the primary areas on which to focus research attempting a more complete picture of village and social organization.

Isotopic research on invertebrate and vertebrate remains is a potential method of assessing seasonal resource use and seasonal residential patterns. Studies utilizing this method have increased in recent years as the technology becomes cheaper and more widespread (Andrus

2011, Blitz et al. 2014, Reitz et al. 2013). The faunal assemblage at the Strange’s site could benefit greatly from this type of analysis. However, isotopic analysis is beyond the scope of this thesis.

CHAPTER SIX: CONCLUSION

Exactly how sedentary the occupants of the Strange's site were remains unclear. During the peak years of occupation there is no doubt that this was a multi-seasonal if not year-round habitation site, with several households maintaining residence at any given time. It is proposed that the site may have been abandoned after roughly A.D. 750, before Wakulla Check Stamped pottery became commonplace (Russo et al. 2011:122), and was afterwards used primarily as a processing camp. This may be an explanation for the cluster of radiocarbon dates around the Weeden Island I/II phases, and the single quite late, outlying date.

Faunal remains from the Strange's Ring Midden site provide an excellent opportunity to explore the subsistence practices and occupation patterns during the Weeden Island phase in coastal northwest Florida. The inhabitants of the site used a wide variety of resources and techniques to acquire a wide variety of taxa, which follows the overall pattern found at other coastal sites both within the region and well beyond it. Most of these resources could have been obtained in the area directly surrounding the site in most if not all seasons.

Sedentism on coasts is increasingly interpreted as a sustainable way of life as opposed to an anomaly (Ellison 2009; Lawson 2005; Quitmyer et al. 1997; Reitz 2013; Russo 1991), an interpretation supported by the data presented in this thesis. Village complexes like the Strange's site, which includes a ritualized burial mound, would not be a transitory encampment, but a long-term habitation site. A place in which your ancestors or family is interred is an important place, either personally or spiritually. This is not a marker of a seasonal fishing/gathering camp, but of a year-round settlement.

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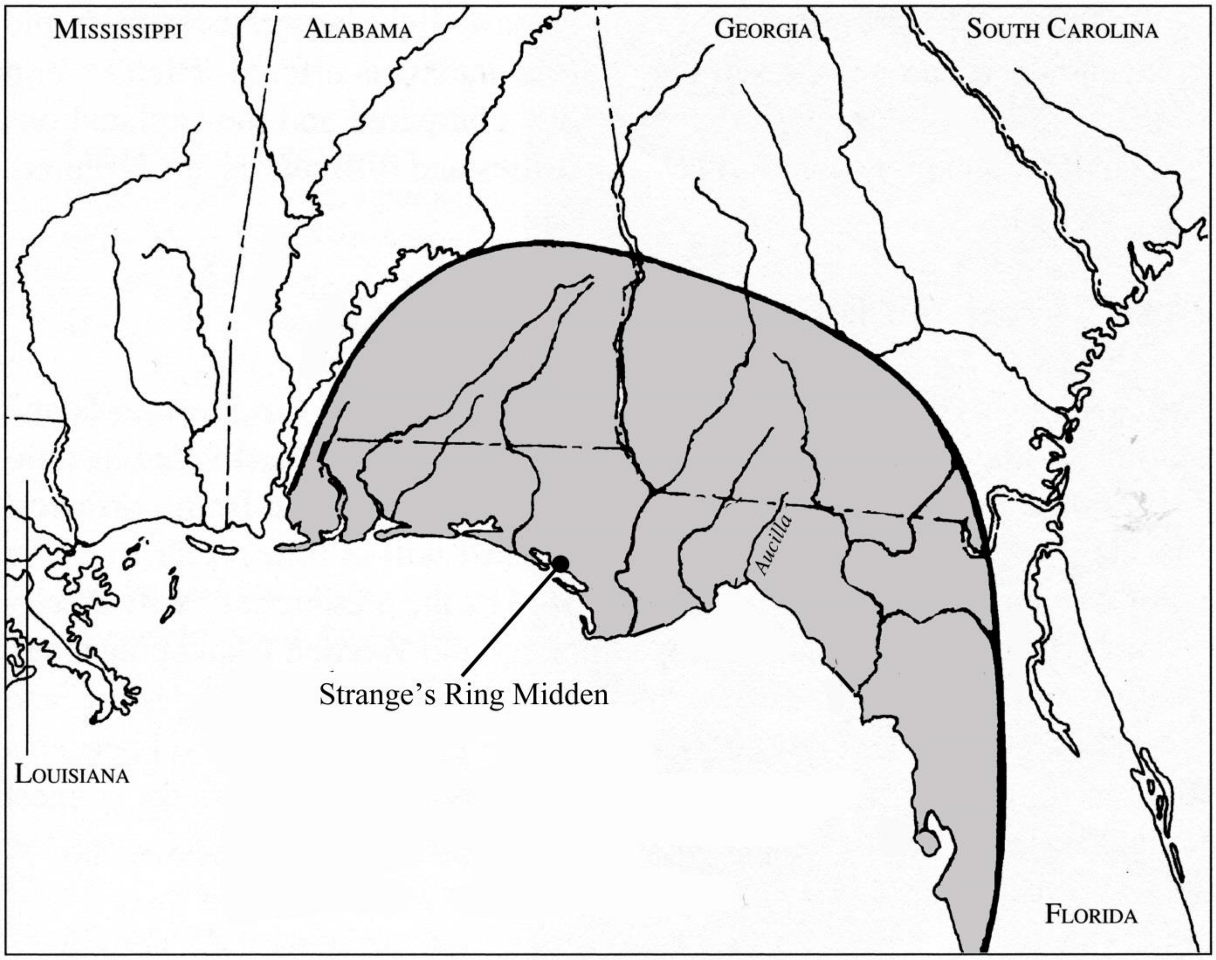

Figure 1: Weeden Island Cultural Area Map (modified from Milanich 2002).

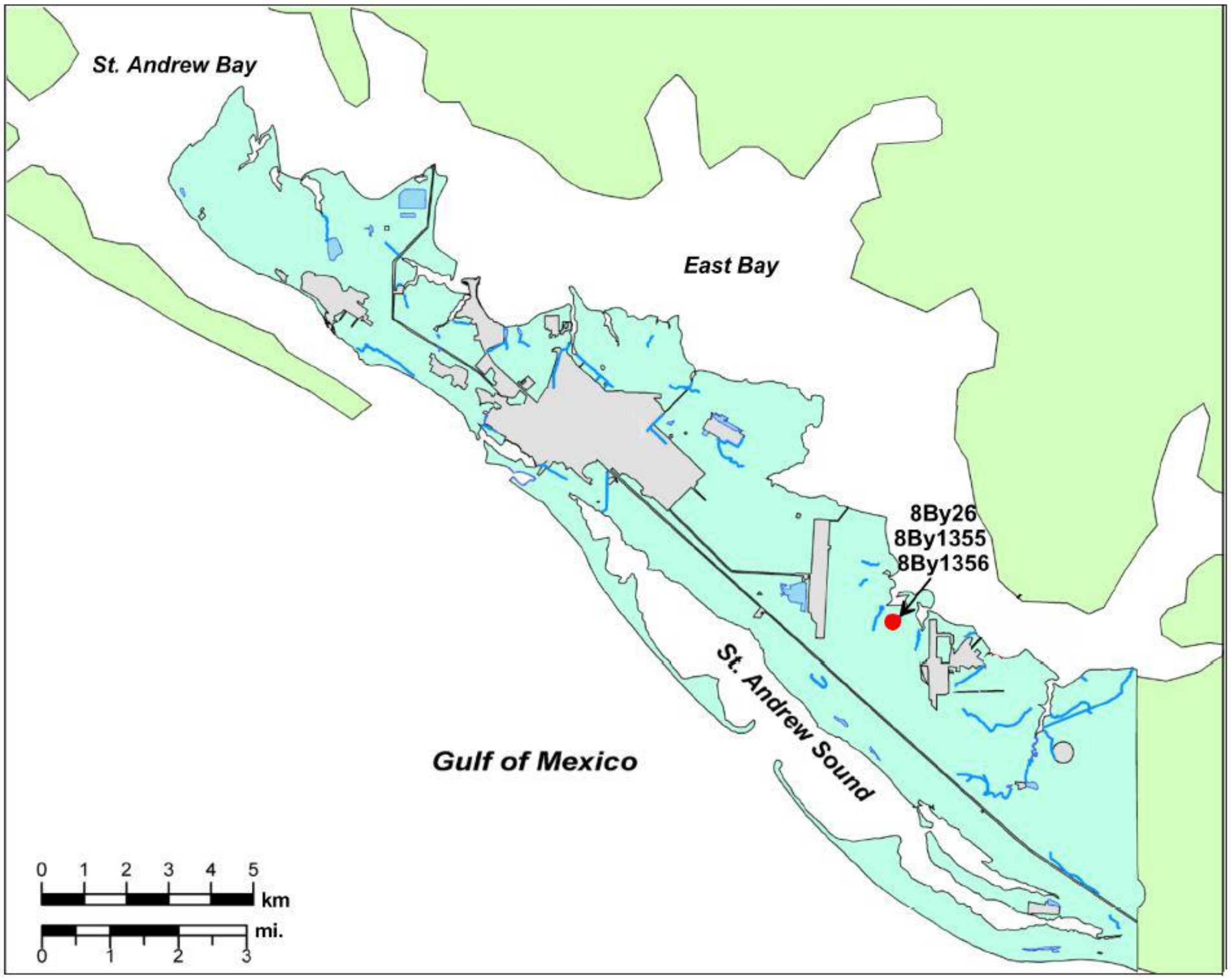

Figure 2: Strange's Site (8By26; 8By1355; 8By1356) Area Map (modified from Russo et al. 2011).

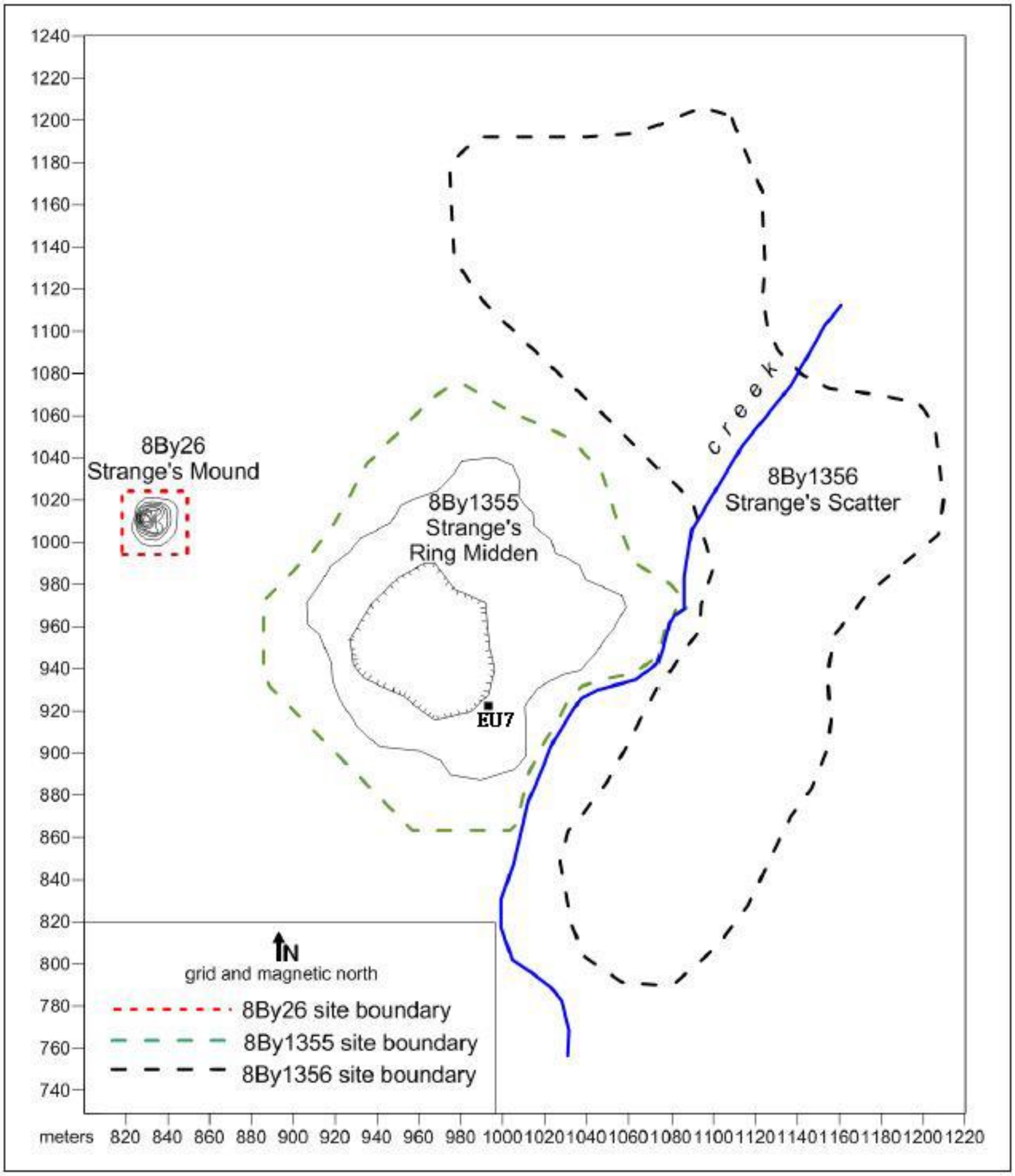

Figure 3: Strange's Site Boundary Map (modified from Russo et al. 2011).

Figure 4: South Profile of EU7, Strange's Ring Midden (8By1355).

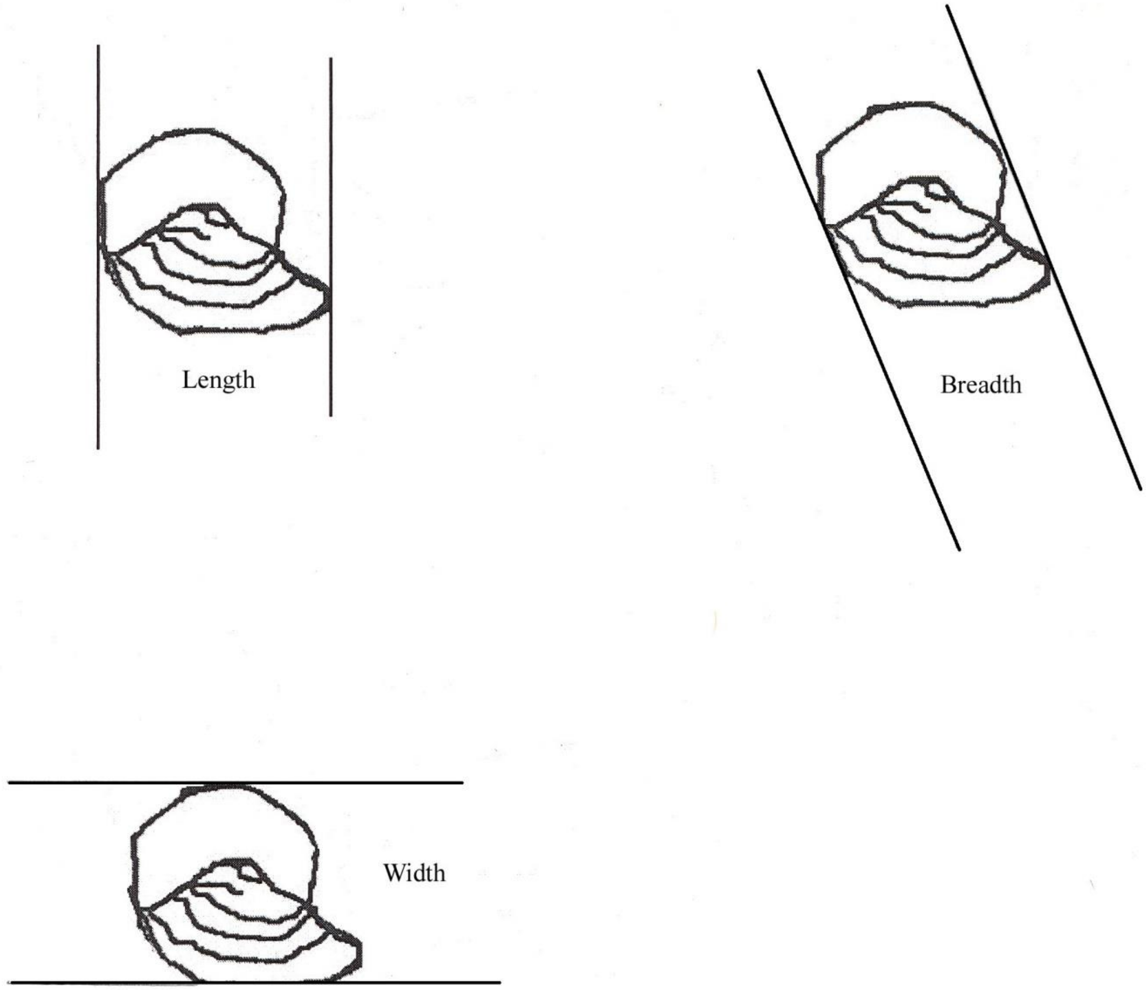

Figure 5: Ariidae Otolith Measurements.

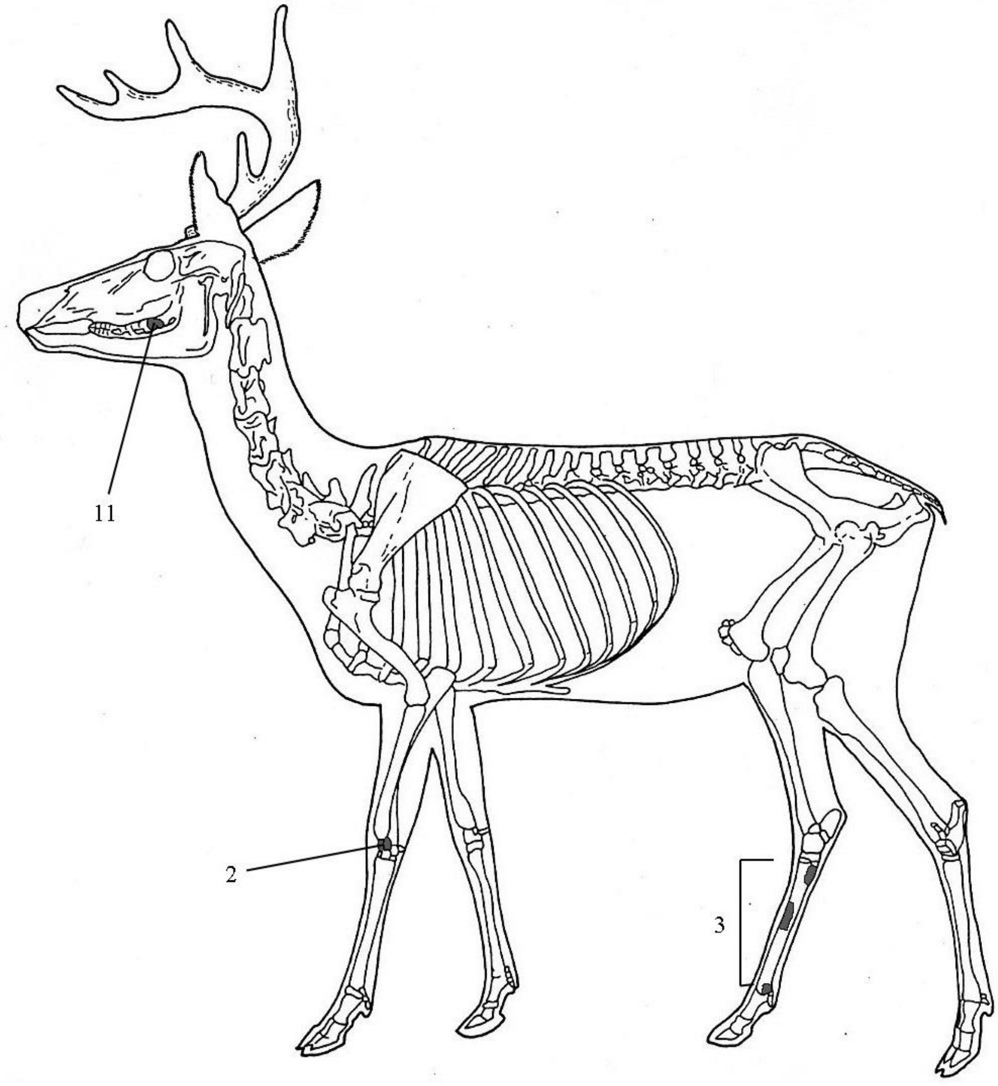

Figure 6: Deer Elements from Strange's Ring Midden, EU7 (NISP=16).

TABLE 1

Northwest Florida Woodland Period Phases.

	Cultural Phase	**Dates**
Early Woodland	Deptford	500 B.C. - A.D. 200
Middle Woodland	Swift Creek	A.D. 0 - A.D. 400
Late Woodland	Weeden Island I	A.D. 300 - A.D. 750
Late/Terminal Woodland	Weeden Island II (Wakulla)	A.D. 750 - A.D. 1000

Note: Date ranges are taken from Russo et al. 2011.

TABLE 2

Species List.

		MNI			
Taxa	**NISP**	**#**	**%**	**Weight, g**	**Biomass, kg**
UID Mollusca Indterminate molluscs				260.712	
UID Bivalvia Indeterminate bivalves				2302.685	0.201
Argopecten sp. Scallop	1			0.256	0.001
Argopecten irradians Bay scallop	1	1		0.206	0.001
Crassostrea virginica Eastern oyster	137	107		879.096	0.122
Cardiidae Cockles	1	1		0.158	0.001
Mercenaria spp. Quahog clam	14	3		272.349	0.061
Macrocallista nimbosa Sunray venus	1	1		0.783	0.001
Gastropoda Gastropods	103	33		114.599	0.054
Strombus alatus Florida fighting conch	2	2		52.391	0.026
Neverita spp. Moonsnail	16	13		29.777	0.016
Polygyridae Terrestrial snails	2	2		0.111	0.001
Euglandina rosea Rosy wolfsnail	1	1		0.095	0.001
Busycon sinistrum Lightning whelk	5	3		89.054	0.043
Busycotypus sp. Whelk	1			0.389	0.001
Busycotypus spiratus Pearwhelk	1	1		1.471	0.001
Melongena corona Crown conch	10	6		37.188	0.019
Pleuroploca gigantea Horse conch	1	1		29.008	0.015
Decapoda Decapods	2			0.031	0.001

Table 2 - *(Continued)*.

		MNI			
Taxa	**NISP**	**#**	**%**	**Weight, g**	**Biomass, kg**
Callinectes sapidus Eastern blue crab	1	1		0.035	0.001
Balanus spp. Barnacle	6	1		0.136	
Chondrichthyes Cartilaginous fishes	1			0.018	0.004
Dasyatidae Stingrays	1	1		0.381	0.055
Rhinoptera bonasus Cownose ray	2	1		0.224	0.035
UID Actinopterygii Indeterminate bony fishes	2203			93.742	1.167
Lepisosteidae Gars	6	1		1.163	0.038
Siluriformes Catfishes	105			4.471	0.083
Ariidae Sea catfishes	88	6		5.939	0.108
Ariopsis felis Hardhead catfish	275	11		17.029	0.295
Opsanus spp. Toadfish	91	8		5.547	0.118
Mugil spp. Mullet	169	21		10.357	0.196
Fundulus spp. Killifish	3	2		0.047	0.002
Carangidae Jacks and pompanos	2	1		0.557	0.023
Orthopristis chrysoptera Pigfish	3	2		0.061	0.003
Sparidae Porgies	2			0.095	0.002
Archosargus probatocephalus Sheepshead	7	1		0.804	0.013
Lagodon rhomboides Pinfish	8	3		0.156	0.003
Sciaenidae Drums	5			0.138	0.009

Table 2 - *(Continued)*.

		MNI			
Taxa	**NISP**	**#**	**%**	**Weight, g**	**Biomass, kg**
Cynoscion spp. Seatrout	15	2		1.768	0.059
Leiostomus xanthurus Spot	4	2		0.106	0.007
Micropogonias undulatus Atlantic croaker	5	3		0.146	0.009
Sciaenops ocellatus Red drum	5	2		0.719	0.030
Paralichthyidae Sand flounders	71			6.414	0.138
Paralichthys spp. Southern flounder	3	2		0.151	0.005
Chilomycterus spp. Burrfish	5	2		1.650	0.045
Sphoeroides spp. Common puffer	2	1		0.129	0.006
Ranidae Frogs	1	1		0.033	
UID Testudines Indeterminate turtles	339			30.485	0.312
Kinosternidae Mud and musk turtles	9			0.755	0.026
Kinosternon spp. Mud turtle	5	2		0.815	0.028
Emydidae Pond and box turtles	9			3.327	0.071
Terrapene carolina Eastern box turtle	2	1		0.928	0.030
Colubridae Colubrid snakes	2	1		0.049	0.001
UID Aves Indeterminate birds	1	1		0.277	0.006
UID Mammalia Indeterminate mammals	102			31.782	0.592
Didelphis virginiana Virginia opossum	1	1		0.276	0.008
Sylvilagus spp. Cottontail rabbit	4	1		0.478	0.014

Table 2 - *(Continued)*.

		MNI			
Taxa	**NISP**	**#**	**%**	**Weight, g**	**Biomass, kg**
Sigmodon hispidus	1	1		0.019	0.001
Hispid cotton rat					
Procyon lotor	1	1		0.128	0.004
Raccoon					
Odocoileus virginianus	16	2		9.804	0.205
White-tailed deer					
UID Vertebrata				57.666	
Indeterminate vertebrates					
Total	3880	261		4359.164	4.318

Note: NISP refers to the Number of Identified Specimens present in the assemblage, MNI refers to the estimated Minimum Number of Individuals represented in the assemblage. See Chapter 3 for a discussion of biomass.

TABLE 3

Species Summary.

	MNI		Biomass	
	#	**%**	**kg**	**%**
Bivalves	113	43.3	0.186	10.9
Gastropods	60	23.0	0.175	10.2
Crabs	1	0.4	0.001	0.1
Invertebrate commensals	3	1.1	0.001	0.1
Cartilaginous and bony fishes	72	27.6	1.050	61.4
Turtles	3	1.1	0.058	3.4
Birds	1	0.4	0.006	0.4
Deer	2	0.8	0.205	12.0
Other wild mammals	3	1.1	0.026	1.5
Vertebrate commensals	3	1.1	0.002	0.1
Total	261		1.710	

Note: Barnacles and amphibians are included in the MNI calculation, but are not included in the biomass calculation because allometric values are not currently available for these taxa.

TABLE 4

Biome Summary.

	MNI		Biomass	
	#	**%**	**kg**	**%**
Estuarine taxa	173	66.3	0.953	55.7
Marine taxa	24	9.2	0.349	20.4
Freshwater taxa	4	1.5	0.066	3.9
Invertebrate mobile taxa	15	5.7	0.017	0.1
Indeterminate gastropod taxa	33	12.6	0.054	3.2
Terrestrial taxa	12	4.6	0.271	15.8
Total	261		1.710	

TABLE 5

Element Distribution for Deer (*Odocoileus virginianus*).

	No. of Elements
Head	11
Vertebra/Rib	
Forequarter	
Hindquarter	
Forefoot	2
Hindfoot	
Foot	3
Total	16

TABLE 6

Epiphyseal Fusion for Deer (*Odocoileus virginianus*).

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal			
Scapula, distal			
Radius, proximal			
Acetabulum			
Metapodials, proximal		1	1
1st/2nd phalanx, proximal			
Middle Fusing:			
Tibia, distal			
Calcaneus, proximal			
Metapodials, distal			
Late Fusing:			
Humerus, proximal			
Radius, distal			
Ulna, proximal			
Ulna, distal			
Femur, proximal			
Femur, distal			
Tibia, proximal			
Total		1	1

TABLE 7

Modifications.

Taxon	**Cut**	**Burned**	**Calcined**	**Pathological**	**Worked**
Indeterminate molluscs		2			
Scallop		1			
Bay scallop		1			
Decapods		1			
Cartilaginous fishes			1		
Stingrays					1
Indeterminate bony fishes		96	18		
Catfishes		8	2		
Sea catfishes		17	8		
Hardhead catfish		28	11		
Toadfish		7			
Mullet		5			
Drums		1			
Red drum		1			
Burrfish		1			
Common puffer		1			
Indeterminate turtles		36	18	1	
Pond and box turtles		1			
Eastern box turtle		1			
Indeterminate birds	1				
Indeterminate mammals	2	16	5		
Indeterminate vertebrates		96	26		
Total	3	320	89	1	1

TABLE 8

Total MNI and Biomass Diversity, Equitability, and Richness.

Taxa	**MNI**	pi	log e pi	pi*logepi	**Biomass**	pi	log e pi	pi*logepi
Argopectin irradians	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Crassostrea virginica	107	0.4100	-0.892	-0.366	0.122	0.0713	-2.640	-0.188
Cardiidae	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Mercenaria spp.	3	0.0115	-4.466	-0.051	0.061	0.0357	-3.333	-0.119
Macrocallista nimbosa	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Gastropoda	33	0.1264	-2.068	-0.261	0.054	0.0316	-3.455	-0.109
Strombus alatus	2	0.0077	-4.871	-0.037	0.026	0.0152	-4.186	-0.064
Neverita spp.	13	0.0498	-3.000	-0.149	0.016	0.0094	-4.672	-0.044
Polygyridae	2	0.0077	-4.871	-0.037	0.001	0.0006	-7.444	-0.004
Euglandina rosea	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Busycon sinistrum	3	0.0115	-4.466	-0.051	0.043	0.0251	-3.683	-0.093
Busycotypus spiratus	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Melongena corona	6	0.0230	-3.773	-0.087	0.019	0.0111	-4.500	-0.050
Pleuroplaca gigantea	1	0.0038	-5.565	-0.021	0.015	0.0088	-4.736	-0.042
Callinectes sapidus	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Balanus spp.	1	0.0038	-5.565	-0.021				
Dasyatidae	1	0.0038	-5.565	-0.021	0.055	0.0322	-3.437	-0.111
Rhinoptera bonasus	1	0.0038	-5.565	-0.021	0.035	0.0205	-3.889	-0.080
Lepisosteidae	1	0.0038	-5.565	-0.021	0.038	0.0222	-3.807	-0.085
Ariidae	6	0.0230	-3.773	-0.087	0.108	0.0632	-2.762	-0.174
Ariopsis felis	11	0.0421	-3.167	-0.133	0.295	0.1725	-1.757	-0.303
Opsanus spp.	8	0.0307	-3.485	-0.107	0.118	0.0690	-2.674	-0.184
Mugil spp.	21	0.0805	-2.520	-0.203	0.196	0.1146	-2.166	-0.248
Fundulus spp.	2	0.0077	-4.871	-0.037	0.002	0.0012	-6.751	-0.008
Carangidae	1	0.0038	-5.565	-0.021	0.023	0.0135	-4.309	-0.058
Orthopristis chrysoptera	2	0.0077	-4.871	-0.037	0.003	0.0018	-6.346	-0.011
Archosargus probatocephalus	1	0.0038	-5.565	-0.021	0.013	0.0076	-4.879	-0.037
Lagodon rhomboides	3	0.0115	-4.466	-0.051	0.003	0.0018	-6.346	-0.011
Cynoscion spp.	2	0.0077	-4.871	-0.037	0.059	0.0345	-3.367	-0.116
Leiostomus xanthurus	2	0.0077	-4.871	-0.037	0.007	0.0041	-5.498	-0.023
Micropogonias undulatus	3	0.0115	-4.466	-0.051	0.009	0.0053	-5.247	-0.028
Sciaenops ocellatus	2	0.0077	-4.871	-0.037	0.030	0.0175	-4.043	-0.071
Paralichthys spp.	2	0.0077	-4.871	-0.037	0.005	0.0029	-5.835	-0.017
Chilomycterus spp.	2	0.0077	-4.871	-0.037	0.045	0.0263	-3.638	-0.096
Sphoeroides spp.	1	0.0038	-5.565	-0.021	0.006	0.0035	-5.652	-0.020
Ranidae	1	0.0038	-5.565	-0.021				
Kinosternon spp.	2	0.0077	-4.871	-0.037	0.028	0.0164	-4.112	-0.067
Terrapene carolina	1	0.0038	-5.565	-0.021	0.030	0.0175	-4.043	-0.071
Colubridae	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Aves	1	0.0038	-5.565	-0.021	0.006	0.0035	-5.652	-0.020
Didelphis virginiana	1	0.0038	-5.565	-0.021	0.008	0.0047	-5.365	-0.025
Sylvilagus spp.	1	0.0038	-5.565	-0.021	0.014	0.0082	-4.805	-0.039

TABLE 8 - *(Continued)*.

Taxa	**MNI**	pi	log e pi	pi*logepi	**Biomass**	pi	log e pi	pi*logepi
Sigmodon hispidus	1	0.0038	-5.565	-0.021	0.001	0.0006	-7.444	-0.004
Procyon lotor	1	0.0038	-5.565	-0.021	0.004	0.0023	-6.058	-0.014
Odocoileus virginianus	2	0.0077	-4.871	-0.037	0.205	0.1199	-2.121	-0.254
Total MNI and Biomass Diversity	**261**	**1**		**-2.478**	**1.7100**	**1**		**-2.918**
Richness				**45**				**43**
log value of richness				**3.807**				**3.761**
Equitability				**-0.651**				**-0.776**

TABLE 9

Invertebrate MNI and Biomass Diversity, Equitability, and Richness.

Taxa	**MNI**	pi	log e pi	pi*logepi	**Biomass**	pi	log e pi	pi*logepi
Argopectin irradians	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Crassostrea virginica	107	0.6045	-0.503	-0.304	0.122	0.3361	-1.090	-0.366
Cardiidae	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Mercenaria spp.	3	0.0169	-4.078	-0.069	0.061	0.1680	-1.784	-0.300
Macrocallista nimbosa	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Gastropoda	33	0.1864	-1.680	-0.313	0.054	0.1488	-1.905	-0.283
Strombus alatus	2	0.0113	-4.483	-0.051	0.026	0.0716	-2.636	-0.189
Neverita spp.	13	0.0734	-2.611	-0.192	0.016	0.0441	-3.122	-0.138
Polygyridae	2	0.0113	-4.483	-0.051	0.001	0.0028	-5.894	-0.016
Euglandina rosea	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Busycon sinistrum	3	0.0169	-4.078	-0.069	0.043	0.1185	-2.133	-0.253
Busycotypus spiratus	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Melongena corona	6	0.0339	-3.384	-0.115	0.019	0.0523	-2.950	-0.154
Pleuroplaca gigantea	1	0.0056	-5.176	-0.029	0.015	0.0413	-3.186	-0.132
Callinectes sapidus	1	0.0056	-5.176	-0.029	0.001	0.0028	-5.894	-0.016
Balanus spp.	1	0.0056	-5.176	-0.029				
Total MNI and Biomass	**177**	**1**		**-1.397**	**0.363**	**1**		**-1.928**
Richness				**16**				**15**
log value of richness				**2.773**				**2.708**
Equitability				**-0.504**				**-0.712**

TABLE 10

Vertebrate MNI and Biomass Diversity, Eqitability, and Richness.

Taxa	**MNI**	pi	log e pi	pi*logepi	**Biomass**	pi	log e pi	pi*logepi
Dasyatidae	1	0.0119	-4.431	-0.053	0.055	0.0408	-3.198	-0.131
Rhinoptera bonasus	1	0.0119	-4.431	-0.053	0.035	0.0260	-3.650	-0.095
Lepisosteidae	1	0.0119	-4.431	-0.053	0.038	0.0282	-3.568	-0.101
Ariidae	6	0.0714	-2.639	-0.189	0.108	0.0802	-2.524	-0.202
Ariopsis felis	11	0.1310	-2.033	-0.266	0.295	0.2190	-1.519	-0.333
Opsanus spp.	8	0.0952	-2.351	-0.224	0.118	0.0876	-2.435	-0.213
Mugil spp.	21	0.2500	-1.386	-0.347	0.196	0.1455	-1.928	-0.280
Fundulus spp.	2	0.0238	-3.738	-0.089	0.002	0.0015	-6.512	-0.010
Carangidae	1	0.0119	-4.431	-0.053	0.023	0.0171	-4.070	-0.069
Orthopristis chrysoptera	2	0.0238	-3.738	-0.089	0.003	0.0022	-6.107	-0.014
Archosargus probatocephalus	1	0.0119	-4.431	-0.053	0.013	0.0097	-4.641	-0.045
Lagodon rhomboides	3	0.0357	-3.332	-0.119	0.003	0.0022	-6.107	-0.014
Cynoscion spp.	2	0.0238	-3.738	-0.089	0.059	0.0438	-3.128	-0.137
Leiostomus xanthurus	2	0.0238	-3.738	-0.089	0.007	0.0052	-5.260	-0.027
Micropogonias undulatus	3	0.0357	-3.332	-0.119	0.009	0.0067	-5.008	-0.033
Sciaenops ocellatus	2	0.0238	-3.738	-0.089	0.030	0.0223	-3.804	-0.085
Paralichthys spp.	2	0.0238	-3.738	-0.089	0.005	0.0037	-5.596	-0.021
Chilomycterus spp.	2	0.0238	-3.738	-0.089	0.045	0.0334	-3.399	-0.114
Sphoeroides spp.	1	0.0119	-4.431	-0.053	0.006	0.0045	-5.414	-0.024
Ranidae	1	0.0119	-4.431	-0.053				
Kinosternon spp.	2	0.0238	-3.738	-0.089	0.028	0.0208	-3.873	-0.081
Terrapene carolina	1	0.0119	-4.431	-0.053	0.030	0.0223	-3.804	-0.085
Colubridae	1	0.0119	-4.431	-0.053	0.001	0.0007	-7.206	-0.005
Aves	1	0.0119	-4.431	-0.053	0.006	0.0045	-5.414	-0.024
Didelphis virginiana	1	0.0119	-4.431	-0.053	0.008	0.0059	-5.126	-0.030
Sylvilagus spp.	1	0.0119	-4.431	-0.053	0.014	0.0104	-4.567	-0.047
Sigmodon hispidus	1	0.0119	-4.431	-0.053	0.001	0.0007	-7.206	-0.005
Procyon lotor	1	0.0119	-4.431	-0.053	0.004	0.0030	-5.819	-0.017
Odocoileus virginianus	2	0.0238	-3.738	-0.089	0.205	0.1522	-1.883	-0.287
Total MNI and Biomass	**84**	**1**		**-2.803**	**1.347**	**1**		**-2.529**
Richness				**29**				**28**
log value of richness				**3.367**				**3.332**
Equitability				**-0.832**				**-0.759**

TABLE 11

Aquatic Trophic Levels.

Taxa	**Biomass, kg**	**TL**	**kg*TL**
Argopecten irradians	0.001	2.1	0.0021
Crassostrea virginica	0.122	2.1	0.2562
Cardiidae	0.001	2.1	0.0021
Mercenaria spp.	0.061	2.1	0.129099516
Macrocallista nimbosa	0.001	2.1	0.00185287
Strombus alatus	0.026	2.1	0.0546
Neverita spp.	0.016	2.5	0.038779729
Busycon sinistrum	0.043	2.5	0.1075
Busycotypus spiratus	0.001	2.5	0.002467458
Melongena corona	0.019	2.5	0.0475
Pleuroploca gigantea	0.015	2.5	0.0375
Callinectes sapidus	0.001	2.6	0.001625895
Dasyatidae	0.055	3.2	0.175689325
Rhinoptera bonasus	0.035	3.2	0.111266183
Lepisosteidae	0.038	4.2	0.158604532
Ariidae	0.108	3.3	0.357709155
Ariopsis felis	0.295	3.2	0.943556961
Opsanus spp.	0.118	3.7	0.4366
Mugil spp.	0.196	2.5	0.49
Fundulus spp.	0.002	3.3	0.0066
Carangidae	0.023	3.9	0.090657975
Orthopristis chrysoptera	0.003	3.4	0.0102
Archosargus probatocephalus	0.013	3.5	0.045383548
Lagodon rhomboides	0.003	4.4	0.012621825
Cynoscion spp.	0.059	4	0.237261707
Leiostomus xanthurus	0.007	3.2	0.023654137
Micropogonias undulatus	0.009	4	0.037472433
Sciaenops ocellatus	0.030	3.7	0.112774754
Paralichthys spp.	0.005	3.5	0.017114671
Chilomycterus spp.	0.045	3.5	0.156982873
Sphoeroides spp.	0.006	3.5	0.020960702
Total	**1.358**		**4.12643625**
Mean			**3.039632749**

APPENDIX A

Faunal Samples Studied.

Unit	FS	Level	Depth (cmbs)	Fraction
EU 7	135	1	(0) - (10)	1/4"
EU 7	135	1	(0) - (10)	1/8"
EU 7	136	2	(10) - (20)	1/4"
EU 7	136	2	(10) - (20)	1/8"
EU 7	137	3	(20) - (30)	1/4"
EU 7	137	3	(20) - (30)	1/8"
EU 7	138	4	(30) - (40)	1/4"
EU 7	138	4	(30) - (40)	1/8"

APPENDIX B

Measurements.

Taxon	Unit	FS#	Level	Faction	Element	Side	Dim	mm	Dim	mm	Dim	mm	Dim	mm
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	8.08						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	11.35						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	9.36						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	6.75						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	5.54						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	12.99						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	3.11						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	4.88						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	4.10	LHPA	30.21				
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	6.87						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Left	LHW	10.73						
Crassostrea virginica	EU7	135	1	1/4"	Valve	Right	RHW	8.99	RHPA	33.55				
Crassostrea virginica	EU7	135	1	1/4"	Valve	Right	RHW	12.31						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.36						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.49						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHPA	36.25						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.74						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.22	LHPA	63.44				
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.16						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	6.67						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	6.03						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.53						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.67						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	5.90						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	7.79						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.12						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	5.29						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.38						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	7.80						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	10.63						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	5.99						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	5.48						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.49						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	10.36						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	7.82						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	4.17						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.47						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	11.19						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	4.61						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	5.40						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	9.18						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	7.34						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Left	LHW	8.45						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	12.39	RHPA	48.19				
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	8.93						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	14.62						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	13.25						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	9.88						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	9.38						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	7.20						
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	9.61						

APPENDIX B - (*Continued*).

Taxon	Unit	FS#	Level	Faction	Element	Side	Dim	mm	Dim	mm	Dim	mm	Dim	mm
Crassostrea virginica	EU7	136	2	1/4"	Valve	Right	RHW	10.10						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	10.26						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	8.09	LHPA	27.46				
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	6.57	LHPA	45.05				
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	13.72						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	8.73						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.64						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	6.53						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.41	LVL	38.46				
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	6.37						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.78						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	4.69						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	3.58						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	8.21						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	7.31						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	9.58						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.93						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	12.24						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	7.41						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	9.91						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.61						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	9.39						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	9.93						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	6.95						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	6.81						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Left	LHW	5.27						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Right	RHW	11.97						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Right	RHW	7.58						
Crassostrea virginica	EU7	137	3	1/4"	Valve	Right	RHW	7.76	RHPA	50.80				
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	4.02						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	8.71						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	9.16	LHPA	40.44				
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	7.04	LVL	33.95				
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	6.05						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	10.94						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	10.70						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	8.04	LHPA	48.97	LVL	49.36	LVH	70.59
Crassostrea virginica	EU7	138	4	1/4"	Valve	Left	LHW	11.46	LHPA	73.13				
Crassostrea virginica	EU7	138	4	1/4"	Valve	Right	RHW	6.95						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Right	RHW	11.31						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Right	RHW	9.98						
Crassostrea virginica	EU7	138	4	1/4"	Valve	Right	RHW	16.53	RHPA	51.02				
Crassostrea virginica	EU7	138	4	1/4"	Valve	Right	RHW	8.45						
Mercenaria spp.	EU7	136	2	1/4"	Valve	Left	HW	20.16	AS	21.64				
Mercenaria spp.	EU7	138	4	1/4"	Valve	Right	HW	15.54						
Mercenaria spp.	EU7	138	4	1/4"	Valve	Right	HW	14.25						
Macrocallista nimbosa	EU7	135	1	1/4"	Valve	Left	HW	4.72						
Melongena corona	EU7	136	2	1/4"	Body		SH	56.08	HS	20.67	AH	38.93		
Ariidae	EU7	135	1	1/8"	Otolith	Right	Len	7.91	Brt	7.89	Wth	6.68	Th	3.44
Mugil spp.	EU7	137	3	1/8"	Atlas		Wth	3.59						
Mugil spp.	EU7	137	3	1/8"	Atlas		Wth	4.20						
Mugil spp.	EU7	137	3	1/8"	Atlas		Wth	3.72						

APPENDIX B - (*Continued*).

Taxon	Unit	FS#	Level	Faction	Element	Side	Dim	mm	Dim	mm	Dim	mm	Dim	mm
Opsanus spp.	EU7	136	2	1/8"	Atlas		Wth	4.00						
Orthopristis chrysoptera	EU7	136	2	1/8"	Atlas		Wth	3.01						
Orthopristis chrysoptera	EU7	137	3	1/8"	Atlas		Wth	2.99						
Cynoscion spp.	EU7	137	3	1/4"	Atlas		Wth	8.53						
Micropogonias undulatus	EU7	135	1	1/8"	Atlas		Wth	3.98						
Sciaenops ocellatus	EU7	137	3	1/4"	Atlas		Wth	6.45						

APPENDIX C

Allometric Values used in Study to Derive Biomass Estimates.

Faunal Category	N	Y-Intercept (log a)	Slope (b)	r^2
Specimen Weight (kg) to Body Weight (kg)				
Chondrichthyes	17	1.68	0.86	0.85
Actinopterygii	393	0.9	0.81	0.8
Non-Perciform Fish	119	0.85	0.79	0.88
Lepisosteidae	26	1.13	0.87	0.96
Siluriformes	36	1.15	0.95	0.87
Perciformes	274	0.93	0.83	0.76
Carangidae	17	1.23	0.88	0.86
Sparidae	22	0.96	0.92	0.98
Sciaenidae	99	0.81	0.74	0.73
Pleuronectiformes	21	1.09	0.89	0.95
Turtle	26	0.51	0.67	0.55
Snake	26	1.17	1.01	0.97
Bird	307	1.04	0.91	0.97
Mammal	97	1.12	0.9	0.94
Shell Weight (g) to Meat Weight (g)				
Crassostrea virginica	100	-0.77	0.97	0.97
Donax variabilis	36	0.39	1.12	0.95
Mercenaria mercenaria	40	-0.5	0.94	0.95
Gastropoda	135	-0.16	0.92	0.89
Callinectes sapidus	11	0.99	0.82	0.58

Note: Formula is $Y = aX^b$; where Y is estimated biomass; X is specimen weight; a is the Y-intercept; b is the slope of the line; and N is the number of observations (Colaninno 2010:477; Quitmyer 1985:40; Quitmyer and Reitz 2006; Reitz et al. 1987; Reitz and Wing 2008:68). Invertebrate estimates are converted to kilograms in the species lists.